NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP Report 403

Guidance for Estimating the Indirect Effects of Proposed Transportation Projects

Transportation Research Board
National Research Council

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Guidance for Estimating the Indirect Effects of Proposed Transportation Projects

LOUIS BERGER & ASSOCIATES, INC.
East Orange, NJ

Subject Areas

Planning, Administration, and Environment
Highway and Facility Design
Aviation
Public Transit
Rail
Freight Transportation
Marine Transportation

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

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FOREWORD

By Staff
Transportation Research Board

This report includes the results of research carried out under NCHRP Project 25-10, *Estimating the Indirect Effects of Proposed Transportation Projects*. The report contains guidance and a framework for practitioners in defining "indirect effects" of proposed transportation projects, identifying tools for estimating these effects, and analyzing these effects. The report should be of interest to state departments of transportation, metropolitan planning organizations, transit agencies, and other transportation project sponsors. It should also provide a valuable resource for transportation planners and engineers, environmental practitioners, and others responsible for project development and environmental impact analysis.

Transportation projects have both direct and indirect effects on the environments in which they are located. Federal environmental policy, as embodied in the National Environmental Protection Act (NEPA) requires the assessment and disclosure of reasonably foreseeable effects of transportation projects as part of the environmental impact assessment process. As a result, procedures have been established to identify and estimate many of the direct effects of projects. However, the indirect effects are both harder to identify and more difficult to assess. These indirect effects have impacts on social and economic conditions, natural resources, cultural/historical resources, accessibility, as well as many other conditions. States and other transportation project sponsors have expressed a need for guidance in identifying and estimating the indirect effects of proposed projects. This information is needed so that projects can be designed to reduce their adverse impacts, as well as to maintain project development progress through the environmental impact assessment and decisionmaking processes.

Louis Berger & Associates, Inc., of East Orange, New Jersey provided the research team for this project and prepared the final report. This report reflects information obtained from a broad range of sources, including a survey of more than 350 federal and state transportation and environmental agencies, academic institutions, and other organizations having interest and expertise in transportation project planning and development. From this data collection, the authors have provided a thorough synthesis of agency regulation, case law, published literature, environmental impact statement content, and practitioner experience and perspective leading to a typology of "indirect effects." The report also includes a framework for identifying and analyzing indirect effects of proposed transportation projects in order to provide planners and practitioners the ability to integrate indirect effects assessment into ongoing evaluation processes. Finally, the authors have identified appropriate tools and techniques for discerning which of the indirect effects of a proposed transportation project warrant detailed analysis and for carrying out those analyses.

CONTENTS

AUTHOR ACKNOWLEDGMENTS

The research reported herein was performed under NCHRP Project 25-10 by Louis Berger & Associates, Inc., the contractor for this study. Nicholas J. Masucci, Group Vice President of Louis Berger & Associates, Inc., and Lawrence Pesesky, Assistant Director of Transportation Studies, were the co-principal investigators. The other authors of this report, all employees or former employees of Louis Berger & Associates, Inc., were Kevin Twine, Frances Hoffman, James Foley, Esq., Alice Cheng, James Parry, Donald Ehrenbeck, and David Nadelman. Information management was performed by Daniel McGuire and Daniel Raine, and editing of the agency report was performed by Claire St. Louis.

GUIDANCE FOR ESTIMATING THE INDIRECT EFFECTS OF PROPOSED TRANSPORTATION PROJECTS

SUMMARY

The research for this project was oriented toward solving the problem of indirect effects assessment of proposed transportation projects. Indirect effects are more difficult to identify and more difficult to assess than direct effects. More fundamentally, the variety of circumstances under which indirect effects occur has led to various interpretations of the term. Accordingly, the objectives of this research were to develop guidance for interpreting the term "indirect effect" and a problem-solving framework that can be applied broadly to facilitate identification and analysis of indirect effects.

The research tasks consisted of collecting and organizing information from various perspectives on the definition, identification, and assessment of indirect effects on proposed transportation projects. Perspectives gained from the following sources were included:

- Transportation and regulatory/resource agency environmental policy implementation regulations and other relevant documents;
- Relevant case law;
- Relevant published literature;
- Sample of transportation project environmental impact statements (EISs); and
- Interviews with transportation and environmental regulatory/resource agency personnel involved in preparing EISs.

The key findings from each of these perspectives include the following:

Broad Findings

- Wide variation of approaches in theory and practice;
- Primary factors
  - Interagency coordination,
  - Early coordination, and
  - Understanding of setting;
- Secondary factor
  - Supporting analytical methods; and
- Impact significance more important than whether it is direct or indirect.

Findings—Agency Documents

- Overall, relatively little guidance on indirect effects;
- FAA—economic orientation;
- FHWA—systems orientation; and
- FTA—planning orientation.

Findings—Case Law

- Emphasis on disclosure instead of results;
- Prevailing issue of effects from induced land-use development;
- Need to consider effects of project selling points (e.g., economic growth);
- Reasonably foreseeable = probable (includes uncertainty);
- Important to consider relative strength of local land-use and zoning controls; and
- Federal agency not responsible for mitigating effects outside its area of control.

Findings—Published Literature

- Relatively sparse literature on the topic;
- Dichotomy—systems oriented versus reductionist;
- Variety of techniques—quantitative to qualitative; and
- Absence of before-and-after studies.

Findings—EIS Content

- Indirect economic and land-use effects predominate;
- Economic development was a project objective of 40 percent of sampled projects;
- Indirect effects are receiving more attention in EISs over time;
- Indirect effects are often controversial in EISs
  - Degree of controversy affects analysis—more detailed,
  - Potential economic or land-use change was issue in all cases sampled,
  - Growth stimulating versus growth serving, and
  - Disproportionate number of highway and port projects;
- Indirect social effects generally not analyzed; and
- Analysis techniques suggested in literature generally are not used.

Findings—Interviews (Prevalent Opinions)

- Modeling techniques are not always better than professional judgment
  - Data intensive, assumption laden,
  - Some suspicion of manipulation, and
  - Models oriented to urbanized areas;
- Local perspective and field investigations are needed
  - However, local plans tend to overpredict growth, and
  - A measure of local needs is required to supplement traffic operational or safety needs; and
- Widespread concern among state departments of transportation about potential litigation.

Findings—Indirect Effects

- Focus on the definition of the Council on Environmental Quality (CEQ) (other definitions have not provided further clarification);

- There are three types of indirect effects
  - Those from project encroachment on the environment,
  - Project-induced growth, and
  - Effects related to project-induced growth;
- Not essential to draw a precise distinction between direct and indirect effects for an EIS or other environmental studies (significance of the effect is the key).

The CEQ regulation for implementing the National Environmental Policy Act (NEPA) notes that indirect effects are reasonably foreseeable. Understanding what is reasonably foreseeable is a key to understanding indirect effects. By equating reasonably foreseeable with probable, case law recognizes the uncertainty surrounding indirect effects. This uncertainty occurs because indirect effects occur in the future and they involve a number of dynamic variables that are difficult, and often impossible, to predict. Indeed, the conceptual difference between an indirect and a direct effect is that an indirect effect involves uncertainty, whereas a direct effect is predictable. The other type of effect, cumulative effect, is also based on the concept of reasonable foreseeability and probability. The difference between indirect and cumulative effects is that the former are caused by the project; the latter are caused by incremental effects of the project plus any other past, present, or future action regardless of the source.

Analysis Framework

An analysis framework for identification and assessment of indirect effects of proposed transportation projects was systematically developed based on the findings and is documented in the report. The framework development consisted of applying key research findings, integrating with component steps of the transportation project development process, and borrowing from general impact assessment frameworks suggested by the research.

The framework developed from the research consists of the following steps:

1. Identify the study area's directions and goals (transportation as well as social, economic, cultural, and ecologic).
2. Inventory the study area's notable features (these are specific indicators of the goals in Step 1 and include elements of the biophysical and human environment considered valuable, vulnerable, or unique).
3. Identify impact-causing activities of the proposed action and alternatives (both activities required for implementing the project and those likely to be caused by the project).
4. Identify indirect effects for analysis (by exploring cause–effect relationships between project activities and goals or notable features and isolating issues of concern).
5. Analyze the identified indirect effects (with an appropriate forecasting tool).
6. Evaluate the analysis results (communicate the results and accompanying level of uncertainty about the results to decision makers and the public; use the results as a factor in project decision).
7. Develop mitigation (if appropriate) based on results.

Underlying the framework steps is a continuous process of coordination with the public, local agencies, and regulatory and resources agencies (by a variety of public involvement techniques).

Although it is possible that every transportation project has indirect effects, it is neither required nor practical to analyze all possible indirect effects. Potentially significant indirect effects (i.e., those of concern to the transportation agency decision maker, regulatory and resource agencies, and the public) are those that should be considered in an overall evaluation of a project's benefits and costs. These are the indirect effects that require detailed analysis. Case law provides the following guidelines for discerning which indirect effects merit analysis:

- The degree of confidence that the effect is going to occur;
- The usefulness of considering the effects in the EIS process; and
- The need to have the information now instead of at some future point after the indirect effect unfolds when the progress of the project would preempt any options for mitigating it.

The framework will not eliminate controversy over indirect effects of proposed transportation projects. Rather, by discovering indirect effects earlier in the process of transportation project development than has typically been the norm, transportation agencies will have information that can be used as a factor in deciding whether to proceed with a project as proposed or to modify the proposed action so that the long-term indirect consequences are consistent with the long-term needs and goals of the affected area.

The research for his study leads to suggested further research on this topic, including the following:

- Case studies in which the framework developed from this study is applied in actual project development situations;
- Synthesis of the results of recent empirical research on transportation–land-use relationships; and
- Before-and-after studies of transportation project settings to observe indirect effects and compare them with predicted effects.

CHAPTER 1

INTRODUCTION AND RESEARCH APPROACH

PROBLEM

From its beginnings, the nation's transportation system has provided a means to move goods and people and an opportunity for economic development for those locales linked by major transportation facilities. Over time, the transportation system played a large part in serving the needs of a growing population and in transforming the nation's economy and landscape.

Large portions of the American landscape and its economy—and, some would argue, its character—have undergone dramatic changes in the post-World War II era. Transportation technology and system improvements undoubtedly contributed to these changes at both macro and micro levels. However, it is sometimes difficult to ascribe many of the distinct changes as effects of transportation system improvements. To illustrate, some have traced the labor dispute that resulted in the 1994 Major League Baseball strike back to the decisions of the owners of the Brooklyn Dodgers and the New York Giants to buck tradition and move their franchises to the West Coast without the consent of other owners. This was ostensibly done to make more money in an area that was experiencing rapid population growth. This move was made possible, in part, by the advent of transcontinental flight and construction of facilities capable of handling jetliners. Who would have guessed in 1957 that the airport improvements made to accommodate jetliners would create a chain of events that would result in a long-term effect in the form of a baseball strike—not to mention the effect on the scorned fans of Brooklyn?

This chain of events encapsulates much of the dilemma that many transportation and environmental agencies face in estimating the potential indirect effects of proposed transportation projects. The planning of many transportation projects is loaded with a degree of uncertainty about potential indirect effects, which have been characterized as not readily apparent and which are temporally or spatially removed from direct project effects. Another common confounding factor is estimating the degree to which other variables contribute to the indirect effects (in other words, the extent to which the transportation improvement is responsible for the effects).

With respect to the function of transportation systems in "introducing" growth or influencing land-development patterns within a complex metropolitan region, an extensive analysis of transportation–land-use relationships concludes that

> Empirical evidence on the land use impacts of both highways and transit indicates that transportation investments do not have a consistent or predictable impact on land use. The evidence clearly shows that land use change does not necessarily follow transportation investments, even when the dollar value of these investments is large. (*1*)

Transportation projects have direct and indirect effects on the environments in which they are located. The National Environmental Policy Act (NEPA) and its implementing regulations mandate the assessment and disclosure of reasonably foreseeable effects of transportation projects. However, the indirect effects are more difficult to identify and to assess. These indirect effects include, but are not limited to, changes in social and economic conditions, natural resources, cultural or historic resources, accessibility, induced traffic, noise levels, and air quality.

Hindsight reveals the cumulative consequences of post-World War II transportation and land-use policies and economic growth in the United States. Massive long-term funding for highways beginning in the 1950s created lower priced travel. This effect combined with rising incomes led to households buying more cars and changing driving habits. Meanwhile, women increased their presence in the workforce, children grew up and learned to drive, households split, and households moved from central areas to suburbs and from rural areas and small towns to large cities. At the same time, businesses moved from small towns to large cities, split their operations between central cities and suburbs, and moved factories to the urban fringe. Land-use policy contributed to the pattern of more and larger trips by segregating origins and destinations and by limiting densities. These changes in location and travel behavior created the problems of congestion and sprawl that plague many areas today. Technical improvements (e.g., intelligent transportation systems) and policy changes (e.g., congestion pricing) are being proposed in response to these problems.

It is against this backdrop that state departments of transportation and other agencies have expressed the need for guidance in defining indirect effects of proposed transportation projects; in developing techniques to identify, under-

stand, describe, and estimate these effects; and in formulating procedures to facilitate the analysis of indirect effects.

OBJECTIVES AND SCOPE

The objective of this research was to develop an analysis framework, guidelines, and supporting methods to identify, understand, describe, and evaluate indirect effects of transportation projects. The work plan developed to accomplish this objective is presented in Appendix A.

To summarize, the scope of the work plan consisted of the following tasks:

1. Establish a working definition of indirect effects based on the NEPA regulations, the literature, and contacts with agencies involved in transportation planning and development and in environmental monitoring and regulation. A critical element was determining the spatial and temporal bounds of a reasonably foreseeable future.
2. Catalog adverse, beneficial, and noninfluencing indirect effects associated with different types of transportation projects. The indirect effects were categorized to reflect the differences in scale between systemwide transportation plans and specific projects. Identify and describe the causal relationships among projects, indirect effects, and the conditions under which they are likely to occur. In this effort, the procedures and techniques that have been applied to estimate indirect effects were catalogued.
3. Evaluate the procedures and techniques for estimating the indirect effects identified in Task 2. Document the sources of data, the analysis techniques or methods used, and the applicability of the methods. Critique the techniques and procedures based on practicality, reliability, cost, and acceptability. Conceptualize other tools to help the analysis process and describe these in sufficient detail to permit their development in Task 8 or later research.
4. Propose a preliminary framework for systematic analysis of indirect effects of transportation projects. The framework incorporated processes (guidance) for establishing the spatial and temporal limits of project impacts and for separating project-induced effects from those that would have occurred without the project. The framework reflected the roles of different agencies in analysis and mitigation of indirect effects. Develop checklists, flow charts, or other tools to facilitate application of the framework.
5. Prepare a draft interim report describing the following:
   (a) The established working definition for indirect effects;
   (b) The proposed framework, supporting rationale, and associated checklists, flow charts, or other aids;
   (c) The techniques and procedures for estimating indirect effects to be used within the framework;
   (d) The recommendations for tools that need to be obtained or developed to support the analysis process (i.e., toolbox);
   (e) The types of case studies that would be used to demonstrate the applicability of the process; and
   (f) The plans for packaging the framework and associated methodologies into a set of guidelines.

The interim report indicates the following areas in which the analysis of indirect effects is not possible without further research:

6. Prepare a revised version of the interim report reflecting the comments of the panel for an extended review of the proposed analysis framework. The contractor will review the comments and recommend changes to the analysis framework and supporting methodologies.
7. Finalize the framework and associated procedures and techniques as approved in Task 6. Compile draft guidelines documenting the various indirect effects, indicating when they should be estimated, and describing the techniques that can be used to estimate them. Develop tools and aids approved by the project panel and package the guidelines into a document that will facilitate their use.
8. Demonstrate the applicability of the analysis framework by undertaking case studies that represent various types of transportation improvements and environmental situations (e.g., urban, suburban, and rural areas). Estimate indirect effects with guidelines developed in Task 7 by applying them to actual projects approved by the project panel. Modify the draft guidelines based on the results of this effort and project panel review.
9. Prepare a final report documenting the entire research effort.

APPROACH

Data to provide the information necessary to accomplish the objectives of the study were obtained from five sources. Each category provides a perspective toward developing a definition of the term indirect effect and toward developing an analytical framework for assessing indirect effects of proposed transportation projects. Generally, examination of each data source focused on how indirect effects are defined, identified, and assessed, both procedurally and technically. The first three sources provided a context from which to evaluate current practice. Agency regulations and other pertinent documents pertaining to the assessment of indirect effects in NEPA documents were reviewed. Case law of federal courts was reviewed to determine how they are analyzing the way indirect effects are being addressed in NEPA documents. Published literature on assessment of indirect effects was

examined. A large sample of EISs were also investigated, focusing on how indirect effects were examined in the documents and the project settings. Finally, interviews with representatives from agencies involved in preparation and review of NEPA documents for transportation projects were conducted to discuss agency practices and perspectives with regard to conducting or reviewing EIS analyses of indirect effects both of the EISs investigated in the content analysis of this study and in general.

Data collection for this study was preceded by a mail survey that was distributed to 359 offices of federal and state transportation and environmental agencies and academic institutions and environmental organizations known to have an interest in transportation project planning. The primary objectives of the survey were to determine who had an interest in being interviewed for the study, to obtain references to appropriate EISs for the study, and to obtain other source material relevant to agency procedures and techniques for assessing the indirect effects of proposed transportation projects. Information obtained from this survey was used in the various study investigations. The survey form and results are in Appendix B.

Agency Regulations

The purpose of this review was to compare and contrast various agencies' definitions of the term indirect effects and their approaches to assessment of indirect effects. Agency procedures and techniques for defining, identifying, and assessing indirect effects were obtained from agency regulations published in the Code of Federal Regulations and from other documents. Chief among the regulations examined was the CEQ regulation implementing NEPA. This regulation defines the term indirect effect and sets forth the procedures for preparing NEPA documents. The CEQ definition of indirect effect was used as the basis for comparison of other definitions and related terms. Among the other regulations examined, because of the broad effect of each on transportation project planning, were the U.S. Environmental Protection Agency's (EPA) Clean Water Act Section 404(b)(1) guidelines for disposal of dredged or fill material in waters of the United States, the EPA Clean Air Act section 176(c) transportation conformity regulation, and the U.S. Department of Transportation (DOT) statewide and metropolitan planning regulations.

The other agency documents examined include agency handbooks, technical manuals, policy and position papers, and other nonregulatory reference material on defining and assessing indirect effects. These other documents were obtained from agencies of the DOT and other federal agencies that review transportation projects either by legal authority (e.g., carrying out responsibilities designated by law) or as cooperating agencies to DOT agencies in preparation of transportation project EISs.

Case Law

The intent of the case law analysis was to determine what common law procedures or standards federal courts have established for agencies to follow for drafting documents required by NEPA related to indirect effects of federal projects. Law review articles, federal digests, and reporters were searched manually to identify relevant cases. Cases were then shepardized both to ensure their current viability and to discover additional, more recent cases that cite them as precedents.

The cases considered focused on reviews of environmental assessments (EAs) or EISs. To a much lesser extent, ancillary indirect impact issues concerning Section 4(f) of the Transportation Act of 1966 were considered. Tangential elements of environmental compliance encompass a spectrum too broad for inclusion.

The case law review was sufficiently comprehensive and illustrative to provide substantive guidance about viable reporting of secondary effects under NEPA. It incorporated the treatment of indirect effects from a wide variety of federal projects. However, it was not intended to be an exhaustive treatise or law review article incorporating the case law of virtually every jurisdiction.

Published Literature

A review of the literature was conducted for definitions of indirect effects and for methods of approaching, identifying, and estimating indirect effects from a primarily academic perspective. In addition to the literature on indirect effects, materials produced by the Land Use Center of the Urban Institute on assessing impacts of land development were also examined, because induced land development is often an effect of transportation projects. Techniques used to locate documents included both manual and on-line searches. Twenty-two pertinent articles published between 1971 and 1993 were located and reviewed and are referenced in this report.

EIS Content

The content review focused on EISs, because they typically include more thorough environmental analyses than categorical exclusions and EAs. Therefore, as a group, they are more useful to a detailed evaluation of indirect effects.

NEPA EISs are also easier to identify and obtain than categorical exclusions or EAs. In the Federal Register, the notices of availability of all NEPA EISs are regularly listed by the EPA along with brief descriptions of the projects and their major issues. The Federal Register was reviewed for the period 1989 through early March 1994, and a list of all transportation-related EISs was compiled. A total of 303 projects were identified. From these EISs, a list of candidate

projects was derived. Projects were chosen primarily from states where interviews would be conducted, based on response to the above-described survey, to ensure that adequate background information could be obtained. Any project whose Federal Register EIS description included reference to indirect effects was included. Projects were chosen to represent the principal categories of transportation facilities (highways, bridges, transit, airports, railroads, and ports). Several projects suggested by survey respondents were included.

The final list included 90 projects for which at least a draft EIS (DEIS) was prepared. Supplemental DEISs (SDEISs) and final EISs (FEISs) were also prepared for certain projects and were included in the content analysis. The final list of projects reviewed during the EIS content analysis is presented in Appendix C.

In the categories of projects studied, there was overlap among transportation facility types, with some projects including two or more (e.g., an airport and a highway). Of the 90 projects, 70 involved highways, 44 of which included at least some segments of new highways and 54 of which included segments of improvements to existing highways. Sixteen projects consisted entirely of new highways, and 26 projects consisted entirely of highway improvements. Bridges were included in 23 projects. The content analysis also included 11 mass transit projects, 1 intercity passenger rail project, 13 airport projects, and 4 port projects. A more complete summary of the project and reviewed EISs is presented in Appendix C.

A comprehensive checklist was developed to inventory the information contained in the EIS documents reviewed. One checklist was filled out for each of the 90 projects, combining, where appropriate, all the EIS documents prepared for that project. The checklist was reviewed and refined several times before it was put into its final form. A copy of the checklist is also included in Appendix C.

The checklist included 11 major categories of information dealing with project description, project setting, and types of direct and indirect effects. Information sought was recorded in both qualitative (descriptive) and quantitative (suitable for statistical analysis) forms. Sections 1 through 5 of the checklist included 21 questions relating to project type, description, setting, need, controversy, and permitting. Sections 6 and 7 were tables designed to elicit detailed information about each indirect effect of the project, including the type of effect, its degree of controversy and significance, when in the project life it was expected to occur, its distance from the project, and the methodology used for analysis. Section 8 included 42 questions about the geographic and environmental settings of the indirect effects. Sections 9 and 10 were qualitative descriptions of each indirect effect, along with a chain of causality as presented in the EIS. Finally, Section 11 was a summary of the direct effects of the project.

Before starting the EIS content review, it was necessary to develop environmental categories so that reviewers would have a logical context within which to work. Six transportation EIS documents in the Louis Berger & Associates, Inc. (Berger) library were selected and their environmental effects typologies were listed and compared. Based on this comparison and on the experience of the project team, the list of environmental categories (i.e., disciplines or environment types) was developed.

Six Berger professionals from various environmental disciplines reviewed the EISs. To ensure consistency and quality of reviews, detailed instructions were attached to the checklists.

The EISs were obtained on loan from the transportation library at Northwestern University in Evanston, Illinois. Each completed checklist was reviewed individually by a senior member of the project team to ensure completeness and consistency. Quality assurance records were maintained.

The quantitative parts of the EIS checklist were tabulated and analyzed statistically. The purpose of the statistical analysis was twofold: first, to describe the database, in terms of the types of projects and EISs and the types of impacts identified; second, to identify any linkages among variables that might explain the assessment of indirect effects or the level of detail used in the analytical methodologies. Variables were set up to reflect information about project type, size, setting, permitting, and indirect effect type.

Mean values were calculated for most of the variables to describe the database. Statistical tests consisted of correlation matrices to identify possible linkages; correlation coefficients in the cases of numeric or ordinal data; χ^2 tests for nominal and ordinal data; and, where appropriate, other nonparametric tests. The statistical significance level was set at 0.05 (i.e., to be considered significant, the relationship had to have a probability of occurring randomly in 5 percent or fewer cases). In many instances, if the type of data permitted, more than one statistical test was used (e.g., a correlation coefficient and a χ^2 test). In these cases, it was possible to distinguish weak and strong relationships between variables, with weak relationships passing one test and strong relationships passing both tests.

Interviews

Interviews were conducted with representatives of transportation and other agencies and with environmental organizations associated with transportation project planning and environmental review. The objectives of the interviews were to obtain first-hand information about current practices reflected in the sample of EISs reviewed in this report and to solicit opinions of those involved in the transportation project development process on definitions of effects used in practice, on analytical methods, and on the process by which projects were developed. Those interviewed also were asked about mitigation practices and policies and were requested to identify general issues relating to indirect effect identification and analysis that needed resolution.

Respondents to the previously described survey who indicated a willingness to participate further were contacted. Those who wished to extend their involvement in the study were sent a list of issues for discussion (Appendix D) and were interviewed in person or by telephone. To provide a balanced sample and a broad picture of indirect effects assessment practice, others beyond those survey respondents were contacted to be interviewed. Geographic representation, agency affiliation, and bureaucratic level of responsibility (state, regional, or federal) were the primary criteria used in constructing this portion of the sample. The duration of an interview typically ranged from 1 to 3 hr. Telephone interviews were generally shorter than those conducted in person.

Fifty-seven interviews were conducted by three Berger professionals: 51 in person and the remaining 6 by telephone (Appendix D). The on-site interviews were almost invariably attended by two or more agency staff. Highway-related agencies were the most frequently interviewed; representatives of 15 state departments of transportation and 10 offices of the FHWA were interviewed. The category of agencies with primary responsibility for environmental and natural resources matters involved 14 interviews, of which 3 were with state natural resource agencies, 3 were with EPA offices, and 6 were with U.S. Fish and Wildlife Service (USFWS) offices. Six offices of the U.S. Army Corps of Engineers (ACOE) were interviewed. Officials at the national offices of the FAA and the FTA and one regional FTA office were interviewed. Representatives from an environmental law organization and two representatives from academic institutions were also included in the sample. In addition, certain consultants responsible for developing some of the EISs in the sample were asked about methods and process. Raw qualitative data from interviews were reviewed and combined to generate a national overview enriched with specific anecdotal examples.

Synthesis

The findings were synthesized into an interpretation of the term indirect effect and an assessment framework for identifying and analyzing indirect effects of proposed transportation projects. The assessment framework was developed primarily with an eye toward functionality (i.e., an ability to be integrated with existing processes) and a goal of facilitating identification of indirect effects. Equally important, the framework was developed with a goal of giving transportation and other agencies tools for discerning which of the identified indirect effects of a proposed transportation project warrant detailed analysis.

CHAPTER 2

FINDINGS

AGENCY REGULATIONS AND OTHER DOCUMENTS

Definition of Indirect Effects and Other Terms

The federal statute most relevant to the assessment of indirect effects is the NEPA of 1970, as amended. Although NEPA does not specifically refer to indirect effects, it contains two sections related to indirect effects as a concern for federal projects. First, in Section 101(b), NEPA makes it the responsibility of the federal government to

> assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings . . . attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences . . . [and] preserve important historic, cultural, and natural aspects of our national heritage . . . . [2; 42 USC 4331 Section 101(b)]

In addition, it states that

> the Federal Government shall include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on the environmental impact of the proposed action [and] any adverse environmental effects which cannot be avoided should the proposal be implemented. [2; 42 USC 4332 Section 102(c)]

The meaning of these sections was clarified when the CEQ issued its NEPA regulation in 1978 as part of its mission to provide assistance to federal agencies on implementing NEPA. In the terminology section of the regulation, the CEQ provides definitions of effects. Specifically, effects are defined as having two components: direct and indirect. Direct effects ". . . are caused by the action and occur at the same time and place," and indirect effects ". . . are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable" (*3*; 40 CFR 1508.8). The CEQ regulation adds that indirect effects ". . . may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems." CEQ differentiates direct and indirect effects from the term cumulative impact, which ". . . is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. . . . "

The CEQ noted that the terminology of 40 CFR 1508.1 should be uniform throughout the federal government. Uniformity is reflected in the NEPA-implementing regulations of the various federal agencies, including those agencies of the DOT (i.e., United States Coast Guard, FAA, FHWA, Federal Railroad Administration, FTA, St. Lawrence Seaway Development Corporation, and Maritime Administration). For example, the FHWA and the FTA reference the CEQ regulation for definitions in their NEPA-implementing regulation—23 CFR 771, "Environmental Impact and Related Procedures." On the other hand, a review of agency manuals, handbooks, policy papers, position papers, and other documents that do not have the force of regulation reveals a variety of terminology.

Many of the agencies under the direction of the DOT have established their own guidelines for implementation of CEQ regulations. The DOT defines the term secondary effects as "those effects which can foreseeably occur due to the proposed action," such as activities that "induce new facilities and activities" (*3*; 1510.1C, p. 232). The DOT refers directly to the CEQ guidelines for the definition of indirect effects but refers to them as "secondary or other foreseeable effects."

For example, the FAA issued a document on the economic effects of airports that attempted to adapt the CEQ definitions to agency-specific activities (*4*). It first states that indirect impacts differ from direct impacts in that they are related to the action yet originate off site. This use is inconsistent with the CEQ terminology in that indirect impacts are ". . . farther removed in distance." It then introduces the term induced impacts, which is defined as the ultimate effect of direct and indirect impacts. This use appears to be inconsistent with the CEQ terminology, which includes ". . . growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate" within the definition of indirect effects. Further, the term ultimate effect used by the FAA (and not by the CEQ) implies ". . . later in time or farther removed in distance," an aspect of the CEQ definition of indirect effects, not direct effects.

In its environmental policy statement, the FHWA uses indirect effects as an overarching term, covering both sec-

ondary and cumulative effects. This document uses the term secondary effects as "social, economic, and environmental impacts which can appear in the future" (*5*). Another FHWA paper also uses the term secondary effects. The paper cites FHWA Technical Advisory 6640.8A on the types of secondary effects that should be discussed in the preparation of documents. "These areas generally involve resources that exhibit induced changes from project activities . . . things like the social and economic structure of a community, floodplains, and areawide water quality" (*6*; p. 2).

In a project planning document, the FTA differentiates indirect and direct effects but does not actually define either of them. They are cited simply as two different aspects of several categories of effects, including economic, social, and environmental (*7*). A second source from the FTA uses the term secondary development, which it states ". . . can be thought of as changes in land use that could be fostered indirectly by the implementation of a mass transportation project on properties adjacent to or near it" (*8*).

A sampling of various other documents from federal agencies also reveals a variety of terminology. The focus here is on definitions used by several agencies with whom DOT agencies often coordinate on NEPA document preparation or in satisfying other requirements. In its handbook on NEPA, the USFWS defines the term secondary effects as those that are beyond the immediate effect on the environment of a project or those that consist of the ultimate changes in the environment (*9*). The USFWS definition of the term secondary effects appears to be consistent with the CEQ definition of indirect effects in that both encompass the concept of "removed in time and distance." The Advisory Council on Historic Preservation uses the term indirect impact but defines it only by differentiating it from direct impacts without specificity (*10*; Appendix).

In its "Guidelines for Specification of Disposal Sites for Dredged or Fill Material," the EPA uses the term secondary effects as ". . . effects on an aquatic ecosystem that are associated with a discharge of dredged or fill material, but do not result from the actual placement of the dredged or fill material." It should be noted that these guidelines implement Section 404(b)(1) of the Clean Water Act, not NEPA. In other words, their terminology is not required to be consistent with the CEQ terminology. Although both CEQ's indirect effects and EPA Section 404(b)(1) guidelines secondary effects are caused by the action and are removed from the direct effect, the latter term does not include the concept of reasonably foreseeable. Further, as discussed below, a Section 404(b)(1) permit is commonly required before transportation project implementation, and it would be expected that similar analyses are typically used for the NEPA document and the Section 404(b)(1) permit application.

This summary of definitions of indirect effects and other terms indicates that a variety of terms are in use by federal agencies—in particular, indirect, induced, and secondary—despite a uniform regulatory definition. In some cases, these terms are used to convey the same or similar meaning. In other cases, the terms are used to convey different meanings. The term indirect effect has been used in a way that varies from the CEQ definition.

Identification of Indirect Effects

Although definitions of indirect effects vary widely among agencies in documents other than regulations, there is some consistency in the examples given to support these definitions. For example, the FAA, the FHWA, and the FTA all have used socioeconomic changes to illustrate indirect effects. A typical case comes from the FTA, which discusses indirect impacts on housing demand, which can lead to higher rents, thus driving out poorer tenants and changing business patterns. Other examples, including increased pressure on public services and population patterns, are listed in Table 1.

EPA Section 404(b)(1) guidelines add that activities to be conducted on fast land created in waters of the United States may have secondary impacts within these waters, which should be considered when evaluating the impact of creating those fast lands. Such fast lands could include roadway embankment or other aspects of transportation projects created on fill in waters of the United States, and such activities could include roadway pollutant runoff.

Planning Procedures

NEPA-Implementing Regulation

The two key emphases of the portions of the CEQ regulations pertaining to project planning procedures are an integrated approach and early involvement. Integration of compliance procedures is targeted to reduce delay in project development and review that is likely to occur when, for example, the NEPA procedures and analyses are completed before application for an ACOE 404(b)(1) permit. The goal is to have all permits, analyses, and procedures operating concurrently (*3*; 40 CFR 1500.2).

Another aspect of this integrated approach is involvement of all appropriate "Federal, state, and local agencies," tribes, and "other interested persons" (*3*; 40 CFR 1501.7). The regulations clarify that the likely cooperating agencies to be included are those with "jurisdiction by law or special expertise" (*3*; 40 CFR 1501.6). In addition, the concept of inclusion is extended by the suggestion that this includes "those who might not be in accord with the action (project) on environmental grounds" (*3*; 40 CFR 1501.7). Public involvement is to be "encourage(d) and facilitate(d)" (*3*; 40 CFR 1500.2).

The time or place in the planning process at which integration should take place is stated as "the earliest possible time" (*3*; 40 CFR 1501.2; 40 CFR 1201.3) or "the earliest time possible" (*3*; 40 CFR 1501.6). Other statements, such as

TABLE 1 Examples of indirect or secondary effects by various agencies

Agency	Source Document	Example
Federal Highway Administration (FHWA)	Position Paper: *Secondary and Cumulative Impact Assessment in the Highway Project Development Process*, FHWA, April 1992.	Changes in land use, water quality, economic vitality and population density; negative impacts on endangered species; effects on the ability of existing environmental protection measures to absorb an increased load (e.g.. water treatment plant must work harder because of more pollutants due to project). *secondary and induced*
	Guidance for Preparing and Processing Environmental and Section 4(f) Documents, T 6640.8A, 1987.	Any land use activities that can be considered secondary, including social, economic and environmental. *secondary*
Federal Transit Administration (FTA)	*Procedures and Technical Methods for Transit Project Planning*, September 1986.	Increased congestion resulting from development; impact on parking and highway traffic; increased demand for housing near a rail station could have the effect of raising rents and driving out poorer tenants; availability of commercial space could be affected by changes in residence patterns; impaired access to buildings, parks, transit delays, etc., all due to construction. *secondary development*
	U.S. Department of Transportation (U.S. DOT), Urban Mass Transit Administration Circular, UMTA C 5620.1, *Guidelines for Preparing Environmental Assessments*, October 16, 1979.	Impacts of secondary development on community development patterns; changes in local infrastructure; changes in local socioeconomic characteristics. *secondary development*
Federal Aviation Administration (FAA)	*Order 5050.4A Airport Environmental Handbook*, U.S. DOT, FAA, October 8, 1985.	Shifts in patterns of population movement and growth, public service demands, and changes in business and economic activity due to airport development; regional growth and development, spin-off jobs, induced impacts on natural environment. *indirect*
	Tips for Airport Sponsors and Their Consultants, FAA, Southwest Region, 1993.	Population increases, public service demands (fire and police), and changes in economic activity due to operation of airport. *indirect*
	Estimating the Regional Economic Significance of Airports, U.S. DOT, FAA, pp. 92-96, September 1992.	Off-site economic activities attributable to the airport, such as travel agency services, hotels, restaurants, retail establishments. *indirect*
U.S. Fish and Wildlife Service (USFWS)	USFWS, *NEPA Handbook*, Release 30-4, September 1983.	Vegetation management causing a change in plant species which can result in a change in grazing patterns and animal population; changes in native fish stock due to artificial fish stocking which increases food demand (by predators) in that stream. *final ultimate change*
U.S. Environmental Protection Agency (U.S. EPA)	U.S. EPA Dredge or Fill Regulations, 404(b)(1) Guidelines, Section 230.21(b).	For an ecosystem: fluctuating water levels in an impoundment and downstream associated with the operation of a dam, septic tank leaking and surface runoff from residential or commercial developments on fill, and leachate and runoff from a sanitary landfill located in waters of the United States. *secondary*

integrating NEPA into the "early planning process" (*3*; 40 CFR 1500.5), preparing the environmental impact assessment "early" (*3*; 40 CFR 1501.1), identifying issues at an "early stage" (*3*; 40 CFR 1501.1), having an "early and open process for scoping," and the possibility of holding an "early scoping meeting" (*3*; 40 CFR 1501.7), reinforce the intent.

Interagency cooperation in identifying impacts of concern before the EIS is prepared, during or even before formal scoping, is considered desirable. This was intended, in part, to avoid the "submission of adversary comments (by cooperating agencies and interested parties) to the completed (EIS) document" (*3*; 40 CFR 1501.1).

The order of pertinent events identified in the CEQ regulation begins with prescoping, followed by a notice of intent to prepare an EIS published in the Federal Register. Lead agencies would then request (*3*; 40 CFR 1501.5) cooperating agencies to participate in the planning process, or agencies could "request the lead agency to designate" (*3*; 40 CFR 1501.6) it as a cooperating agency for involvement in scoping sessions.

Intermodal Surface Transportation Efficiency Act (ISTEA) Planning Regulation

Another regulation implemented in recent years can affect transportation project planning with respect to consideration of environmental effects, including indirect effects. The Statewide Planning/Metropolitan Planning regulation was issued by the FHWA and the FTA on October 28, 1993, to implement sections of ISTEA and corresponding sections of Title 23 United States Code and the Federal Transit Act.

These statutes require a continuing, comprehensive, and coordinated transportation planning process in metropolitan areas and states. As noted in the planning regulation's preamble:

> The planning process provides a mechanism for linking the existing human, natural and built environment with future development patterns. In meeting the demands of the current and future system users, the process must address not only the results of the management systems but the other factors specified by the ISTEA.

These other factors include the overall social, economic, energy, and environmental effects of transportation decisions; the effects of transportation policy decisions on land use and land development; and the consistency of transportation plans and programs with the provisions of all applicable short- and long-term land-use and development plans. Transportation planning is also to provide for the involvement of local, state, and federal environmental, resource, and permit agencies to the extent appropriate.

A key transportation planning process required for urban areas is the major metropolitan transportation investment study. A major metropolitan investment means a high type of highway or transit improvement of substantial cost that is expected to have a significant effect on capacity, traffic flow, level of service, or mode share at the transportation corridor or subarea scale. Such studies are intended to substantially improve the linkage between the transportation planning process and the environmental review process, thereby reducing redundant analyses and providing for early consideration of environmental effects.

Such studies are to be carried out at the corridor or subarea scale. Neither scale has a predefined size but refers to a geographic focus that may be dictated by existing or proposed systems or transportation demand.

Provision is made in the regulation for a cooperative process to determine the scope of such a study. This process is to include the state, metropolitan planning organization, transit operator, affected local officials, environmental and resource agencies, FHWA, FTA, and operators of other major modes of transportation as appropriate. To initiate the cooperative process, the affected parties will meet to define the conduct of the study, including the respective roles of the participating agencies and determination of the lead agency. The participating agencies are to consider an initial, sketch-level analysis of potential alternatives. In other words, the process will help ensure that a particular alternative does not become locked in before the environmental and other effects have been considered.

In sum, the ISTEA planning regulation recognizes the linkage between transportation and land use and between transportation and an area's development. It considers these linkages and other social, economic, energy, and environmental effects of transportation decisions to be integral parts of the transportation planning process. The regulation also requires coordination with environmental, resource, and permitting agencies when transportation plans and programs are developed.

EPA Transportation Conformity Regulation

The EPA issued transportation conformity regulations on November 24, 1993, to implement Section 176(c)(4) of the Clean Air Act as amended. The transportation conformity regulations apply to actions by the FHWA and the FTA. Actions of other federal agencies, including other transportation agencies, are covered by the general conformity regulations issued by the EPA on November 30, 1993.

The transportation conformity regulation establishes criteria and procedures for determining that transportation plans, programs, and projects conform with state or federal air-quality implementation plans. The implementation plans are the plans for attaining and maintaining health-based air-quality standards. The regulations apply to transportation decisions in all nonattainment and maintenance areas for transportation-related criteria pollutants for which the area is designated nonattainment or has a maintenance plan (may include volatile organic compounds, nitrogen oxides, certain particulates, and carbon monoxide).

The implication of the transportation conformity regulation for indirect effects assessment is primarily through the transportation–land-use linkage. The conformity determination must be based on the latest planning assumptions, which include current and future population and employment. Further, ozone and carbon monoxide nonattainment areas designated serious or higher procedures for determining regional transportation-related emissions are to include a network-based transportation demand model or models relating travel demand and transportation system performance to land-use patterns, population demographics, employment, transportation infrastructure, and transportation policies. Among the attributes of such a model are the following:

- The model(s) must utilize and document a logical correspondence between the assumed scenario of land development and use and the future transportation system for which emissions are being estimated. Reliance on a formal land-use model is not specifically required but is encouraged.
- A dependence of trip generation on the accessibility of destinations via the transportation system is strongly encouraged but not specifically required.
- A dependence of regional economic and population growth on the accessibility of destinations via the transportation system is strongly encouraged but not specifically required.

In sum, the transportation conformity regulation intends that conformity determinations include assessment of the interplay between transportation decisions and land use and

land development, and population and employment growth, which are all variables in the CEQ definition of indirect effects.

Techniques

NEPA-Implementing Regulation

The CEQ regulation emphasizes a "systematic, interdisciplinary approach" (*3*; 40 CFR 1501.1) in identifying and analyzing impacts of proposed projects. The discussion suggests that with identification of environmental effects in the early stages of planning, "significant issues deserving study" can be differentiated from those that do not necessitate detailed analysis. This serves to "narrow the scope" (*3*; 40 CFR 1501.1) of investigation, making the process more efficient and credible.

Cautionary passages alert lead agencies to "ensure the integrated use of natural and social sciences" as well as the "environmental design arts" in project planning and analysis (*3*; 40 CFR 15072). It is stated that "the identification of environmental effects and values" should be analyzed "in adequate detail" and circulated at the same time as economic and technical analyses to give more balanced consideration of potential project effects. It is also stated that "environmental analyses and proposals of cooperating agencies" be used "to the maximum extent possible" while maintaining consistency with the lead agency responsibilities (*3*; 40 CFR 1501.6). Funding for this work is expected to come first from the cooperating agencies, with secondary support from the lead agencies for "major activities and analyses" (*3*; 40 CFR 1501.6).

Indirect effects are referred to specifically for inclusion in the environmental consequences section of the EIS documents (*3*; 40 CFR 1502.6). Both short- and long-term environmental effects of land use and a discussion of means to mitigate the negative effects must be addressed.

Transportation Agency Documents

The FAA guidelines on the economic effects of airports (*4*; p. 19) delineate specific steps to determine the indirect aspects of these economic effects. The guidelines suggest concentrating on the economic activities that would not have occurred in the absence of the airport. One way to achieve this is to distinguish between persons who would not have traveled to the region if there were no airport and those who would have come to the area anyway by some other means. The former should be used to determine indirect effects. After the number of visitors who come to the airport is estimated, the guidelines describe how it is possible to use a table of value-added expenditures per visitor to arrive at an approximation of the indirect economic impacts to the region. The guidelines caution that the distinction between those who come to the region simply because of the airport and those who would come to the region anyway by other means is blurry. This can result in an exaggeration of indirect economic effects credited to the airport.

The FTA also provides a step-by-step approach for assessing indirect effects, although it is much more general than that of the FAA (*8*). The FTA prescribes the following steps:

1. Work with local planning boards, which may have a more accurate view of types of potential indirect effects than an outside observer (i.e., a federal agency);
2. Conduct a survey of potentially affected areas;
3. Compile a list of potentially affected development projects;
4. Compare the probable course of development to local zoning restrictions; and
5. Compile a list of probable indirect impacts, including the extent of these impacts in relation to the characteristics compiled in earlier steps.

A guide to the significance of potential indirect impacts is then provided with several examples. Part of this table is presented as Table 2.

TABLE 2 Guide to significance of potential indirect impacts

Generally Not Significant	Possibly Significant	Generally Significant
■ Proposed project may generate a demand for secondary development, but evaluation by local planning agencies indicates that, if such development occurs, it will be desirable and in conformance with adopted public land use plans.	■ Secondary development would require a change in zoning that is supported by local planning agencies.	■ Proposed project would induce secondary development that is inconsistent with the comprehensive plan and surrounding development. ■ Public infrastructure is not adequate to support anticipated secondary development.

Source: UMTA C 5620.1, Table R, 1979.

One noteworthy aspect of Table 2 is that the significance of impacts is positively correlated with the degree to which an impact is viewed as negative. In other words, the more negative the effect, the more significant it is deemed to be. According to this logic, even an indirect impact that affected a huge area would not be called significant if it were deemed acceptable by the local community. Obviously, if any of the secondary development had a potential effect on sensitive resources (e.g., wetlands or critical endangered species habitat), the indirect effect could be considered significant regardless of size. Furthermore, the CEQ regulation notes that impacts may be both beneficial and adverse (Factor 1 in Table 3).

The FHWA position paper on secondary impact assessment (*6*) takes a more philosophical approach to indirect impact assessment. The paper highlights several ways of approaching indirect effects:

1. Consider indirect impacts as early in the EIS process as possible;
2. Think about resources as part of an integrated system, so that a change to any one part affects all others;
3. Cooperate with local planning boards and building inspection agencies who may have a more accurate sense of the potential indirect effects than a federal agency;
4. Establish parameters for both the area affected and the time for which indirect impacts can be acceptably traced back to the original project (without these parameters, an accurate accounting of indirect effects is difficult to achieve);
5. Assess the potential indirect impacts, paying particular attention to the public service and natural resource base; and
6. Consider mitigation measures, although mitigation of indirect effects is trying because of the cost and the difficulty in planning for uncertain events.

A second FHWA document refers to assessment of indirect impacts in the context of direct impacts, but it does not discuss assessment techniques specific to either (*11*). However, the document is noteworthy because of the way indirect effects are organized. Although most of the guidelines reviewed here contain separate sections on indirect effects,

TABLE 3 Factors to consider in evaluating impact intensity according to CEQ regulation

1.	Impacts may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that the effect will be beneficial.
2.	The degree to which the proposed action affects public health or safety.
3.	Unique characteristics of the geographic area, such as proximity to historic or cultural resources, parklands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.
4.	The degree to which the effects on the quality of the human environment are likely to be highly controversial.
5.	The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.
6.	The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.
7.	Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance cannot be avoided by terming an action "temporary" or breaking it down into small component parts.
8.	The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed on the National Register of Historic Places, or may cause loss or destruction of significant scientific, cultural, or historic resources.
9.	The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973.
10.	Whether the action threatens a violation of Federal, state, or local law or requirements imposed for the protection of the environment.

Source: NEPA Regulations, 40 CFR 1508.27.

this document includes indirect effects under the headings of each of the traditional impact categories (e.g., social, environmental, economic). This treatment of indirect effects makes it clear that they are part of all aspects of an EIS or an EA, something that is not altogether clear in many documents that classify indirect effects separately.

CEQ Ecosystem Approach

General goals of ecosystem (biodiversity) management have been developed and have become generally accepted in recent years. In its report "Incorporating Biodiversity Considerations into Environmental Impact Analysis Under the National Environmental Policy Act" (*12*), CEQ suggests that the following principles be considered by federal agencies when assessing the effects (direct, indirect, cumulative) of their actions:

1. Take a big picture or ecosystem view;
2. Protect communities and ecosystems;
3. Minimize fragmentation, promote the natural pattern and connectivity of habitat;
4. Promote native species, avoid introducing nonnative species;
5. Protect rare and ecologically important species;
6. Protect unique or sensitive environments;
7. Maintain or mimic natural ecosystem processes;
8. Maintain or mimic naturally occurring structural diversity;
9. Protect genetic diversity;
10. Restore ecosystems, communities and species; and
11. Monitor for biodiversity impacts, acknowledge uncertainty, and be flexible.

CEQ notes that:

> Ecosystem management includes both the elements and the interrelationships involved in maintaining ecological integrity. This approach uses a local-to-regional perspective that considers impacts at the appropriate scale within the context of the whole system.

Accordingly, the ecosystem approach can make indirect effects of proposed transportation projects more readily apparent.

CASE LAW

Background on Case Law and Judicial Standards of EIS Review

NEPA requires preparation of an EIS for all major federal actions "significantly affecting the quality of the human environment" [2; 42 USC 4332(2)(C)]. In fulfilling this mandate, neither an EA nor an EIS can engage in the segmentation of a project's effects. Segmentation is piecemealing or dividing an action into component parts, each involving action with insignificant environmental effects. To avert fractionalization into smaller, less significant actions (*11* at 1134, 1142), it should be avoided.

This antisegmentation principle drives the indirect effects cases. The courts have held that indirect effects are important enough to trigger an EIS. Furthermore, if agency actions have a cumulative or synergistic environmental effect, the consequences must be considered in an EIS (*13* at 1307). Therefore, the agency must "take into account both the long- and short-term consequences of the action for society as a whole and for the local region, and consider the 'intensity' or 'severity' of the impact" (*14* at 829, 838). Note that the terms indirect effects, secondary effects, and induced growth, and their variations, are often used interchangeably in case law but with the meaning ascribed to indirect effects in the CEQ regulation.

Courts that review the adequacy of either an EA or an EIS are charged with ensuring that the agency has taken a hard look at the environmental consequences of its action (*15* at 390, 410 no. 21). If they find that the agency has failed to take the requisite hard look, the decision maker and the public will not be informed of the consequences. The agency will be held in violation of NEPA.

Some of the cases that discuss the appropriate analysis of indirect effects in great detail are those in which an EA has wrongly resulted in a finding of no significant impact (FONSI). These erroneous agency findings spark judicial review into whether the agency's decision was "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law" (*16*; U.S. at 402, 414; S.Ct. at 814, 822). Under this deferential standard of review, a court can disturb an agency's decision only if it was not based on relevant factors or if it was a clear error of judgment. As the U.S. Supreme Court has held, the decision is arbitrary and capricious:

> if the agency has relied on factors which Congress has not intended it to consider, entirely failed to consider an important aspect of the problem, offered an explanation for its decision that runs counter to the evidence before the agency, or is so implausible that it could not be ascribed to a difference in view or the product of agency expertise. (*17*; U.S. at 29, 43; S.Ct. at 2856, 1867)

It should be noted that judicial rulings in one Federal Circuit Court of Appeals are not required to serve as precedent for other circuits. For example, the Fifth and Eleventh Circuits follow a standard of reasonableness when reviewing agency decisions (*18, 19*). This standard is less deferential to the agency than the arbitrary and capricious standard more commonly applied. Therefore, it is easier for a court to overturn an agency's decision by this standard—it merely has to determine that the agency was unreasonable and not that it engaged in a clear error of judgment. With either standard,

however, the court may not substitute its judgment for that of the agency. It is limited to assuring that the agency considered the environmental consequences of its proposed action (*16*; U.S. at 416; S.Ct. at 823–824).

NEPA works as procedural rather than substantive law. Its mission is to provide for broad dissemination of relevant environmental information instead of to compel an agency into any particular environmental action. As the U.S. Supreme Court has held,

> Although these procedures are almost certain to affect the agency's substantive decision, it is now well settled that NEPA itself does not mandate particular results, but simply prescribes the necessary process (citations omitted). If the adverse environmental effects of the proposed action are adequately identified and evaluated, the agency is not constrained by NEPA from deciding that other values outweigh the environmental costs. . . . Other statutes may impose substantive environmental obligations on Federal agencies, but NEPA merely prohibits uninformed—rather than unwise—agency action. (*20*; U.S. at 332, 351; S.Ct. at 1835, 1846)

The question that then arises is how far the intensity or severity of the impact must be considered in the EA or EIS. There are no bright-line rules to be followed. Therefore, guidance must be taken from a wide range of court decisions on the subject.

Case Law Interpretation of Foreseeability of Indirect Effects Versus Speculation

As stated above, the CEQ regulation requires consideration of those effects that are reasonably foreseeable. CEQ's "Forty Most Asked Questions" supplies some limits to this reasonably amorphous regulation.

> [I]f there is a total uncertainty about the identity of future land owners or the nature of future land uses, then of course, the agency is not required to engage in speculation or contemplation about their future plans. But, in the ordinary course of business, people do make judgments based upon reasonably foreseeable occurrences. It will often be possible to consider the likely purchasers and the development trends in that area or similar areas in recent years; or the likelihood that the land will be used for an energy project, shopping center, subdivision, farm or factory. The agency has the responsibility to make an informed judgment, and to estimate future impacts on that basis, especially if trends are ascertainable or potential purchasers have made themselves known. The agency cannot ignore these uncertain, but probable, effects of its decisions. (*21* at 18031)

NEPA becomes operative when agency actions significantly affect the human condition. The CEQ regulation defines significantly as an action that "requires considerations of both context and intensity" (*3*; 40 CFR 1508.27). Context and intensity are described as follows:

- Context means that the significance of an action must be analyzed in several contexts, such as society as a whole (human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of the proposed action. For instance, in the case of a site-specific action, significance usually depends on the effects in the locale instead of in the world as a whole. Both short- and long-term effects are relevant.
- Intensity refers to the severity of the impact. Responsible officials must bear in mind that more than one agency may make decisions about partial aspects of a major action (*3*; 40 CFR 1508.27).

Table 3 lists those factors to be considered for evaluating intensity.

Differentiating between effects that are reasonably foreseeable and that constitute mere speculation is the next obstacle. Broad requirements for reporting foreseeable environmental impacts are discussed in *Scientists' Institute for Public Information, Inc. v. Atomic Energy Commission* (*22* at 1079).

> [O]ne of the functions of a NEPA statement is to indicate the extent to which environmental effects are essentially unknown. It must be remembered that the basic thrust of an agency's responsibilities under NEPA is to predict the environmental effects of the proposed action before the action is taken and those effects are fully known. Reasonable forecasting and speculation is thus implicit in NEPA, and we must reject any attempt by agencies to shirk their responsibilities under NEPA by labeling any and all discussion of future environmental effects as "crystal ball inquiry." "The statute must be construed in the light of reason if it is not to demand what is, fairly speaking, not meaningfully possible." But implicit in this rule of reason is the overriding statutory duty of compliance with impact statement procedures to the "fullest extent possible." (citations omitted) (*22* at 1092)

This case calls for speculation as well as for reasonable forecasting. It further holds that the agency cannot simply write off any attempt at such forecasting as totally uncertain. A bona fide attempt must be made to identify, to the fullest extent possible, future effects arising from the project.

The issue of speculation versus reasonable forecasting was narrowed considerably in *Trout Unlimited v. Morton* (*23* at 1276). In that case, environmental organizations and others brought suit to enjoin further construction of the Teton dam and reservoir. The plaintiffs attacked the EIS as not being in compliance with NEPA because of its failure to discuss many possible environmental consequences. The court held that

> Many of these consequences while possible are improbable. An EIS need not discuss remote and highly speculative consequences. . . . A reasonably thorough discussion of the significant aspects of the probable environmental consequences is all that is required by an EIS. (*23* at 1283)

Plaintiffs also alleged that the EIS should have included a discussion of the environmental impacts of the development of docks, second homes, and corresponding structures and

facilities as well as an analysis of changes in land-use patterns that could arise from the project. The court concurred that the EIS could have been improved by a discussion of these issues. However, fact-finding of the specific circumstances therein convinced the court that no significant change could be expected in population or in land use. It also noted that

> While agreeing that under a given factual situation failure to include a discussion of secondary impacts might render an EIS fatally defective, we can not say that a specific treatment of secondary impacts is a substantive requirement of the impact statement. The central focus should not be on a primary/secondary impact analysis but upon those impacts (either primary or secondary) which have a "significant impact" upon the environment. (*23* at 1283, no. 9)

Gloucester County Concerned Citizens v. Goldschmidt saw a challenge to the proposed construction of a freeway. Plaintiffs sought an injunction against funding for planning and construction because of

> a violation of NEPA based upon the purported absence of consideration of 'secondary impacts' of the . . . project, specifically: (1) how the highway would fit into the state's existing highway network; (2) what effect it would have on existing and planned mass transit lines; and (3) the impact upon development and population growth. (*24* at 1222)

They also complained that

> although the FEIS acknowledges that the highway will act as a catalyst to development in the surrounding area, it does not go on to study the secondary effects of the road such as increased development, with its concomitant increase in population and demand for state, county, and municipal services, such as schools, police and fire protection and sewerage facilities. (*24* at 1228)

The court found that there was adequate reference, accompanied by several maps, of the relationship between the proposed highway and its specific place within the state's highway network and that it would not detract from usage of existing rapid transit lines. Further planning of rapid transit lines was unlikely without the presence of the new facility. Population figures in the FEIS demonstrated that the area had grown and would continue to grow with or without the proposed project, because there were existing roads that serviced the area. Therefore, plaintiffs failed to demonstrate that the secondary impact was significant.

The court held that the failure to speculate on future events, "which, based on the information available at the time of the FEIS, appear improbable, does not articulate a serious deficiency in the FEIS" (*24* at 1229). The court also held that "a secondary impact must be significant to render an EIS inadequate" (*24* at 1229).

Both *Trout Unlimited* and *Gloucester County* held that review of specific fact patterns would determine whether impacts were (1) probable, and (2) significant. Defining what constitutes probable is the next step.

Case Law Interpretation of Relevant Terms and Scope of Indirect Effects Assessment

The First Circuit Court of Appeals in *Sierra Club v. Marsh* (*25* at 868) reviewed a matter involving a proposal to build a port and causeway on a rural island in Maine. The EA resulted in a FONSI. Using the CEQ regulation as a guide, the court set forth the following three questions to be asked to determine whether a particular set of impacts is definite enough to take into account or too speculative to warrant consideration:

1. With what confidence can one say that the impacts are likely to occur?
2. Can one describe them now with sufficient specificity to make their consideration useful?
3. If the decision maker does not take them into account now, will the decision maker be able to take account of them before the agency is so firmly committed to the project that further environmental knowledge, as a practical matter, will prove irrelevant to the government's decision? (*25* at 878)

The court then reviewed the administrative record, which included a municipal response plan. This plan noted that construction of the port and industrial park would constitute a "two-part development package" (*25* at 868).

The record also included an EA prepared by the Maine Department of Transportation, which projected further industrial development after construction of the cargo port.

> Development of the cargo terminal will . . . act as the principal stimulus to further industrial development on the island itself. Several forest product and food industries are also expected to have facilities on the island, as well as suppliers of paper-making machinery and machinery components. . . . Industrial development, indirectly stimulated by constructing the cargo terminal, will generate increased revenues [for the town]. The eventual fiscal impact on the town will, of course, depend upon the degree and timing of the expected co-development of the island. (*25* at 868)

These entries into the records clearly satisfied the confidence question that impacts were likely to occur. The second question of the three-part test was whether the impacts could be described with sufficient specificity to make their consideration useful.

The plans for further development included two documents in the record—the 35-page "Land Use Plan/Industrial Marketing Study" prepared for the owner of the southern half of the island, and the town's 50-page "Municipal Response Plan for the Industrial Development of Sears Island." The documents provided detailed descriptions of likely further development, analysis of the physical characteristics of the lower half of the island, discussion of the feasibility of construction at various sites on the island, discussion of development options, and discussion of the likely impact of indus-

trial development on employment, housing, medical services, municipal services, the environment, and so forth. The court cited the CEQ regulation noted above and held that "The agency is not required to engage in speculation. . . . But it will often be possible to consider likely purchasers [of land] and the development trends in that area or similar areas in recent years. . . . The agency cannot ignore these uncertain, but probable, effects of its decisions" (*25*, citing *20* at 18026, 18031).

The court then succinctly noted that the land-use and response plans were detailed enough for an EIS to describe the type of development likely to occur, even if it was pointless to analyze precise details. This satisfied the specificity question.

Third, once the causeway and port were built, the pressure to develop the rest of the island could prove irresistible. Therefore, putting off an EIS for a later time would result in environmental knowledge that would not offer the decision maker a meaningful choice about whether to proceed.

These three points—confidence in induced growth, enough specificity of the type of growth to be useful, and the need to know these things before making an irreversible commitment—are a recurring theme in case law. They should be based on an examination of the administrative record and should involve reasonable forecasting based on that record. Their consideration in an EIS will support its analysis of indirect effects to the point where it would not be considered arbitrary and capricious. Any EIS that can meet the test of being reasonable will be upheld by the courts.

In the course of subsequent litigation, *Sierra Club v. Marsh* (*26* at 763) (Sierra Club IV), the Sierra Club again sued after an FEIS was prepared. The court discussed the terms likely, foreseeable, and reasonably foreseeable and found that, as in other legal contexts, the meaning was limited, rather than exhaustive.

> [T]he terms "likely" and "foreseeable," as applied to a type of environmental impact, are properly interpreted as meaning that the impact is sufficiently likely to occur that a person of ordinary prudence would take it into account in making a decision (citations omitted). Thus, "duty" to discuss in the EIS particular ones among all the types of potential impacts is not an "absolute" or "strict" duty, but one measured by an objective standard. (*26* at 767)

Taking this ordinary prudence standard for the decision maker, it then made a second point, further limiting the inclusion of impacts.

> [E]ven as to those effects sufficiently likely to occur to merit inclusion, the EIS need only "furnish such information as appears to be reasonably necessary under the circumstances for evaluation of the project." (citations omitted) (*26* at 767)

The EIS in that matter restricted its indirect impact analysis to four light-dry industries. Plaintiffs complained that the indirect effects evaluation was inadequate because it did not evaluate heavy industries.

The administrative record revealed water and sewage treatment facilities on the island were inadequate to sustain heavy industry. Furthermore, the cost of upgrading the water alone to sustain heavy industry was prohibitive. Local officials and property owners directed their marketing toward light-dry and not heavy industry. The court held that

> NEPA requires an EIS to evaluate only those secondary impacts that are reasonably foreseeable. We conclude that it was permissible for the agencies not to analyze other water-dependent industries, such as auto processing, petroleum, and cement, because the likelihood of these industries developing on Sears Island is too speculative to be reasonably foreseeable. (*26* at 778)

The identification of the four targeted light-dry industries reasonably identified the type of industry likely to develop. The court upheld the EIS as a reasoned decision based on the agencies' evaluation.

In *Thomas v. Peterson* (*27* at 754), plaintiffs brought an action to enjoin construction of a timber road in a roadless area in a former national forest. An EA prepared for the agency resulted in a FONSI.

In support of the FONSI, the forest service argued that timber sales were too uncertain and too far in the future for the environmental impact to be analyzed along with that of the road. The court found that argument to strain credibility:

> This comes close to saying that building the road now is itself irrational. We decline to accept that conclusion. Rather, we believe that if the sales are sufficiently certain to justify construction of the road, they are sufficiently certain for their environmental impacts to be analyzed along with those of the road. (*27* at 760)

In sum, using ordinary prudence to apply the three-step test found in *Sierra Club v. Marsh* will result in an examination of foreseeable consequences substantive enough to inform all parties concerned of the project's indirect effects. The courts have found such an inquiry to be reasonable and, therefore, sustainable.

Case Law on Growth-Induced Indirect Effects

The questions of confidence in and specificity of types of induced growth or secondary impacts as set forth in *Sierra Club v. Marsh* often can be condensed into a single question. If the benefits of induced growth are selling points of the project, an EA or EIS must consider them.

In *Sierra Club v. Marsh*, the court found an induced development theme running through the record. The two-part development package cited, as well as references to development of the cargo terminal acting as the "principal stimulus to further development on the island itself," the generation of increased revenues, and expected co-development of

the island, served as selling points for the project that warrant consideration. Ignoring selling points in an EA or EIS can lead to segmentation and a judicial finding of inadequacy.

Other courts have embraced the selling point criteria as well. In *Chelsea Neighborhood Associations v. United States Postal Service* (*28* at 378), the U.S. Postal Service sought to build a vehicle maintenance facility. New York City planned to build apartment units on top of the facility. The postal service's EIS addressed the virtues of air-rights housing and ignored its disadvantages. The result was segmentation. The court held that "using the housing as a 'selling point' without disclosing its possible negative aspects is certainly not the 'environmental full disclosure' required by NEPA" (*28* at 388).

In *Sierra Club v. Sigler* (*29* at 957), the ACOE issued permits authorizing private construction of a multipurpose, deep-water port and crude oil distribution system in Galveston, Texas. The plaintiffs argued, among other things, that the project's adverse effects should have been examined as secondary or indirect effects in the FEIS.

The court found that the FEIS cited many benefits flowing from the terminals. However, it avoided an objective cost–benefit analysis. Because the benefits were included in the FEIS as a selling point, there could be no hard look at costs and benefits until the costs were disclosed (*29* at 979).

City of Davis v. Coleman (*30* at 661) involved a proposal to build a highway interchange (the Kidwell interchange) to stimulate and service future development in a rural area. Neither an EA nor an EIS was prepared. A three-page negative declaration of environmental impact was prepared instead. This document was found to be completely inadequate, and it precipitated discussion of the desirability of including secondary effects in an EIS.

> The growth-inducing effects of the Kidwell interchange are its raison d'etre, and with growth will come growth's problems: increased population, increased traffic, increased pollution, increased demands for services such as utilities, education, police and fire protection, and recreational facilities. (*30* at 675)

The court further held that not knowing the exact type of development is not an excuse for failing to file an EA or EIS. Current and contemplated plans of private parties and local government outside the direct control of state and federal government must be reviewed. Based on that review, reasonable forecasting of the type of development must be conducted.

It may be concluded that if the record reveals that the agency mustered support for the project by means of marketing-induced growth or other project-generated benefits to the area, then there is no question that such effects are reasonably foreseeable under NEPA and must be included in the NEPA document.

Case Law on Land-Use and Zoning Controls

Different results have been reached on the ability of land-use and zoning regulations to control indirect land-use effects. The three cases presented below offer examples of these divergent holdings.

In *Mullin v. Skinner* (*31* at 904), property owners brought an action challenging the proposed construction of a high-rise bridge to a rural island. The EA resulted in a FONSI. The defendants defended the FONSI, claiming that significant changes in development patterns can be brought about only with zoning changes and not by construction of a high-rise bridge.

The court took strong exception to this argument.

> Defendants'. . . point is so utterly devoid of common sense and inconsistent with NEPA that it cannot be taken seriously. This court did not need plaintiff's experts to tell it that zoning changes inevitably follow development pressures. To believe otherwise is to ignore reality. More importantly, defendants' argument that it is these zoning changes which will cause increased development, and not the bridge, completely ignores the regulatory definition of "indirect effects" which they are required to abide by: Indirect effects are those "which are caused later in time . . . [and] may include growth-inducing effects . . . . " Even though zoning changes may be necessary to alter existing uses of land, if a major Federal action makes it likely that such changes will occur, the action will have an indirect effect on the environment. (*31* at 921)

It further noted that the EA contained predictions of growth, including enhanced economic and employment opportunities, increased tourism, greater use of existing recreational areas, and increased property values and tax base. "These predictions simply cannot be squared with the conclusion that land use, development, and traffic will not be significantly altered by the new bridge" (*31* at 921). (Note the consistency with the selling points argument discussed above.)

In contrast, *Florida Wildlife Federation v. Goldschmidt* (*32* at 350) also saw expert testimony claiming that land-use planning would not be an effective way to control the type and density of development because of its vulnerability to political pressures. The plaintiffs claimed that the proposed extension of I-75 would induce massive residential, commercial, and industrial development in the area. However, the results were quite different.

A witness for the defendants testified about the Broward County land-use plan. This plan was developed over a 3-year period after 30 or more public hearings and extensive studies, and it had the full force and effect of law throughout the county. It consisted of 275 pages of text plus maps and amendments. Procedures for adopting amendments were stringent and required 6 to 9 months to complete. The four amendments adopted since its inception actually reduced the number of residences allowed in the study area. Therefore, the evidence pointed strongly against induced development.

> In short, plaintiffs' fears that I-75 will induce massive, total development of the study area have little evidentiary support. Though it may be true as a general rule that access to transportation causes development, the history of and projected increases in population growth for South Florida demonstrate that growth will occur because of market demands even when transportation is lacking. There is already some development in the study area, and development will continue there as planned and allowed under Broward County's Land Use Plan, whether or not I-75 is constructed, because it is the next logical area for development. . . . Though plaintiffs distrust the political process, all the evidence indicates that the Land Use Plan is, and will continue to be, enforced. (*32* at 368–369)

Somewhere in the middle of these two decisions is *Enos v. Marsh* (*33* at 1363). This case concerned a project designed to provide a second deep-draft harbor for commercial and industrial use on the island of Oahu. Plaintiffs claimed that the ACOE failed to discuss secondary impacts adequately in the EIS. First, the court examined the discussion of secondary effects in the EIS.

> The EIS specifically addresses industrial growth. The Corps takes the position that growth and expansion of existing industry is expected in the area with or without the new harbor facility, but that industrialization may be spurred as a result of the project. The EIS states that the relocation of existing industries in the area is expected, but that the development of new industries is not expected because Hawaii's basic industries are service-oriented, and those industries will grow commensurate with the population. The EIS discusses the potential increase in population, acknowledging that the urbanization of lands which are currently undeveloped or in agricultural use may be "far-reaching." The EIS acknowledges that harbor development may affect the level of traffic, noise and air pollution, as well as the demand for water, power, sewage treatment facilities and roadway improvements. (*33* at 1373)

The court held that

> [T]he Corps repeatedly alerted decision-makers and the public to the potential secondary effects of the harbor project. Discussion was not extended; however, such consequences are speculative, and dependent upon local development and zoning policies. (*33* at 1373)

By this logic, conventional zoning policies will adequately control indirect land-use effects, which are merely speculative.

It can be concluded that a general rule (or presumption) exists that equates new transportation access with secondary development. However, this presumption can be rebutted through a demonstration of viable and effective regional land-use plans, which generate judicial confidence in their stringent enforcement. Speculative indirect effects will not be afforded much weight and, therefore, can be left to lightweight controls.

Case Law Responsibility for Nonfederal Indirect Effects

Enos v. Marsh, supra (*33* at 1363), concerned a project designed to provide a second deep-draft harbor for commercial and industrial use on the island of Oahu. Plaintiffs claimed a failure in the EIS to discuss adequately the environmental effects of state-planned shoreside facilities.

The court acknowledged NEPA's mandate in requiring an EIS for major federal actions significantly affecting the quality of the human environment. However, it recognized that "Whether the shoreside facilities planned by the state are to be included in the EIS turns on whether that action is 'Federal.' This determination requires 'careful analysis of all facts and circumstances surrounding the relationship'" (*33* at 1371).

Plaintiffs argued that the state's shoreside facilities and the federal harbor project were so functionally interdependent that the projects constituted a single federal action. The court disagreed. It noted that the state and federal projects serve complementary but distinct functions. This matter was distinguished from instances in which certain segments of highway construction projects were designated as state and others were designated as federal in an attempt to avoid the requirements of NEPA (*33* at 1371).

Two additional factors dissuaded the court from including the state's activities within a federal NEPA action.

> First, the shoreside facilities are completely state-funded. As this court observed in *State of Alaska v. Andrus,* 591 F.2d 537, 541 (9th Cir. 1979), "[w]here Federal funding is not present, [we have] generally been unwilling to impose the NEPA requirement" of filing an EIS. Second, the Federal Government exercised no control over the planning and development of these facilities. Rather, local officials have been the only relevant decision-makers (citations omitted). Lacking both Federal funding and Federal supervision over the development of the facilities, the construction of the shoreside facilities is not "Federal" action for purposes of NEPA. (*33* at 1372)

In a footnote, the court added the following:

> The EIS did not have to treat the shoreside facilities as part of the Federal action. The environmental effects of the state action were not ignored, for the state project was taken into account as one of the secondary effects of the Federal action. (*33* at 1372, footnote 11)

Plaintiffs also strongly urged that the costs of the shoreside facilities be included in the analysis of the EIS because the ACOE included the economic benefits of a harbor with shoreside facilities in operation in its cost–benefits analysis. However, plaintiffs did not specify which costs should have been included. The court presumed that they referred to those construction costs that would be borne by the state of Hawaii and not by the federal government and therefore did not need to be included in the EIS (*33* at 1372, footnote 11).

The question of mitigation by local entities was addressed by the U.S. Supreme Court in *Robertson v. Methow Valley Citizens Council* (*20*; U.S. at 332; S.Ct. at 1835). The forest service issued a special-use permit for development and operation of a ski resort on national forest land. Plaintiffs wanted the EIS to include a complete mitigation plan to address both the on- and off-site effects on air quality and the mule deer herd. The court acknowledged that, although NEPA and the CEQ regulation both require detailed analysis of on-site and off-site mitigation measures, this went too far.

> There is a fundamental distinction, however, between a requirement that mitigation be discussed in sufficient detail to ensure that environmental consequences have been fairly evaluated, on the one hand, and a substantive requirement that a complete mitigation plan be actually formulated and adopted, on the other. (*20*; U.S. at 352; S.Ct. at 1847)

In other words, detailed mitigation plans would carry the EIS beyond the requirement, but conceptual plans and methods for reducing or avoiding impacts can be discussed generally.

This holding reinforced NEPA's requirement to advise courses of action rather than to require them. The court also found that if NEPA were to substantively empower local entities with the final word on the forest service action, it would come at the expense of the agency's congressional grant of broad authority. It therefore echoed the findings of *Enos v. Marsh*, which distinguished federal and state jurisdiction in NEPA reporting.

> In this case, the off-site effects on air quality and on the mule deer herd cannot be mitigated unless non-Federal Government agencies take appropriate action. Since it is those state and local governmental bodies that have jurisdiction over the area in which the adverse effects need be addressed and since they have the authority to mitigate them, it would be incongruous to conclude that the Forest Service has no power to act until the local agencies have reached a final conclusion on what they consider necessary. (*20*; U.S. at 352; S.Ct. at 1847)

In addition, the U.S. Supreme Court held that it would go too far if it required the agency to prepare a worst-case analysis. Therefore, once the agency has detailed mitigation measures for nonfederal entities to consider, it has done its job under NEPA and can proceed with the permitting process. The court concluded by expressly holding that "NEPA does not require a fully developed plan detailing what steps will be taken to mitigate adverse environmental impacts and does not require a 'worst-case analysis'" (*20*; U.S. at 359; S.Ct. at 1850).

It can be concluded that NEPA remains a procedural law that requires federal agencies to inform the decision maker and the public of the environmental consequences of its significant actions. Attempts to federalize indirect effects that are completely subject to local funding and control will be rejected.

Conclusion of Case Law Review

Case law does not establish any bright-line rules to be followed for determining the extent to which indirect effects must be addressed in NEPA documents. However, it does supply some general procedures to be followed in drafting them.

NEPA is procedural, not substantive. It requires a federal agency to take a hard look at the environmental consequences of a proposed significant action and to provide a fair evaluation of same to the decision maker and other concerned parties. It should not—and cannot—be structured to require any specific course of action. Although mitigation measures should be discussed in the course of creating a fair evaluation, a mitigation plan would carry the report beyond its mandate to inform and would be excessive under NEPA.

In examining the environmental consequences of the agency action, speculation is not necessary. Only those impacts that are reasonably foreseeable are subject to analysis. Reasonably foreseeable impacts are those that are (1) probable, and (2) significant.

Three questions guide in determining probability. (1) With what confidence can one say that the impacts are likely to occur? (2) Can one describe them now with sufficient specificity to make their consideration useful? (3) If the decision maker does not take them into account now, will the decision maker be able to take account of them before the agency makes an irreversible commitment to the project?

Significance varies according to context and intensity. Significant impacts can be beneficial or adverse. A factual determination of the impacts of each project in its particular setting is necessary to identify whether the impacts will be significant.

Impacts that are not probable are not reasonably foreseeable, and they are not required to be included in a NEPA document. Impacts that are not significant are likewise not to be included.

However, if induced growth or other impacts are used to market the project, these impacts meet the test of being probable and significant. Therefore, they are reasonably foreseeable and should be included so the decision maker and others can be advised of their impacts.

Local zoning and land-use regulations cannot be relied upon to control indirect impacts. They are subject to political pressure and will not be sustained unless they inspire judicial confidence in their integrity.

In sum, case law does not define what must be done proactively about indirect effects in NEPA documents. However, it does identify certain steps that would be overreaching the mission of NEPA and, as such, helps the agency to eliminate some wasteful and excessive efforts.

PUBLISHED LITERATURE

Definitions of Indirect Effects and Other Terms in Published Literature

The seminal piece on indirect effects of proposed highway projects is a 1976 study for the DOT conducted by Vlachos, who stated that

> [D]irect effects are those which result from actual physical construction of the facility, and may be short- or long-term in duration. Indirect effects, on the other hand, are those which are not readily apparent, but are generated by the construction, maintenance or use of the facility.
>
> [S]econdary impacts of highway improvements can be seen as expanding rings of chain reactions, of "ripple effects" extending outward to ever-increasing, but less severe cycles of interrelated consequences. (*34*; p. 5–22)

He also wrote that

> [S]econdary effects are seen as derivative of primary, being either induced by or stemming from primary. Secondary impacts are related more to primary impacts than to the project itself; they are in a sense indirect possible consequences triggered by the construction or sustained use of a highway project but not in themselves "necessary" to the project. (*34*, p. 5–22)

The difference Vlachos points out between secondary effects and direct effects is that secondary effects are possible consequences of a project, whereas direct effects are a necessary or highly predictable consequence of a project. He further states that primary effects are often just the tip of the iceberg, and it is the secondary impacts that, over the long term, far outweigh the importance of the direct impact. These characteristics of indirect and secondary effects are presented in Table 4. What differentiates Vlachos's interpretation of secondary effects from the CEQ definition of indirect effects is his emphasis on the effects being part of an interactive system, in which the effects generated may work to reinforce one another (*34*, p. 3–6).

Vlachos is consistent with the CEQ in defining indirect effects as happening later than direct effects. In addressing the distance specification of the CEQ regulation, he says that defining distance issues for indirect effects is complex, as the boundaries for political, socioeconomic, and physical indirect effects from the same project will differ.

Hamilton defines direct effects as those that result from construction and operation of the roads (*35*, p. 5). Under this definition, use of the highways also contributes to the direct effect. In Hamilton's example of direct effects, water pollution is a direct effect and includes impacts from construction and maintenance of the road, public use of the road, and surface water runoff. Compared with the CEQ definition, this definition does not specify the timing of the impact or the distance within which the impact must occur to be considered a direct effect.

In Hamilton's interpretation, indirect effects are those caused by acquisition, storage, and transportation of materials used in construction and operation of the highway system, such as the environmental degradation from strip mining for paving materials (e.g., sand, gravel, and limestone). This definition is expansive compared with the CEQ definition of indirect effects. The lack of timing or distance specificity incorporates impacts to land, as in strip mining, possibly thousands of miles from the road alignment. It should be noted that Hamilton's paper discussed effects from the interstate highway system as a whole and not project-specific effects.

Hamilton defines induced effects as impacts resulting from accelerated activities caused by operation and use of the interstate highway system—e.g., growth of strip developments and their subsequent impact on urban form. The examples given for this interpretation of induced effects include disposal of cars at the end of their life cycle, use of petroleum necessary to power cars, and the environmental impacts of petroleum mining and processing. Hamilton's definition is based on the premise that over the long term road improvements will encourage consumption of automobiles as a favored form of transport.

TABLE 4 Vlachos's characteristics of indirect and secondary effects

Effect	Characteristic	Definition
INDIRECT	Traceability	direct-indirect
	Order	first-higher
	Space	immediate-extended; local-regional-national
	Timeframe	short-term; long-term
SECONDARY	Scope	proportion of people/things affected, as well as extent (local-widespread) of indirect effects
	Intensity	significance of potential losses/benefits and importance or extensiveness of secondary impacts
	Duration	time required to restore base to present conditions, or achievement of new equilibrium, as well as time span of occurrence (transient vs. persistent and simultaneous vs. delayed)

Source: Vlachos, p. 5-22.

Note that induced impacts is not a term defined by the CEQ. Induced changes to growth, land use, and ecosystems are used by the CEQ to describe indirect effects. The language of the CEQ definition suggests that indirect effects are induced changes caused by a project and are not separate and distinct impacts as delineated by Hamilton. Although the CEQ definition for cumulative impacts uses the defining term incremental impact, Hamilton's interpretation of induced effect is closer to the definition of cumulative than to an indirect effect.

Beale cites the CEQ definition and writes that both direct effects and indirect effects of a project "are caused by the action." Direct effects "occur at the same time and place," whereas indirect effects "are later in time or farther removed in distance, but are still reasonably foreseeable." The time–distance parameters in Beale's definition are consistent with those of the CEQ. Beale's interpretation that these effects are "beyond the boundaries of their immediate jurisdiction" is similar to the CEQ's farther removed in distance specification. Where he departs from the letter of the CEQ is in considering secondary impacts synonymous with indirect effects (*36*, p. 4).

Beale deviates from the CEQ in his interpretation of cumulative effects. He defines them as "all effects, including indirect effects, that are induced by the project or exogenous factors. . . . Indirect impacts are induced by a project. Other cumulative impacts are largely independent of a project" (*36*, p. 4). Beale argues that the two effects are linked and that an assessment of cumulative effects must be done to properly assess indirect effects. The CEQ guidelines are silent on this issue. However, the CEQ does define cumulative effects and indirect effects in different sections.

Like Vlachos, Beale perceives indirect effects to be a consequence of the project as well as of the direct effect. Moreover, similar to Vlachos, he writes that, whereas direct effects are highly predictable, indirect effects are reasonably foreseeable. Table 5 summarizes his interpretations of direct, indirect, and cumulative effects.

In "Measuring Impacts of Land Development," Schaenman and Muller use the term spillover effect interchangeably with indirect effect. This study is part of a series of research conducted by the Land Use Center of the Urban Institute in the 1970s that assessed the impacts of land development. The authors explain spillover effects as those effects that "have significant environmental and economic effects beyond the boundaries of their immediate jurisdiction. Examples are water pollutants dispersed through a drainage network, or air pollutants emitted into an air shed . . ." (*37*, p. 26).

This study states that secondary effects are those that are induced by an action. The authors give the example of a new development that may act as a catalyst for economic activity that may prompt regional immigration. These descriptions of spillover effects and secondary effects are consistent with the CEQ definition of indirect effect. The authors also refer to secondary effects as ripple effects. No time specificity is made for either spillover or secondary effects.

In "Transportation Decision-Making: A Guide to Social and Environmental Considerations," Manheim et al. define indirect effects as those effects "that have ramifications beyond their primary consequences" (*38*, p. 65). This definition emphasizes the causal chain between direct effects and indirect effects but does not go further to include a time–distance parameter consistent with the CEQ or to require that the effect be reasonably foreseeable. The term indirect effects again is used interchangeably with secondary effects.

The common denominator of the definitions found in published literature appears to be that nondirect (i.e., indirect,

TABLE 5 Beale's time–distance differentiation of various impact categories

Attribute	Direct Impacts	Indirect Impacts	Cumulative Impacts
Location of Impact	Same Place	Removed in Distance	Removed in Distance
Timing of Impact	Same Time	Later	Later
Predictability of Impact	Highly Predictable	Reasonably Foreseeable	Reasonably Foreseeable
Cause of Impact	Highway Project	Highway Project & Effects of Induced Intermediate Actions	Highway Project & Effects of Induced Intermediate Actions & Other Past, Present & Reasonably Foreseeable Future Actions

Source: Beale, p. 5.

secondary, spillover, and ripple) effects are effects on a natural resource, socioeconomic, or land-use system that are a result of the project or a consequence of the direct effects.

A close look at interpretations of indirect effects developed before the CEQ definition shows no consensus on any of the elements of the CEQ definition—location of impact, timing of impact, predictability of impact, and cause of impact. The definitions developed after 1978 (those constructed by Hamilton and Beale) show more cohesion. Both authors agree that indirect effects are effects that are removed in distance from the project. However, apart from that point, the definitions diverge on the critical element of what causes the indirect effect. Hamilton believes that it is the materials used in building the road that cause indirect effects, whereas Beale says it is the highway project and the direct effects of that project that prompt indirect effects.

Tables 6 and 7 summarize the different interpretations of indirect effects that have developed. The following section examines approaches to identifying indirect effects.

Approaches Suggested by Published Literature for Identifying Indirect Effects

Two general approaches have been presented in the literature for identifying direct and indirect effects: matrix evaluation and component analysis. Both require listing possible impacts on social, economic, and ecologic systems. Leopold proposed a matrix technique to identify and evaluate potential impacts from a project. Studies by Vlachos and by Gramling and Freudenberg suggest using the component approach to examine various systems to fully identify the indirect effects of a project.

Matrix Approach to Impact Identification

In a study for the U.S. Geological Survey, Leopold et al. suggest a matrix approach to identify probable impacts of actions (*39*). This matrix approach (see Table 8) was suggested primarily for assessing direct effects. The methodology is included in this literature review, as its application can be extended to indirect effects.

Leopold's matrix lists actions that impact the environment on one axis (e.g., constructing roads and dredging a harbor) and the existing environmental conditions that may be affected on the other axis (e.g., scenic views and water quality). Leopold's sample matrix lists 100 possible actions grouped categorically (e.g., land transformation) at the horizontal axis and 88 environmental characteristics at the vertical axis. Overall, Leopold's matrix allows for 8,800 possible interactions of impacts from an action.

Leopold's approach first asks the user to identify all actions that are part of the proposed project. After each proposed action is identified, each cell in the matrix corresponding to the actions is marked with a diagonal slash. Then the impact on the particular environment is ranked by its magnitude and the importance of the possible impact (magnitude/importance). The ranking system Leopold uses is a scale of 1 to 10, where 1 represents the least magnitude or importance and 10 represents the most magnitude or importance. However, Leopold notes that any scale can be used.

This approach has the following advantages:

1. The matrix aids in isolating impacts for consideration in assessing alternatives to the project;
2. It provides an extensive list that can be modified to suit user needs; and
3. It allows for visual linking of project actions to potential effects.

Component Analysis for Impact Identification

The second approach discussed in the literature requires conceptualization of possible impacts, as in the matrix, but it is less structured. Two uses of this approach are presented, both of which attempt to disaggregate effects into various systems or components. In the first study, Vlachos proposes examining indirect effects categorically by first breaking down the components of the impact (e.g., ecologic versus economic) to examine the impacts and the long-range ramifications of those impacts. He comments that lists that attempt to identify all possible impacts of a project are inherently selective and subjective. Vlachos calls for integrating identification of impacts with analysis of the interactions and linkages of key variables within a system. His approach is presented in Table 9.

Vlachos's approach attempts to define key categories of impact, after which interactions among the categories and their impacts can be discussed. He points out that secondary effects do not occur in clearly defined categories but rather interact with each other and can be mutually reinforcing. The weakness of this approach, he says, is that it is difficult to develop static categories that attempt to define effects that are dynamic.

The second framework, proposed by Gramling and Freudenburg (see Appendix F), allows looking at effects across three different time periods and across different systems of the human environment (see Table 10). Unlike Vlachos's method, this approach does not differentiate effects into impacts and consequences but rather considers impact and consequence merely as possible effects. The authors state that their conceptual framework should be used not simply as a checklist but rather should serve as a tool to help in conceptualization of social impacts.

Approaches to Assessing Indirect Impacts Suggested by Published Literature

Two distinct procedures for assessing indirect effects are evident in the literature. The assessment approach advocated

TABLE 6 Definitions and examples for direct and nondirect impacts by source

Source	Direct Effects	Indirect Effects	Secondary or Induced Effects	Examples of Effects	
CEQ (39 CFR 1508.7 and 1508.8), 1978	Effects which are caused by the action and occur at the same time and place.	Effects that are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable.		Induced effect:	Induced changes in land use, population density or growth rate.
Vlachos, 1976	The immediate or first-order effects or impacts of a given activity.		Secondary effect - Derivative of primary effect, being either induced or stemming from the primary effect.	Direct effect:	Influx of construction workers, alterations in land use patterns.
				Secondary effect:	Potential for population growth, potential for sprawl and haphazard development.
Hamilton, 1988	The direct result of the construction and operation of roads. Use of the roads by cars is also a direct impact.	Impacts caused by the storage, acquisition and maintenance of materials used to build and maintain the highway.	Induced effect - Effect resulting from accelerated activities caused by the interstate highway system.	Direct impact:	Visual, noise level increase, air pollution.
				Indirect impact:	Litter and other solid wastes, strip mines.
				Induced impact:	Strip development, auto manufacture.
Beale, 1993	Usually occur within an alignment and can be more widespread or delayed.	Effects caused by the action later in time than direct effect but still reasonably foreseeable.		Incorporates CEQ example for indirect effect by reference.	
Schaenman and Muller, 1974		Significant environmental and economic effects beyond the boundaries of the project (spill-over effects).	Secondary effect - Induced effect from a project/development (ripple effect).	Spill-over effect:	Greater-than-local development impact such as water and air pollution.
				Secondary effect:	Additional construction from increasing residential and commercial development.
Manheim, et. al., 1975		Impacts that have ramifications beyond their primary consequences.		Impact:	Changes in activity distribution pattern, travel demand, ecological relationships and neighborhood character.
				Indirect:	Land value and land use changes.

TABLE 7 Definitions of indirect effects compared with CEQ

	pre-CEQ				post-CEQ	
	Schaenman and Muller, 1974	**Manheim, 1975**	**Vlachos, 1976**	**CEQ, 1978**	**Hamilton, 1988**	**Beale, 1993**
Term Used	Spill-over effect and ripple effect		Secondary effect			
Location of Impact	Removed in distance	(No mention)	Boundaries vary for political, physical and socioeconomic effects	Removed in distance	Removed in distance	Removed in distance
Timing of Impact	(No mention)	(No mention)	Later	Later	Present and later	Later
Predictability of Impact	(No mention)	(No mention)	(No mention)	Reasonably foreseeable	(No mention)	Reasonably foreseeable
Cause of Impact	Induced by an action	Caused by the direct effects	Highway project and primary impacts	Highway project	Materials used in highway project	Highway project and effects induced by intermediate action

by Vlachos is systematic and holistic. The approach presented by Hamilton, a classification and ranking method, examines the direct, indirect, and induced effects of the interstate highway system. Hamilton's method, however, like Leopold's matrix technique, can be applied to individual project assessment.

Systems Analysis

Vlachos's approach entails systematic exploration, analysis, and evaluation of all the possible consequences that proposed alternatives can impose on an ecologic, spatial, or socioeconomic system. He contends that, to understand the indirect effects of a transportation project, one must go through the process of model building of a system to understand its components and its interrelationships before making accurate predictions of indirect effects. Vlachos emphasizes that the systems concept is based on the premise that a change in a system can affect parts of other systems through mutual interactions.

Because of the interconnectedness of many systems, he suggests replacing the term indirect impact analysis with causal-loop analysis or systems analysis.

Vlachos's systems approach encompasses the following elements:

1. Delineation of objectives and goals as well as alternatives;
2. Description of the system (boundaries);
3. Constraints of the system (inputs);
4. Time constraints; and
5. Evaluation of the performance of the system (*34*, p. 3–11).

According to the author, the comprehensiveness of this approach is not without problems, particularly in examining social systems. The following elements pose problems for use of this approach:

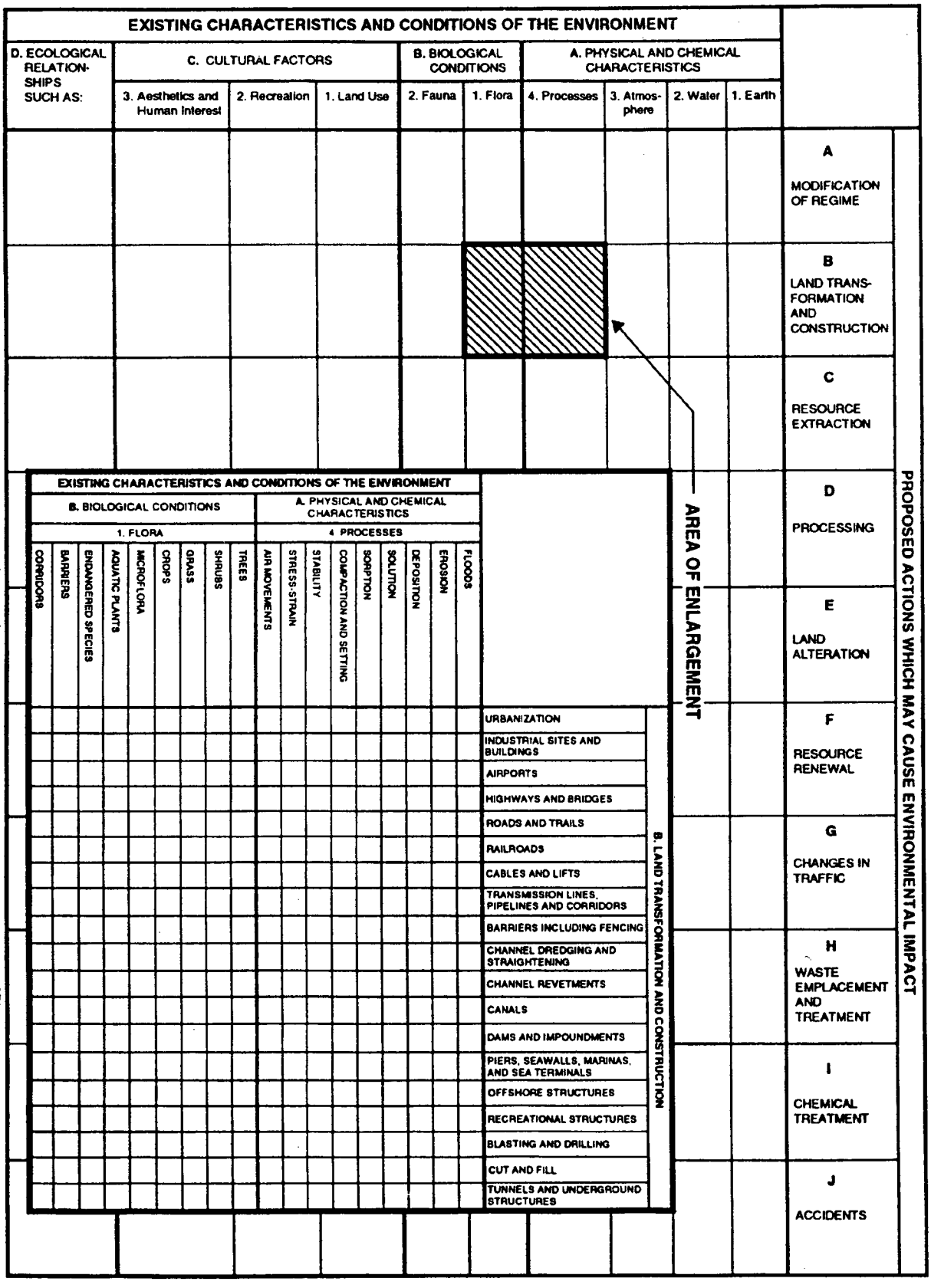
1. Inadequate knowledge about the state of the system;
2. Simplistic assumptions about the system;
3. Lacking, inadequate, or difficult-to-obtain data for model validation;
4. Problems with modeling large systems;
5. Confusing causal links;
6. Difficulties in breaking down complex systems for manageable elements; and
7. Time and physical scales of systems critical to analysis that may differ.

Despite these difficulties in implementing a systems approach, Vlachos says that the critical distinctions of this methodology—the development of a map for organizing the dimensions of the problem and the notion of impacts being interactive and interconnected—should be used to assess indirect effects.

Ranking Approach

Hamilton proposes a ranking system to identify overall impacts associated with a highway system. He devised two approaches that group impacts in different ways and ranked each impact by its relative significance according to the systems used. This ranking process is designed to aid problem identification so that solutions, alternatives, or mitigation strategies can be developed.

TABLE 8 Information matrix for environmental impact assessment



Source: Leopold, Luna B. et al, A Procedure for Evaluating Environmental Impact, Geological Survey Circular 645. US Department of the Interior: Geological Survey, Washington, 1971.

TABLE 9 Vlachos's component analysis approach

COMPONENTS	IMPACTS	CONSEQUENCES (long-range ramifications)
Ecological	■ Physical ■ Biological ■ Human interface	■ Seral disturbances ■ Ecological stability ■ Modification of regime
Social	■ Demographic ■ Spatial/Human Ecology/ Proximic ■ Community/Institutional ■ Cultural/Normative	■ Community viability ■ Population shifts ■ Value and social-organizational changes
Economic	■ Construction of influences ■ Employment and income ■ Economic base	■ Distribution and redistribution of resources ■ Changes in the organization of economic activities
Aggregate	■ Quality of life ■ Social well-being	■ Morphological transformations ■ Structural differentiation's ■ Proximic transfigurations ■ "Cultural" metamorphosis

Source: Vlachos, 1976, p. 5-5.

His first approach is to combine impacts into functional groups. Hamilton differentiated three classes of impacts: Class I, physical—impacts that alter the physical environment; Class II, sensual—impacts that affect the human senses (e.g., noise); and Class III, conceptual—impacts on lifestyles and the sociological makeup of society.

Class III is subdivided into permanent and temporary effects. Impacts are typologized by direct, indirect, and induced effects. Impacts such as visual, noise level increases, and air pollution are direct effects and would be noted as a Class I, Class II, or Class III impact.

Once an identification matrix is completed, with possible impacts on the vertical axis and categories of impacts on the horizontal axis, a system for ranking impacts can be applied (see Table 11).

As the next step, Hamilton proposes a ranking system that groups each impact by its permanent or temporary nature and by whether three classes, two classes, or one class of impact is incorporated. With this classification scheme, more attention can be given to impacts with higher ranks or greater significance.

Hamilton's second classification approach is to group an impact by its source—i.e., road construction, road maintenance, road use, and development of adjacent lands. Each source of impact is then subdivided into two columns, permanent and temporary. On the vertical axis, impacts are categorized as direct, indirect, and induced. The relative ranking of impacts can be grouped from most significant (e.g., permanent impact of four sources) to least significant (e.g., permanent impact of no source).

This approach used by Hamilton is similar to Leopold's matrix scheme in that he cross-references source of impact (e.g., development of adjacent lands) with categories of impact. Although Hamilton's approach does not specify the source of impact to the same degree of detail as Leopold's, he differentiates the nature of the impact in terms of permanence (Leopold does not). Within the matrix, Hamilton does not evaluate each impact (Leopold does). Instead, he ranks effects by the vastness of their consequences; e.g., a permanent impact of four sources has a higher importance rank than a permanent impact of one source.

Assessment Techniques/Forecasting Tools Suggested by Published Literature

The review of techniques covers techniques that have been used to assess indirect effects, particularly for land inducement effects, as well as techniques that can be used to assess indirect effects but that have not been used to date in the relevant literature examined. The techniques reviewed are in one of two categories: perspective and prospective. Table 12 summarizes these assessment techniques.

Perspective techniques aim to explain how certain conditions in the past affected the present. The most commonly used methods of assessing indirect effects are the comparative approach and regression techniques. Perspective tech-

TABLE 10 Gramling and Freudenburg's conceptual approach

System Affected	Temporal Phase		
	Opportunity-Threats	Development/Event	Adaptation/Post-Development
Physical	Anticipatory construction or lack of maintenance, decay of existing structures and facilities.	Potential massive alteration of the physical environment, construction of new and upgrading of existing facilities.	Creation of development-specific facilities, deterioration of alternative productive facilities, destruction of environment.
Cultural	Initial contact, new ideas, potential for loss of cultural continuity.	Suspension of activities that assure cultural continuity (e.g., subsistence harvest).	Gradual erosion of culture: loss of unique knowledge, skills, and/or perspectives.
Social	Organizational changes investment of time, money, or energy for support or resistance; differential construction of risk.	Population increase, influx of outsiders: decline in density of acquaintanceship: social change.	Gradual loss of social human capital (e.g., organizational networks and skills, replacements having limited optional application).
Political/Legal	Litigation to force or block proposed development, heightened political claims-making.	Intrusion of development activity into community politics, litigation and conflict over activity impacts.	Zoning and regulatory changes in search of new development, new laws/ruling in response to impacts.
Economic	Decline or increase in property values, speculation, investment.	Traditional boom/bust effects, inflation, entrance of outsiders into local labor market.	Loss of economic flexibility, specialization of business.
Psychological	Anxiety, stress, anger: gains or losses in perceived efficacy.	Stress associated with rapid growth, psycho-social pathology, loss of efficacy.	Acquisition of coping strategies that are potentially maladaptive under future scenarios.

Source: Gramling and Freudenberg, p. 218.

niques could aid in estimating indirect effects of proposed transportation projects by providing insight into the effects of similar past projects in similar settings.

Prospective techniques aim to predict the future based on current and past information and trends. The following three categories of forecasting methods are discussed:

1. Modeling/causal methods;
2. Extrapolation/time series; and
3. Normative forecasting/qualitative methods.

Perspective Techniques

Comparative Approach. The study entitled "Measuring Impacts of Land Development," sponsored by the Land Use Center of the Urban Institute, was examined for indicators for evaluating indirect effects. In the absence of studies directly on indicators for indirect effects, this study is referenced because induced changes in land use and associated changes in the environment are included in the CEQ definition of direct effects. Therefore, going one step beyond land development, the effects of land development per se are often the type of indirect effects of projects (i.e., related effects of induced growth or induced changes in land use, population, and employment), including transportation projects, referred to in the CEQ definition.

To evaluate impacts, Schaenman and Muller propose the before-and-after analysis, which entails gathering data of existing conditions both before and after development. They recommend using a list of 48 impact measures to examine the economy, the natural environment, aesthetic and cultural values, and public and private services. For example, to measure changes in the quality of public and private services, they suggest looking at indicators to measure services such as quality of drinking water, hospital care, crime control, fire protection, recreation, and education, among others. (For the full list of indicators, see Table 13.)

TABLE 11 Hamilton's ranking approach

Hamilton's Alternative 1: Classes and Types of Impacts

	Class				
	I	II	III		
Impact	Physical	Sensual	Conceptual	Permanent	Temporary
Direct					
Visual		X	X	X	
Noise level increase		X		X	
Wildlife	X				X
Wetlands	X				X
Land loss	X	X		X	
Soil erosion	X	X			X
Vegetative modification	X	X		X	
Air pollution	X	X			X
Water pollution	X	X			X
Land alteration	X	X		X	
Cultural resources			X	X	
Indirect					
Litter	X	X	X		
Strip mines	X	X		X	
Induced					
Strip development	X	X	X	X	
Urban alteration	X	X	X	X	
Auto manufacture	X	X	X	X	
Petroleum production	X	X	X	X	
Junk cars	X	X			X

Hamilton's Alternative 2: Impacts Grouped by Source

	Source of Impact							
	Road Construction		Road Maintenance		Road Use		Development of Adjacent Lands	
Impact	P	T	P	T	P	T	P	T
Direct								
Visual	X				X		X	
Noise level increase		X		X	X		X	
Wildlife		X		X	X		X	
Wetlands		X					X	
Land loss	X						X	
Soil erosion		X						X
Vegetative modification	X		X				X	
Air pollution		X		X	X		X	
Water pollution		X		X	X		X	
Land alteration	X						X	
Cultural resources	X						X	
Indirect								
Litter		X		X	X		X	
Strip mines	X		X					
Induced								
Strip development	X						X	
Urban alteration	X				X		X	
Auto manufacture					X			
Petroleum production		X		X	X			
Junk cars					X			

NOTE: P = permanent, T = temporary.

Source: Hamilton, TRB 1166, p. 5 & 7.

TABLE 12 Summary of assessment techniques and forecasting tools

	Comparative Approach	Schaenman & Miller's "Before-and-After" Analysis	1) Identify community objectives & impacts of most importance locally, now and in foreseeable future. 2) Define specific measures for each impact area. 3) Identify data collection and best available analysis procedures for each measure.
		Christensen's "Before" Scenario	1) Collect baseline data, i.e. current profile of physical & social conditions in neighborhood. 2) Identify physical changes to neighborhood that will result with & without development. 3) Estimate social impacts, or differences between "with" & "without" development profiles. 4) Evaluate significance of impacts. 5) Identify alternatives to mitigate negative impacts.
	Regression Techniques	Use of Regression Equations	Use variables, e.g., proximity to transportation arteries, income, neighborhood amenities, and closeness to shopping, to examine changes in system.
	Modeling/ Causal Methods	Buffington, et al.'s Urban Development/ Land Use Simulation Models	1) EMPIRIC Activity Allocation Model. 2) Projective Land Use Model (PLUM). 3) Integrated Transportation and Land Use Models Package (ITLUP). 4) Access and Land Development Model (ALD). 5) Land Use Allocation Model (LUAM).
		Talhelm's Community Options Model	1) 1-day scoping session to clarify issues and develop framework for model based on those issues. 2) 2-day workshop in which modeling experts specify equations of model to develop first draft model. 3) Interviews of workshop participants & local residents to review model for forecasting accuracy.
		Green's Land Use and Traffic Modeling	1) Green's two-step method for assessing population and housing growth (Table 14). 2) Green's approach to estimating growth of trade and service centers that may accompany transportation project (Table 15).
	Extrapolation / Time Series	Vlachos' Trend Extrapolation and Correlation	1) Sample extrapolation: whatever trends existed in past will continue in future. 2) Curve fitting: use of judgement in forecasting trend; trend may not be linear in nature. 3) Trend curves: looking at trend's relationship to two or more other trends.
		White's Probabilistic Forecasting	1) Estimate increased land value of individual land parcels due to project, assuming that economic effects of project will be capitalized into value of land. 2) Establish relationship between land value and land use, assuming change in land value prompts change in land use. 3) Estimate probability of certain type of land use physically impacting wetlands; apply probability to each land parcel. 4) Probability of land use change X probability of wetland impact = estimate of increased probability of impact.
	Normative Forecasting/ Qualitative Methods	Vlachos' Delphi Technique	1) Make effective use of informed intuitive judgment. 2) Combine individual judgments systematically and obtain reasoned consensus. 3) Zero in on the most important issue and developments. 4) Establish time horizon and severity framework.
		Vlachos' Scenario Writing	1) Identification of potential users and uses of scenarios. 2) Statement of assumptions or "visions" about world and future. 3) Problem definition & structure — ID factors affecting developments, elaborate "themes" & select critical issues. 4) Selection of time horizon suitable to specific problem requirements. 5) Collection and compilation of relevant data and information base to be used in developing scenarios.
		Vlachos' Alternative Futures Analysis	Emphasizing what may plausibly happen rather than what is predicted to happen.

TABLE 13 Indicators used to measure effects of land development

Impacted Sector	Variable	Indicator
Economic	Public Fiscal Balance	1) Net change in government fiscal flow.
	Employment	2) Number of new long-term and short-term jobs provided. 3) Change in numbers and percent employed, unemployed, and underemployed.
	Wealth	4) Change in land values.
Natural Environment	Air Pollution	5) Change in level of air pollutants and change in number of people at risk or bothered by pollution.
	Water Pollution	6) Change in the level of water pollutants, change in tolerable types of use, and number of persons affected, for each body of water.
	Noise Pollution	7) Change in noise and vibration levels, and the number of people bothered by excessive noise and vibration.
	Greenery and Open Space	8) Amount and percent change in greenery and open space.
	Wildlife and Vegetation	9) Number and types of rare or endangered species that will be threatened. 10) Change in the abundance and diversity of wildlife and vegetation in the development and community.
	Scarce Resource Consumption	11) Change in the frequency, duration and magnitude of shortages of critically scarce resources, and the number of persons affected.
	Natural Disasters	12) Change in number of people and value of property endangered by flooding, earthquakes, landslides, mudslides, and other natural disasters.
Aesthetic and Cultural Values	Views	13) Number of people whose views or sightlines are blocked, degraded, or improved.
	Attractiveness	14) Visual attractiveness of the development as rated by citizens and "experts." 15) Percent of citizens who think the development improves or lessens overall neighborhood attractiveness, pleasantness, and uniqueness.
	Landmarks	16) Rarity and perceived importance of cultural, historic, or scientific landmarks to be lost or made inaccessible.
Public and Private Services	Drinking Water	17) Change in the rate of water shortage incidents. 18) Change in indexes of drinking water quality and safety.
	Hospital Care	19) Change in number of citizens who are beyond x minutes travel time from a hospital emergency room (using such time as the community considers reasonable). 20) Change in average number of days of waiting time for hospital admittance for elective surgery.
	Crime Control	21) Change in rate of crimes in existing community of new development (or expert rating of change in hazard presented). 22) Change in percent of people feeling a lack of security from crime.
	Fire Protection	23) Change in incidence rates. 24) Change in rating of fire spread and rescue hazards.
	Recreation	25) Change in the number of people within or beyond a reasonable distance (x miles or y minutes) from recreational facilities, by type of facility. 26) Change in usage as a percent of capacity; waiting times; number of people turned away; facility space per resident; and citizen perceptions of crowdedness at recreational facilities. 27) Change in perceived pleasantness of recreational experience.
	Education	28) Change in number of students within x minutes walk or y minutes ride from school, by type of school. 29) Number and percent of students having to switch schools or busing status (from walking to busing or vice versa). 30) Change in crowdedness "breakpoints" (such as needed for added shifts) or indicators (such as student-teacher ratio); and student, teacher, and parent perceptions of crowdedness and pleasantness of schooling.
	Local Transportation	31) Change in vehicular travel times between selected origins and destinations. 32) Change in duration and severity of congestion. 33) Change in likelihood of finding a satisfactory parking space within x distance from destination or residence. 34) Change in numbers and percent of residents with access to public transit within x feet of their residences; and numbers and percent of employees who can get within x distance of work location by public transit. 35) Change in the rate of traffic accidents (or expert rating of change in hazard presented). 36) Number and percent of citizens perceiving a change in neighborhood traffic hazard; and change in pedestrian usage of streets, sidewalks, and other outdoor space.

(continued)

TABLE 13 Indicators used to measure effects of land development (*continued*)

Impacted Sector	Variable	Indicator
Public and Private Services (Continued)	Shopping	37) Change in the number of stores and services, by type, available within x distance of people. 38) Change in the percent of people generally satisfied with local shopping conditions (access, variety, crowdedness).
	Housing Adequacy	39) Change in number and percent of housing units that are substandard, and change in number and percent of people living in such units. 40) Change in number and percent of housing units by type (price or rent range, zoning category, owner-occupied and rental, etc.) relative to demand or to number of families in various income classes in the community.
	People Displaced	41) Number of residents or workers displaced by development — and whether they are satisfied with having to move.
	Population Mix	42) Change in the population distribution by age, income, religion, racial or ethnic group, occupational class, and household type.
	Crowdedness	43) Change in the percent of people who perceive their neighborhood as too crowded.
	Sociability/ Friendliness	44) Change in frequency of visits to friends among people in the existing neighborhood, and frequency of visits between people in the existing neighborhood and the new development. 45) Change in the percent of people perceiving their neighborhood as friendly. 46) Number and percent of people with change in "visual" or "auditory" privacy. 47) Number and percent of people perceiving a loss in privacy.
	Overall Contentment with Neighborhood	48) Change in percent of people who perceive their community as a good place to live.

Source: Schaenman and Miller, November 1974.

Data needed for these measures can be obtained from citizen surveys, physical measurements, physical inventories, and economic data from U.S. census and municipal records. According to the authors, all these measures need not be used for every analysis; rather, it is useful to use them in the following three steps:

1. Identify community objectives and the associated types of impacts of most importance locally now and in the foreseeable future;
2. Define specific measures for each impact area; and
3. Identify data collection and the best available analysis procedures for each measure (*36*, p. 23).

This before-and-after approach is clearly defined in Christensen's "Social Impacts of Land Development" (40), another study in the Urban Institute's series on land development impacts. The study recommends the following framework for estimating social impacts (i.e., the "before" scenario):

1. Collect baseline data—i.e., current profile of physical and social conditions in the neighborhood;
2. Identify physical changes to the neighborhood that will result with and without the development;
3. Estimate social impacts or those differences between the "with development" and "without development" profiles;
4. Evaluate significance of the impacts; and
5. Identify alternatives to mitigate the negative impacts (*40*, p. xiii).

Regression Techniques. Regression analysis is commonly used by researchers to analyze changes in a system. To examine changes in land values, variables such as proximity to transportation arteries, income, neighborhood amenities, and closeness to shopping are used in regression equations. This method can shed light on which variables were significant in influencing change. The major advantage of this technique is that a control is not needed. The disadvantage is that extensive data are needed to conduct the regression. Regression studies frequently cannot fully account for changes to the system—i.e., the effects of other, unaccountable variables.

Prospective Techniques

Modeling/Causal Methods. *Urban Development/Land-Use Simulation Models*. According to Buffington et al., there are five predominant models being used to simulate land changes, given exogenous projections in future population, employment, and land use (*41*, pp. 54–61). They are as follows:

1. EMPIRIC activity allocation model;
2. Projective land-use model;
3. Integrated transportation and land-use models package;

4. Access and land development model (ALD); and
5. Land-use allocation model.

Most of these models are very data intensive. The exception here is the ALD model, which is programmed to distribute a given amount of development among a group of zones in ways that reach an equilibrium level between development in each zone and the accessibility of each zone. Buffington writes that it is questionable whether the ALD model is reliable in providing traffic generation forecasts for small areas.

Community Options Model. Talhelm, contracted by the Michigan Department of Transportation, is developing a simulation modeling tool for use by rural communities. The goal of this model is to provide rural communities with a tool they can use independently of the Michigan Department of Transportation to estimate impacts of simulated local highway changes. The model aims to help rural communities manage change to their localities associated with highway construction. Talhelm's approach to developing the community options model incorporates expert collaboration into the building of the model. His model-building process entails the following:

1. A 1-day scoping session to clarify issues and develop the framework for the model based on those issues;
2. A 2-day workshop in which modeling experts specify the equations of the model to develop the first draft model; and
3. Subsequent interviews of workshop participants and local residents to review the model for forecasting accuracy (*42*).

Talhelm's model will be designed to be issue specific and adaptable so that it can be community specific.

Land-Use and Traffic Modeling. DeSanto and Erickson propose using a traffic modeling tool, MinUTP, developed by the DOT to predict changes in land use that may occur with road improvements. They used this model to predict spatial changes as a consequence of constructing a 20.92-km (13-mi) limited-access highway through three adjacent towns in New England. Growth in employment and square footage for residences and offices resulting from the project are predicted outside of the model. The forecast is then input into the traffic model for distribution throughout zones based on factors such as traffic levels and existing land use. This model forecasts where growth is most likely to occur as a result of a transportation project. These projections can be used by planning and zoning agencies to prepare for potential impacts.

Green's approach is similar to the model of DeSanto and Erickson in that exogenous factors such as population and economic growth are factored into an allocation model to forecast how land use will change as a consequence of a transportation improvement (*43*). He proposes a two-step technique for assessing population and housing growth as a result of transportation improvements based on the premise that home-to-work travel time is the chief determinant of where households choose to live. Changes in travel times that result in improving existing roads or in building new roads will affect household location decisions and, consequently, housing developments or vice versa.

Green recognizes that housing growth is also contingent on factors that may encourage or constrain growth, such as the existing infrastructure of the area, available developable land, physical characteristics of that land, and public policy concerning the land. Taking these factors into account, Green's two-step method includes (1) allocating employment place of work to place of residence based solely on access; and (2) modifying this employment allocation due to the encouraging or constraining factors of the site. Table 14 details Green's two-step method.

Green states that there is no scientific way to judge the importance of site-specific factors to its propensity for growth subject to transportation improvements. Consequently, for Step 2 of this approach, judgment is needed to assess which of various factors—e.g., the physical characteristics of the land, zoning ordinances, or image of the area—has greater or less importance in determining whether an area will grow. However, Green says that a weighing process can be used to arrive at a conclusion for all the given factors.

Green's approach to assessing changes in industrial location, as illustrated in Table 14, is similar to residential location and is subject to similar constraints. His approach to estimating the growth of trade and service centers—e.g., gas stations and strip development—that may accompany a transportation project is presented in Table 15.

Extrapolation/Time Series. To predict trends, both trend extrapolation and probabilistic forecasting techniques require historical data for statistical analysis. These tools provide the needed projections, such as population and economic forecasts, for use by other techniques. According to Vlachos, these tools have their weaknesses; they are not reliable for long-range projections beyond 5 years. Moreover, extrapolation techniques are based on the questionable assumption that past trends are likely to remain constant.

Trend Extrapolation and Correlation. Within the common tool of trend extrapolation, Vlachos discussed three widely used techniques: simple extrapolation, curve fitting, and trend curves. Simple extrapolation is based on the assumption that whatever trends existed in the past will continue into the future. Curve fitting allows for judgment in forecasting the trend and accepts that the trend may not be linear in nature. Trend curves, or trend correlation analysis, examine a trend by looking at its relationship to two or more other trends.

TABLE 14 Green's two-step method for assessing population and housing growth

STEP ONE:

1. Estimate number of employees in target year by general location.
2. Determine "possible" residential land in target year.
3. Measure travel time between each significant employment area and each general competitive residential location.
4. Tentatively allocate the employment at each general location to each residential area.

STEP TWO:

1. Determine amount of industrial land.
2. Determine which industries are compatible with the industrial land available.
3. Determine projected regional growth rate for the compatible industries.
4. Measure travel times of the compatible industrial land areas to markets and suppliers for the compatible industries.
5. Allocate projected industrial growth at each competitive industrial location on the basis of minimizing travel costs.
6. Adjust the projection for non-access-related factors.

Source: Green, June 1979.

Simple extrapolation, says Vlachos, has weaknesses. The validity of assumptions used concerning the continuity of a trend, the validity of long-term forecasts, and the crudeness of input data pose problems for the reliability of extrapolations. Nevertheless, Vlachos says, these techniques can be useful for assessing indirect effects if the underlying forces for the trends—economic, social, political, and ecologic—are considered.

Probabilistic Forecasting. In examining potential wetland impacts from the proposed Southwestern Expressway through the city of Virginia Beach, White (*44*) devised the following approach:

1. Estimate increased land value of individual land parcels due to the project based on the assumption that the economic effects of a project will be capitalized into the value of land.
2. Establish a relationship between land value and land use based on the assumption that a change in land value can prompt a change in land use.

TABLE 15 Green's approach to estimating growth of trade and service centers

1. Identify and map all centers (existing, potential and proposed) that could reasonably be expected to be significantly affected by the project in question.
2. Classify each center by type.
3. For each adjacent pair of centers (of the same type), delineate the trade area breakpoint between them.

   Breakpoint = [Time/Distance] ÷ [1 +(Size of Center A/Size of Center B)$^{1/2}$]
4. Allocate expenditure to them based on trade area thus delineated.
5. Reallocate dollars to centers based on changed access.
6. Difference is impact.
7. Adjust the impact prediction based on consideration of non-access-related factors.

Source: Green, June 1979.

3. Estimate the probability of a certain type of land use physically affecting wetlands; apply probability to each land parcel.
4. Multiply the probability of a land-use change by the probability of a wetland impact to yield an estimate of the increased probability of impact (*44*, p. 18).

According to White, this estimation approach is data intensive, and the only realistic way to assemble the necessary data is to incorporate geographic information system technology into the study. This method also may be difficult to apply statistically because the approach is laden with assumptions, says White. For example, a comparison of secondary impacts with the expressway to impacts without the expressway assumes that no change will occur if the road is not built.

Normative Forecasting/Qualitative Methods. Vlachos proposes that use of what are commonly called soft techniques—such as the Delphi process of developing consensus, scenario building, and alternative futures analysis—can be useful in evaluating indirect effects where historical information is lacking, or to supplement hard techniques such as modeling. According to Vlachos, these methods look at problems holistically and allow for more intuitive problem conceptualization.

Delphi Technique. The Delphi technique is systematic solicitation of expert opinion, which achieves consensus through a carefully designed program of sequential individual analyses subject to peer review. Because consensus in this technique is derived without the forum of open discussion, where more forceful opinions may override others, this output is considered to be better informed and more valid. At the end of the process, this technique solicits a consensus from a group of knowledgeable people on what the impacts may be.

The purpose of the Delphi technique is the following:

1. To make effective use of informed intuitive judgment;
2. To combine individual judgments systematically and obtain reasoned consensus;
3. To zero in on the most important issue and developments; and
4. To establish time horizon and severity framework (*34*, pp. 6–31).

Vlachos contends that the advantage of the Delphi technique is that it narrows expert opinion and provides a means to gather opinion on causal relationships that cannot be adequately modeled. Talhelm's method uses this technique in gathering experts to build the most appropriate model to simulate changes to a given rural community that will result from a transportation project.

Scenario Writing. Scenario writing, another qualitative forecasting technique suggested by Vlachos, is the process of imagining outcomes given a set of assumptions about the present and a sequence of events that occur in an interim period. According to Vlachos, scenario writing can be used effectively as a forecasting approach because the process can unearth faulty assumptions, encourage open-ended thinking, and illustrate various possibilities without the constraints of data-intensive, hard approaches, such as regression studies. Vlachos states that scenario writing should include the following:

1. Identification of potential users and uses of scenarios;
2. Statement of assumptions or visions about the world around us and about the future;
3. Definition of the problem and its structure, including identification of factors that affect developments, elaboration of themes, and selection of critical issues;
4. Selection of the time horizon suitable to specific problem requirements; and
5. Collection and compilation of relevant data and an information base to be used in developing the scenarios (*34*, pp. 6–36).

Vlachos cautions that for scenario writing to be an effective tool it must provide plausible, interesting, understandable, and credible projections of the future.

Alternative Futures Analysis. This technique of forecasting emphasizes what may plausibly happen instead of what is predicted to happen. Alternative futures analysis can also raise questions about the preferable future. Vlachos says that this technique may be helpful in developing a larger framework in which the magnitude and significance of indirect effects may be analyzed.

Conclusion of Published Literature Review

In examining the approaches offered by the literature on assessing indirect effects, the two methodologies offered could be classified as either systems oriented, which Vlachos advocates as a comprehensive survey of impacts across various systems, or reductionist, which Hamilton and Leopold recommend through the use of matrices with specific categories as an identification and evaluation tool. As none of the empirical pieces reviewed discussed their assessment methodologies, it is difficult to say whether a systems-oriented approach is more amenable to implementation than a reductionist approach or vice versa. Moreover, it is uncertain whether this approach dichotomy is mutually exclusive or mutually reinforcing. However, what these past studies may have to offer in addressing indirect effects may be that there is no single right way to assess indirect effects. Options exist in identifying, assessing, and evaluating these effects;

we can select methodologies and methods to suit specific situations and problems.

Although there have been many evaluation techniques recommended in the published literature since the issue of indirect effects arose in the 1970s, few studies have attempted to measure the degree of indirect effects from a transportation project. It is evident from this review that these attempts have used solely hard techniques, such as modeling. For example, within the review, the three studies that empirically used a method to measure indirect effects are Talhelm's Community Options Model, DeSanto and Erickson's use of the DOT model MinUTP, and White's use of probabilities forecasting.

Having noted that past studies have been skewed toward modeling indirect effects, Talhelm's model incorporates the Delphi method, which is considered a soft technique, into his model-building process. As Talhelm's study is currently under way, perhaps it can be said that the value of qualitative techniques is becoming more recognized; hence, these techniques are being incorporated into the conventional quantification tools.

EIS CONTENT ANALYSIS

Definitions of Indirect Effects and Other Terms

There was no consistent definition of indirect effects presented in the 90 EISs studied. When all projects were considered together, the terms indirect and secondary essentially were used interchangeably, and their usage was not limited to any single discipline, such as socioeconomics or land use. Induced effects, on the other hand, were most often tied to land-use or economic impacts. The term induced was used to indicate effects such as land-value changes, land-use changes, changes in income due to project construction purchases, and local employment generated by project construction and operation.

As a general rule, cumulative effects tended to be differentiated from indirect effects by reason of consideration of the effects of other projects. However, it is not possible to develop any more specific differentiation based on data from the content analysis. In fact, in several instances, the definitions of cumulative and indirect effects overlapped considerably.

Two examples illustrate the different types of terminology in use. The first is from the 181st Avenue to Sandy River Columbia River Highway (I-84) FEIS (Portland, Oregon). This EIS discussed several types of indirect effects. In one case, for example, secondary impacts on water resources were projected because of increased development as a result of the project. These secondary effects included nonpoint source pollution effects on surface waters and aquifers. In another case, indirect land-use change was attributed to possible changes in development caused by the project. Cumulative land-use changes were linked to other highway projects in the study area and considered the effects of these in combination with the effects of the 181st Street project. When wetlands and ecologic impacts were considered, however, the distinction between indirect and cumulative began to blur. Nondirect wildlife impacts were referred to jointly as indirect and cumulative.

At another place in the FEIS, economic effects were divided into indirect and induced impacts, distinguished as follows:

> Indirect impacts include purchases that are made by businesses selling products or services to direct suppliers of products or services. Induced impacts include purchases by households due to increased incomes that are linked directly and indirectly to expenditures for the project. (*45*, pp. 16–17)

Another example of the different types of terminology is from the Sears Island dry cargo terminal in Searsport, Maine, a port project. The Sears Island FEIS included the following definitions of primary, direct, indirect, secondary, and induced effects:

> "Primary" impacts include both "direct" effects—the first round of expenditures, jobs, and other effects associated with the port's construction and operations—and "indirect" effects—the second and successive rounds (multiplier) of effects associated with the port's construction and operations.
>
> In contrast, "secondary" impacts are the impacts "induced" by and attributable to the port's facilities and operation. For example, secondary impacts would result from the industrial development targeted for the port. (*46*, pp. 4–88)

Examples of indirect effects from the content analysis are shown in Table 16.

The content analysis also suggests that many indirect effects were assessed according to the CEQ definition but were not explicitly referred to as indirect. This was particularly true in the socioeconomic category, in which one-third of the EISs assessed effects that could have been labeled indirect but were not.

Identification of Indirect Effects in EISs

Indirect effects were analyzed in two ways: in terms of the number of projects that reported them and by counting the number of indirect effects identified for each project. The following paragraphs consider these two perspectives. This section also considers the statistical relationships that were identified between indirect effects and geographic, environmental, and institutional variables and provides a more detailed look at projects in which indirect effects were identified as an area of controversy. The controversial projects provide insight into how indirect effects are dealt with when there is conflict among agencies or with the public.

Number of Projects Reporting Indirect Effects

Of the 90 total projects reviewed, 81 (or 90 percent) identified indirect effects. However, this number cannot be used

TABLE 16 Examples of indirect effects

PROJECT ACTION	DIRECT EFFECT	INDIRECT EFFECT	INDIRECT EFFECT	INDIRECT EFFECT	INDIRECT EFFECT
Socioeconomics and Land Use					
Bridge to undeveloped area	-> Improved access	-> Residential development			
Highway extension	-> Improved access	-> Land use development	-> Floodplain encroachment		
Harbor improvements	-> Improved movement of goods	-> Industrial development near waterfront	-> Visual impact on shoreline		
New highway	-> Improved access	-> Land use development	-> Pre-emption of farmlands		
By-pass highway	-> Improved access	-> Development of commercial land uses on by-pass	-> Increased tax revenues from commercial ratables		
Construction of new highway	-> Immigrant Construction work force	-> Income to construction workers spent locally	-> Local businesses hire new employees	-> Population increase because of new employees moving into area	-> Increased demand for community facilities
New highway	-> Improved access to vacant land suitable for industrial development	-> Development of new businesses and industries on these industrial lands	-> Regional economic growth (increased income, employment & earnings)		
New highway bypass around congested downtown area	-> Improved access to vacant suburban land suitable for commercial development	-> New shopping malls and highway-oriented businesses locate on this land	-> Business declines in older downtown area which was by-passed	-> Downtown area deteriorates	
Adopt 'No Action' alternative instead of highway bypass around congested downtown area	-> Additional parking areas and bus routes provided to serve downtown businesses	-> Downtown businesses upgraded	-> More business activity and shopping takes place in downtown	-> Public improvements such as malls, sheltered bus stops, etc	
Adopt `No Action' alternative instead of highway bypass around congested downtown area	-> Businessmen and planners cannot agree on downtown renewal program	-> Downtown business slows and the area deteriorates	-> The city suffers declines in population, income, employment		
New general aviation airport	-> Aviation-related businesses locate on or near new airport	-> New businesses hire and provide income for local workers	-> Regional economy improves		
Addition of new runway at metropolitan area airport	-> Construction materials purchased in region of airport	-> Local suppliers use increased income for productivity improvements	-> Productivity improvements increase competitiveness of local suppliers	-> Improved competitive position of local suppliers leads to increased employment	-> Regional economic growth results from new employment and income
Water Quality					
Highway extension	-> Improved access	-> Land use development	-> Increased non-point source water pollution	-> Decline in surface water quality	-> Health problems
Highway extension	-> Improved access	-> Land use development	-> Increased non-point source water pollution	-> Contaminants enter water supply aquifer	-> Contamination of groundwater

(*continued*)

TABLE 16 Examples of indirect effects *(continued)*

Wetlands					
New highway	-> Improved access	-> Land use development	-> Many small wetlands eliminated during development	-> Significant aggregate loss of wetlands due to development	
New highway	-> Alteration of surface water drainage patterns	-> Elimination or degradation of downstream wetlands			
Ecology					
New commuter rail line	-> Removal of vegetation and habitat	-> Fragmentation of large habitat area	-> Elimination of species which require this large habitat		
New highway on barrier island	-> Migration of dunes places sand on highway, interrupting traffic	-> Structures built to keep sand off highways	-> Migration pattern of dunes altered	-> Impacts to sensitive barrier island habitat	
New highway in coastal area	-> Culverts built over numerous small streams	-> Interruptions to migration patterns of anadromous fish	-> Juvenile anadromous fish killed in fresh waters	-> Decline in numbers of adult anadromous fish in salt water	-> Decline of commercial fishery for anadromous fish
Air Quality					
New highway	-> Improved access	-> Development of new suburban shopping center and associated commercial activities	-> Creation of air quality contamination `hot spot' exceeding standards	-> Reduction in available increment for future highway projects	
Noise					
New or expanded major international airport	-> New access roads and parking areas required to handle increased passenger load	-> Additional vehicular traffic on these roads produces noise above standards	-> Nearby residential property values are lowered		
Cultural Resources					
New rail mass transit project	-> Improved access for employees to station areas	-> Development of office parks in the vicinity of stations	-> Historic buildings are removed to make way for offices		
New Interstate highway interchange near older city	-> Improved access to nearby rural area	-> Development of land uses in vicinity of interchange	-> Significant alteration of view from historic farm property		
Other					
Highway extension	-> Improved access to undeveloped areas near a city	-> New land use development encounters hazardous waste sites			
New highway	-> Improvement of traffic flow, stabilization of vehicular speeds	-> Reduced fuel usage for vehicles using new highway	-> Reduced utilization of fossil fuels		

as a generalization for all transportation EISs, because the sample for this study was deliberately selected to include primarily projects identified in the Federal Register as indirect effects.

Airport project EISs differed somewhat from other project EISs in their emphasis on indirect socioeconomic effects. All airport project EISs included analyses of indirect socioeconomic effects. The other categories of indirect effect were considerably less emphasized in the airport project EISs examined. The analysis of indirect effects of transit projects differed substantially from other transportation projects in many respects. Socioeconomic indirect effects were dealt with on a par with other types of transportation projects, but other categories of effects were dealt with considerably less often if at all. Port projects appeared to follow the same general pattern as other projects, but the small size of the sample, four, does not lend itself to overall generalizations.

Numbers of Indirect Effects Identified by Projects

All transportation project EISs in the sample recorded an average of about five indirect effects each. However, there were some noteworthy differences among project types. On average, port project EISs reported 7.5 indirect effects per project (there was no statistical significance to this difference because of the small sample size). On average, transit and airport project EISs recorded fewer indirect effects than highway projects. Transit projects were statistically different from the other modes primarily because of fewer identified indirect land-use and wetlands effects (this difference was statistically significant in some, but not all, tests). A strong statistical relationship indicated that airports identified indirect socioeconomic effects more than other projects.

EISs of highway projects including bridges tended to identify somewhat more overall indirect effects than other highway projects. Statistical tests showed some relationship between new highways and indirect land-use and noise effects, indicating that these effects tended to appear more frequently on new highway projects. Indirect wetlands effects, on the other hand, were more strongly associated with highway improvement projects than with new highway projects.

Statistical Relationships Between Indirect Effects and Project Settings

Overall, there were relatively few geographic, environmental, or institutional factors that statistically related to the indirect effects identified in the sampled EISs. Several tests were conducted to explore relationships that might be reasonable to expect based on experience, the literature, or interviews. For example, it was hypothesized that the region of the country might influence indirect effects identification. Projects were aggregated into FHWA regions to test this hypothesis; however, no significant relationships were observed. Another hypothesis tested was that more indirect effects would appear in cases where supplemental EISs were required; however, statistical tests did not bear this out. In addition, no statistically significant relationships were identified between indirect effects and population change rate, sponsoring agency, project size, or development objectives.

The one tested hypothesis that was borne out by statistical analysis concerned the date of the project DEIS. As shown in Figure 1, there was a clear trend toward identifying increasing numbers of indirect effects over the time period of the sampled EISs (1986–1993). This was a very strong statistical relationship, supported by two tests. The implication of this finding is clear; indirect effects are receiving more attention. Many sponsoring agencies in all likelihood will have to devote more resources to identifying indirect effects.

Correlation matrices were used to probe for other statistical relationships, and a few showed up. These are interesting and deserve discussion.

First, there was a strong, positive relationship between the existence of a local land-use plan and identification of indirect effects. In other words, the number of indirect effects identified varies between projects in areas with local plans (55 in the sample) and those without. There was no relationship indicated with any other type of plan (county, state, or other land-use plans). One particular aspect of this relationship stood out; when plans existed, there was a strong correlation between indirect cultural resources effects and highway projects.

Another interesting finding was that the number of indirect effects identified in EISs tended to be higher for projects outside of metropolitan statistical areas (MSAs). This relationship is illustrated in Figure 2, which shows the average number of indirect effects identified for projects inside MSAs, outside MSAs, and both inside and outside MSAs. This relationship was particularly strong for indirect wetlands and ecologic effects.

Indirect Effects As Areas of Controversy

There were 12 projects in the sample whose EISs indicated that a controversy existed concerning indirect effects. It is instructive to discuss these projects separately, because the degree of controversy appears to affect the type of analysis used.

Overall, the controversial projects identified an average of 6.3 indirect effects, as opposed to 4.5 in the sample of 90 projects. Every one of the controversies involved the potential economic and land-use change that would occur because of the project. On each of the 12 projects, at least one socioeconomic or land-use indirect effect was identified.

The number of land-use indirect effects identified was strongly correlated with controversial projects. The projects can be further categorized. Certain projects are growth stim-

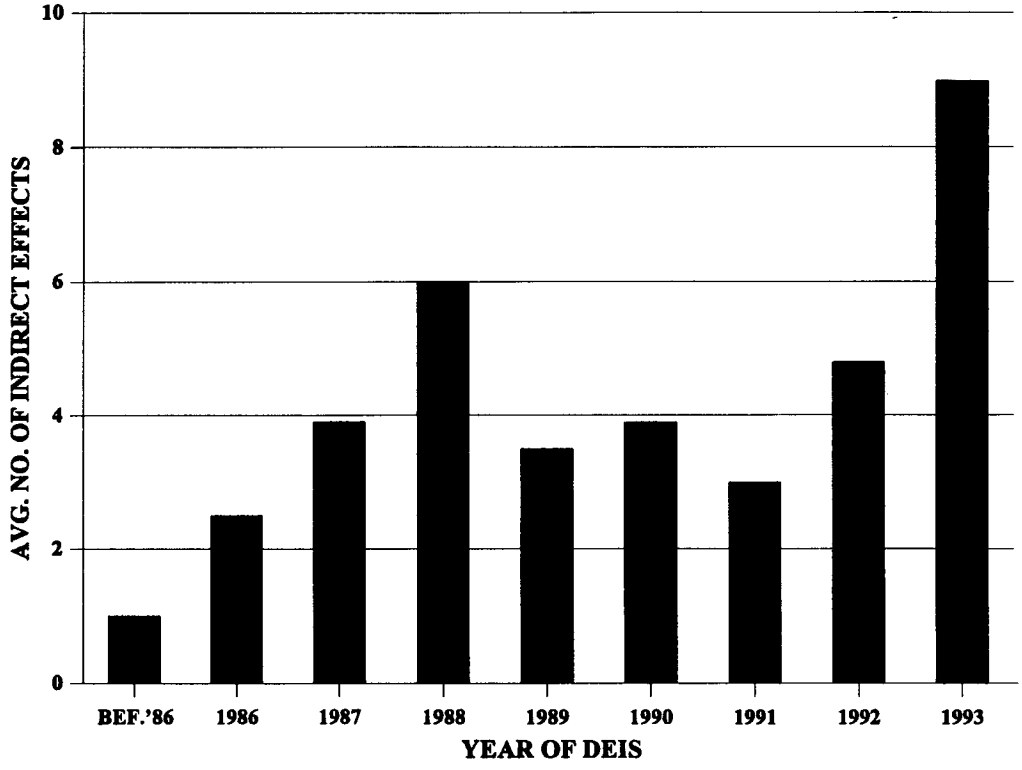


Figure 1. Indirect effects by DEIS year.

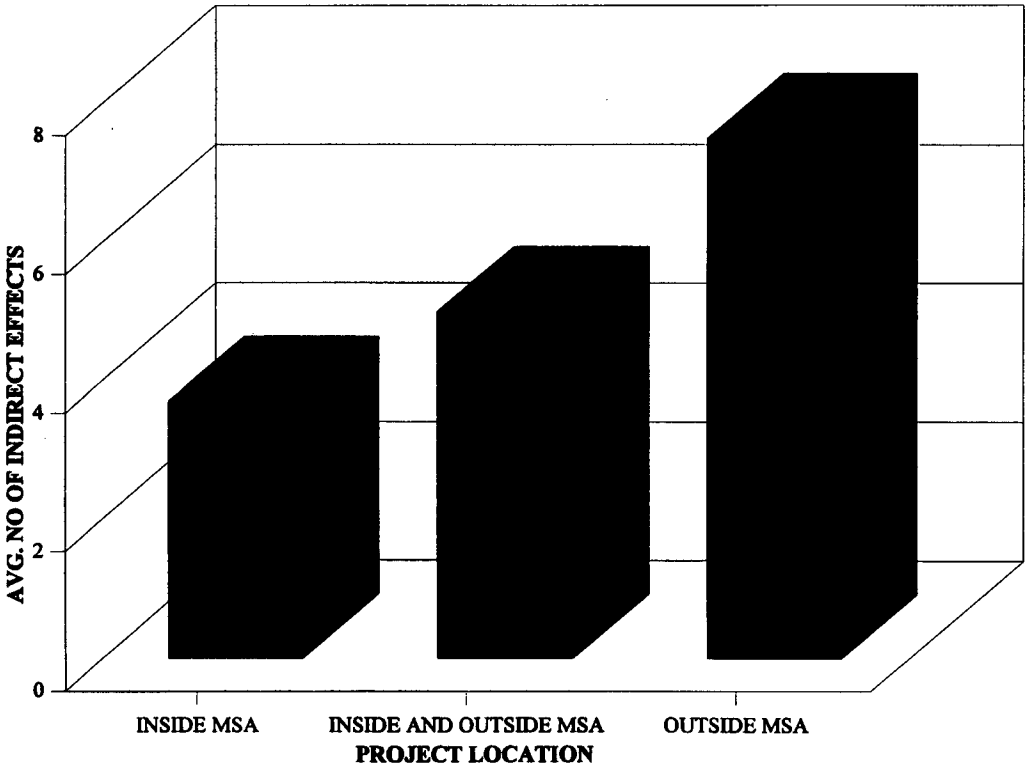


Figure 2. Indirect effects by project location.

ulating—those whose purpose is to stimulate economic growth vis-à-vis land development (i.e., those that have economic development as a project selling point). An example of a project of this set is the New Hampshire Route 101/51 Improvements FEIS, which stated that one of the areas of controversy was "impacts associated with secondary development possibly stimulated by the project" (*47*, p. xxi). Only one indirect effect was analyzed in any depth, generally referred to as secondary development, and only one other category of indirect effect was identified (wetlands). These are distinguished from projects that are growth serving—those whose purpose is to serve existing or planned future development (i.e., land development that is largely or exclusively independent of the transportation project).

Two of the more comprehensive studies of indirect effects as areas of controversy took place in Pennsylvania: one link of the Mon/Fayette transportation project south of Pittsburgh and the Lackawanna Valley industrial highway in the Scranton area. Both projects involved controversies concerning indirect effects. Both projects also had an identified goal of stimulating economic development within their areas of influence.

In essence, the Mon/Fayette DEIS provided a development feasibility analysis for each of the parcels considered suitable for potential industrial or commercial development based not only on economic data but on resource information as well. In addition, the DEIS identified indirect effects concerning vegetation and habitat, fiscal impact, community cohesion, and community facilities. For the Lackawanna Valley EIS, key concerns were identified with respect to the effects of secondary development on a broad array of resources and existing infrastructure. A total of 20 indirect effects were identified, and detailed studies of each were prepared. The studies covered socioeconomic, land-use, water-quality, wetlands, ecologic, air-quality, noise, cultural resources, and other types of indirect effects.

There was a tendency for controversial projects in the sample to involve highways, although the statistical relationship was not strong. Of the 12 controversial projects sampled, 10 involved highways. This was a somewhat higher ratio than the general sample (70 of 90 were highways). There were no transit or airport projects in the sample with controversial indirect effects identified in the EIS. The only type of project to have a significant statistical relationship with controversial indirect effects was port projects. Of the four port projects identified, two had controversies concerning indirect effects (Sitka Harbor, Alaska, and Sears Island dry cargo terminal, Maine). This sample is not large enough for firm conclusions to be drawn.

The Sears Island Dry Cargo Terminal project was conceived as a means of stimulating the Maine economy. The port plan included a bridge and access highway. Among the extensive list of controversial issues on this project was "secondary impacts related to the potential industrial park on Sears Island" (*46*, p. viii). A total of 19 indirect effects were identified in the EIS on the Sears Island project from all the major categories. There were five socioeconomic, four land-use, and five wetlands/ecologic indirect effects.

For all indirect effects categories on controversial projects, fewer than one-third were in the sketch qualitative categories; the comparable percentage for the general sample of 90 projects was 61.7 percent.

Indirect effects studies conducted on controversial projects tended to be methodologically more complex than was the case with the general sample, regardless of the number of indirect effects considered. The typical level of detail in indirect effects studies carried out on controversial projects is found in the EIS for the Page Avenue extension project near St. Louis, Missouri. Secondary effects were identified as being controversial in the DEIS because of the potential for induced development in the Mississippi River floodplain. An extensive discussion of this issue was included in the EIS along with a calculation of projected acreage of development that might occur in the floodplain and a detailed assessment of the floodplain capacity. Other related indirect effects, such as visual, were also discussed.

Even though wetlands and ecologic indirect effects were not explicitly listed as controversial in any of the 12 controversial projects, quantitative techniques were typically used when these indirect effects were identified (which occurred on five of the projects).

An example of ecologic studies carried out because of a controversial indirect effect is found in the South Lawrence trafficway EIS documents. The project was located near Lawrence, Kansas, and in the vicinity was an ecologic resource known as Elkins Prairie, which contained two threatened and endangered plant species. The preservation of prairie land, identified as disappearing rapidly because of development and agriculture, was noted as a major issue in this area. The indirect effect at issue was the effect of secondary development on Elkins Prairie. A detailed biological assessment, involving qualitative as well as quantitative information, was carried out, closely coordinated with the USFWS.

Techniques for Analyzing Indirect Effects in EISs

The discussion of techniques used in the EISs for analyzing indirect effects examined is divided into two sections; the first covers the results of statistical analyses concerning levels of effort and detail in indirect effects studies, and the second gives examples of several types of methodologies that appeared in EISs in the content analysis.

Statistical Analysis of Techniques

The checklist used in the content analysis grouped levels of effort/detail on indirect effects studies into three cate-

gories: quantitative, with numerical results derived by arithmetic or mathematical methods; detailed qualitative, comprehensive discussions of effects generally consisting of more than three paragraphs; and sketch qualitative, discussions generally consisting of three paragraphs or less. Detailed qualitative techniques in the EIS are essentially an elaboration of the kinds of arguments presented in sketch qualitative analyses. Typically, more arguments are utilized, more potential issues are discussed, and more data sources are consulted in the detailed qualitative approaches compared with the sketch qualitative approaches.

Overall, the EISs examined tended to use simpler techniques to evaluate indirect effects. Of the 275 indirect effects identified, 147 (53.5 percent) were evaluated by sketch qualitative techniques. The comparable percentage for detailed qualitative techniques was 14.5 percent, and 32 percent of indirect effects were evaluated by quantitative techniques. Socioeconomic indirect effects tended to be evaluated somewhat more frequently by quantitative techniques than the other categories, whereas sketch qualitative techniques were used somewhat more frequently for land-use and ecologic indirect effects.

The level of study detail/effort varied to some degree by type of project, reflecting the data presented earlier about indirect effect identification. EISs of new highway projects tended to use the more detailed qualitative, or quantitative, techniques. Less detail was typically used in EISs for projects involving bridges or improvements to existing highways. Transit project EISs typically used either quantitative or sketch qualitative techniques, whereas airport projects tended to use the more detailed techniques for their indirect socioeconomic effects analyses and sketch qualitative or quantitative techniques for the others. Port project EISs tended to use quantitative techniques for most indirect effects studied.

Some project-specific variables were found to relate statistically to the level of detail/effort used to study indirect effects. Quantitative or more detailed qualitative techniques tended to be used more frequently on more lengthy highway projects. The number of acres to be acquired by a project also varied positively with the level of detail/effort connected with indirect effects studies.

Population trends in a project's vicinity were also a factor in level of detail/effort. In areas with declining or static population, quantitative or more detailed qualitative techniques tended to be employed in indirect effects studies.

Techniques Used for Indirect Effects Studies

Sketch Qualitative Methodologies. An example of an objective sketch qualitative technique is found in the Ozark Mountain Highroad FEIS, a project located near Branson, Missouri. This project was being proposed to alleviate a declared economic emergency in which the economic growth of this tourist-oriented area was being stifled by traffic problems. Both the DEIS and FEIS were prepared in 1992. The project also had a controversial indirect effects issue involving the potential for larger-than-expected secondary development.

The entire indirect effects analysis for the Ozark Mountain Highroad EIS comprised three paragraphs. However, the analysis was cogent and to the point. It pointed out that new development associated with the highway would likely occur near the seven interchanges. It was noted that the steep, wooded terrain in the vicinity of the proposed route would limit the amount of development that could take place near the highway. The large amount of interagency coordination to study the area was also mentioned. The last paragraph of the indirect effect analysis concluded

> It is reasonable to assume that no substantial future areawide increases in development impacts are indicated by the highway alternative. The highway alternative can be expected, however, to have some influence over the location and pattern of the significant level of anticipated future development, which is expected to occur with or without the highway alternative. (*48*, pp. IV–7)

The Ozark Mountain Highroad study is a good example of a systems approach to evaluating indirect effects, where the indirect effects are considered together as a unit. The systems approach was not commonly used in the sample. Most EISs used a reductionist approach, in which the indirect effects were analyzed separately by category. This approach can fail to link the indirect effects, resulting in an incomplete understanding of how they function. The Ozark Mountain Highroad EIS was praised by the EPA in its summary of comments on the DEIS published in the Federal Register.

Detailed Qualitative Methodologies. An example of a detailed qualitative technique is included in the 181st Avenue to Sandy River Columbia River Highway (I-84) FEIS. This project was proposed as a major highway improvement in a suburbanizing area east of Portland, Oregon. Although the principal goal of the project was congestion relief, one of the goals was to "encourage economic development dependent on access to and from the freeway" (*45*, p. 4). The specific example of a detailed qualitative technique concerned water resources. In a one-and-a-half-page discussion, the induced land-use and traffic causes of the indirect effects on water resources were discussed in a complete and clear manner and then evaluated. Surface water and groundwater as well as wetlands were considered together in this discussion. It was clear that extensive research field work was carried out in the study area with respect to direct effects.

The 181st Avenue to Sandy River project included both qualitative and quantitative techniques. The resulting analysis of indirect effects in the FEIS is an example of a systems approach to the study of indirect effects. Although the presentation in the FEIS was by separate effect category, the effects were considered in relation to one another.

Another example of an indirect effects study taking a detailed qualitative technique is found in the North Douglas highway extension DEIS. This project concerned a highway whose purpose was to provide access to land developments and recreational opportunities on an island near Juneau, Alaska. The evaluation of indirect effects concerning habitat and endangered species was presented in a detailed qualitative manner, covering flora, fish, game animals, other animals, and eagles. The primary method of evaluation was professional judgment on the part of a knowledgeable observer. However, each individual indirect effects analysis was contained in a separate section of the EIS and was not related to the other types of indirect effects. The study is an example of the reductionist technique for evaluating indirect effects.

A further example of a detailed qualitative study of an indirect effect is taken from the Astoria bypass DEIS in Oregon. This project was intended to solve traffic congestion problems by diverting downtown Astoria traffic to a bypass. The principal purpose of the land-use analysis for the build alternatives on this project, which consisted of three and a half pages, was to discuss the potential for land-use change and development along the routes. It considered in some depth several of the subjects normally included in a land development feasibility assessment: existing land uses, recent development activities, zoning, comprehensive plans, traffic circulation, land availability, and, unique to Oregon, the urban growth boundary, outside of which development activities are severely restricted. The result of this analysis was a generalized map of lands that would need to be developed.

The Astoria bypass DEIS also included qualitative discussions of indirect effects concerning cultural resources, social groups, economic development, water resources, and wetlands. Each discussion of indirect effects was in a separate subsection of the corresponding section of the EIS devoted to environmental consequences. This type of presentation was common in indirect effects studies in EISs throughout the sample of projects. This mode of presentation does not necessarily lead to a reductionist approach. However, in the Astoria bypass DEIS, each discussion was essentially an independent entity, with little assessment of how the effects might interact. For example, the developable lands identified in the land-use discussion were not specifically considered in the water resources or wetlands indirect effects studies. Rather, the wetlands and water resources discussions were more generic in nature. This type of approach was common in the 90 projects sampled when multiple indirect effects were discussed.

Another type of approach to detailed qualitative analysis of indirect effects can be found in the Trunk Highway 371 new construction DEIS, a project near Brainerd, Minnesota. The purpose of this project was to ease traffic congestion, especially during the tourist season. In this EIS, indirect effects were considered briefly in several different subsections and then discussed in more detail in a separate section. This section included a detailed qualitative study that considered only indirect land-use effects. Although many potential subjects for indirect studies were briefly mentioned, the emphasis on indirect effects was effectively almost entirely on land use. Thus, an essentially reductionist approach was followed in a format that could have been more suitable to a systems approach.

Quantitative Techniques. There are a great many quantitative techniques in use in the environmental professions. Many of them were encountered during the content analysis. A review of examples of the techniques for assessing indirect effects of transportation projects follows, along with a more detailed assessment of some of the more comprehensive ones. The discussion is organized according to major categories of disciplines typically analyzed in EISs.

Socioeconomics. The field of socioeconomics includes areas of concern such as economic development, employment, population, fiscal impacts, community cohesion, community facilities, and relocation. Socioeconomics were frequently combined with land use in the EISs examined. However, for the purposes of this study, the two categories are separated. Because so many of the transportation projects were connected with economic development in some way (close to 40 percent of the projects included it as a project objective), socioeconomic indirect effects were commonly addressed in the EISs examined. A total of 25 EISs used some form of quantitative socioeconomics indirect effects analysis.

One of the common quantitative techniques used for analyzing socioeconomic indirect effects was the economic base, or multiplier, approach. The basis for this technique is economic base theory, which asserts that a region's economy is driven by basic industries, meaning those industries that are involved in exporting goods and services to other regions. Hence, they bring in revenues to the region, thereby stimulating growth in nonbasic, or local, industries. The unit of measurement in this type of analysis is usually employment; sometimes it is earnings or income. The tool used to calculate the gain is the multiplier, a ratio measuring the amount of local growth that follows growth in basic industries. Several rounds of effects are possible, indicating successive impacts of jobs, income, more jobs, more income, etc.

Multipliers are derived in many ways and are available by industry, region, and county from several federal and state government sources. Sophisticated techniques, such as input–output analyses, are sometimes used to derive multipliers on a regional basis. These were usually found only in major EISs.

A simple example of the multiplier approach is presented in the 181st Avenue to Sandy River (I-84) FEIS. Here, the Oregon Department of Transportation estimated that 16 jobs are generated directly and indirectly for every $1,000,000 spent on highway construction. Therefore, construction costs

of $56 million will result in 900 jobs that are generated directly and indirectly by project construction.

A more comprehensive variant of this technique was included in the New Austin Airport, Manor, Texas FEIS. The FAA *Airport Environmental Handbook* requires this type of approach on airport EISs. Employment was estimated for construction activities, airport operations, and airport-associated development. With multipliers from a variety of sources, direct, indirect, and induced employment was then estimated for 1998, 2002, and 2012 (the base year was 1993) for the three principal alternative actions. Income and economic output were then estimated in the same format for Texas and the Austin area. Earnings were estimated for the county where the proposed project was located. A similar type of analysis was then conducted to estimate the effects of construction expenditures. In the course of this analysis, the FEIS explained the interrelationships as follows:

> Direct effects are those arising from the purchases made by the construction sector needed to undertake the project. Indirect effects are the sum of all rounds of purchases by all the interrelated sectors of the state economy, beginning with those which supply the suppliers of the airport construction sector. Indirect effects are distributed throughout the economy with additional rounds of purchases. Induced effects of the project are generated by the consumption of goods and services made possible by payrolls associated with the construction project. (*49*, pp. 4–39)

Several secondary sources, including economic studies by the U.S. Air Force and two private consultants, were used for the economic analyses conducted in the New Austin Airport FEIS.

Estimating the number of employees by using the acreage of project-related development was another technique used to assess indirect socioeconomic effects. An example of this methodology appeared in the Sears Island dry cargo terminal FEIS. The project relied on data from the Maine State Planning Office and a market study of the port. The number of employees expected at the associated industrial park was estimated based on the acreage available and the types of industries likely to locate there. Factors taken from secondary sources were used to estimate the number of employees per acre by industry. An analysis of the labor market within 80.47 km (50 mi) of the project was used to estimate labor shortages that might follow. Income of the projected work force was then estimated along with expenditures on goods and services by employers.

Subsequent sections of the Sears Island FEIS illustrate how indirect economic effects are spread into other socioeconomic areas of concern, all under the heading of secondary effects. Based on the labor market analysis, the number of workers potentially moving into the Searsport area was estimated and then multiplied by a persons-per-household factor to arrive at an estimated population impact. From this, demand for housing was estimated, and demand for local and state services was estimated. The cost of the services (fiscal impact) was then calculated, and fiscal revenue, in the form of increased tax revenues (property, sales, income), was estimated. Net fiscal impacts were then calculated by subtraction. This entire analysis was conducted in some detail, with attention to local schools, police forces, public works, recreation facilities, and so forth. A total of 27 pages of the FEIS were used for this purpose, and most results were presented in quantitative form.

One of the most sophisticated socioeconomic techniques was used in the Nashua–Hudson circumferential highway (New Hampshire) FEIS. This methodology interwove both land-use and economic projections. An extension of a traffic forecasting model (MinUTP) was used to calculate employment and land-use secondary/cumulative effects by traffic zone in the study area. The MinUTP model comprises three main parts: (1) socioeconomic data, (2) a highway network and traffic analysis zones, and (3) MinUTP algorithms, which determine trip generation and trip attraction, trip distribution by purpose, and assignment to a highway network.

Traffic analysis zones were defined by using a set of boundary criteria, including factors such as municipal boundaries, major activity centers, population density, rivers and streams, and future land-use development. Three municipalities and 48 traffic zones were included in the study area.

The project staff interviewed socioeconomic specialists and local business and civic representatives to develop the basis for projecting employment and land-use changes that could be expected in each zone without the project. This was a common approach in the more comprehensive indirect effects studies and appears to provide a level of credibility that otherwise might be absent.

Regional data were used to prepare an overall land-use projection for the study area. This projection was based on zoning, land suitability, and current and anticipated development trends. Buildable areas were estimated by excluding known wetlands. Regional employment projections were allocated to the zones based on projected nonresidential land uses.

Trips were then generated for each zone depending on existing land uses and the number of dwelling units. Trip attractions were also identified by using data on employment, school enrollment, and dwelling units. The number of trips was then estimated among all zones by using factors based on nationwide studies. Trips were distributed with a gravity model that took travel time into account. Trips were assigned to routes by an equilibrium assignment process that minimized travel times.

Traffic was projected in each zone to the year 2010 for no-action and project alternatives. An interactive process was then used to reallocate land uses to specific traffic zones based on traffic projections. For each traffic zone, the projected land use and employment that could be attributed to the project were isolated by subtracting the model's results for the no-action alternative from the results for the action alternatives. For each traffic zone, the following statistics were calculated:

- Total housing units with and without the project;
- Total square footage of nonresidential building space with and without the project; and
- Total number of employees with and without the project.

These data were used to estimate other indirect socioeconomic effects for each municipality in the study area, culminating in a calculation of total additional municipal costs and revenues attributable to the project.

Land Use. All the quantitative land-use indirect effects techniques involved land-use acreage, traffic volumes, and, in some cases, farmlands. Quantitative methodologies for assessing land-use indirect effects were utilized on 11 projects (12 percent of the sample). Zoning, recreation, and visual impact concerns were dealt with exclusively by qualitative means.

Quantitative techniques for projecting land uses involved estimating changes in housing, employment, and traffic. Traffic projections by zone were calculated with housing, land-use, and employment data used as input. A modeling technique used in New Hampshire has been discussed. A somewhat similar approach was pursued in the Ferry Street Bridge (Eugene, Oregon) DEIS. Here, input to the traffic model consisted of employment and dwelling unit data supplied by the metropolitan planning organization. As part of the land-use allocation process, growth was located in transportation zones in a manner consistent with past trends. The resultant land-use changes were in accordance with the regional comprehensive plan. Therefore, the primary concern became the rate of land-use growth instead of its location. The forecasts did not take into account any pressure for changes in zoning or plan designations, which was regarded as too speculative.

One of the most comprehensive land-use studies was undertaken as part of the Mon/Fayette transportation project. This project, which would connect West Virginia with Pittsburgh by a limited-access highway, was conceived primarily as a means of stimulating a stagnant local economy by relieving traffic congestion and enhancing vehicular access. The Mon/Fayette project was broken down into four EISs, the limits of which were defined by using the logical termini concept.

In the southernmost of the Mon/Fayette EISs, a DEIS for the section from I-68 in West Virginia to State Route 6119 in Fayette County, Pennsylvania, a comprehensive land-use forecast was prepared based on use of a geographic information system (GIS). Based on a consensus of those involved in the study, a decision was made to limit the studies of land-use change to the area within 1.6 km (1 mi) of the proposed interchanges. Potential developable tracts were identified by extensive consultation with regional, municipal, and local planning officials, chambers of commerce, private developers, and economic development associations. Existing land-use and development constraint maps were then prepared and entered into the GIS for those areas within 1.6 km of each interchange.

Next, regional economic projections were used to project employment and population changes at the local level. The forecast data were then allocated to developable tracts to estimate the ultimate land-use composition within the study areas. This was mapped and entered into the GIS. A comprehensive evaluation of each interchange area was presented in the EIS to evaluate and tabulate potential land-use changes. Tables were presented with the following information for the no-build and project alternatives:

- Total development area, in acres;
- Acres required to accommodate growth; and
- Percent of the total area identified for each land-use type.

Land-use types were divided into three categories: light industrial, commercial, and residential. The projections were prepared for 1997, 2010, and 2020 (base year was 1993). The GIS files prepared during the land-use indirect effects study served as the basis for subsequent land-use and resource indirect effects studies.

Another GIS approach was followed for land-use indirect effects studies in the Bolton Interchange DEIS. This was a proposal for a new interchange on I-89 in a rural area of Vermont. The purpose of the project was to relieve traffic congestion and improve safety conditions on local roads that were heavily used for access to ski areas.

A study area was selected to cover 0.8 km (0.5 mi) on either side of an 8-km (5-mi) segment of the local highway that would be affected by the interchange. After consultations with local officials, existing and future land uses and zoning were mapped and entered into the GIS. Steep slopes, wetlands, soil types, floodplains, and prime agricultural lands were also mapped and entered into the GIS. Criteria for land-development constraints were identified, and the GIS was used to overlay all development constraints and identify developable land. The resulting maps were presented in the DEIS.

Development trends and data, such as building permits, were addressed, and local officials were consulted to identify the parcels and land uses most likely to be developed as a result of the new interchange. An extensive discussion of the findings was presented in the DEIS.

The resource impacts of secondary development were not considered in detail in the Bolton Interchange DEIS; they were evaluated in a sketch qualitative manner. The detailed land-use data and GIS files were not used to quantify the potential indirect effects on wetlands, floodways, waterways, wildlife habitat, groundwater, agriculturally valuable soils, or scenic resources. Of the 11 land-use studies in which quantitative techniques were used, 6 did not include a comprehensive analysis of indirect natural or biological resources effects.

Examples of projects that included comprehensive quantitative land-use indirect effects studies as well as detailed natural resource studies are the U.S. Route 301 corridor location study EIS (Delaware), the Lackawanna Valley industrial highway EIS (Pennsylvania), and the 181st Avenue to Sandy River (I-84) FEIS (Oregon). These projects employed extensive mapping of land uses and projections based on numerous consultations with local officials, planners, and developers. The U.S. Route 301 Study, which was one of the most comprehensive analyses of socioeconomic and land-use effects, included detailed qualitative consideration of wetlands indirect effects. In the cases of the Lackawanna Valley and 181st Avenue projects, the analyses were extended in a systems manner to cover several resource issues in detail (these are discussed in subsequent sections).

Four projects incorporated quantitative studies of indirect effects on farmlands. An example of such a technique was included in one of the Mon/Fayette transportation project EISs, this one covering the portion of the project between I-70 and Route 51 in Washington and Allegheny counties, Pennsylvania. The FEIS for this project discussed secondary effects on land use and farmlands and used an analysis of aerial photographs, soil surveys, and maps to identify farmlands that could be affected by secondary development. A rating system of high, moderate, and low indirect effects potential was used. Of the 28 secondary development sites identified, 8 were rated as having high potential for impacts on farmlands, 9 were rated with moderate potential, and the remaining 11 were rated with low potential.

Because of the U.S. Department of Agriculture requirement for a land evaluation and site assessment (LESA) on projects affecting prime farmlands, this area of concern potentially lends itself to quantitative analyses. The LESA methodology considers the types of agricultural operations taking place on individual farm properties, the soil types on the property, and factors such as zoning, adjacent land uses, and availability of utilities. The resulting scores (LE and SA) are summed to derive an overall value for the property. Criteria are then set to determine the degree of adverse impact. This technique can be pursued for indirect effects analysis, but it requires that individual parcels be identified, which was often considered beyond the scope of indirect effects studies for EISs.

A modified LESA-type methodology was used on studies for the U.S. Route 13 relief route project in Delaware. Modification of the LESA methodology aggregated properties so that a larger study area could be accommodated without an unduly cumbersome evaluation process. The goal was to use the methodology to indicate the magnitude of each alternative corridor's impacts on the agricultural industry in Delaware. A study area consisting of a minimum of 1.6 km on either side of the alternative rights-of-way was designated. Because alternatives often ran parallel to one another, the study area was actually considerably wider than 1.6 km in most areas and exceeded 8 km in some cases. The result of this was that most of the potential secondary development areas were included in the detailed analysis.

Indirect effects were specifically addressed in the study, although the modified LESA scores were not separately calculated. Instead, the indirect effects studies concentrated on evaluating the potential distribution of secondary land-use development without singling out any specific sites. The LESA scores covered both direct and indirect effects within each alternative corridor. However, it probably would not be difficult to extend such a rating system to studies in which individual secondary parcels or sites are identified in indirect effects studies such as the detailed land-use analyses discussed previously.

Geology, Soils, and Water Quality. Quantitative studies of geology, soils, and water quality indirect effects were conducted in only two instances among the sample projects, both in Pennsylvania. These were the Lackawanna Valley industrial highway and the Mon/Fayette transportation project. The first is used as the example of how quantitative indirect effects studies were conducted in this area of concern. One of the important areas of controversy in the Lackawanna Valley project was the potential effects of secondary development on formerly mined sites and their acid runoff. This is a unique problem, but the indirect effects technique would be generally applicable in cases in which geology and water issues are of concern. The Lackawanna Valley project involved comprehensive mapping of land uses and potential development parcels within a large study area. The study area included all municipalities touched by the project, and its resultant extent was considerable, covering about 259 km^2 (100 mi^2) for this 29-km (18-mi) proposed highway. The study took a systems approach, tying all the indirect effects together in a single, comprehensive analysis. A 102-page technical memorandum devoted to indirect effects studies was included with the FEIS.

Soils and geology were examined from the points of view of erodibility and mining/mine hazards. To tie the problem together, watersheds, groundwater, public water supplies, and stormwater/floodplain management were also studied. Each evaluation followed fundamentally the same procedure, in which information was gathered and tabulated, calculations were performed as necessary, and judgments were made about the potential for impacts in a high, medium, and low format. Each category of concern was studied for each potential secondary development site.

The geology/soils study concentrated on mapping soil units, identifying and measuring those that were erodible or otherwise unsuitable, and identifying the percentage of erodible or unsuitable soils adjacent to water. The mining/mine hazards study identified, mapped, and tabulated formerly mined sites and recorded their status (reclamation, subsidence, depth) and the potential for reclamation. Surface waters were evaluated by inventorying stream quality (physical/chemical and biological status), mapping and measuring

subwatersheds, and identifying the percentage of each subwatershed within each secondary development site. Groundwater studies were limited, because the primary aquifers were already heavily polluted with acid mine drainage, and secondary aquifers were very limited in yield. Therefore, the public water supply was entirely dependent on surface waters, and quality, use, and treatment of surface water were the main issues. The public water supply analysis included consideration of the likelihood of impacts on water quality in each subwatershed, the extent of public water service, current treatment plant loadings, and the potential for problems with sewer extensions.

Wetlands. Quantitative wetlands studies were included in indirect effects studies in only five of the EISs in the 90-project content analysis sample. Extensive, detailed quantitative wetlands studies were undertaken in only three of the projects: 181st Avenue to Sandy River (I-84) in Oregon and the Lackawanna Valley industrial highway and Mon/Fayette transportation project in Pennsylvania. All three projects represented systems approaches to indirect effects studies, with comprehensive and integrated analyses of indirect effects categories. In each case, the wetlands potentially subject to indirect effects were mapped within the study area by using National Wetlands Inventory (NWI) maps and related to areas or sites with the potential for secondary development. The 181st Avenue to Sandy River (I-84) project is used here as an example. The project consisted of a major widening of I-84 in the eastern suburbs of Portland, Oregon, along with a major new access highway segment. The study area included roughly the land within 8 km of the project, which was described as the generalized region. Existing land uses were mapped and future land uses in this area were described, in accordance with the regional and local land-use plans. Vacant lands designated for future development in local land-use plans were delineated and measured, yielding a net study area of 110.5 km^2 (27,300 acres).

NWI maps were used to map wetlands within the vacant lands zoned for development. Areas designated for protection in the local comprehensive plans were not included. Hydric soils were identified by using soils surveys, and reconnaissance-level field studies were carried out to supplement the mapped information. Identified wetlands were classified, tabulated, and summed. A detailed qualitative discussion followed, in which judgments were made about the potential for impacts in the wetlands areas. All the wetlands were also considered as a functioning unit to capture any potential areawide effects, such as interruptions to wildlife corridors or reduction in the area's ability to absorb pollutants from urban runoff.

Ecology. Habitat studies lend themselves to quantitative methodologies because there are some commonly used and well-understood quantitative techniques, such as the habitat-evaluation procedure (HEP). HEP studies can be carried out on a broad regional level or for individual parcels, depending on the nature of the project. However, to observe the types of habitats or species present, field studies are usually required to complement secondary data. This often is considered to be too specific and speculative for indirect effects studies, and the number of quantitative habitat/wildlife studies was therefore limited in the project sample under study. The projects that performed such studies were the same three identified in the wetlands discussion.

The 181st Avenue to Sandy River (I-84) project in Portland, Oregon, is an example of this type of study. As noted in the wetlands discussion, potential secondary development sites that were properly zoned were identified in this FEIS. The habitat/wildlife analysis evaluated the same 110.5-km^2 study area.

Field work, map work, and secondary data were used to assess indirect habitat and wildlife effects. A random sample was taken of existing vegetative cover for various land uses, and the information was superimposed onto an aerial photograph mosaic of the study area. The sample was used to generalize the cover type information for all the potential secondary development sites. Field checks were made to update the aerial photos, which were 2 years out of date. The cover types were then classified according to the USFWS HEP. The effects of land-use changes as indicated by land-use plans and zoning were assessed by using habitat suitability index models developed by USFWS. The results were quantified and presented in a matrix that considered the types of habitat strata, their status, the strata area lost, and the percentage loss. A detailed qualitative discussion accompanied the quantitative study.

Other Indirect Effects. These effects include air quality, noise, and cultural resources as well as several other types such as energy, hazardous waste, and human health. Quantitative indirect effects techniques were used to study these areas of concern on 12 projects. The Lackawanna Valley industrial highway project near Scranton, Pennsylvania, serves as an example of the more comprehensive approaches to these types of indirect effects.

Air-quality indirect effects were assessed by first identifying the types of industries and commercial establishments that were most likely to locate in the secondary development sites. This was based on consultations with and data from planning and business organizations. The projected industry types were used to estimate potential air-quality impacts based on typical pollutant loadings. The potential land-use categories of secondary development sites were used in a similar manner to assess the potential for noise impacts at each site.

For cultural resources indirect effects studies, each secondary development site was evaluated for its potential for including historic structures or historic/prehistoric archaeological sites eligible for the National Register of Historic Places. The sites were inventoried with secondary data from

the State Historic Preservation Officer and field visits. The eligible or potentially eligible sites were inventoried and tabulated, and then each was discussed to assess its significance. Each secondary development site was then rated on a five-step scale to estimate the potential for significant cultural resources effects.

Municipal, industrial, and hazardous waste sites were studied in relation to secondary development sites. Known hazardous waste sites were identified through state and federal environmental listings. Trash sites were identified from aerial photography. In addition, a qualitative assessment was made concerning the potential for unknown landfill or hazardous waste sites. Based on field observations, assessments were made about the volume of waste, its areal extent, and its relative hazard. These assessments were combined to provide a three-step potential impact rating for each secondary development site.

Conclusions of the EIS Content Analysis

Based on the content analysis, several observations can be made about the indirect effects of transportation projects. First, the concern about indirect effects appears to be increasing. Second, there was no consistent definition of indirect effects used in EISs. The primary concentration in EISs appeared to be on the socioeconomic and land-use indirect effects of projects, with less effort on evaluating natural resources or other indirect effects. When indirect effects became a subject of controversy, it was likely that economic development and land-use issues were the main concerns.

Highway and port projects in general were more involved with indirect effects than the other types of transportation facilities, and they were more controversial. However, there is no assurance that any single project type has to pay less attention to indirect effects. General project setting variables were not a consistent predictor of either the number of indirect effects or the level of effort necessary for their analysis. A project's specific circumstances, including its degree of controversy, largely determines the level of effort necessary.

The techniques used for analyzing indirect effects varied both in level of detail and in approach. Reductionist approaches and less detailed qualitative techniques were used more frequently than the more detailed qualitative or quantitative techniques. Systems approaches, considering indirect effects as a whole rather than as individual entities, were not commonly used. When they were, the analyses were usually extensive and comprehensive.

No single technique appeared to be superior or more effective than the others. The techniques for indirect effects studies appeared to be largely determined by what was required by local environmental and geographic factors and by the regulatory and political situation. There were many instances in which brief analyses, relying primarily on professional judgment, appeared to provide sufficient information for a decision maker and the public.

In sum, the content analysis has revealed an array of potentially useful techniques and has indicated some trends. The content analysis suggests that the content of an EIS is controlled primarily by the details of local environmental, geographic, political, and regulatory conditions.

INTERVIEWS ON PRACTICE

Interview Results on the Definition of Indirect Effects

In general, the transportation agencies and regulatory and environmental resource agencies and interest groups commenting on the EISs recognize the CEQ definitions of indirect and direct impacts as the basis for their discussions and actions. Despite this common reference point, there was little agreement about definitions as they were used in assessing indirect impacts. This finding concurs with that of the literature review and analysis of the large sample of EISs. In practice, identification of indirect impacts varies from denying the existence of indirect impacts to insisting that analysis of indirect impacts encompasses land and water resource areas far from the footprint of the proposed project and forecasts far into the future and to issues that have uncertain connections to the project.

Most of those interviewed stated that their definitions of indirect effects are based on an initial determination of direct effects. Therefore, to present a context for indirect effects, definitions of direct effects are presented.

A wide range of definitions of direct effects is evident in the responses of different agency representatives. One agency staff member referred only to the effects associated with the project activity before operation of the facility—"from the survey to ribbon cutting." This includes land taking and relocation of residences and businesses, effects on cultural resources within the project footprint, and limited effects on endangered species and wildlife habitat. However, most respondents extended that definition to include operation of the immediate project but limited the focus to the footprint or slightly beyond the footprint of the project. Noise, air, and water contamination from construction and operation of the project are contained under this definition, as are safety factors and energy usage. Others added fill and borrow or dredging activities to the items for consideration under direct impacts. The ACOE and the state historic preservation officers sometimes use a distance from the center line standard in highway projects for determining a spatial boundary between direct and indirect effects.

A broader definition held by approximately one-third of those interviewed included effects further removed in distance from the project but clearly associated with construction and immediate operation of the project's primary function. This connotation of the term encompasses, for example, changes in hydrology such as upstream flooding and downstream sedimentation caused by construction and ecologic

systems impacts relating to fragmentation of habitat for animals and plants being disrupted by the project. A small number of respondents also consider the change of character and land value in neighborhoods abutting a transportation project as a direct effect. Some of these effects, particularly those that are more removed in time or distance from the project, are characterized as indirect effects by roughly one-half of respondents.

Based on the interviews of this study, there is no universally accepted definition of indirect effects among transportation and other agencies and other interests. Similarly, there is no overall accepted, practical distinction between direct and indirect effects among those interviewed. In an attempt to resolve this issue, a few practitioners suggested that indirect effects be defined as "impacts other than direct impacts, located in or near the project and due to the project." There was some suggestion that indirect effects should satisfy the "but for" test—i.e., the effect was present because of the existence of the project (but for the project the effect would not exist). However, it was noted in almost every interview that differentiating between what would have transpired without the project and what is likely to occur because of the project is a difficult task.

Some interviewees mentioned relatively unique circumstances involving effects that would generally be recognized as indirect effects. Examples cited by interview participants include the following:

- Water-quality effects from point source discharges on wetlands distance from the proposed project;
- Dune migration and beach erosion due to coastal highway projects;
- Effects on the relative scarcity of materials used to construct projects (in some cases certain materials markets, such as gravel, have been nearly depleted by large projects);
- Effects on communities into which residents and businesses are relocated because of land-taking action in projects;
- Effects on quality-of-life issues, such as changes anticipated over time from owner-occupied to rental properties, character of neighborhood, type and quality of commercial activity, and health and safety for high-risk populations; and
- Both negative and positive indirect impacts to affected resources to facilitate cost-benefit aspects of decisions.

The term cumulative impacts has been defined as "a summation of direct and indirect impacts of past, present, and reasonably foreseeable future changes in land use, regardless of sponsorship, in specific geographic and resource areas affected by the project under immediate attention." This includes other transportation projects, planned residential development or industrial parks, recreational facilities, land banking, and the like. Another definition, offered by one FHWA official, was limited to projects sponsored by the same agency proposing the project under immediate consideration.

The term induced impacts is generally used interchangeably with the concept of socioeconomic development indirect impacts. They are typically considered as the environmental impacts resulting from land development generated by the existence of a particular event or project.

Another approach to defining impacts, suggested by approximately one-sixth of those interviewed, is to categorize them as primary and secondary impacts and, within this framework, include a subset of direct and indirect impacts. Primary impacts are defined as concrete impacts projected from the project, and secondary impacts are more speculative, less significant, and more questionable with regard to the impetus for the impact. There appeared to be less difficulty and more uniformity among interviewees with interpreting this framework. Among those commenting on this set of definitions, there was general agreement that it would be better to follow the established order than to try to modify the current approach.

There was an approximately even split among those interviewed about whether it was more helpful to differentiate between direct and indirect impacts or whether to refrain from distinguishing between them. Of those who favored the distinction, some believed that it would draw specific attention to those categories of impacts and fewer indirect impacts would be overlooked or ignored. Others believed that clear definitions might help place limits on seemingly endless requests for studies. Still others commented that distinguishing between the two types of impacts would make a transportation agency less vulnerable to accusations that particular impacts had been ignored.

Among those who believed that it was better not to differentiate between direct and indirect impacts, some argued that categorizing an impact as indirect reduced its status and decreased its perceived importance, even when that impact might be of greater significance than any of the direct impacts considered. Others suggested that a designation of indirect would exclude the possibility of mitigation for the impact. The primary argument for not differentiating among categories of impacts was that what mattered was recognition of the impact and not its classification.

Interview Results on Identification of Indirect Effects

Factors that appear to be most influential in determining the identification of indirect effects of proposed transportation projects are agency or interest group emphasis, the nature of interaction among interests and the working style of the people involved, court decisions, and the specific project under consideration—its physical, social, economic, and political setting.

It appears that those agencies with traditional responsibility in transportation planning, project design, and construction are more likely to define effects with limited parameters that are indisputably a direct result of the proposed project and not far removed physically from the project footprint. The agencies that most often fit this description are state departments of transportation. Typically, representatives of state departments of transportation report that assessing environmental impacts as presented in the NEPA process often conflicts with the traditional measures of success for highway departments—i.e., managing traffic, laying down a good road as rapidly as possible, and getting the job done.

Representatives of agencies whose function is protection of and advocacy for natural and cultural resources tend to extend the boundaries of concern for indirect impacts. These agencies are typically state natural resource agencies, the USFWS, the EPA, and the state historic preservation organizations. The federal transportation agencies (FHWA, FAA, and FTA) and the ACOE occupy a middle territory, adhering to their nationally mandated policies and procedures and overseeing their implementation at state and local levels. Agencies often have apparently conflicting mandates. Therefore, reaching agreement on definitions and degree of assessment is often fraught with contention from the onset.

Effects on various aspects of hydrology, often removed in time and distance from the immediate project footprint, are being included with increasing frequency in the Section 404(b)(1) permit review by ACOE offices. In addition, the FAA uses the terms induced and secondary to denote issues that would be considered indirect impacts by other practitioners.

Certain issues generally have been targeted by some offices of specific agencies. For example, indirect effects caused by habitat fragmentation were typically a particular concern of the EPA and the USFWS as well as their state counterparts.

Based on the interviews, regional and state variation in identification of indirect effects of proposed transportation projects appears to depend to a great extent on the planning culture of the area, on the characteristics of individuals in key positions in the transportation and other agencies, and on the relative independence of agency regional offices from their national headquarters. For example, over a period of time, comprehensive planning practices in the state of Oregon have helped increase the sensitivity of each agency to the regulatory mission orientation of other agencies. Project identification of indirect effects typically reflects the combined agency perspectives. In the state of Vermont, a state-level impact assessment law (Act 250) has helped underscore the need to develop workable interagency definitions of impacts.

Years of staff experience and longevity with the agency were said to have substantial bearing on identification of indirect effects. This opinion was mentioned by approximately one-half of those interviewed. Agencies with high staff turnover rates lose the collective wisdom accrued over many years. Personnel new to the subject are likely to be less certain of impact parameters and to have less knowledge of how certain project-related actions and implemented plans are apt to unfold over time.

The broadness or narrowness with which indirect effects are identified has been determined in certain cases by the relative strength or power of one agency compared with others and by the stance of the federal agencies involved. In areas with powerful departments of transportation, identification of indirect effects has tended to be more limited in scope, whereas in states with strong and well-supported environmental agencies, indirect effects appear to be given a broader look. A pattern was observed from the interviews that, generally, when the regional offices of federal transportation agencies take a proactive role in preparation of EISs, the identification of indirect impacts is more extensive than in regions where the agency offices are comparatively more passive.

Certain state departments of transportation were characterized by counterpart environmental agency staff as not acknowledging the existence of indirect effects. This was reflected during the interviews, when many state department of transportation staff initially associated the term only in relation to socioeconomic development, to the exclusion of natural or biological resources. This was reflected in the comment by some resource agency representatives that engineering factors and land-use planning techniques were typically too dominant over ecologic and natural resource issues in transportation EISs. Some of this focus was said to emanate from an emphasis in highway planning to stimulate development and to create construction jobs in different locales. Typically, upon further questioning and discussion, natural and biological resources were generally added to the transportation agency's definition by examples. It was commonly noted by transportation agency staff that pressure by agencies such as the USFWS and the EPA as well as by the general public and environmental organizations has prompted more attention to indirect impacts on natural systems.

Certain interviewees were aware of court decisions and litigation on transportation project indirect effects assessment. In most instances, it was the opinion of those interviewed that the court actions were influencing the practice of indirect effect identification and assessment. It was often mentioned that many projects under construction or recently completed would not have advanced if they had been proposed in the current regulatory and political climate. Projects currently in planning and review stages are more carefully scrutinized for indirect effects.

One of the most universally held opinions dealt with the degree of specificity that a regulatory definition should have. Respondents believed that highly detailed definitions were not appropriate or meaningful. They suggested that flexibly administered categorical guidelines and illustrative examples were needed to promote the desired direction of impact

assessment and argued that each situation reflected such unique characteristics that indirect effects ought to be selected for detailed assessment on a case-by-case basis.

There is also consistent agreement that delineation of spatial boundaries for indirect effects assessment be situation specific and derived from factors such as resources of concern—geographic, topographic, hydrographic, and hydrogeologic situations—and settlement patterns. Interviewees strongly discouraged drawing a circle with an arbitrarily defined radius or designating a square on a map containing what may be considered an appropriate number of square miles. These areas are best drawn by those familiar with the character of the resources and with the topography, quality of habitat, plans, and value systems operating in the immediate geographic area.

Interviewees indicated a range of time projections for circumscribing indirect effects assessment that covered 5 to 50 years. Preferred time limits for projections varied according to the transportation mode and agency or resource area. The longest time frame was suggested by some airport planning officials, although FAA headquarters representatives did not concur. The FAA headquarters staff suggested that 10 years is more reasonable because of anticipated changes in aviation noise technology. The most frequently mentioned projection time frame was 20 years. This is the traditional road design standard for life of project expectation used in highway design, and many economic forecasts use this time delineation. Transit officials in some regions use a 15-year projection for assessment of indirect effects. Time projections of 5 to 10 years were also frequently mentioned. In two interviews, agency representatives stated that local economics can change significantly within 10 years and that pollution standards that can affect limits on development are very likely to be modified within that time. One respondent believed that anything beyond 5 years was simply no more than a guess.

The definition of the CEQ term reasonably foreseeable future has substantial bearing on time projection decisions. It has been so controversial an issue that several practitioners involved in one large project expressed the need for establishing boundaries of reason, offering the phrase "that which is commonly considered appropriate" as a definition for reasonable.

Reluctance to assess indirect effects in detail appears to be based on the following:

- The speculative nature of predicting growth in specific areas;
- Lack of baseline information;
- Lack of control and responsibility for zoning and land-use regulation;
- Concern for being required to mitigate for projections based on speculation;
- Unwillingness to allocate funds to underwrite research and analytical studies;
- Resistance to regulation; and
- Fear on the part of transportation agencies to be directly linked to development interests.

There was a strong endorsement for setting boundaries for regions of effects based on affected resources. The concept is considered critical in identifying indirect effects for analysis. Most interviewees emphasized that each project has a unique and complex set of conditions. In selecting indirect effects for detailed study, a broad sweep rather than a narrow look was preferred by environmental agencies, because a narrow view, either spatially or temporally, might overlook foreseeable undesirable effects—effects that might be avoided by modifications in project design.

Most interviewees suggested that specific triggers typically prompted assessment of certain effects in detail. Each agency appeared to be somewhat biased and more sensitive toward triggers that corresponded to their own area of responsibility. Those interviewed stressed this as a compelling reason for multispecialty teams to perform field inspections during initial stages of project development. The FAA extends indirect (or secondary) effects assessment geographic boundaries to encompass that area beyond the physical boundaries of the airport where the traffic is primarily airport related. Some state departments of transportation and offices of the FHWA suggest that a 10 percent increase in projected traffic volume due to a proposed project in an area should stimulate analysis of indirect traffic-related effects. The ACOE and some state historic preservation offices have designated certain distances from the footprint (4 times the footprint) or the center line [61 m (200 ft), 244 m (800 ft), or 0.4 km (0.25 mi)], depending on the circumstances) of a project as the focus for any effect, direct or indirect. Areas characterized as sensitive, nonattainment, or noncompliance in relation to environmental resources were also suggested as triggers (areas needing detailed investigation for indirect effects) by interviewees from the EPA, the USFWS, and state departments of natural resources.

Several comments during the interviews highlighted specific effects that need more consistent analytical attention. They are as follows:

- Limits imposed by the ability of local infrastructure—sewage and wastewater treatment, storm water management, potable water supply, and school, medical, fire, and police services—to absorb additional demand;
- Quality-of-life issues; and
- Social equity concerns, such as impacts on cultural and racial minorities, high health risk and special-need populations, and economically deprived populations.

Interview Results on Techniques for Assessing Indirect Effects

The interviews confirmed that a wide range of analytical methods are used to assess indirect effects. There appear to

be few standard or preferred techniques except for assessing indirect effects on wildlife habitat. The HEP developed by the USFWS and shorter versions modified by state wildlife agencies (e.g., Texas and Pennsylvania) are typically used for detailed habitat studies. Two independent sources estimated that an average of approximately 10 percent of transportation project EIS analytical budgets are allotted to analysis of indirect effects. They did not consider this an unreasonable demand.

There are three findings of particular importance that concern analytical techniques. One is that most of those interviewed believed that qualitative professional judgment of seasoned staff was generally better, or equally proficient, at estimating indirect effects than sophisticated computer modeling techniques. Even though most interviewees were more comfortable making decisions based on quantitative analyses, there was a high level of concern about the reliability and level of uncertainty in the results of sophisticated computer modeling techniques. In addition, a number of interviewees associated with large projects that used extensive computer modeling methodologies in assessing impacts voiced concern about the susceptibility of impact assessment methods to project promotion and marketing instead of their use to take a hard look at impacts. They also believed that the assumptions driving the data collection and analyses were not sufficiently discussed or questioned in relation to their appropriateness to the project under review. Regardless of the underlying motivation, whether it be professional bias, lack of analytical rigor, or political pressure, it was believed that much expense was incurred and much time was committed to performing elaborate analyses that, in effect, "did little else than generate a lot of numbers that had little meaning."

The second finding was a conviction voiced by slightly more than half of those interviewed. They believed that current local data are more useful and reality oriented than universal predictors and that local information is relatively easy to collect and analyze with labor-intensive techniques compared with computer modeling methods. Comprehensive plans or master plans used as secondary source information in preparing EISs were reported to overpredict levels of growth, thereby inflating projected traffic volumes and indirect effects. It was also stated that many EIS results have not had accurate predictive force over time. In addition, neighborhood character and local value orientation were noted as being rarely addressed. Extensive local interviews with pubic officials, planning staff, representatives from chambers of commerce, professional associations, environmental organizations, and individual residents of communities were deemed by many of the interviewees to be critical for obtaining credible information. It was noted by some that information derived from these sources can provide a reality check on likely land use and economic development as well as on local needs, preferences, and controversies. One interviewee commented: "There was no substitute for this information." Another added that there is a need to develop acceptable measures for such information to provide a balance with the economic or traffic operations data that typically support a project need.

Closely associated with this second finding was the universally held opinion that, to obtain adequate assessment of indirect natural resources effects, some level of field investigation by appropriate experts is necessary. Some interviewees stressed this more than others, but all insisted on its importance. Each situation is different, and the actual conditions cannot truly be represented by secondary means.

The third principal finding indicates an increased need for reliable methods for estimating impacts. This need will become more evident as the planning procedures of the ISTEA and the Clean Air Act Amendments (CAAA) are implemented and with them the need for rigorous and comprehensive analysis of indirect effects—in particular, those related to growth in vehicle miles of travel and in growth of population and employment. The same is true in meeting conformity requirements of the CAAA in nonattainment or maintenance areas. The apportioning of the burden of reducing air pollutant emissions must be accomplished through a statewide interagency planning process. One federal agency interviewee noted that there appears to be little recognition at the state level of the potential magnitude of the effect of these laws.

The following items were noted by study participants as critical gaps in information needs for improved analysis of transportation project indirect effects:

- Before-and-after studies of comparable situations: Before-and-after studies depicting indirect effects of transportation projects on land use, economic development, and quality of life are limited. However, the need for more studies was a commonly expressed sentiment among those interviewed. It was suggested that a carefully selected set of studies be developed in elaborate detail, reflecting baseline data, projection assumptions, sources of data, analytical models and research methods used, assumptions employed in research methods and modes, and results over time increments of 5 years.
- Carrying capacity analyses for indirect effects: This includes information on variables such as soils, topography, wetlands, and maximum density for human and wildlife populations.
- Baseline data: It was reported that, in many cases, staff resources and funding have not been allocated in sufficient amounts to establish adequate baseline information on natural resources (typically, adequate data are not already compiled or readily available through other sources).
- Monitoring practices: State departments of transportation have funded research of highway project effects on habitats and species (e.g., desert tortoise) for use in better predicting the effects of future projects. However, monitoring is generally not performed to determine

short- or long-term impacts on land use, water and air quality, noise level, wildlife and habitat, and other environments. Monitoring would test projections and add to case information for predicting impacts from future projects.
- Quality-of-life variables: Agency representatives appeared to be generally unaware of how to approach measuring this category of indirect effects. Compilation of analytical criteria and tools by which quality-of-life variables can be assessed are needed to facilitate the analysis of effects.

Interview Results on Indirect Effects Integration with Planning Procedures

The process by which project design and assessment parameters are determined appears to be the most critical aspect that shapes the content of EISs. As a general rule, indirect effects were reported as being more likely to be recognized as matters of importance when the following practices are followed:

- Lead and cooperating agencies meet regularly (at least once a month) for general discussion as well as for specific project planning purposes;
- All lead and cooperating agencies are involved in assessing project effects at the inception of the project;
- All lead and cooperating agencies continue to be regularly involved in project discussions; and
- An element of field scoping is done by interagency teams in the project environs.

The highway planning process appears to be more decentralized than that of other transportation modes. Frequently, districts within a state's department of transportation assess needs, begin initial planning, and approach the department's central staff for assistance in further planning and design. In some states, needs assessment across districts is fairly consistent. Local needs are reviewed on a periodic basis, and it is decided at the state level, in consultation with the district and the locality, whether the proposed project becomes included in the state's transportation plan. In most cases, the central office of the state department of transportation is the recognized authority. This is not always the case, however. Districts in some states operate with a great deal of autonomy, using different criteria to determine need and different methods to identify and assess impacts.

Although FHWA division and regional offices generally encourage flexibility of approach and inclusion of indirect effects in the issues to be addressed, the level of direction from these offices varies.

The scale of transit systems and airports necessitates state and federal agency involvement very early in the needs assessment process. The state, regional, and often national impact of the traffic to be managed, and the high capital outlay for construction and startup operations, require multilevel cooperative planning. Transit systems planning utilizes the ISTEA major investment analysis review system. Plans for airports are led by the regional offices of the FAA, and procedures are strongly guided by the central headquarters in Washington, DC.

The first formal meetings in which objectives and initial parameters for the project are set are referred to as scoping sessions. There may be only one or two meetings designated as such, but often the project scoping activities cover a more extended period. As new issues surface, significant modification in project design may occur, and subsequent rounds of scoping may be needed. In a small number of states, prescoping meetings have been held to establish direction for the project and, in some cases, to complete some aspects of impact assessment critical to defining the focus of the project.

Most states represented in this study have begun or are beginning to integrate project NEPA compliance with requirements of the Clean Water Act Section 404(b)(1) permitting process. This is being done either formally, through memoranda of agreements or understanding among the involved agencies, or informally on major projects. The specific content of these agreements varies from state to state, but they are designed to establish standard patterns of interaction among agencies, including early coordination, so that NEPA signoffs and Section 404(b)(1) permitting can occur concurrently and all cooperating agencies can provide comment on projects in a coordinated fashion. These steps have been taken to prevent the often time-consuming and costly exercises of reanalyzing projects and reestablishing alternatives to meet the Section 404(b)(1) permitting requirements and going back to scratch in response to agency comments on DEISs. An example of guidance on this topic is the document "Applying the Section 404 Permit Process to Federal-Aid Highway Projects" (*50*).

It was generally reported that, in at least half the cases, most comments and controversy about a project's EIS relate to indirect effects. Several interviewees stated that if the lead agencies bring in cooperating agencies and other major interests well before the DEIS is prepared, the step from DEIS to FEIS will most likely be much shorter and more consensual.

In approximately half the cases, those interviewed stated that project sponsors and lead and cooperating agencies met on a regular (monthly) basis to discuss matters of shared concern. The meetings often included reference to specific ongoing NEPA document efforts, but general business was also discussed. In areas where regular interagency meetings have occurred (e.g., monthly), cross-agency understanding has been enhanced. Without exception, cooperating agency representatives indicated that they prefer to be part of the scoping process from the inception of the process. They believe that this fosters better understanding among agencies, reduces the amount of time and funds expended on the project as a whole, and results in better transportation projects and sys-

tems. In Pennsylvania and Oregon, comprehensive multi-agency planning has been practiced actively over the past decade. Each agency has acquired a working knowledge of the concerns of others represented, and the lines of responsibility appear to have merged somewhat over the years of practice. Projects are apparently designed with less contention. In addition, the interaction required by Mini-NEPAs in states such as Vermont (State Law 250) and Washington (SEPA) was reported to engender more mutual understanding.

It appears that in states where project sponsors and lead and cooperating agency representatives interact with each other solely on a project-by-project basis, frustration with the perceived resistance and inflexibility of other agencies is expressed. Several interviewees believed that agencies tend to defend their own position or impose their perspective in a contentious manner under such circumstances. Under these circumstances, interagency relationships appeared more adversarial, and distrust of another agency's motivation was evident. A few state departments of transportation scope projects without the contributions of other agencies.

It was the general opinion among cooperating agency representatives and some department of transportation staff that when interagency involvement occurred very early in the project scoping stage, a wider range of alternatives and impacts could be looked at more freely in much less time, and presumably at much lower cost, than if debate occurred later. A few transportation agencies include other agencies in identifying the transportation problem—i.e., in the prescoping stage.

It appeared that approximately half the state transportation agencies circulated a short list of alternatives to other agencies immediately before completion of the DEIS. Many representatives of the other agencies believe that establishment of the NEPA Section 404 memoranda of agreements will result in earlier involvement and more extensive recognition of indirect effects.

Another issue that was frequently mentioned by transportation and other agencies was lack of staff and financial resources. It was reported that there are often too few staff to provide the necessary depth and breadth of input into scoping sessions, field visits, and ongoing deliberations. In many cases, comment on EISs was provided only through written correspondence. It was also noted by some transportation agencies that certain other agencies occasionally milked the budgets of their agencies by requesting studies that were not germane to the project under consideration but that related to another area of that agency's responsibility.

A few inteviewees believe the focus of attention on interagency responsibilities and conceptual differences has resulted in a public that is inadvertently left out. Different agencies have responded to this issue with different degrees of concern.

The planning team in a Tyler, Texas, project has been carefully selected to include a broad representation of interests from the local area. In Wyoming, a recreational project design team consisted of representatives from user groups as well as the agencies involved. One regional office of the FAA appears to actively seek public input very early in the scoping process. Informal public meetings are held, and local interests are encouraged to duke it out and suggest parameters of design before the agencies proceed.

Respondents indicated that in relatively sparsely populated states, such as Wyoming and Vermont, public participation is quite a different issue than in more densely populated states—"any road or transportation project is 'big news.'" Under these circumstances, people who live and work in localities where projects are being proposed usually learn about them before planning progresses very far. It was reported that opinions are generally expressed openly and strongly if the issues are deemed important and if local values are being impinged upon. In other words, "everybody finds out about it, and wants to let their opinions be known."

A different method for including public participation has been through active outreach throughout the project planning and implementation stages. For example, it was reported that this has been done in the central artery/tunnel project in Boston, Massachusetts. Outreach workers are assigned to specific neighborhoods to explain the project impact to that specific area of the city and overall and to elicit comments, opinions, and complaints about the plans or actions related to the project.

It was reported that yet another way public interests have been included is with analytical methods. In a few projects, interviews with local officials and residents provided current context and a reality check for master plan projections. In one of these projects, each person or entity submitting comment on the DEIS was contacted directly and asked about the comment in detail.

CHAPTER 3

INTERPRETATION, APPRAISAL, AND APPLICATIONS: DEFINING THE TERM INDIRECT EFFECT

Extensive study of indirect effects in regulations, case law, the literature, EISs, and interviews of agency representatives reported in Chapter 2 demonstrates that there is no clear, common definition of the term indirect effects beyond that in the CEQ regulation. However, interpretation of what an indirect effect is must use the CEQ definition as a point of departure because of the overriding requirement that federal projects comply with NEPA. However, as a practical matter, any interpretation also should satisfy other statutory requirements to the extent possible to avoid redundant analyses where applicable. The other statutes often include Section 404(b)(1) of the Clean Water Act (effects on waters of the United States), Section 106 of the National Historic Preservation Act (effects on locations on or eligible for listing on the National Register of Historic Places), and Section 7 of the Endangered Species Act (effects on critical habitats of threatened or endangered species).

Other definitions and similar terms in agency documents sometimes attempt, with mixed results, to elaborate on the CEQ definition. Published literature also attempts to define indirect effects, with results that do not substantially differ from the regulations (in several instances, definitions in the literature preceded the CEQ or other regulatory definitions). Content reviews of the EISs showed the same result. The content reviews and the interviews indicate that subsequent definitions have not been successful in further clarifying the CEQ definition; it is important to note that, by and large, subsequent definitions have not contradicted the CEQ definition either. Consequently, an appropriate strategy for interpreting what constitutes an indirect effect is to focus on the CEQ definition.

The CEQ definition of indirect effects includes the following aspects:

- Indirect effects are caused by the action;
- Indirect effects are later in time than direct effects;
- Indirect effects are farther removed in distance than direct effects; and
- Indirect effects are reasonably foreseeable.

A conclusion from the findings is that there is little disagreement about what constitutes a direct effect; direct effects are clearly linked to the action (i.e., the project). Therefore, to be caused by the action, an indirect effect must be linked to a direct effect.

The findings indicate general agreement with the aspects of later in time and farther removed in distance that distinguish indirect from direct effects. However, there is not a consensus about what degree of temporal or spatial specificity in assessing indirect effects is practical or acceptable. This is a topic of the analysis framework presented in Chapter 4.

The term reasonably foreseeable has received extensive review in the courts. It is a critically important parameter of indirect effects not only because of its inclusion in the CEQ definition but also because it can affect the level of effort required for an EIS as well as its outcome. The term was discussed extensively in the interviews conducted for this study.

According to CEQ's *Forty Most Asked Questions*, reasonably foreseeable includes uncertainty; however, the effects, although uncertain, must also be probable. The findings note that, to a certain extent, the courts have adopted this rationale. One decision interprets the term reasonably foreseeable broadly, citing the agencies' "overriding statutory duty of compliance with impact statement procedures to the 'fullest extent possible.' " Another decision defines the narrowest limit of the term, requiring a "reasonably thorough discussion," but not requiring discussion in cases where indirect effects would be improbable even if possible. *Sierra Club v. Marsh* (*26*) found that "the terms 'likely' and 'foreseeable' . . . are properly interpreted as meaning that the impact is sufficiently likely to occur that a person of ordinary prudence would take it into account in making a decision."

Considering that indirect effects are probable eliminates from consideration effects that are possible, as suggested by CEQ's *Forty Most Asked Questions* and case law. The findings indicate that this clarification is necessary. The use of probable also helps distinguish indirect effects from direct effects in that direct effects appear to be inevitable results of the action on the project's affected environment; indirect effects are not inevitable but are probable.

Based on the examples of indirect effects observed from the research findings reported in Chapter 2, it can be concluded that there are three types of indirect effects:

- Alteration of the behavior and functioning of the affected environment caused by project encroachment (physical, chemical, or biological) on the environment;
- Project-induced growth; and
- Effects related to project-induced growth.

An example from water resources is used to illustrate the encroachment-alteration type of indirect effect. It should be noted that encroachment-alteration effects are not limited to

natural systems or ecosystems. These effects also occur in neighborhoods (e.g., from segmentation) and in agricultural areas (e.g., from alienating parcels). As an example, a highway project is proposed in an area that is within a lake's watershed. The roadway portions of the project will create a surface for pollutant accumulation. Meanwhile, fertilizers will be used to establish roadside vegetation. Each of these activities increases the pollutant load to the lake via runoff, a direct effect. A typical constituent of this pollutant load is phosphorus, a plant nutrient. For many lakes, phosphorus is a limiting factor of lake eutrophication (aging) or infilling—i.e., a relatively low concentration of phosphorus limits the lake's aging. Simply put, the direct surcharge of phosphorus from the highway right-of-way can increase plant productivity; the dead organic matter from the plants increases the rate of lake infilling, among other effects that are indicative of eutrophication. Say it was determined that the phosphorus load from the highway project would accelerate the lake's eutrophication process (an indirect effect of the project); it should be noted that, as with other natural systems, other natural and anthropogenic factors (e.g., residential septic systems) probably also contributed phosphorus to the lake and were factors in the assessment that accelerated eutrophication would be caused by the transportation project.

The CEQ definition of indirect effects includes aspects of "growth-inducing effects" and "other effects related to induced changes," the second and third types of indirect effects noted above. The findings indicate that these types of indirect effects have generally been the most contentious and suggest that the change in accessibility or change in travel time—for example, from a freeway or a fixed guideway transit facility—that induces growth is a direct effect of the action. Following this logic, the induced and related effects are indirect effects caused by the action. In other words, it is appropriate to consider as direct effects factors that induce land-use or other changes; the changes and their effects should be considered indirect effects.

Similar to the lake example, the key factors in land development are also both natural (e.g., availability of developable land) and anthropogenic (e.g., favorable economic conditions or local political support). In an induced-growth scenario, the transportation investment may often be the limiting factor of development (i.e., insufficient transportation access limits development of an area). Therefore, analogous to the example of phosphorus in the lake, once access is provided the development potential of the area is enhanced. The development will, in turn, encroach on an affected environment, altering its behavior and functioning (the third type of indirect effect).

The typology is presented to illustrate the variations of an indirect effect. These variations may contribute to different interpretations of what is considered an indirect effect. Despite the variations, each type of indirect effect meets the following tests:

- There is a rational nexus between the project activity and the effect through a direct effect (i.e., caused by the action); and
- The effect is manifested by other transportation projects in similar settings (i.e., reasonably foreseeable or probable).

The distinction between direct, indirect, and cumulative effects as indicated by the CEQ definitions of these terms is summarized in Table 17. As with direct and cumulative effects, some indirect effects are beneficial and others are

TABLE 17 Distinctions between types of effects

Type of Effect	Direct	Indirect	Cumulative
Nature of Effect	Typical/ Inevitable/ Predictable	Reasonably Foreseeable/ Probable	Reasonably Foreseeable/ Probable
Cause of Effect	Project	Project's Direct and Indirect Effects	Project's Direct and Indirect Effects and Effects of Other Activities
Timing of Effect	Project Construction and Implementation	At Some Future Time after Direct Effect	At Time of Project Construction or in the Future
Location of Effect	At the Project Location	Within Boundaries of Systems Affected by the Project	Within Boundaries of Systems Affected by the Project

adverse. Often, determination of whether an indirect (or cumulative) effect is beneficial or adverse depends on the specific viewpoint; i.e., it depends on who benefits and who pays. As an example, a commuter rail station is constructed in a suburban town. Ridership from outlying areas (i.e., those who drive to the transit station) is needed to make the rail line viable. This demand necessitates construction of a park-and-ride lot adjacent to the station—a benefit to those who drive to the town from outlying areas. However, the park-and-ride lot uses land that the town would like to devote to transit-oriented office and retail development (the town pays). The town also pays for the adverse indirect effects of air pollution, noise, and travel congestion from park-and-ride lot users. Conflicts between beneficiaries and payers of indirect effects of proposed transportation projects are commonplace. They lead to demands on the technical analysis of indirect effects (the subject of the next chapter).

It is important to note that the findings indicate that distinguishing direct from indirect effects is not as important as making sure that project effects as a whole are adequately addressed in the project's EIS. As the FHWA position paper on secondary and cumulative impact assessment noted, "it is the significance of impacts which determines [importance], not whether they are direct [or] indirect" (*6*). Therefore, it is not considered essential to draw a precise distinction between the terms direct and indirect, because this distinction will not materially affect the level of effort required for an EIS or other environmental studies. However, because of the inherent nature of indirect effects (i.e., not readily apparent), the findings indicate that a framework is needed for identifying and assessing those indirect effects of proposed transportation projects that are appropriate for consideration in project EISs.

CHAPTER 4

INTERPRETATION, APPRAISAL, AND APPLICATIONS: FRAMEWORK AND GUIDELINES FOR ESTIMATING INDIRECT EFFECTS

BACKGROUND

The framework and guidelines for estimating indirect effects of proposed transportation projects, presented below, was developed from the following input: relevant research findings, components of the transportation project development process, and general impact assessment framework elements. These input items are summarized below followed by a discussion of the resulting framework.

Key Findings for Framework Development

The research resulted in several findings with implications for development of a framework for estimating indirect effects. The key findings are as follows:

- Indirect effects are different than direct effects. Indirect effects are relatively difficult to predict because they occur in the future; for any given indirect effect, there is a degree of uncertainty about whether it will occur. Therefore, the approach to indirect effects assessment should not be to predict what will happen from implementing a proposed transportation project but rather should be oriented toward identifying what might happen given knowledge of cause–effect relationships and functioning and behavior of the affected systems.
- Indirect effects can extend some distance from a project footprint. Project location is an important variable in determining the extent of indirect effects. Therefore, indirect effects should be considered primarily during analysis of alternative project locations while it is possible to reassess the proposal (e.g., to avoid or lessen the effect by selecting an alternative location).
- The type and nature of indirect effects vary from project to project. No single analytical method is suited to identifying or assessing indirect effects in all situations.
- Although it is possible that every transportation project has indirect effects, it is neither required nor practical to analyze all possible indirect effects. Based on case law (*24*), the three considerations to be followed to determine whether a particular set of impacts should be taken into account are (1) with what confidence can one say that the impact is likely to occur; (2) is there sufficient specific knowledge about the impact to make its consideration useful (e.g., specificity about type of development that would occur); and (3) is there a need to know about the impact (e.g., because of potential controversy over the impact).
- There are a number of promising indirect effects identification and analysis methods suggested in the literature that are not typically applied in practice; these methods can help make potential indirect effects and their certainty more apparent.
- Consideration of indirect effects in transportation project planning and development should be part of an overall process of impact identification and analysis required by NEPA and the CEQ regulation to be integrated with project planning and decision making.

Components of the Transportation Project Development Process

Each DOT agency has a project development process that differs slightly from the others. For example, FHWA and FTA projects are developed through a process that involves both long-range transportation system planning and short-term programming of projects drawn from the plan. In addition, project development in certain states is subject to state environmental review processes. These processes typically coincide with parallel federal requirements. Figure 3 illustrates the fundamental commonalities of the various transportation project development processes, considering major milestones and generic terms, and serves as a starting point for developing the framework.

In addition to the steps shown in Figure 3, FHWA/FTA ISTEA planning regulations include the requirement that studies be conducted of major highway and transit investments in metropolitan areas. The major investment study essentially includes the problem identification/needs assessment and alternatives analysis/project design concept and scope steps. It broadens the alternatives under consideration and front-loads the alternatives analysis compared with past practice so that a preferred alternative is advanced to NEPA evaluation. Indirect effects can be important considerations in a major investment study, and the framework and guidelines are suited to the major investment study process.

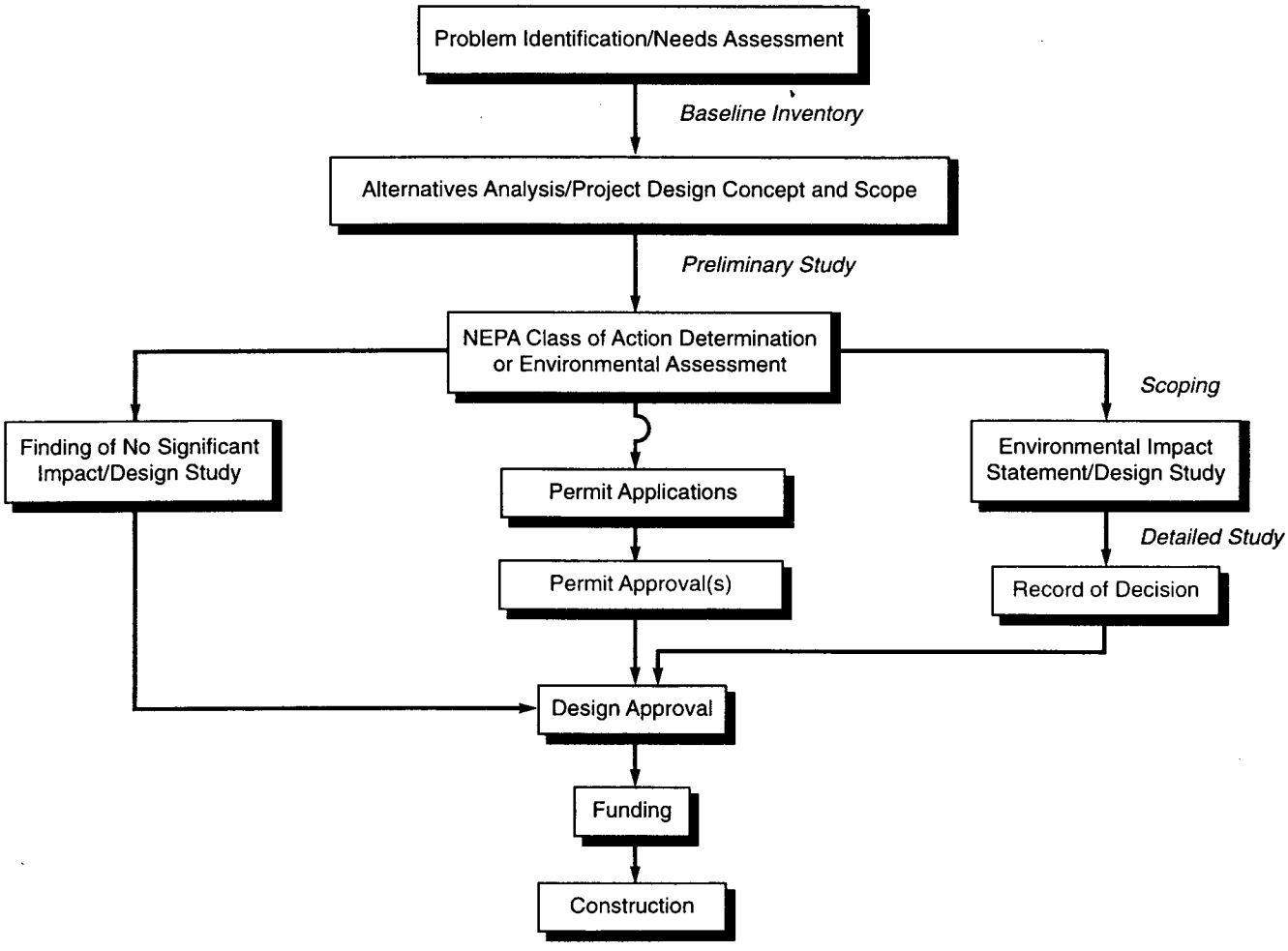


Figure 3. Generic steps of major transportation project planning and development process.

Elements of Various Impact Assessment Frameworks

Various impact assessment frameworks have been proposed since passage of NEPA. Three examples are shown in Table 18. Included are an example of a general framework, one specific to social impact assessment, and one specific to ecologic impact assessment. Each contributes to understanding the required elements of a framework for estimating indirect effects. These frameworks have many common elements useful for framework development.

OVERVIEW OF INDIRECT EFFECTS ASSESSMENT FRAMEWORK

Figure 4 illustrates the indirect effects assessment framework developed from the factors discussed above. Key aspects of the framework are as follows:

- Its focus is on using information provided by studies—specifically, needs assessment and environmental screening studies (Steps 1 and 2, respectively)—that are currently part of early stages of the typical transportation project planning and development process. In this way, the framework can become an integral part of a transportation agency's overall project planning and development process.
- It places the indirect effects assessment in the broader context of local or regional social, economic, ecologic, and growth-management directions and goals (Step 1) and specific notable features (Step 2), defined by the transportation agency, regulatory and resource agencies, local governments, and the public. The framework focuses attention on those indirect effects of identified project actions (Step 3) that can be related by cause and effect to the goals and features. This context provides a means (1) for discerning which indirect effects, if any, merit detailed study because they are potentially significant (Step 4); (2) for analyzing the magnitude of the indirect effects (Step 5); and (3) for communicating the results to decision makers and the public in a meaningful way (Step 6). However, this context also requires

TABLE 18 Components of various environmental impact assessment frameworks

Generic[51]	Ecological Impact Assessment[52]	Social Impact Assessment[53]
Impact Identification	Gather Data	Develop Public Scoping Program
↓	↓	↓
Impact Measurement	Establish Baseline Conditions	Describe Proposed Action and Alternatives
↓	↓	↓
Impact Interpretation	Identify Ecological Elements at Risk	Describe Relevant Human Environment and Area of Influence
↓	↓	↓
Impact Communication to Information Users	Select Ecological Goals and Objectives	Identify Probable Impacts
	↓	↓
	Predict Likely Project Impacts	Investigate Probable Impacts
	↓	- Determine Probable Response of Affected Publics
	Establish Mitigation Objectives	- Estimate Higher Order and Cumulative Impacts
	↓	↓
	Form Mitigation Monitoring Objectives	Recommend Changes in Proposed Action or Alternatives
	↓	- Mitigation Plan
	Select Monitoring Indicators	↓
	↓	Develop Monitoring Program
	Identify Monitoring Control Areas/Treatments	
	↓	
	Design and Implement Monitoring	
	↓	
	Confirm Relationships Between Indicators and Goals and Objectives	
	↓	
	Analyze Trends and Recommend Changes to Management	

that resource and regulatory agencies, local governments, and citizens provide input for the assessment.
- It facilitates early consideration of indirect effects—i.e., at the system planning or project planning stage so that the proposed transportation improvement can be reassessed, or adverse indirect effects can be mitigated, if necessary, by reassessing mode, location, access, and so forth (Step 7). The framework is consistent with NEPA and ISTEA goals.
- The framework is consistent with emerging principles of cumulative impact assessment, social impact assessment, and ecologic impact assessment. Therefore, the indirect effects assessment framework complements and can be integrated with direct and cumulative impact assessment of a transportation plan or project so that duplicative efforts are minimized. Accordingly, an attempt is made to use terms that are consistent with those currently used in other related contexts.

In general, the framework that has been developed is oriented toward proposed transportation projects that are major federal actions as defined by NEPA *(2,3)*. Highway or transit projects in the category of major metropolitan transportation investment as defined by ISTEA are also likely candidates for framework application. For projects that do not fall under either category, it is suggested that the framework at least be used to scope the potential for significant indirect effects when the project

- Is in proximity to notable features (see Step 2) that could be affected by project activities; or
- Is in an area where one or more of the following conditions is present:
  - There is an absence of local comprehensive planning or zoning or subdivision ordinances;
  - Land development is the project's reason for existence;
  - The project will substantially improve accessibility to the area; or
  - There is a large amount of developable land in proximity to the project.

The importance of these factors is discussed in detail in Step 4.

It is worth noting that indirect effects assessment is but one of many factors considered in making decisions about proposed transportation projects. Capital project and other decisions are typically made under conditions of uncertainty. The purpose of the framework and supporting methods is to make the indirect effects assessment as comprehensive and systematic as possible to reveal the essential understanding about the project's indirect effects that the decision maker needs to know.

A more detailed description of framework steps and supporting methods follows.

FRAMEWORK STEPS AND SUPPORTING GUIDELINES AND METHODS

Step 1: Identify the Study Area's Various Directions and Goals

Step 1a: Objectives for Defining Directions and Goals

The objective of this step is to use the problem identification/needs assessment stage of transportation project plan-

STEP	1	2	3	4	5	6	7
ACTIVITY	**Identify Study Area's Directions & Goals** →	**Inventory Study Area's Notable Features** →	**Identify Impact-Causing Activities of Proposed Action & Alternatives** →	**Identify Potentially Significant Indirect Effects for Analysis** →	**Analyze Indirect Effect** →	**Evaluate Analysis Results** →	**Assess Consequences (& Develop Mitigation)**
OBJECTIVE	Define Context for Assessment	Identify Specific Environmental Issues by Which to Assess Project	Flesh Out Project's Component Activities	Identify Indirect Effects that Merit Detailed Analysis	Analyze Probable Magnitude of Effect	Evaluate Uncertainty of Results	Evaluate Acceptability of Effects (Develop Measures to Avoid or Lessen Unacceptable Effects)
POSSIBLE DATA SOURCES/ METHODS	• Available Plans • Visioning • Focus Groups • Citizen Surveys	• Ecological Databases • U.S. Census • Interviews • Field Studies • Focus Groups	• Checklist • Presentational Matrix	• Matrices • Network Diagrams • Cartographic Techniques • Qualitative Inference • Comparative Case	• Models • Trend/Correlation Analysis • Probabilistic Forecasting • Delphi Technique • Scenario Writing • Alternative Visions/ Futures	• Sensitivity Analysis • Risk Analysis	• Compare Magnitude of Effect with Goals & Notable Features (• Reanalyze Effect with Mitigation)
INTERAGENCY/ PUBLIC INVOLVEMENT	• Provide Input • Review Work Product	• Provide Input • Participate in Discerning what is Notable	Review Work Product	• Participate in Exploring Cause - Effect Relationships • Review Work Product	• Provide Input • Review Work Product	Participate in Bounding Uncertainty	• Participate in Judging Acceptability of Effects (• Provide Input to Mitigation Development)
WORK PRODUCT	Synthesis of Relevant Plans, Trends, Policies & Shaping Forces (Tables 19 & 20)	• List of Features • Map of Features' Locations (Tables 21-24)	List of Impact - Causing Actions (Table 25)	Technical Memorandum (Identification) (Tables 32-35)	Technical Memorandum (Analysis)	Documentation of Uncertainty	Compilation of All Steps Into Package to Support EIS

Figure 4. Indirect effects assessment framework.

ning to identify and consider directions and goals of the study area independently of the proposed transportation project. The relevant directions and goals are typically social, economic, ecologic, and growth oriented. Their consideration can help identify the spatial and temporal boundaries of indirect effects analysis (e.g., neighborhood versus community concerns).

This step is timed to coincide with the transportation problem identification step of the generic transportation project planning and development process. The objective is to define goals of the study area (e.g., preservation of community character or a particular ecosystem) in an effort to complement the conventional transportation goals or problems (e.g., traffic safety, inadequate level of service). Consequently, the social, economic, and environmental goals of the subject area plus the transportation goals can be used as input to form a project proposal, the next step in the generic transportation project planning and development process.

Social, economic, and environmental goals expressed through formal plans reflect a current vision of the future. Because of their inherent rippling effect over space and time, one way to measure a transportation system's or project's indirect effects is to envision the future both with and without the system or project improvements. Consideration of various goals early in the planning process can help focus the effort toward balancing transportation and other needs and also toward understanding potential indirect (and cumulative) effects.

Empirical evidence indicates that transportation investment and changes in land use appear to occur only in the presence of other factors, such as supportive local land-use policies and development incentives, availability of developable land, and a good investment climate. Therefore, an understanding of local goals combined with an understanding of the role that a transportation investment could play in achieving these goals, given local circumstances, could lead to coordinated formulation of a broad range of actions for reaching these goals. Ideally, the desired future or outcome should lead, and the transportation solution combined with other appropriate strategies (e.g., land use, environmental protection, and housing) should follow.

For efficiency, this step should be coordinated with related activities of the metropolitan planning organization in developing the long-range transportation plan and locally accepted forecasts and assumptions, where appropriate.

Step 1b: General Issues of Defining Directions and Goals

Goals are typically spelled out in plans or policies. The content of available plans is typically examined during the transportation project development process. For example, such plans can provide future population and employment growth and land development information for the study area. Further, the CEQ NEPA regulation (*3*) requires an evaluation of project consistency with local plans. The findings and literature indicate that better understanding of the interrelationships between an area's transportation and other goals early in the process can lead to better anticipation of a proposed transportation project's indirect effects issues—e.g., a balance between conflicting needs and goals. However, this does not mean that conflicts over indirect effects will necessarily be avoided by considering nontransportation goals in the process.

As discussed in Chapter 2, CEQ has outlined general goals (11 principles) of ecosystem (biodiversity) management (*12*). CEQ suggests that federal agencies consider these goals when assessing the effects (direct, indirect, and cumulative) of their actions, including actions at the project-specific or site-specific level. These goals have been expressed through a number of federal, state, and local resource-management plans (e.g., those for the Chesapeake Bay and Great Lakes watersheds).

Relative to ecologic goals, social or economic goals are typically not as well formulated or articulated at this time, both generally and at the local level (e.g., in comprehensive or growth-management plans). While general principles of social impact assessment are being advanced, goals are typically expressed in very broad terms (e.g., maintain community character or manage growth) and vary with location.

Proposed transportation improvements are often planned to support an area's economic development goals. In this case, the anticipated economic growth and land-use conversion from that growth are to be treated as indirect effects of the transportation project. Understanding the economic development goals not only should help us formulate the scope of the proposed transportation improvement but also should help us eventually understand the nature of the induced indirect effects.

Although it is recommended that available plans be used to help determine the area's various goals, the following items should be kept in mind:

- The age of the plan: In many areas there is no requirement for periodic updating of comprehensive plans even where there is a formal planning process. Political winds tend to change over time and a dated plan may not reflect the area's current needs and goals.
- The geographic area covered by the plan: Often, an incorporated area may have a comprehensive plan and zoning, whereas an adjoining unincorporated area does not. The distinction between the incorporated and the unincorporated area in terms of current land use may not be clear. However, the absence of land-use controls in the unincorporated area may affect the character of future urbanization in the incorporated area. In addition, one municipality's growth-management plan may not conform to the overall plan for a region.
- Who was involved in preparing the plan: It is important to know, for example, whether the local citizenry has

bought into a resources-management plan prepared by a nonlocal entity.
- The degree of importance attached to the goals by the public and their decision-making authorities.

Even in areas where there is an up-to-date plan and an effective planning process, it is probably wise to use a public involvement method or methods at least to confirm the directions and goals expressed in the plan as well as to gather information on the area's directions and goals first hand when appropriate. Moreover, certain methods can be used to substantiate alternative scenarios in more detail than expressed in a plan. This greater level of detail may be needed for subsequent indirect effects assessment if issues are anticipated. Accordingly, the methods discussion evaluates appropriate public involvement techniques for this step.

The area's expressed goals give a part of the picture needed to understand potential indirect effects in a big-picture context. It is also important to understand direction (i.e., where an area has been, where it is, and where it is going). Direction can be understood in part by identifying past, present, and anticipated socioeconomic, environmental quality, and land-development trends. Equally important is knowing the forces that have shaped landscapes, economic activity, and land-use patterns (e.g., transportation system, physical environment, political, and market influences) and knowing how the forces have been influential (the same is true of existing and anticipated forces).

Step 1c: Methods for Defining Directions and Goals

Two basic tasks are required for this step: (1) define the study area, and (2) collect, organize, and synthesize the relevant data for the study area. A degree of professional judgment is required for both of these tasks.

The study area consists of the broad geographic limits within which the proposed project will likely have an influence. For encroachment-alteration effects, these limits may be defined by the limits of environmental systems (e.g., watershed boundaries or regional landscape units). For induced growth effects, these limits may be defined by the area over which the project could influence travel costs or travel patterns. These limits may be defined by the travel forecasting model, where employed, or an area 15 to 30 min from the proposed project. Political and U.S. census geography also should be considered in delimiting the study area for practical purposes.

It should be expected that the study area boundaries will be refined in subsequent steps before proceeding with the analysis of indirect effects. For example, the boundaries will likely be shaped by the issues of concern specific to the project (see Steps 2 to 4). Because it is obviously easier to narrow the study area for focus than to expand the study area, it is advisable to err on the side of inclusion at this point in the process.

The data collection task for this step generally should rely on readily attainable sources. Data collection should not be viewed as an end in and of itself but rather as a foundation for future steps. Data for this purpose can be both quantitative and qualitative. The checklists provided in Tables 19 and 20 are for use in identifying, organizing, and documenting directions and goals.

Of course, it is important to deal with facts, particularly when facts are readily obtained. However, facts tell only part of the story (or do not exist for all items of interest). Perceptions of directions and goals or opinions about them can be valuable in establishing a big-picture context.

A number of public involvement techniques are advocated for obtaining the perceptions or opinions. For example, the DOT document *Innovations in Public Involvement for Transportation Planning* (*54*) is a notebook that outlines various practical techniques of public involvement that can be used in a variety of situations. The reader should consult these and other pertinent documents for details. A comparison of techniques relevant to goals development includes the following:

- Visioning: This technique typically consists of a series of meetings focused on long-range issues. It looks for common ground among participants in exploring and advocating strategies for the future. With overall goals in view, it avoids piecemeal and reactionary approaches to addressing problems. It accounts for the relationship between issues and how one problem's solution may generate other problems (e.g., indirect effects). To be balanced, visioning requires involvement of all stakeholders and a cross-section of citizens. Resources required for visioning typically include a staff leader committed to the process, a community participation specialist who is well versed in the applicable subject matter, and staff who can interpret and integrate participants' opinions from surveys and meetings. If forecasts of information or alternative scenarios are to be developed, research and preparation time can be extensive.
- Citizen survey: This technique is used to assess widespread public opinion with a survey administered to a sample group of citizens by a written questionnaire or by interviews in person, by phone, or by electronic media. Surveys can be used to obtain information for determining residents' perceptions of an area's future directions and goals. Surveys can be informal or formal (scientific); formal surveys are more expensive and require a higher level of expertise. Survey respondents should be selected to provide a composite view of the larger population. In this respect, a survey can capture the views of those who are not ordinarily informed or involved in transportation processes (including those who may not have the time to participate in visioning or other public

TABLE 19 Organization and tabulation of goals

(Check where applicable)

Project Name: Location: Analyst: Date:

	Notes
Social Health and Well-Being Goals	
___ Achieve adequate, appropriate and accessible open space and recreation	
___ Comply with state and federal water and air quality laws	
___ Preserve or create multicultural diversity	
___ Preserve heritage	
___ Provide choice of affordable residential locations	
___ Provide urban environment for those with special needs	
___ Promote land use patterns with sense of community	
___ Provide a range of services accessible to all	
___ Promote a healthy and safe environment	
___ Provide sound management of solid and hazardous waste	
___ Other _____	
Economic Opportunity Goals	
___ Support activities to meet changing economic conditions	
___ Provide energy-efficient transportation	
___ Provide developments with transit-supported capabilities	
___ Target economic export activities	
___ Attract and maintain workforce	
___ Promote infill of smaller, passed-over sites	
___ Encourage redevelopment of older areas for new purposes	
___ Other _____	
Ecosystem Protection Goals	
___ Protect ecosystems	
___ Minimize fragmentation	
___ Promote native species	
___ Protect rare and keystone species	
___ Protect sensitive environments	
___ Maintain natural processes	
___ Maintain natural structural diversity	
___ Protect genetic diversity	
___ Restore modified ecosystems	
___ Other _____	

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involvement initiatives). One drawback of the survey is that it is not interactive.

- Focus group: The focus group is another tool to gauge public opinion and identify citizen concerns, needs, wants, perceptions, and expectations. A focus group is a small group discussion with professional leadership. Participants in a focus group are selected in two ways: random selection to ensure representation of a cross section of society or nonrandom selection to help elicit a particular position or point of view. A focus group can help conform or deny established goals. A focus group is relatively inexpensive compared with the costs and effort of administering a full opinion survey.

There is obviously some sensitivity involved in exploring the directions and goals of plans developed by others. For this reason, visioning is recommended as a public involvement tool in most situations for determining or confirming the area's directions and goals for the future at a broad level. Visioning can be used to develop alternative future scenarios for eventual comparison with the proposed project scenario. The citizen survey or focus group techniques can be used to

support visioning when more details about directions and goals are required.

Step 1d: Product of Defining Directions and Goals

The product from the work on Step 1 consists of comprehensive lists (completed Tables 19 and 20 checklists) of the area's various directions and goals. The sponsoring transportation agency should be responsible for preparing the list, sharing it with those who participated in its development, and finalizing its content after review and comment by participants. The list can be used to support a technical memorandum that synthesizes the study area's relevant plans, trends, policies, and shaping forces. The technical memorandum is recommended for more complex situations.

Step 2: Inventory Notable Features

Step 2a: Objective of Inventorying Notable Features

An inventory of baseline environmental conditions (or screening) is typically done as a project proposal is being developed, usually before the NEPA class of action determination. The typical inventory has become fairly routine, and the sources of data to undertake the typical inventory are relatively well established. The baseline environmental screening can be used as a tool to identify notable features or specific valued, vulnerable, or unique elements of the environment. The objective of this step is to identify specific environmental issues within the study area against which the project may be assessed.

Step 2b: General Issues of Inventorying Notable Features

Whether from encroachment-alteration or project-induced growth, indirect effects from transportation projects change the environment. Society has preferences for how much change is acceptable. The acceptability of the degree of change varies depending on the affected setting or population. A number of terms are found in the literature that describe settings or populations commonly afforded special attention with respect to change. The term notable features is used in this study as an overarching term that encompasses the various terms found in the literature. Meanwhile, the various terms are described in the following paragraphs.

EPA (*52*) uses terms such as sensitive species and habitats, noting that the term sensitive applies to ecologically valuable species and habitat and those vulnerable to impact. EPA added that rarity is often a good indicator of vulnerability. EPA notes the following other characteristics as being indicative of vulnerability as:

- Species requiring high survival rates instead of high reproduction rates;
- Species whose intrinsic rates of increase fluctuate greatly; and
- Communities with vulnerable keystone predators or mutualists.

Irwin and Rodes (*55*) use the term valued environmental component as a "characteristic or attribute of the environment that society seeks to use, protect, or enhance." Forman and Godron (*56*) use the terms relative uniqueness and recovery time as measures of a landscape element's (ecosystem's) value. Relative uniqueness is "a measure of how many comparable examples of this landscape element exist at different levels of scale, from the local area to the nation, even the globe." Recovery time is "a measure of how long it would take to replace the existing landscape element in comparable form if it were disturbed or destroyed." Forman and Godron also note the importance of unusual landscape features, that is, "types of landscape elements only found once or a few times across an entire landscape." Such features—e.g., a single major river in a landscape—are notable as activity centers "where flows of species, energy, or materials are concentrated."

The field of social impact assessment also recognizes vulnerable elements of the population (*53*). It has been suggested that vulnerable segments of the population of a neighborhood or community include the elderly, children, the disabled, and members of low-income or minority groups. Such segments may be more at risk from the effects of air pollutant emissions (e.g., the elderly, children), susceptible to changes in pedestrian mobility (the elderly, children, the disabled), or typically underrepresented in providing input to transportation decisions.

What constitutes a notable feature depends on perspective (there are likely many other perspectives or disciplines of study not discussed here that are captured by the term notable features). Therefore, the inventory should cast as wide a net as possible on perspectives. Similarly, the definition of notable features in an area depends on scale. What is notable to a region will often differ from what is notable to a community or city. The various geographic scales should be examined in keeping with the CEQ regulations, which state that significance varies with context (*3*).

Step 2c: Methods for Inventorying Notable Features

The objective of the environmental inventory step of the typical transportation project development process is to gather information about baseline environmental conditions.

TABLE 20 Study area directions and goals checklist

(Check where applicable)

Project Name: Location: Analyst: Date:

1. **Generalized Setting**

   Within Metropolitan Statistical Area (Identify MSA) ____
   Outside of MSA ____
   Both Inside and Outside MSA ____

   Indicate Distance to Nearest Metropolitan Center ____

2. **Characteristics of Transportation System** (Note: These items are not intended to cover entire transportation need but rather to use information from more detailed assessments to provide a preliminary indication of existing accessibility, service and modal interrelationship characteristics, i.e., factors relevant to subsequent indirect effects analysis).

   - Identify missing links in transportation system _____.
   - Map and describe existing level of service on minor and principal arterials and their access characteristics.
   - Indicate distance to nearest interstate highway if not in study area.
   - Map and describe existing transit routes and demand.
   - Map and describe major concentrations of existing and planned development.
   - Describe modal interrelationships including competing and complementary characteristics.

3.

Population	Trend	Projection
Declining	___	___
Static (±1%/10 years)	___	___
Slow Growth	___	___
Rapid Growth (>10%/10 years)	___	___

Employment	Trend	Projection
Declining	___	___
Static (±1%/10 years)	___	___
Slow Growth	___	___
Rapid Growth (>10%/10 years)	___	___

4. **Planning Context**

	Yes	No	If yes, identify by title, agency and date
Zoning	____	____	_____
State Master Plan	____	____	_____
County/Regional Master Plan	____	____	_____
Municipal Master Plan	____	____	_____
Growth Management Plan	____	____	_____
Water Quality Management Plan	____	____	_____
Other Natural Resources Management Plan	____	____	_____

5. **For each plan identified in No. 3, summarize key goals, elements and linkages to other plans (specify, in particular, elements related to economic development, land use development, the transportation system, and natural resource protection).** _____

_____

6. **Describe any efforts to elicit local needs and goals from residents and/or agencies (source and result).** _____

_____

7. **Describe known plans for major new or expanded activity centers including public facilities.** _____

_____

Is the activity center dependent on transportation system improvement? Yes ____ No ____

8. **Is the transportation need linked to economic growth and land development?** Yes ____ No ____

If yes, is the nature of the linkage to:

Serve the needs of planned growth _____ or

Channelize growth _____ or

Stimulate growth _____ or

9. **Based on information obtained, are there any apparent conflicts between transportation and other needs that could result in controversy? (Describe).**

Yes _____ Possible _____ No _____

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Indirect effects assessment requires a big-picture approach. Tables 21 and 22 were developed, respectively, primarily from concepts in EPA's report on ecosystem approaches to highway impact assessment (*52*) and from Pivo's approach to community impact assessment (*57*). These tables are to be used by the analyst to perform the requisite big-picture inventory. Notable features can then be gleaned from the inventory lists with the checklists in Tables 23 and 24. Table 24 was prepared to note that, through enactment of laws, society as a whole has in effect placed a value on certain resources or determined that certain resources require special consideration before actions like transportation projects are undertaken. Table 24 lists pertinent federal laws; state and local transportation agencies should expand the list to include pertinent state and local laws. The following are potentially useful sources of ecologic information: National Biological Service, National Heritage Program Network, Fish and Wildlife Information Exchange, Regional Natural Resource Plans, and Resource Agency Management Plans. In addition, habitats of concern for various regions of the country have been described generically in a report to EPA by Southerland (*58*); it should be determined whether or not such habitats are present in the study area.

The following are potentially useful sources of socioeconomic information:

- Comprehensive plan, historical studies of the community, newspaper accounts of public opinion;
- Published statistics—existing measures and future projections of demographic factors in area, region, and nearby areas from the U.S. census, comprehensive plans, and utility companies and journey-to-work statistics from the U.S. census (within an urbanized area, the metropolitan planning organization should be consulted for population and employment statistics because it would have these and the future, locally approved projects for use in transportation planning);
- Citizen survey or focus groups to ascertain what people like most about the area and where they would take visitors to give them a feel for the area (uniqueness);
- Field studies to analyze physical elements of neighborhood or community form.

Field investigations should be performed to confirm secondary source information or to investigate items not identified through readily available information. After confirmation, the location and extent of inventoried items should be mapped or tabulated.

It is possible that a project study area could contain a number of possible notable features and differing views of what is notable or why it is notable. For these reasons, it is in a

TABLE 21 Ecosystem conditions inventory

Project Name: _____ Location: _____ Analyst: _____ Date: _____

Setting	Describe/Characterize (Map Locations)
___ Suburban Landscapes Remnant Communities Greenways Remnant Populations Wetlands and Riparian Zones Drainage Patterns Natural Vegetation Diversity	
___ Rural Watersheds Local Ecosystem Integrity Riparian Corridors Endemics and Migratory Species Riparian and Forest Corridors Hydrology Landscape Pattern Diversity Dispersal Routes	
___ Wildland Regional Ecosystems Remote Habitat Contiguous Habitat Habitat Interior Species Unique Environments Structural Components of Interior Habitat Subpopulation Movements	

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TABLE 22 Socioeconomic conditions inventory

Project Name: _____ Location: _____ Analyst: _____ Date: _____

	Describe/Characterize
Economic	
Residents' occupational mix	
Jobs in community (mix)	
Jobs/housing balance (self-containment)	
Income distribution mix	
Journey to work (length and mode)	
Job growth rate	
Business ownership and services characteristics	
Demographic	
Population growth rate	
Population age mix	
Household types	
Retired population percent	
Social	
Community cohesion	
Crime rates	
Clubs, sports and organizations participation	
Education levels mix	
Sense of control over change	
Balance of old timers and newcomers	
Physical	
Housing stock mix and values	
Open space percent	
Town area and form	
Separation from other activity centers	
Residential density	
Mix of land uses	
Town edge activity	
Historic structures and places	
Circulation and traffic characteristics	
Neighborhood design characteristics	
Infrastructure character	
Commercial building scale	
Town entrance setting	
Scenic character	
Trees and vegetation presence	
Noise levels and timing	
Lighting influence	

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transportation agency's interest to have as many interested parties as necessary involved in determining the notable features for a particular study area.

The collaborative task force public involvement technique appears ideally suited for this purpose. This technique is described in detail in the DOT *Innovations in Public Involvement for Transportation Planning* (*54*) document. A collaborative task force is assigned a specific task with a time limit to come to a conclusion to resolve an issue subject to ratification by official decision makers. A collaborative task force has the following basic features:

- A sponsoring agency that is committed to the process;
- A task force formed of representative interests;
- Emphasis on resolving an issue through task force consensus;
- Detailed presentations of material and technical assistance for complete understanding of context and subject matter; and
- Serial meetings to understand and deliberate the issues.

A collaborative task force can require relatively significant resources. Among these are an experienced, neutral facilita-

TABLE 23 Notable features checklist

(Check where applicable)

Project Name: _____ Location: _____ Analyst: _____ Date: _____

	Specify
Ecosystem Features	
___ Regional habitats of concern/critical areas	
___ Rare, threatened or endangered species and associated habitat	
___ Species requiring high survival rates	
___ Species whose intrinsic rates of increase fluctuate greatly	
___ Communities with vulnerable keystone predators or materialists	
___ Other _____	
Socioeconomic Features	
___ Substandard amounts of open space and recreation	
___ Non-compliance with state and federal environmental laws	
___ High concentration of uncontrolled solid and hazardous waste sites	
___ Inadequate affordable housing	
___ Inadequate access to amenities	
___ Economically distressed areas	
___ Lack of institutional land use controls	
___ High proportion of population consisting of:	
___ Minorities	
___ Low-income residents	
___ Elderly	
___ Young	
___ Disabled	
___ Low proportion of long-term residents	
___ Locations of poor traffic flow	
___ Other _____	

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tor, staff technical support, presentation materials understandable to lay individuals, and, usually, specialized consultants. Several meetings are likely, with each consuming several hours.

After collecting data, the transportation agency should assemble a preliminary list of notable features for potential use as impact measures in the indirect effects analysis. The same list could be used for direct and cumulative impact analysis as well. This list forms the basis of discussion at a collaborative task force meeting(s). The final list of selected assessment notable features should reflect the task force consensus.

Step 2d: Product of Inventorying Notable Features

The product from the work in Step 2 consists of completed Tables 21 to 24, with an accompanying map illustrating the location and extent of each notable feature where appropriate. The list should be prepared by the sponsoring transportation agency with the collaborative task force, where used, and shared with those who participated in its development.

Step 3: Identify Impact-Causing Activities of the Proposed Action and Alternatives

Step 3a: Objective of Identifying Impact-Causing Activities

The problem identification/needs assessment stage is typically followed by alternatives analysis and development of a project design concept and scope (proposed action). Typically, the transportation project description consists of basic information that describes the facility to result from the proposed action or alternative—e.g., estimated year of completion, type and function of facility, project length, termini, access points, and number of lanes. This is especially true in early project stages before detailed information becomes available from preliminary design studies. It is clear from this study's research findings that a more detailed project description than is typical is needed to make indirect effects more apparent earlier in the project planning and development process.

The objective of this step in the framework is to go beyond the typical project description to substantiate those impact-causing activities that a project will entail. This is consistent

TABLE 24 Notable features addressed by federal statutes

(Check where applicable)

Project Name: Location: Analyst: Date:

Resource Type or Area	Statute/Order	Source of Information and Map Locations
___ Section 4(f) Resources ___ Public Parks and Recreational Lands ___ Wildlife and Waterfowl Refuges ___ Historic Sites ___ Historic Districts ___ Archaeological Remains ___ Historic Structure	Department of Transportation Act	Local Parks or Recreation Officials, State Historic Preservation Office or local historic preservation organizations
___ Coastal Zone	Coastal Zone Management Act	State Coastal Zone Management Office
___ Waters of the United States	Clean Water Act; E.O. 11990	State Fish and Game Commission; U.S. Fish and Wildlife Service
___ Sole Source Aquifer	Safe Drinking Water Act	State Natural Resources Agency; U.S. Environmental Protection Agency
___ Areas of Known Contamination	Comprehensive Env. Response Compensation Liability Act	State environmental protection agency; U.S. Environmental Protection Agency
___ Floodplains	E.O. 11988	Federal Emergency Management Agency
___ Range or Habitat of Threatened or Endangered Species	Endangered Species Act	State Fish and Game Commission; U.S. Fish and Wildlife Service
___ Wild, Scenic or Recreational River	Wild and Scenic Rivers Act	U.S. National Parks Service
___ Prime or Unique Farmland	Farmland Protection Act	U.S. Soil Conservation Service
___ Sensitive Receptor	Clean Air Act; Noise Control Act	State environmental protection agency
___ Nonattainment or Maintenance Areas	Clean Air Act	State and local air and transportation agencies; metropolitan planning organizations; state implementation plans; conformity determinations of transportation plans, programs and projects.
___ Residential or Commercial Establishments	Uniform Relocation Act; E.O. 12898	Local governments

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with the overall framework objective of promoting consideration of indirect effects earlier in the transportation project development process. This is an exercise that occurs formally or informally during the environmental impact assessment of a project. From the review of dozens of transportation project EISs reported in Chapter 2, it appears that this exercise is typically done by the analysts who prepare the environmental consequences section of the EIS—i.e., after preparation of the affected environment section of the EIS or later in the process rather than sooner. However, with as complete a description as possible of the proposed action and alternatives early on, it is possible to begin the process of identifying cause–effect relationships between activities and the context of the study area defined by goals and notable features.

Step 3b: General Issues for Identifying Impact-Causing Activities

A transportation project may involve a number of impact-causing activities. Few details may be known about these activities at the early stages of project development beyond the basic project design concept and scope. Therefore, this step may require some leap of faith by those developing the description as well as an understanding that the information provided is for purposes of conceptualizing, not quantifying, effects. In other words, what is important at this point is identification of the types of activities the project will entail. This step can be accomplished with a level of detail commensurate with 400-scale mapping.

An understanding of the transportation agency's past practices in similar situations—e.g., bridging of streams versus placing a stream in a culvert—as well as knowledge of relevant sections of the agency's design manual and standard specifications is needed. Some experience is necessary to make judgments about these items.

The project description should also be viewed as a piece that will evolve and should be updated as details about the project become known with more certainty. In particular, the linking of impacts and goals/notable features in Step 4 should prompt development of more details about activities that have potential for significant impact where such details are lacking.

Step 3c: Methods for Identifying Impact-Causing Activities

Table 25 is a checklist developed primarily from Leopold et al. (*39*) to help substantiate typical impact-causing activities

TABLE 25 Project impact-causing activities checklist

Project Name: _____ Location: _____ Analyst: _____ Date: _____

	Yes	No	If Yes, Describe Generally (Breadth, Duration, Location and Type)
Modification of Regime			
Exotic Flora Introduction	___	___	_____
Modification of Habitat	___	___	_____
Alteration of Ground Cover	___	___	_____
Alteration of Groundwater Hydrology	___	___	_____
Alteration of Drainage	___	___	_____
River Control and Flow Modification	___	___	_____
Channelization	___	___	_____
Noise and Vibration	___	___	_____
Land Transformation and Construction			
New or Expanded Transportation Facility	___	___	_____
Service or Support Sites and Buildings	___	___	_____
New or Expanded Service or Frontage Roads	___	___	_____
Ancillary Transmission Lines, Pipelines and Corridors	___	___	_____
Barriers, Including Fencing	___	___	_____
Channel Dredging and Straightening	___	___	_____
Channel Revetments	___	___	_____
Canals	___	___	_____
Bulkheads or Seawalls	___	___	_____
Cut and Fill	___	___	_____
Resource Extraction			
Surface Excavation	___	___	_____
Subsurface Excavation	___	___	_____
Dredging	___	___	_____
Processing			
Product Storage	___	___	_____
Land Alteration			
Erosion Control and Terracing	___	___	_____
Mine Sealing and Waste Control	___	___	_____
Landscaping	___	___	_____
Wetland or Open Water Fill and Drainage	___	___	_____
Harbor Dredging	___	___	_____
Resource Renewal			
Reforestation	___	___	_____
Groundwater Recharge	___	___	_____
Waste Recycling	___	___	_____
Site Remediation	___	___	_____

Changes in Traffic (including adjoining facilities)

- Railroad
- Transit (Bus)
- Transit (Fixed Guideway)
- Automobile
- Trucking
- Aircraft
- River and Canal Traffic
- Pleasure Boating
- Communication
- Operational or Service Charge

Waste Emplacement and Treatment

- Landfill
- Emplacement of Spoil and Overburden
- Underground Storage
- Sanitary Waste Discharge
- Septic Tanks
- Stack and Exhaust Emission

Chemical Treatment

- Fertilization
- Chemical Deicing
- Chemical Soil Stabilization
- Weed Control
- Pest Control

Access Alteration

- New or Expanded Access to Activity Center
- New or Expanded Access to Undeveloped Land
- Alter Travel Circulation Patterns
- Alter Travel Times between Major Trip Productions and Attractions
- Alter Travel Costs between Major Trip Productions and Attractions

Others

- _____
- _____
- _____

Reviewed by:	Name	Affiliation	Date

of transportation projects. For a given project, pertinent impact-causing actions can be viewed as potential catalysts for indirect effects. The question for the analyst is Does the tabulation provide sufficient information about the breadth, duration, location, and type of activity so that the general types of impacts to be expected from the project can be inferred?

Step 3d: Product of Identifying Impact-Causing Activities

The product from the work in Step 3 consists of a comprehensive list (completed Table 25 checklist) of the impact-causing actions of the proposed plan or project and alternatives in as much detail as possible. The list is usually prepared by the sponsoring transportation agency. A list should be made of assumptions used to fill in gaps where details about activities are lacking. This list should be consulted and updated as details are developed but no less frequently than the inception of each subsequent step of the indirect effects assessment process. If there is a substantial difference between an assumption and the detail developed about a particular activity—e.g., use of fill material instead of structure—then an assessment needs to be made of whether the difference causes a substantial change in either the identification of potentially significant indirect effects (Step 4), the analysis of the effects (Step 5), or the conclusions about the acceptability of the effects (Step 7). This assessment can be done by using the sensitivity analysis or risk analysis task described in Task 6.

Step 4: Identify Potentially Significant Indirect Effects for Analysis

Step 4a: Objective of Identifying Indirect Effects

Section 101(a) of NEPA (*2*) is the "Declaration of National Environmental Policy," and reads as follows:

> The Congress recognizing the profound impact of man's activity on the interrelations of all components of the natural environment, particularly the profound influences of population growth, high density urbanization, industrial expansion, resource exploitation and new and expanding technological advances . . . declares that it is the continuing policy of the Federal Government, in cooperation with State and local governments, and other concerned public and private organizations, . . . to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic and other requirements of present and future generations of Americans.

This language has two elements pertinent to indirect effects analysis: (1) recognition of the impact of human activity on the interrelationships of all components of the natural environment; and (2) implication that the impact should be balanced against other considerations. This step deals with the first of these elements; the second element is the subject of Step 7—use analysis results in planning and decision making. The objective of this step is to compare the list of project impact-causing actions with the lists of goals and notable features to explore potential cause–effect relationships and establish which effects are potentially significant and merit subsequent detailed analysis (or, conversely, which effects are not potentially significant and require no further assessment).

Step 4b: General Issues for Identifying Potentially Significant Indirect Effects

The discussion of general issues is organized by the three types of indirect effects noted in Chapter 3—namely, encroachment-alteration effects, induced growth effects, and effects related to induced growth.

Encroachment-Alteration Effects. *Ecologic Effects.* The ecosystem approach embodied in CEQ's biodiversity document (*12*) recognizes the "fundamental interconnections within and among various levels of ecological organization." Ecologic organization is a hierarchically arranged continuum as illustrated in Table 26. Reduction of diversity at any level has effects at the other levels. Therefore, an understanding of the interconnections can help reveal the chain of events delayed in time or space from the original transportation project action or disturbance on or within a particular level of ecologic organization.

As illustrated in Figure 5 (*59*), an energy flow diagram of an aquatic ecosystem, the interconnections in ecosystems are many and complex. Many ecologic communities are constantly changing. However, there is a certain range of possibilities that help define a given community. In the absence of a major disruption, species composition and relative abundance in a community can be expected to vary within definable boundaries, perhaps cyclically or perhaps randomly. Disruption of such systems—e.g., introduction of contaminants—creates new boundaries, changing the range of possibilities in ways that are not always predictable.

Transportation corridors have unique impacts on ecosystems associated with their linear form. These corridors may function as specialized habitats, conduits of movement, barriers or filters to movement, or sources of effects on the surrounding habitats. The literature, EISs, and interviews indicate that the following indirect effects of transportation project actions can have important consequences for ecosystems:

- Habitat fragmentation from physical alteration of the environment;
- Lethal, sublethal, and reproduction effects from pollution;
- Degradation of habitat from pollution;

TABLE 26 Components of biological diversity

- **Regional ecosystem diversity:** The pattern of local ecosystems across the landscape, sometimes referred to as "landscape diversity" or "large ecosystem diversity."
- **Local ecosystem diversity:** The diversity of all living and non-living components within a given area and their interrelationships. Ecosystems are the critical biological/ecological operating units in nature. A related term is "community diversity," which refers to the variety of unique assemblages of plants and animals (communities). Individual species and plant communities exist as elements of local ecosystems, linked by processes such as succession and predation.
- **Species diversity:** The variety of individual species, including animals, plants, fungi and microorganisms.
- **Genetic diversity:** Variation within species. Genetic diversity enables species to survive in a variety of different environments, and allows them to evolve in response to changing environmental conditions.

The **hierarchical nature** of these components is an important concept. Regional ecosystem patterns form the basic matrix for, and thus have important influences on, local ecosystems. Local ecosystems, in turn, form the matrix for species and genetic diversity, which can in turn affect ecosystem and regional patterns.

Relationships and interactions are critical components as well. Plants, animals, communities and other elements exist in complex webs, which determine their ecological significance.

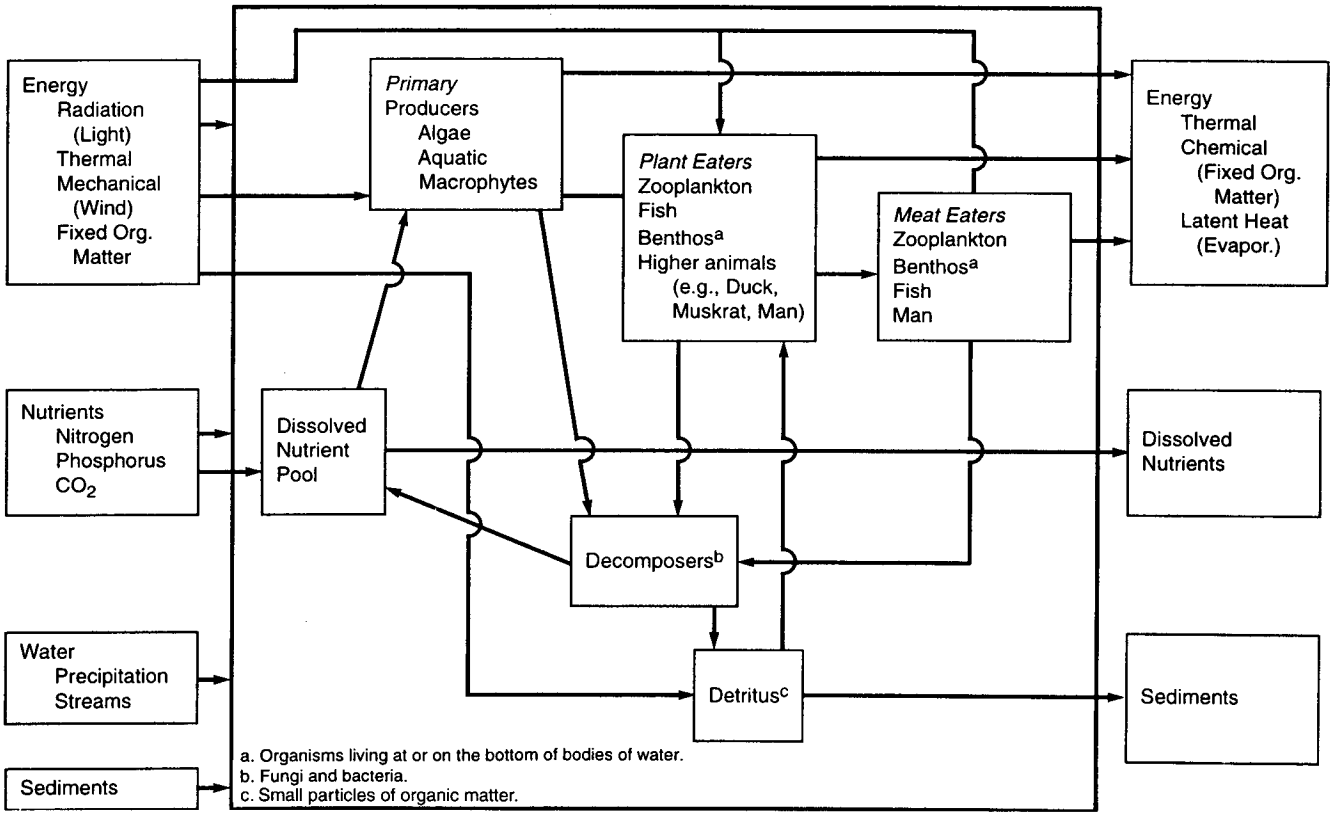


Figure 5. Material and energy flows in an aquatic ecosystem.

- Disruption of ecosystem functioning from direct mortality impacts; and
- Disruption of natural processes from altered energy flows.

As shown in Table 27, these effects often work in combination to produce population-, community-, and ecosystem-level consequences. The linkage to project actions depends on how the affected site or corridor relates to the various levels of ecologic organization.

How an ecosystem may respond to a disturbance or perturbation from a transportation project is a function of two rather dissimilar characteristics of the ecosystem, resistance and recovery (*56*). Resistance is the ability of the system, when subjected to an environmental change or potential disturbance, to withstand or resist variation. Recovery or resilience is the ability of the system to bounce back or return after being changed. This concept of ecosystem stability is useful for assessing indirect effects.

Socioeconomic Effects. There is evidence (*60,61*) that changes associated with highway projects indirectly affect the stability of communities. For example, just as habitat fragmentation from transportation projects can lead to ecologic consequences, neighborhood segmentation may increase residential mobility as well as increase conversion of single-family dwelling units to apartments or addition of new multiple-family dwelling units. The reasons for this phenomenon are complex and may have numerous physical, demographic, and economic causes. Indeed, it is generally agreed that a single variable cannot be used to quantify the effects of transportation projects on communities.

A transportation project can change the physical environment of a neighborhood or community. This physical environment supports human activities and interactions. Critical factors such as community character or neighborhood satisfaction are related to the physical environment and the way residents use and perceive their spaces. Christensen (*40*) identified seven social impact variables related to the physical environment and neighborhood satisfaction, as follows:

- Recreation patterns at public facilities;
- Recreational use of informal outdoor spaces;
- Shopping opportunities;
- Pedestrian dependency and mobility;
- Perceived quality of the natural environment;
- Personal safety and privacy; and
- Aesthetic and cultural values.

It was suggested that these variables be used to explore effects from changes in the physical environment from land development; the variables appear to be applicable to the effects on the physical environment from transportation projects as well. For example, a highway project can physically alter the local street network or increase traffic volumes on local streets, both of which could affect pedestrian mobility and, consequently, interactions and neighborhood satisfaction.

Categorization of effects on the environment presented in Table 10 can be a useful tool for identifying socioeconomic indirect effects. Of particular note in Table 10 is the opportunity-threat category of effects—i.e., those that can occur while a project is being planned but before construction. Examples include effects on real estate investment and

TABLE 27 Some possible effects on ecosystems from transportation projects

Direct Effect	Indirect Effect	Some Manifestations	Possible Consequences (from individual effects or combination of effects)
• Physical Alteration—Habitat Destruction	• Habitat Fragmentation	• Creation of Smaller Patches • Creation of Barriers • Creation of More Edges • Draining or Ponding	• Local extinction of wide-ranging species • Loss of interior or area-sensitive species • Direct mortality impacts • Erosion of genetic diversity and amplification of inbreeding (particularly for isolated sedentary species) • Increased probability of local extinction from small population sizes and reduced likelihood of re-establishment (because immigration is inhibited by barriers) • Increased abundance of weedy species • Generally, reduced biological diversity
• Introduction of Pollutants—Toxicity and Behavioral Effects	• Degradation of Habitat	• Changes in Reproductive Behavior and Rates • Changes in Food Sources	• Changes in Community Structure—relative abundance of various species • Changes in Ecosystem Structure and Function
• Alteration of Natural Processes—e.g., Hydrology, Species Interactions (e.g., competitor and predator—prey), migration	• Altered Energy Flows	• Changes in Population Sizes from effects on births, deaths, immigration and emigration • Changes in Vegetative Structure	• Change in Ecosystem Ability to Support Life

maintenance of property. Such effects may indicate the long-term indirect effects of a project once implemented.

Induced Growth Effects. Three general categories of transportation-related induced growth effects can be concluded from this study's research findings: (1) projects planned to serve specific land development; (2) projects that would likely stimulate land development having complementary functions; and (3) projects that would likely influence intraregional land-development location decisions. The degree of certainty, specific knowledge, and need to know about the induced growth and related effects—i.e., the amount of attention that should be devoted to identifying and analyzing such effects—varies among the categories; it is generally highest for the first category and lowest for the last category. For all categories, the search for certainty and knowledge should include an evaluation of current and contemplated plans of private entities and local governments and interviews of individuals with knowledge of the local real estate market and capital improvement and land-use plans. Moreover, as with indirect effects in general, the focus should be on exploring interrelationships among the effects and the goals and notable features.

Projects Planned to Serve Specific Land Development. This category of induced growth occurs when the proposed transportation facility would serve specific planned land development (at existing or proposed activity centers)—e.g., highway interchange or transit access for a planned shopping mall or stadium. This type of effect is common when land development is used as a selling point for the project and the transportation and land-development projects are interdependent. This category is associated with highway, transit, and rail modes. The land-development proposal and its related effects are indirect effects of the transportation project. There should be a high level of confidence that the effects will occur; there should be a high level of specificity about the nature, extent, and timing of the effects; and because the land development is the transportation project's reason for being, there should be a high need to know the effects so the costs of land development can be weighed against its benefits. Consequently, such effects should be detailed in the environmental document.

Projects That Would Likely Stimulate Land Development Having Complementary Functions. This category of induced growth occurs when the proposed transportation facility will likely stimulate land-development supporting functions that complement the facility's operation—e.g., gas stations, rest stops, and motels at highway interchanges, cargo and parking areas near airports, and cargo areas at ports. This category is associated with all transportation modes. The confidence that the effects will occur, specific knowledge about the effects, and the need to know about the effects vary with the circumstances of the project. In some cases—e.g., port or airport landside facilities—specific land development proposals by other entities may have been formed in reaction to, or in conjunction with, the proposed transportation project. In such cases, the land-development and related effects should be treated as indirect effects of the transportation project, similar to the project-serves-specific development of the first category. The extent and nature of eventual landside development can be forecast from market studies, infrastructure capacity, and other factors. In other cases, confidence and specificity about the likelihood of complementary development can be identified from studies of comparable situations. For example, research (*60*) suggests that highway-oriented businesses figure more prominently in the landscape of rural interchanges than suburban or urban interchanges (where land values typically support higher density uses). Distance to nearest urban area is a major factor in the rate of development of rural interchanges. Other factors include traffic volume on the intersecting road (higher growth potential with higher traffic volume), presence of a frontage road (more intensive development), availability of water and sewer, and proximity to a regional town (*62*). Quadrants on the right-hand side of motorists approaching the interchange on the main (interstate) highway are more prone to development. The need to know about such effects depends on the potential for significance—i.e., the likelihood that the indirect effect will have an unacceptable impact on important study area goals or notable features.

Projects That Would Likely Influence Intraregional Land Development Location Decisions. This category of induced growth occurs when the transportation facility will likely influence decisions about the location of growth and land development among various locations within a region, a phenomenon commonly referred to as intraregional development shifts. This category is associated with highway and transit modes. On a regional basis, the impact of highway and transit projects on economic growth appears to be minimal; however, the localized effect of such projects on land use can be substantial (*1,60*). If the conditions for development are generally favorable in a region—i.e., the region is undergoing urbanization—then highway and transit projects can become one of many factors that influence where development will occur. Extensive research on the topic of the impact of highways on intraregional locational decisions by others, and a lesser amount of related research on transit impacts, has produced certain generalizations about the circumstances of transportation-induced development shifts. These generalizations relate to the potential nature (type and density) and location of such development shifts; the timing of such shifts is very difficult to forecast as it is highly dependent on the national economy and other factors. Where transportation projects do influence land development, the general tendency is toward relatively high-density commercial or multifamily residential development near facility nodes: up to 1.6 km (1 mi) around a freeway interchange; up to 3.2 to

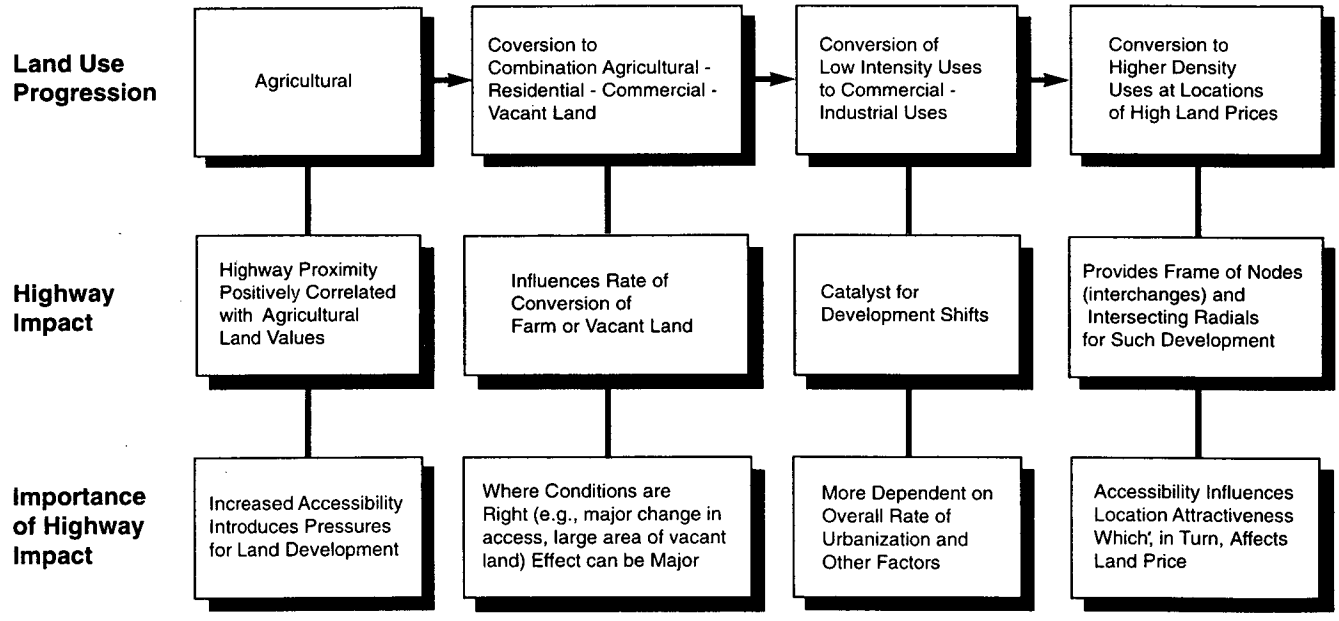


Figure 6. Highway investment impact on typical progress of urbanization.

8 km (2 to 5 mi) along major feeder roadways to the interchange; and up to 0.8 km (0.5 mi) around a transit station. The exception is at the urban fringe where low land prices and high land availability favor single-family residential development. Key generalizations about the circumstances in which transportation projects induce development shifts include the following:

- The potential influence of transportation projects on the typical process of urbanization, including induced development shifts, is generally highly localized, rather than widespread (Figure 6). Any effect of a transportation project on land conversion is typically pronounced at first; after the initial effect, the location of subsequent land conversion in the area is commonly more a function of other factors. Further, the influence of highway improvements on land use diminishes with successive improvements as each new improvement brings a successively smaller improvement in accessibility. In economic terms, this is because of the law of diminishing marginal returns.
- Land-use changes from a transportation project are derivative of that project's indirect economic and social changes (Figure 7, Tables 28 and 29). For example, differences in transportation costs promote the segregation of industrial and commercial activities; office and retail

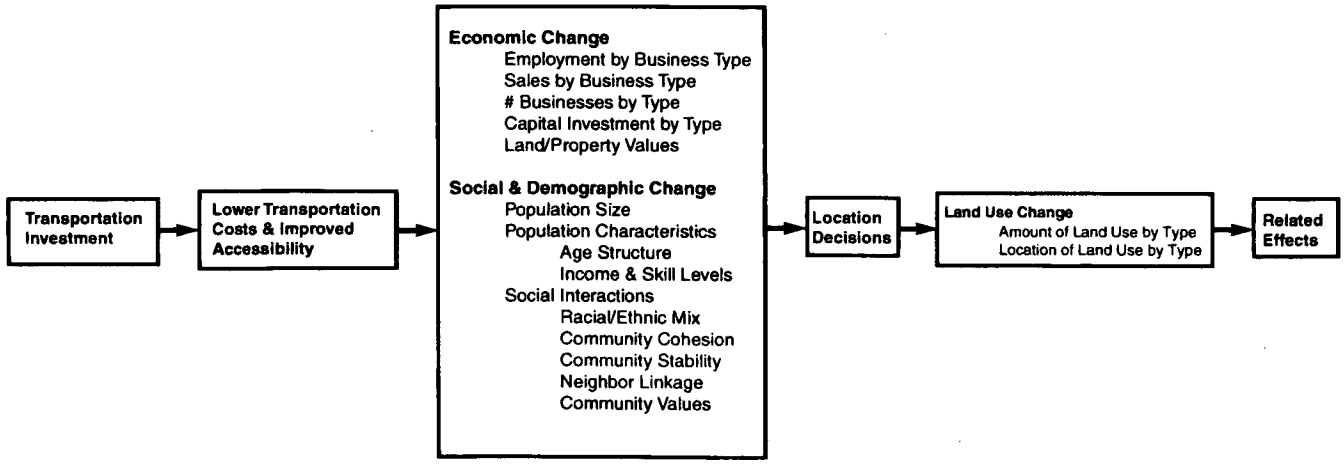


Figure 7. Linkage of transportation access–land-use change.

TABLE 28 General relationships between highway and transit proximity and economic changes

Type of Change	Highway Proximity		Transit Proximity	
	General Relationship	Comments	General Relationship	Comments
Industrial Location	Weak-Moderate Factor in Location Decisions	Access to highway network typically considered after location decision has been narrowed within a region; other elements of desirability typically not sacrificed to gain a highway site. Historically, new circumferential and radial highways aided relocation of industries from central city to suburb.	Weak Factor in Location Decisions	Generally, transit does not increase employment through improved access to jobs.
Wholesale Trade Location	Moderate-Strong Factor in Location Decisions	Concerned with proximity to highway network adequate for serving market but does not typically require direct access or exposure to a highway. Historically, the interstate highway system played an important part in decentralization of wholesale trade activity from the CBD.	None	No apparent relation between location of wholesale business and mass transit facilities.
Retail Trade Location	Strong Factor in Location Decisions	Particularly sensitive are service stations, motels, restaurants, and other highway-oriented retail establishments. Historically, highways played a significant role in migration of retail trade to suburbs by weakening CBD competitive advantage.	Strong Factor in Location Decisions	Mass transit generally benefits CBD retail trade and ability of CBD to compete with suburban shopping centers.
Services Location	Moderate-Strong Factor in Location Decisions	Generally, insensitive to highways; however, following population shifts to the suburbs, ring highways and radials provided the geometry for services-based growth zones.	Strong Factor in Location Decisions	Services tend to locate near areas served by rapid transit. Historically, helped maintained service employment in central cities, although some systems accelerated development shifts.

firms tend to locate where there is good access, visibility, and traffic (e.g., along arterial streets or near intersections).

- Manufacturing firms generally locate where there is good access to intercity highways or to ports and rail lines as well as where there is lower land cost to allow lower cost production in single-story buildings. Households, on the other hand, generally locate away from the noise and traffic associated with major streets. As indicated by Tables 28 and 29, the influence of transportation on land use varies by mode.
- The right mix of conditions must be present for development to occur at a given location. Land development represents the sum of numerous decisions made by investors and consumers or land users. Each of the basic types of land users—i.e., households, manufacturing firms, service firms, and retailers—faces different transportation costs. Development prerequisites taken into account by individual decision makers include a potentially wide variety of factors, such as land availability, the quality of existing development, local politics, growth history, and state of the regional economy. The overall judgment of the marketplace determines whether land will be changed in its use. The factors that an investor or consumer takes into account are therefore the ones that should be considered in determining whether a transportation facility will affect development. Figure 8 illustrates the major factors that influence land-development decisions and their interactions. One of these factors, not necessarily the most important, is adequate transportation facilities.
- Property values can change significantly near new transportation facilities compared with similar properties not affected by the new facilities (Table 30). Property values are de facto indicators of the potential for land-use change, because investment decisions revolve around the prices people are willing to pay for real property.
- Land availability and price can work in combination with the degree of change in accessibility to affect the location, type, and intensity of transportation-induced development shifts (Figure 9). Access improves as transportation costs decrease.
- Land-use controls can change over time both as a result of a transportation project and because of other factors. Zoning and other forms of land-use control are intended to protect residents from undesirable development. They limit the use and intensity to which individual parcels of land may be put. In theory, therefore, they influence the amount of development that can occur in a community and potentially limit transportation-influenced land development. However, if the marketplace determines a land-development pattern that is inconsistent with local land-use control, then pressure to change (weaken) the land-use controls is typically brought to bear. If such pressure is likely, and the transportation project is a likely contributor to the pressure, then an evaluation should be made that considers the likelihood that changes in land-use controls will occur. This evaluation should account for factors that indicate the strength of the controls. These factors include whether the local land-use plan was developed in conjunction with a long-range master plan, the historical record of zoning

TABLE 29 General relationships between highway and transit proximity and land-use changes

Type of Change	High Proximity		Transit Proximity	
	General Relationship	Comments	General Relationship	Comments
Residential Development	Relationship Varies	Complex relationship. Low-density single-family development is often independent of highways. Highways appear to promote conversion of vacant (farm) land to low-density residential use at the urban fringe (although such development is generally some distance from the highway). High-density residential development appears to be promoted by highways, particularly at or near interchanges.	Moderate-Strong Catalyst	Rapid transit tends to stimulate high-density residential development based on limited available information. Effect is largely concentrated within five- to ten-minute walking distance from station (i.e., 1,000 to 2,000 feet).
Industrial and Commercial Development	Moderate-Strong Catalyst	Highways promote conversion of vacant and residential land to commercial and industrial uses. Increased accessibility provided by highways introduces pressures for commercial development of land. Arterial streets and radial highways tend to promote string development; circumferential highways, more comprehensive development. Circumferential highways may lead to accelerated development along major intersecting arterials. Land use changes are most rapid, and land uses most intensive, at or near interchanges.	Moderate-Strong Catalyst	Rapid transit tends to stimulate office building and urban retail center development based on limited available information. Spatial dimension of effect similar to residential.
Development of Highway-Oriented Businesses	Strong Catalyst	Prominent component of land development at rural interchanges but less relative to commercial and high-density residential uses at interchanges along metropolitan circumferential highways. Topography and proximity to urban area are significant variables in rate of development of rural interchanges. Quadrants on motorist right-hand side of interchange approach more prone to development. At interchanges, those with access provided by frontage roads have significantly more intensive development than restricted-access interchanges.	N/A	

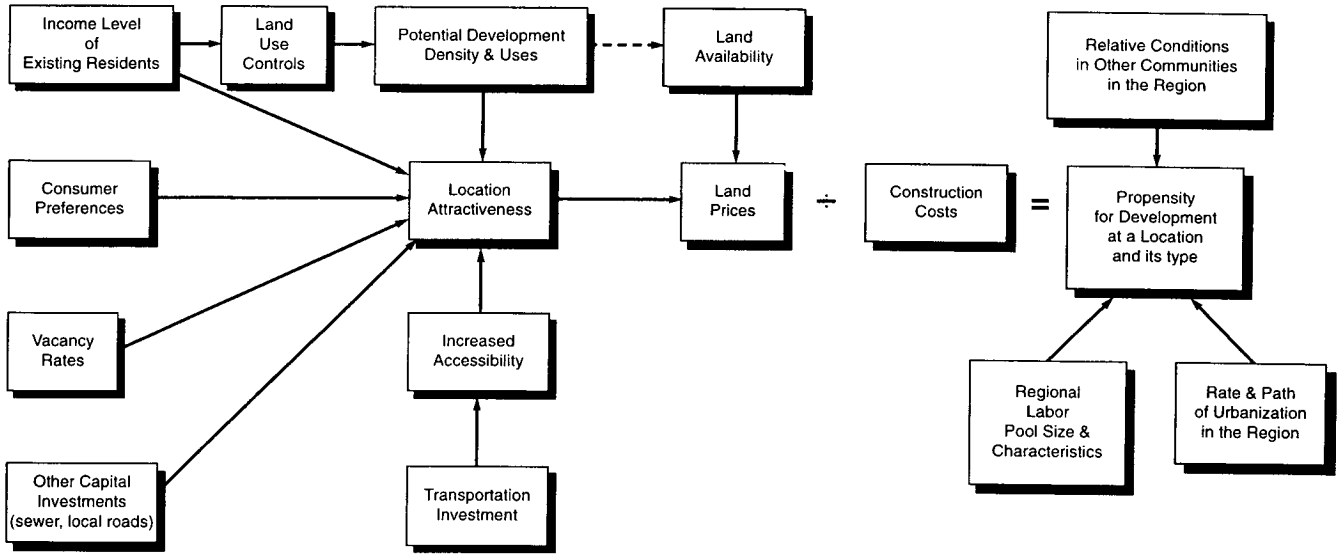


Figure 8. Simplified model of various factors influencing development location decisions.

enforcement, and the existing amounts of undeveloped land zoned for each use. If variances have been difficult to obtain, then development probably will be restricted to levels near the amount of properly zoned land for each category of use.

The most common implication of this situation is a limitation on the amounts of industrial, commercial, and multifamily residential development that can occur with little or no limitation on construction of single-family housing. However, if variances are easy to gain, then it is likely that zoning will have no moderating or controlling influence on land development—i.e., market forces will govern land development.

Effects Related to Induced Growth. Induced growth and land development themselves can affect the environment in many ways. A general tabulation of possible land-development effects is presented in Table 13. A tabulation of possible socioeconomic effects of land development from Christensen (*40*) is presented in Table 31. Obviously, the degree of certainty, specificity, and need to know about the induced effects determine the extent to which the corresponding related effects should be examined.

One particular effect related to induced growth, the effect of transportation investments on air quality vis-à-vis land-use change, has come to the forefront in recent years. From the above discussion, it is clear that transportation investments influence land use under certain circumstances. Data from large cities worldwide show a consistent, strongly negative correlation between residential density and measures of metropolitan average per capita vehicular travel consumption (vehicle miles traveled, trips, fuel consumption, emissions)

TABLE 30 General relationships between highway and transit proximity and changes in land value

Type of Change	Highway Proximity		Transit Proximity	
	General Relationship	Comments	General Relationship	Comments
Land Value Appreciation	Often strong, i.e., appreciation is maximum for land abutting the highway and declines regularly thereafter; however, relationship can be complicated.	Changes in land use associated with highway proximity are important in determining appreciation. Land value increases are most substantial after conversion to a more intensive use (e.g., farmland conversion to a commercial use). Value of land used for single-family residences is, on average, not significantly affected by highways.	Inconsistent effect.	A number of studies suggest increases of real estate values following extension or introduction of rapid transit. However, other studies suggest that the results are inconclusive.

Note: NA = not applicable; 1 ft = 0.3m

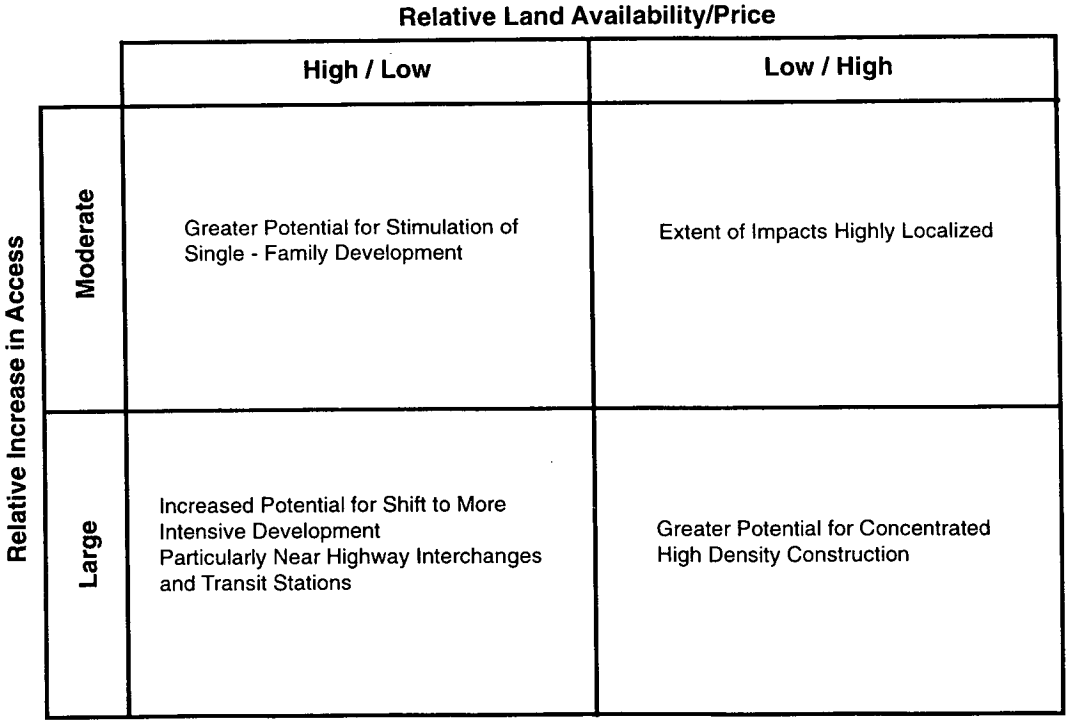


Figure 9. Influence of land availability and price on potential for development shifts.

(*63*). The data suggest that transportation investments worsen per capita emissions when they support development at the urban fringe—i.e., the location where the lowest density and highest travel consumption are found. From this it is inferred that transportation investments will improve per capita emissions when they create arrangements of land uses that require less vehicular travel.

However, the relationship between travel and land use is complex. For example, income accounts for a portion of travel variability with land use. In addition, insufficient data are available to determine causality—e.g., whether low-density residential development causes people to have more vehicle travel or whether people with a proclivity toward extensive automobile use select low-density areas for living. Regardless, the general interrelationships among transportation investment, land use, and air quality merit exploration, particularly for those plans or projects that involve the urban fringe (generally high land availability and low land prices in an urbanizing area).

Step 4c: Methods for Identifying Potentially Significant Indirect Effects

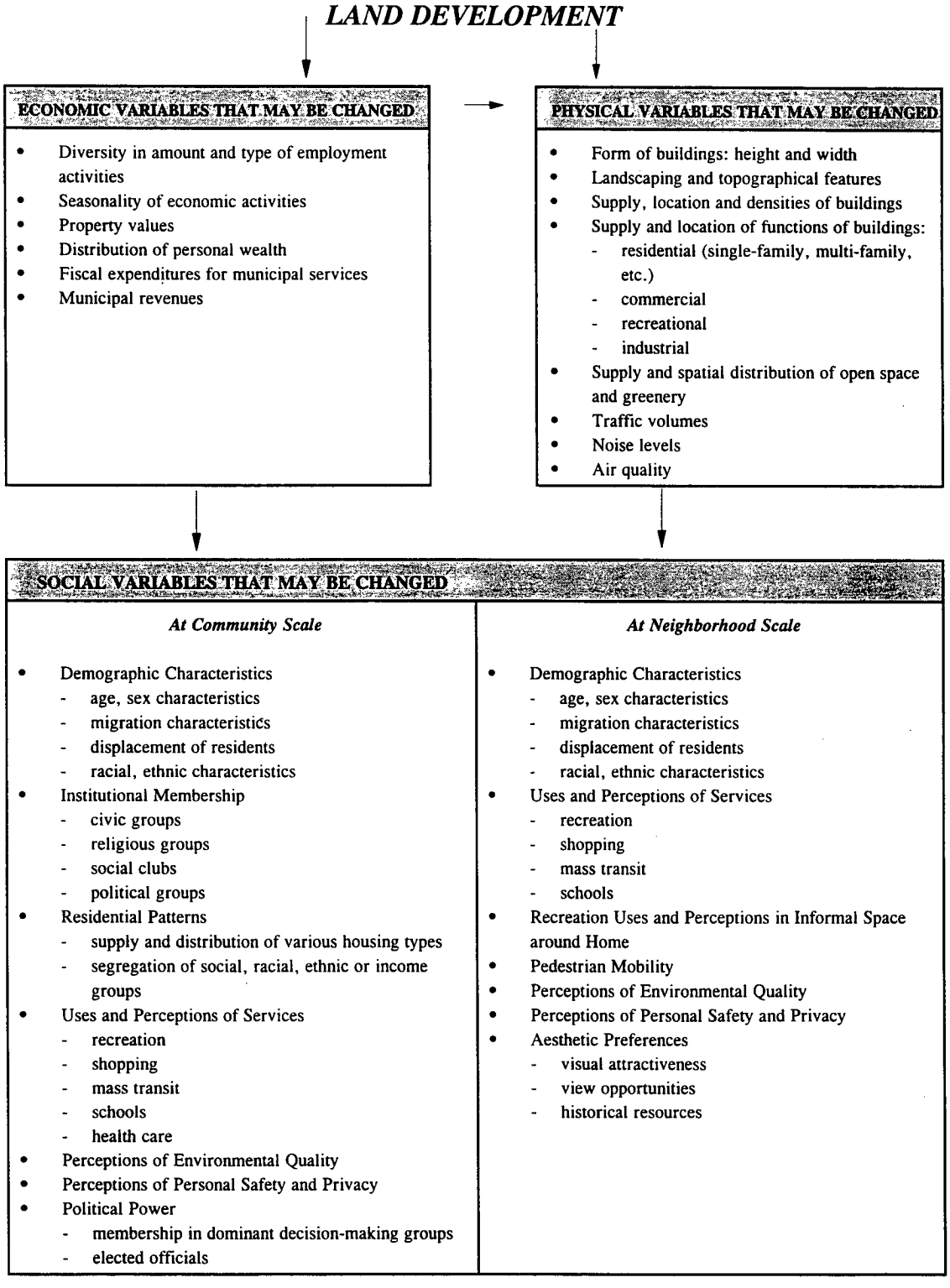
There are a number of techniques discussed below that could support identification of cause–effect linkages between project impact-causing actions and goals and notable features. The techniques can be used individually or in combination. The techniques involve various degrees of background research, which in large part would be conducted by the transportation agency staff. Although analysis of potential linkages would also be performed by the transportation agency staff, use of a collaborative task force to participate in linkage identification and to identify the scope of identified effects for further study is advocated. This collaborative task force could be the same entity created to designate notable features under Step 2 adjusted appropriately based on the expertise needed to provide input on the issues at hand.

Matrices. A project evaluation matrix is commonly a grid diagram in which two distinct lists are arranged along perpendicular axes (e.g., actions and environmental characteristics), and interactions between the two are noted. A weighting of the interactions relative to impact significance is often performed. Included are presentational matrices or mathematical matrices. Presentational matrices include descriptive (*64*), symbolized (*65*), characterized (*65*), numeric (*39,66,67*), and combinative (*68*). Although of value for identifying direct effects, presentational matrices give inadequate consideration to indirect effects. Therefore, at best, the presentational matrix can be used to display initial broad judgments from other techniques about project activities and indirect effects on specific environmental components.

A mathematical matrix is a rectangular array of quantities upon which algebraic operations can be legitimately performed. Mathematical matrices include multiplicative (*69*), component interaction-minimum link (*67*), and input–output (*70–72*). A critique of these various mathematical matrices by Shopley and Fuggle (*51*) is as follows:

- Multiplicative matrix: Although this approach had some success in considering project indirect effects, coverage of such effects was not detailed or structured.

TABLE 31 Possible effects of land development on socioeconomic variables



- Component interaction matrix: Although the minimum link matrix can indicate the existence and length of a linkage (i.e., number of intervening interactions) between any two components, the structure of these linkages is not revealed.
- Input–output matrix: Very high resource needs are involved in constructing an input–output matrix in terms of data and analytical effort. Monetary and material flows in the economic and biophysical environments can support a quantification of indirect effects.

Although mathematical matrices could help identify indirect effects, the effort involved in most cases would not be justified by the information gained. This is because larger transportation projects by their nature result in numerous indirect effects. However, for practical purposes, only a relatively small number of the effects, if any, are nontrivial or important for the decision.

Networks. Also known as system diagrams, networks can be used to classify, organize, and display problems, processes, and interactions and to produce a causal analysis of the indirect effects situation. Obviously, the network is only as good as the underlying understanding or assumptions of often complex processes and interactions. Figure 5, presented previously, is an example of a complex network with many interactions and feedback loops. Figure 10 is a network diagram that illustrates transportation–land-use interactions and feedback loops. The chains of indirect effects presented in Table 16, developed from EISs, could be used as the basis for development of networks suited to a particular situation or problem.

Cartographic Techniques. Specific techniques, like the McHarg overlay (*73*), are time tested. These can be particularly useful for visualizing potential indirect effects related to alteration of the physical environment—e.g., habitat fragmentation or community segmentation. Computerized geographic information systems have greatly enhanced the ability to process and display cartographic information. Cartographic techniques are limited in their ability to reveal the structure, function, and dynamics of areas. However, their utility can be expanded by relating inventoried information about these characteristics via a relational database.

Qualitative Inference. This involves a case study description of an area of concern (e.g., habitat or neighborhood) and an identification based on professional judgment of the possible changes that the proposed project would entail. The case study should focus on the elements or indicators that characterize the area of concern by using ecologic, economic, demographic, or social profile information from baseline investigations.

This technique also can be used to identify an area's potential for induced growth. The list of questions in Table 32 was

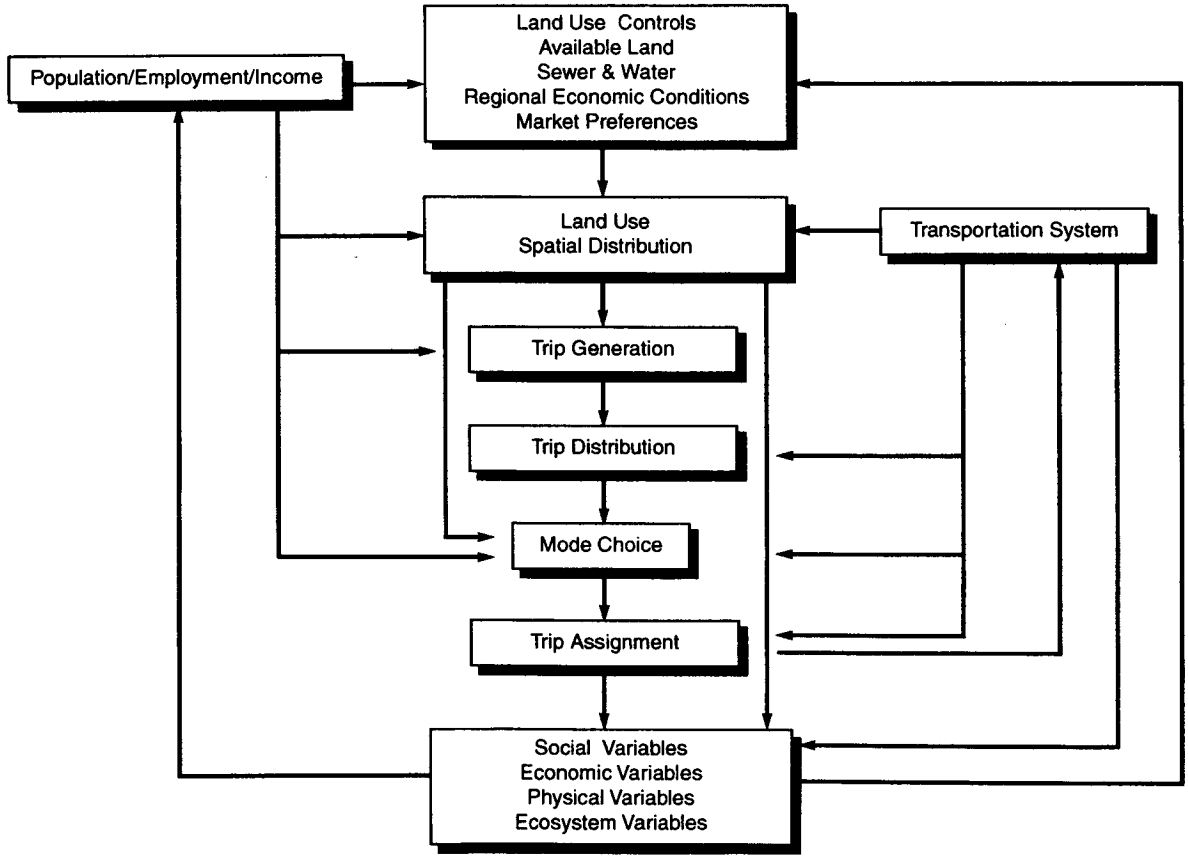


Figure 10. Network diagram of transportation–land-use interactions and feedback loops.

TABLE 32 Checklist for assessing study area's potential for induced growth

Project Name: Location: Analyst: Date:

Regional Study Area Conditions

[A yes answer indicates that conditions generally favor growth; the more yes answers, the higher the certainty that regional conditions generally favor growth.]

1. Is the regional population increasing rapidly (generally, >5% per 10 years)?
2. Is the region considered favorable for receiving FHA/VA loans?
3. Are there any major growth generators (e.g., universities, military installations, industries, tourist attractions) in the region?
4. Is the regional office/commercial market characterized by low (generally, <10%) vacancy rates in any class of space?
5. Is the region's business and civic leadership committed to rapid development?
6. Is the region an exporter of natural resources?

Local Study Area Conditions

[If it is concluded that regional conditions generally favor growth, then proceed with the next series of questions. A yes answer indicates that the area in the immediate project vicinity has land use conversion potential; the more yes answers, the higher the certainty that land use conversion will be induced by the project to its immediate vicinity.]

General indicators

7. Is the regional path of development in the direction of the local study area?
8. Is the project within 5 miles of a growing community (generally, >5% per 10 years)?
9. Is the local study area characterized by middle and/or high income levels?
10. Is the local study area free of moratoriums on development (e.g., sewer moratoriums, growth restrictions)?

Indicators of conditions favorable to conversion to lower density development

11. Is the local study area within a 30-minute drive of a major employment center?
12. Does the local study area have relatively high land availability/low land prices (generally <one-third of larger parcels developed)?
13. Is the vacant land characterized by relatively large parcels?
14. Is the local study area characterized predominantly by level land (generally, <5% slope)?
15. Is the project's Potential Impact Area characterized by soils suitable for development?
16. Is the project's Potential Impact Area predominantly free of flooding or wetlands?

Indicators of conditions favorable to conversion to higher density development

17. Does the local study area have relatively low land availability/high land prices (generally >two-thirds of larger parcels developed)?
18. Is the local study area served by existing principal arterials and water/sewer systems?
19. Is the local study area covered by relatively few governmental jurisdictions?
20. Is the local study area characterized by poorly enforced zoning regulations?
21. Does the local study area lack recent (generally, <10 years old) master plans?

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prepared based on the research conducted for this study. The questions are closely related to the factors real estate investors or consumers consider when making a development or purchase decision. Some of the questions can be answered by consulting publicly available information, such as U.S. census data, U.S. Geological Survey topographic maps, or road maps. Other information may require contacts with planners, officials, or real estate professionals familiar with the region or locality in question. Known future development trends should be taken into account in the evaluations.

Qualitative inference, although practical and simple, has obvious limitations. Foremost among these is speculation based on limited data or unusual circumstances. Broad participation, including input from local planners in the local real estate market, can help avoid speculation.

Comparative Case Analysis. A comparative study involves comparing a like area where a similar project has been completed with the area of concern where a project is proposed. The two projects and areas must be similar in size; project type, location, and design; and geographic and other pertinent characteristics. The data sources for the two areas and projects also should be similar. Study of the like area essentially consists of beginning with a retrospective analysis (or case history) in which adequate information about conditions in the area before the project must be obtained. Although some of this baseline information will be in the project EIS, this information may not match the data requirements. In other words, the retrospective analysis estimates conditions that no longer exist, a task that may not be easier than predicting conditions that do not yet exist. Another problem in undertaking retrospective analyses involves separating project-related impacts from those caused by other factors. In addition, a number of effects that may eventually occur because of the transportation project may not have occurred yet—e.g., because of an economic slowdown.

Comparative case analysis entails a double effort for data collection and assumes that the proposed project has an accessible twin. Even if similar circumstances can be found, the results may differ because of various random and nonrandom effects. For example, objectives and policies tend to change over time. Although it is preferable to compare the proposed project with several analogous cases, this entails more resources. It is obvious that caution must be used in implementing comparative case analysis. However, comparative case analysis does have potential for improved identification of indirect effects that are otherwise difficult to identify.

Recommended Method for Identifying Potentially Significant Indirect Effects. It is likely that, to identify the indirect effects of the proposed transportation project, some combination of methods will be needed in most situations. This combination includes cartographic techniques for spatial analysis; matrices or networks for visualizing systems functions and behavior and interconnections with the project; and either qualitative inference or comparative case study to support the visualization. Networks are recommended over matrices as they are more flexible and provide a better basis for identifying feedback mechanisms. Qualitative inference is more practical than comparative case study; in most situations, the time required to locate and identify the comparative setting, if it exists, and the effort of conducting the comparisons make the comparative case approach impractical. Qualitative inference is relatively acceptable provided that knowledgeable individuals are involved in the study. Regardless of the method used, tabulation is necessary to organize the information discerned to date and to make explicit the process used to determine which indirect effects should be carried forward to detailed analysis (Step 5). Table 4 was prepared for this purpose. Typically, a determination of impact significance includes considerations of impact magnitude and importance. Tables 33 and 34 list considerations that are relevant to indirect effects.

Step 4d: Product of Identifying Potentially Significant Indirect Effects

The sponsoring transportation agency, with participation and input from other stakeholders, should identify the indirect effects; where appropriate, input from a collaborative task force, if one has been formed, should be included. The product of the effort is in the form of Table 35, supported by a technical memorandum that lists the indirect effects that warrant further analysis and presents the scope of analysis to be conducted in Task 5. The technical memorandum should contain relevant documentation supporting the list of identified indirect effects (e.g., checklists, networks, and maps) as well as documentation of the indirect effects considered but dismissed from further analysis by agreement of the parties involved.

Step 5: Analyze the Identified Potentially Significant Indirect Effects

Step 5a: Objective of Analyzing Potentially Significant Indirect Effects

Step 4 described how to identify nontrivial indirect effects of proposed transportation projects. The process of identifying the cause–effect relationships between the project and goals and notable features provides the foundation for analysis of the identified indirect effects. The objective of Step 5 is to perform the analysis necessary to estimate the magnitude of the indirect effects of a proposed project.

Step 5b: General Issues for Analyzing Potentially Significant Indirect Effects

Because indirect effects occur in the future, forecasting is often an important component of their assessment. The

TABLE 33 Impact magnitude considerations for assessing potential significance of indirect effects

Encroachment—Alteration Effects

Indicators of significance include when such effects:

- Are wholly or partially within or substantially contiguous to a notable feature (see Step 2)

and

- Impair the character or quality of important historical, archaeological, architectural or aesthetic resources

or

- Impair existing community or neighborhood character

or

- Substantially change the capacity of the environment to support existing uses or functions

Induced Growth and Related Effects

Indicators of significance include when a simultaneous or subsequent action:

- Is likely to be taken as a result of the transportation project

or

- Is dependent on the transportation project

and

- Could attract a large number of people to a location compared with existing location attractiveness

or

- Could cause a substantial adverse change in existing air quality, ground or surface water quality or quantity, energy usage, traffic or noise levels

or

- Could cause a substantial increase in potential for erosion, flooding, leaching, or drainage problems

or

- Could cause a substantial change in the use, or intensity of use, of land

or

- Could cause substantially adverse encroachment alteration effects

key in forecasting is an underlying system of logic that can produce reproductive and relatively consistent results regardless of the forecaster. As Vlachos (*34*) noted, "forecasting is not the exact determination and prediction of the future, but the . . . logical extrapolation of likely effects [that will occur] from known associations among different critical parts of the system." Forecasts can help determine what is probable.

As with other forms of impact analysis, indirect effects forecasting techniques may be conducted quantitatively or qualitatively. Quantitative methods consist of modeling or searching for causal factors and extrapolation or emphasis on time series. Qualitative methods can serve to evaluate the context or overall situation where little historical data exist or where existing data are questionable or inconsistent. A variety of qualitative and quantitative methods are described and evaluated below.

No single method is best for forecasting indirect effects. Indeed, as discussed below, the best method for a given project may be an integration of several techniques. Following are considerations for selecting a method for a project:

- The circumstances under which the agency is working (e.g., politics, controversy);
- The particular needs of the problem;
- The reliability, completeness, and quantitative precision of the database;
- The purpose of forecasting; and
- The time and resources available to generate complete forecasts.

The analysis should be sensitive enough to distinguish differences between consequences of the indirect effects of various alternatives. In addition, the method should provide a consistent basis for making comparisons among alternatives. Numeric terms are less likely to be misinterpreted than qualitative terms. However, use of numeric terms may imply a higher degree of certainty than is justified.

TABLE 34 Impact importance considerations for assessing potential significance of indirect effects

Context

- Regional consequences
- Potential divergence from local needs and goals (see Step 1)

General Considerations

- The need to know about the consequences of a simultaneous or subsequent action now (or the degree to which the decision on the transportation project represents a decision in principle about a simultaneous or subsequent action)
- Probability or confidence that the effect will occur
- Effect duration and irreversibility
- Degree to which the effect can or will be controlled
- Degree of controversy related to the effect
- Whether the effect threatens a violation of federal, state or local law, or requirements imposed for the protection of the environment
- Degree of effect on public health and safety

TABLE 35 Evaluation matrix for potentially significant indirect effects

Project Name: _____ Location: _____ Analyst: _____ Date: _____

Indirect Effect Type	Direct Effects from Impact-Causing Activities	Indirect Effects from Direct Effects (List)	Potential Manifestation of Indirect Effects (List)	Link between Indirect Effect and Goal or Notable Feature that Meets Impact Significance Criteria[1]	
				Yes (Go to Step 5)	No (Assessment Complete)
Encroachment-Alteration	Ecosystem-related				
	Socioeconomic-related				
Induced Growth (Access-Alteration)		Serves specific development			
		Stimulates complementary development			
		Influences location decisions			
Effects Related to Induced Growth			Ecosystem-related		
			Socioeconomic-related		

[1] Refer to Tables 34 and 35.

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Step 5c: Methods for Analyzing Indirect Effects

Table 36 lists a number of quantitative and qualitative forecasting techniques that are suited to indirect effects analysis. The following discussion describes and compares the advantages and disadvantages of the techniques for indirect effects analysis. The reader should refer to the references cited for more details about the techniques and their application.

Quantitative Techniques. These techniques include modeling/causal methods, extrapolation/time series, and probabilistic methods. Key features of each method are noted as well as advantages and disadvantages for application in indirect effects analysis.

Modeling/Causal Methods. Models are simplified representations of the real, complex systems that may be affected by a project. Models are useful in attaining a broad perspective and a better grasp of the totality of a problem, in foreseeing effects that otherwise may have been overlooked, and in anticipating reactions to alternatives. Modeling can range in complexity and difficulty from empirical equations to comprehensive, formal models that deal with quantitative relationships over time and require special expertise and computerization. Networks and matrices described in Step 4 are, in fact, models and often are components of building more comprehensive, formal models.

TABLE 36 Possible methods for analyzing indirect effects

Quantitative Techniques
Modeling/Causal Methods
Structural Models
Dynamic Models
Trend Extrapolation
Simple (straight line) Extrapolation
Curve Fitting (exponential)
Trend Curves
Envelope (upper limit) Curves
Trend Correlation
Regression Analysis
Correlation Analysis
Probabilistic Forecasting
Point and Interval Estimation
Monte Carlo Simulation
Markov Processes
Parametric Sensitivity Analysis
Queuing Theory
Decision Analysis
Risk Analysis
Optimization Methods
Qualitative Techniques
Delphi Technique
Scenario Writing
Alternative Futures/Visions
Multiple (Adaptive) Methods

The task of modeling a system begins with conceptualizing the system itself and establishing the boundaries of the system in both time and space. Feedback loops must be established to provide a qualitative picture of the system structure (e.g., see feedback loops illustrated in Figure 5). A feedback loop traces qualitative cause–effect relationships from a given variable back to itself. There are direct relationships in which an increase in one element causes an increase in a related element and inverse relationships in which an increase in one element causes a decrease in another element. If a formal model is desired, such a structure can be mapped quantitatively by assigning specific numerical values for the parameters identified in the system structure. Model construction can be valuable in anticipating the indirect effects of proposed transportation projects and alternatives.

In structuring the model, it is necessary to recognize that different cause–effect relationships may exist between problem elements. These relationships can be illustrated with loops or in a matrix as follows:

- Some go in one direction only (e.g., precipitation causes runoff but runoff does not affect precipitation).
- Some run in both directions (e.g., environmental quality inhibits development and development degrades environmental quality).
- Some are valid only between certain limits or may reverse beyond certain limits (e.g., quality of life may be enhanced by population increase up to some point and degraded by population increase beyond that point).
- Some problem elements have no relationships or at least none of consequence to the problem.
- Some problem elements may have relationships with more than one other element and therefore may form a subsystem within the overall system (*74*).

Structural models focus on selection of the components of a system, explicitly stating the interactions among them, and on intersectoral linkages and identification of critical paths. Dynamic modeling focuses on system behavior, or functional processes, and defines relationships within a system (*75*). It permits construction of complex, nonlinear systems and study of the evolution of systems over time. A systems dynamics model is used to assess the consequences of an action taken within a system and to test the alternatives open to planners. Shopley and Fuggle (*51*) suggest that explicit identification and evaluation of indirect effects require a study of the dynamic mechanisms that control the internal state of a system and therefore conclude that dynamic models are best suited for extending indirect effects analyses.

Input–output modeling (*71*) is a well-established technique of double accounting by tabular display, which shows

the transfers of goods and services in an economy in monetary terms. Input–output modeling provides a way to quantitatively link together a multitude of interactions in a complex economy; it is appealing as a device for showing the mutual interactions of a number of societal activities. The difficulty is in the treatment of societal sectors not involved in monetary exchanges (e.g., ecologic variables). A number of economic and demographic forecasting models use input–output tables as a basis of their construction. Stakhiv (*70*) demonstrates the use of input–output analysis to understand economic–ecologic linkages and various consequences of development.

The review of EISs for this study found that indirect effects analyses have relied on existing models instead of creating new ones. This is likely because modeling is a resource-intensive procedure. Examples of frequently occurring existing models used to support indirect effects analyses are the various land-use and travel-demand forecasting models (*76*). Some criticisms of these models include the typical use of exogenous (determined outside the model) forecasts of major variables such as land use and demographics; the questionable assumption of constant forces continuing to shape the future in determining regional population and employment levels; and the fact that, although many models address immediate effects of changes in the transportation network, there is a notable lack of treatment of the longer term ways regional socioeconomic and land-use changes feed back to affect the transportation system—e.g., the phenomenon of supply-induced demand.

Dynamic modeling can involve making explicit assumptions about how decisions are made (e.g., travel behavior), which means that rates must be formulated by mathematical equations indicating how the rate depends on the perceived state of the system at a given instant in time. However, it often is difficult to provide a quantitative formulation for a decision variable or rate. The commitment of time and resources is substantial. Feedback loops must be designated and each control factor specified. Moreover, this method requires a large amount of data and an experienced model builder skilled in systems dynamics and simulation. Limitations aside, the concept has great value for planning as a means for gaining insight into the interaction of a system in a qualitative sense. This is accomplished by identifying the interrelated elements and graphically tracing the direct and inverse relationships. Such a diagram can serve as a communication tool that highlights effects and can also point out relationships that should be examined with particular care.

Trend Extrapolation/Correlation. These methods have in common the fact that they are based on a series of historical data that can be analyzed in various statistical ways to arrive at a forecast of potential long-range consequences (*77*). These methods are the most understandable of all forecasting methods; however, they require some form of advanced mathematical skill and the use of subtle assumptions. The methods can be applied to examine a wide variety of problems and can be used as inputs to many forecasts based on more elaborate models.

Trend extrapolation is a commonly used type of projection and is based on the development of historical time series, holding the assumptions that the factors that contributed to the trend in the past are more likely to remain constant than to change in the time period of future consideration. There are a number of trend extrapolation techniques including the following:

- Simple (straight line) extrapolation;
- Curve fitting (exponential) with judgment modification;
- Trend curves of monitored changes; and
- Envelope (upper limit) curves.

Trend correlation analysis results from the relationship between two or more trends and a third. Trend correlation is designed to test relationships and determine the most likely future state or direction. Regression analysis can be applied to any single equation model intended to capture a one-way flow of causality from a set of independent variables to a dependent one. Correlation analysis then may reveal sensitivity to future changes in elements of the system and even suggest likely trade-offs. One difficulty of trend correlation is that truly independent variables and probable relationships to dependent variables are difficult to find. For example, so-called independent variables like location accessibility and attractiveness are often greatly affected by the variables being projected. Also, a substantial amount of historical data are required to form even the simplest regression equation.

Trend extrapolation, in particular, has been criticized for being too simplistic. Vlachos (*34*) notes other criticisms including the following:

- The validity of assumptions concerning the continuity and orderly fashion of many trends today;
- The crudeness of data as well as the lack of statistical sensitivity in the phenomena involved;
- The fact that trend extrapolation loses validity over time and that anything beyond 5 years may lead to ridiculous relationships;
- The idea that there is little proof to demonstrate that past forces will continue to support the trend so that extrapolations may, in many aspects, be intellectually and philosophically unacceptable; and
- The observation that trend extrapolation and correlation are highly susceptible to new controls, attitudes, value systems, and societal choices that do not coincide with the linear assumptions that this type of forecasting entails.

Despite these arguments, trend extrapolation and correlation can serve indirect effects analysis best when, after the trend has been projected, there is exploration for factors or

developments that will alter, limit, or violate the projected trend.

Probabilistic Forecasting. These techniques involve development, testing, and use of mathematical stochastic models to predict the future behavior of phenomena that are presumed to behave in a random manner (*78*). Stochastic is used here to refer to any phenomenon that obeys no discernible cause–effect relationship but that varies within limits. Numerical odds are assigned to all outcomes or combinations of outcomes. On the basis of such odds, predictive statements can be made about the future behavior of a particular phenomenon studied. Probabilistic forecasts help discover where, how, and when a phenomenon may be best anticipated in the future and where nonpredictable occurrences must be accepted.

There are numerous probabilistic methods. Examples include point and interval estimation, Monte Carlo simulation, Markov processes, parametric sensitivity analysis, queuing theory, decision analysis, risk analysis, and optimization methods. In recent years, risk analysis has received particular attention as a forecasting, planning, and decision tool. Its potential for presenting results of the indirect effects analysis to the public and decision makers is discussed in Step 6, which follows.

To be acceptable, probabilistic forecasting requires that adequate models be developed. This requires that any factor included be assigned a probability of occurring. This can be problematic for highly subjective variables and requires expert direction. Probabilistic forecasting also requires that the public and decision makers fully understand the results.

Qualitative Methods. These are softer forecasting methods aimed at portraying systems holistically. These methods provide the basis for developing an intuitive sense of system complexity and of the variety of exogenous factors that affect future development. Although promising, they are currently the least developed and least used of the various classes of forecasting techniques. There was no evidence of explicit use of these techniques in the EISs reviewed for this study. However, from its use in other applications—e.g., water resources planning—it can be stated that the Delphi technique is the most practical of the techniques described.

Delphi Technique. Delphi is a survey research technique directed toward the systematic solicitation and organization of expert intuitive thinking from a group of knowledgeable people (*79*). It provides a means for arriving at an informed, objective judgment based on a variety of sometimes conflicting opinions. Instead of achieving consensus by open discussion, Delphi uses a carefully designed program of sequential individual interrogations interspersed with information and opinion feedback derived from consensuses computed from earlier parts of the technique. Table 37 from Vlachos (*34*) shows the logical sequence of a typical Delphi study and its series of questionnaire rounds. The issues must be structured carefully to bring out the most important questions. This technique provides sensitivity for potential futures and opinions for delineating probable future actions. It can be used to obtain expert opinion on cause–effect relationships and related probabilities when adequate models are not available. Skilled facilitation is required to elicit the experts' opinions. Selection of

TABLE 37 Delphi study flow chart

Activity	Round 1	Round 2	Round 3
Type of data and information	- Broad trends, events developments	- Agreed developments from Round 1 - Newly suggested items	- Narrowing of items from previous rounds - Detailed analysis of selected trends, events and developments
Inquiry	- When might these take place?	- When might these occur? - Under what conditions? - Justification of extreme views	- Reasons for consensus or non-consensus - Reasons for time estimates - Likelihood and severity of consequences
Analysis	- Collation of statements - Configurations of first agreements - Analysis of commentary	- Summary of selections - Estimation of median - Any additional considerations	- Tabulation of major consequences - Range of agreement - List of selected threatening and desirable items
Suggestions	- What other developments can be suggested? - What is the level of the participant's expertise?	- What major technological and societal consequences may result?	- What can be done to alleviate or mitigate effects? - Reestimates for time horizon or other comments

experts and methods to avoid means of influencing opinion are other important elements of Delphi. Although this technique is less well defined and requires more expert direction than other detailed qualitative techniques, it can develop ideas and identify causal relationships that might not surface in more structured methods. Where consensus building is an important element of the indirect effects assessment, Delphi can be an effective tool.

Scenario Writing. Scenarios are an outline in narrative form of some conceivable future environment given certain assumptions about the present and a sequence of events in the intervening period (*80*). Multiple scenarios can include a variety of changing conditions, a spectrum of potential developments, and a series of hypothetical sociopolitical, ecologic, and economic consequences of proposed actions. Rather than predictive, scenario writing is a technique that attempts to establish some logical sequence of events to show how, under present conditions and assumptions, a future environment may evolve. A scenario is a synoptic view of as many events as can be grasped and as many as appear relevant to the circumstances of the project.

Vlachos (*34*) outlines the following basic principles for construction of scenarios:

- Identification of potential users and uses of the scenarios;
- Statement of assumptions or visions about the world around us and about the future;
- Problem definition and its structure, including identification of factors that affect development, elaboration of themes, and selection of critical issues;
- Selection of time horizon suitable to the specific problem requirements; and
- Collection and compilation of relevant data and of an information base to be used in developing the scenarios.

A particular difficulty in scenario writing is consideration of the various uncertainties in forecasting arising from long-range, future-oriented planning. Included are broader uncertainties about the external planning environment; future intentions of other decision makers; appropriate value judgments; and institutional and social changes. Another difficulty is in uncovering a variety of variables that may not be apparent in the present but that may be significant in future environments.

There are obvious questions about the extent of completeness, validity, or overall accuracy or reliability of scenarios. Effective scenario writing requires continuous questioning of the values, insights, assumptions, and level of information of the scenario writer(s). The level of confidence in scenario writing therefore depends on both the plausibility and the credibility of the argument as well as on the competence and qualifications of the scenario writer(s).

Alternative Futures/Visions. This technique is based on broad visionary forecasts oriented on a particular problem or issue (*80*). The study of an array of alternative futures provides a larger context for setting long-term goals and policies, in mapping causes of events, and in developing a larger framework within which the evaluation of significance and importance of indirect effects may be made. Alternative futures emphasize what societal features could reasonably coexist instead of how trends in fact will develop. Problems with this technique are that it is relatively undeveloped and the number of alternative futures is virtually endless.

Replogle (*81*) offers that this technique can help to reflect future visions that may be held by distinct segments of the community, better explore potential alternative futures by using internally consistent assumptions about how things might change, and compare these with a trend scenario and a set of performance benchmarks—i.e., endpoints, such as meeting air-quality requirements, providing a certain level of service or accessibility, or being financially feasible. He adds that preparing several alternative visions can help define the outer envelope of possible choices facing a region as it prepares a long-range transportation plan. Replogle notes that alternative visions should be treated as constructs for plan and study and not as plans per se.

Multiple (Adaptive) Methods. Use of multiple methods to improve confidence in the estimate of an indirect effect is common, although this approach is more formal in some situations than in others. For example, Talhelm (*42*) has developed an approach for the Michigan Department of Transportation that integrates comparative case, trend analysis, and the Delphi technique. Lewis (*82*) suggests a risk analysis approach that integrates networks and other causal models with risk analysis modeling and Monte Carlo simulation.

Analysts on several projects have linked a number of forecasting techniques to analyze the effects of a transportation project via land-use changes. A network diagram, Figure 10, or something similar can be used to structure the analysis. Population and employment forecasts can be developed by using trend extrapolation and then allocated spatially via correlation analysis of location attractiveness and travel time and adjusted for land-use controls and land availability (land-use forecast). Travel forecasts can then be developed via a structural model of trip generation, trip distribution, mode choice, and trip assignment. The forecast of land-use and related effects from a transportation system change can then be developed. The forecast of land-use and related effects is probably best accomplished by a qualitative technique—e.g., Delphi or scenario writing—supported by cartographic and quantitative techniques. The cartographic techniques can be used to illustrate the land-use spatial distribution forecasts with and without the project. An example of a supporting quantitative method is use of regression analysis to forecast changes in the percentage of impervious surface as a func-

tion of change in population density. The disadvantage of such an approach is the lack of analysis of feedback linkages—e.g., that between the transportation system and land use. Currently, no model is available for analyzing the changes in land-use and related effects attributable to incremental changes in the transportation system.

The multiple method approach is recommended for indirect effects analysis, particularly in situations where the reliability of each method alone is questionable. Multiple methods can be combined in many ways. When combined in a sequential manner from simpler to more detailed, the simpler methods can help focus the analysis or serve as model building blocks. Some authors have used the term adaptive methods to describe this analysis approach (*55*). If the results of all methods point in the same direction, confidence in the estimated effect will be higher than when a single method is used. On the other hand, if the results of several approaches are mixed, it is difficult to know which is right, but at least appropriate lines of further inquiry are drawn. Use of multiple methods obviously requires more resources. The reliability of any single method, the degree of controversy, and the desired level of detail are important factors to consider when deciding whether to use multiple methods for analyzing indirect effects.

Step 5d: Product of Analyzing Potentially Significant Indirect Effects

Indirect effects analysis should be conducted by the sponsoring transportation agency with participation and input from other stakeholders where appropriate, including that from a collaborative task force if one has been formed. Each of the formal analysis methods is supported by expert input. This presents the need to identify pertinent experts from sources such as government agencies, academic and other institutions, and private business and to elicit the input in an effective manner. The product of the effort is a technical memorandum that describes the identified indirect effects issue, the selected analytical method or methods, and the analysis results. The analyzed indirect effects of various alternatives should be compared with each other as well as with local and regional goals and effects on notable features. The technical memorandum should contain relevant documentation supporting the analysis of indirect effects—e.g., data sources and assumptions.

Step 6: Evaluate the Analysis Results

Step 6a: Objective of Evaluating the Analysis Results

In Step 5, the magnitude of indirect effects was measured. The results of this analysis depend on assumptions about the nature of the impact-causing activities, the nature of the cause–effect relationships, and how the environment will be affected by the impact. The objective of this step is to evaluate these assumptions and the uncertainty they produced so the indirect effects can be better understood.

Step 6b: General Issues for Evaluating the Analysis Results

Estimated indirect effects are but one consideration in formulating and implementing plans and projects. As with other inputs to making a decision about whether to proceed with a project, judgment must be used when considering the estimated indirect effects based on the information at hand. Vlachos (*34*) noted that

> Judgements result from two major sources: knowledge and estimates. In view of the perennial problems of uncertainty and risk, we must use both knowledge and estimates to arrive at some decision. The important point here is the mix of the two. Ideally, what we want to do is increase the fraction of knowledge and decrease the amount of guessing.

The purpose of the framework to this point has been to outline techniques and procedures that can lead to informed decisions with respect to indirect effects of proposed transportation projects. There is inherent uncertainty in estimating indirect effects or a risk that the actual outcome will differ from the forecasted outcome. Therefore, information about the level of uncertainty of an estimate of indirect effects should be communicated to decision makers and the public for consideration along with the results of the analysis. Similarly, information about differences among stakeholders throughout the process also should be disclosed. Included are differences in goals, notable features, indirect effects meriting analysis, and analysis techniques and results.

Step 6c: Methods for Evaluating the Analysis Results

Two methods for evaluating uncertainty in indirect effects analysis results are discussed: sensitivity analysis and risk analysis.

Sensitivity Analysis. This procedure involves changing forecast assumptions one at a time to test the sensitivity of effects to the particular assumptions. In other words, the purpose of this analysis is to test whether slight shifts in analytical assumptions will cause larger changes in the effect and help clarify degrees of confidence in estimating effects.

Schaenman (*83*) suggests that except when there is high confidence in the validity of the assumptions behind impact assessments, analyses should be made for the entire range of plausible assumptions. Further, where the results clearly indicate substantial indirect effects (substantial change in endpoint) or, conversely, no substantial effect, then the sen-

sitivity analysis often can be done in the analyst's head. However, where the analysis indicates great sensitivity of the outcome to particularly narrow or questionable assumptions, then a formal sensitivity analysis should be done and the results should be reported.

Sensitivity analysis is usually relatively inexpensive because it typically entails a repeated set of computations already thought through. For example, changing assumptions can readily be done with trend forecasts.

Lewis (*82*) notes several disadvantages of sensitivity analysis. For one, assumptions and judgments are typically varied by arbitrary amounts instead of by reference to reasoned analysis of potential error. Consequently, "[a]ny measured shifts in the bottom line are thus impossible to interpret meaningfully." He notes that what-if assumptions or scenarios are flawed in their failure to identify the probability of alternative outcomes and worst-case scenarios assume the highly unlikely event that all assumptions will deviate from expectations in the same direction.

Risk Analysis. Risk analysis includes a family of forecasting techniques and planning processes used to examine risk and uncertainty in alternative courses of action. Because risk analysis attempts to distinguish the probable implications of transportation investments from the improbable, it has promise as an indirect effects analysis forecasting or decision support method. Perhaps more than other forecasting tools, risk analysis recognizes that the essential uncertainty involved in understanding the consequences of actions should not be viewed as a handicap. In keeping with this philosophy, risk analysis seeks to improve the quality of information available for investment decisions by revealing and clarifying the implications of uncertainty in technical and analytical decision support material. There is no presumption of best or most accurate forecast; rather, the whole range of conceivable outcomes is arrayed together with the estimated probability of each occurring. Combined with group-oriented public involvement methods—e.g., a collaborative task force of stakeholders—risk analysis can promote consensus. In this way, it can bridge gaps between the forecasting level and the policy level.

Lewis (*82*) describes the three basic factors of sound risk analysis as (1) organizing the planning process for flexibility and consensus; (2) blending the subjective beliefs of stakeholders with the scientific knowledge of experts; and (3) accounting for simultaneously occurring risks. The basic steps of risk analysis are outlined in Table 38. Central to the analysis is the accurate detailing of cause–effect relationships and interactions. The availability of off-the-shelf software for generating probabilities enhances the practicality of risk analysis. Various software packages allow users to visualize the results, a feature that can aid consensus building. A trained risk analysis facilitator is also required.

Risk analysis is used when there are good data about how individual components of a system will be affected by an action, but there are inadequate data about how the overall system will be affected by the action. If experience or data indicate how the overall system will be affected, then risk analysis is unnecessary. The optimum benefits of risk analysis can be realized when the system under review has numerous components that are clearly identifiable and operate relatively independently. For this reason, risk analysis has been applied to study ecologic systems. More dynamic systems, like urban development, are less amenable to risk analysis (*84*).

Step 6d: Product of Evaluating Analysis Results

The product of Step 6 consists of documentation of the evaluation of uncertainty in a technical memorandum.

TABLE 38 Risk-analysis process

Stage	Components	Product
1	• Identify result variables and suspected causal factors • Hypothesize relationships between result variables and causal factors	• Structure and logic diagrams • Model for risk analysis
2	• Elicit expert and stakeholder beliefs about the effects of causal factors, their uncertainty, and the nature of the relationships that link them to results	• Causal variables characterized by ranges (probability distributions) using off-the-shelf software
3	• Enter the probability values from Stage 2 into the model from Stage 1 • Use results in decision-making	• Quantitative statement of the probability that an investment will yield desired outcome(s) and of the risk that it will not

Step 7: Assess the Consequences and Develop Mitigation (If Appropriate)

Step 7a: Objective of Assessing the Consequences and Developing Mitigation

The purpose of estimating indirect effects of proposed transportation projects is to contribute to the body of information that will support a decision about whether to proceed with the plan or project as proposed, to formulate a revised plan or project, or to otherwise mitigate adverse indirect effects associated with the proposed plan or project. The objective of this step is to assess the consequences of the analyzed indirect effects and develop strategies to minimize or avoid unacceptable indirect effects.

Step 7b: General Issues for Assessing the Consequences and Developing Mitigation

Uncertainty can lead to controversy about indirect effects. The project sponsor is responsible for the recommendation to the decision maker on the impacts and therefore bears the obligation to ensure that the descriptions and analysis in the EIS are reasonable and accurate. One of the tests for reasonableness deals with resolution of controversy. Should the question (e.g., degree of impact, likelihood of impact) have two sides, each with reasonable arguments, then the agency's obligation is to reveal both sides of the matter and, using the agency's expertise (or an outside agency), choose a side. The key is to disclose the controversy and to make a reasonable choice on the impacts.

The review of case law discussed in Chapter 2 indicates a requirement that mitigation of effects (direct, indirect, and cumulative) be discussed in an EIS in sufficient detail to ensure that environmental effects have been fairly evaluated (*20*). It is suggested that mitigation be considered for those indirect effects that are unacceptable. As discussed in Chapter 3, it is often the case with indirect effects that what is acceptable to some may not be acceptable to others.

Guidance for determining what is unacceptable can be found in the initial steps of the indirect effects assessment process—i.e., the goals and notable features identification. If analysis indicates that the proposed project could produce effects that would conflict, delay, or interfere with a study area goal identified in Step 1, then the proposed project, or the activity of the project responsible for that effect, is potentially unacceptable. Step 1 also suggests that the goals identification process attach relative importance to each relevant goal. Effects that would conflict, delay, or interfere with relatively important goals should be considered significant in the local context.

Relative importance is also helpful for dealing with uncertainty. Experience indicates that if something extremely important could be affected through a chain of causality linked to a proposed project, then there will likely be reaction to the effect regardless of the degree of uncertainty about whether the effect will really occur. As Lounsbury (*85*) notes, "Whether a specific use of the land in reality causes any economic or social problems may not be as important as what people perceive the problem to be." The message for indirect effects assessment is that the goals identification should not be treated lightly, as it lays the foundation and context for the entire assessment.

Depending on the circumstances of the project, mitigation of indirect effects on notable features also may require consideration. It is suggested that such consideration occur when one or more of the following circumstances exist:

- The indirect effect could worsen the condition of a notable feature considered sensitive or vulnerable.
- The indirect effect could interfere with or delay the planned or required improvement of a notable feature.
- The indirect effect could eliminate a notable feature that is valued or unique or render the valued or unique feature ordinary.
- The indirect effect is otherwise inconsistent with an applicable law.

As with mitigation of direct effects, mitigation of indirect effects is not always practicable. The EPA Section 404(b)(1) guidelines (*86*) provide a definition of the term practicable with respect to project alternatives as available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes. These considerations should be part of the evaluation of alternatives to avoid or minimize an indirect effect or other form of mitigation.

The issue of responsibility for mitigation was a common theme of interviews conducted as part of the research for this study. The essence of the issue is whether the indirect effect is within or outside the control of the sponsoring agency. This issue was a subject of debate in EPA's promulgation of its general conformity rules (*87*). These rules require that federal agencies make determinations that each of their agency's federal actions conform to the state implementation plan for attaining and maintaining air-quality standards. In developing the rules, many federal agencies stated that it is unreasonable to withhold a conformity determination where it is impracticable for the federal agency to remedy the situation. The EPA concluded that it would be unreasonable to interpret the Clean Air Act as requiring federal agencies to take responsibility for emissions that they cannot practicably control and for which they have no continuing program responsibility. The EPA used the U.S. Supreme Court's analysis in its 1989 decision in *Robertson v. Methow Valley Citizens Council* (*20*) to support this conclusion (this case is reported in the results of the case law research in Chapter 2). In that case, which involved the U.S. Forest Service's issuance of a special-use permit to a private developer, the imposition of the mitigation plan was within the jurisdiction

of state and local agencies. The court held that "it would be incongruous to conclude that the Forest Service has no power to act [on issuing the permit] until the local agencies have reached a final conclusion on what mitigation measures they consider necessary." However, the court added that the federal agency in such circumstances does need to advise the state and local agencies with mitigation authority about what it considered appropriate mitigation. This advice is considered part of the federal agency's NEPA responsibility.

It is suggested that mitigation responsibility for indirect effects of proposed transportation projects be based on the distinction between indirect effects that are within the control of the project agency and those that are outside the control of that agency to the extent that such distinction is consistent with federal and state laws. The typology for distinguishing indirect effects presented in Chapter 3 is consistent with this approach. Specifically, encroachment-alteration effects can be equated to within the control of the project agency, whereas induced growth and effects related to induced growth are generally outside the control of the project agency (the exception being to avoid or minimize impacts through change in access location where practicable). Indeed, the EPA used airport expansion and adjacent development of an industrial park as an illustrative example of federal control within the preamble to its general conformity rule. In the example, development of the industrial park is known to depend on FAA approval of the airport expansion. Under Step 4 of the typology, the airport expansion is a project that "would likely stimulate land development having complementary functions." For purposes of Clean Air Act conformity, the example notes that the FAA is responsible for emissions from airport-related activities but is not responsible for emissions from the industrial park. Within the context of the indirect assessment framework, however, the FAA would be responsible for analyzing the industrial park and its effects and recommending mitigation if such effects would be unacceptable.

Those indirect effects that should be considered within the control of the project agency include the following:

- Generally, those indirect effects associated with where the project, including access provisions, is located;
- Those related to how the project is constructed—e.g., modification of regime, land transformation and construction, land alteration, and resource extraction; and
- Those related to how the project right-of-way will be used and maintained—e.g., traffic and traffic-related effects, fertilization, chemical deicing, weed control, and pest control.

Step 7c: Methods for Assessing the Consequences and Developing Mitigation

The method for assessing the consequences and developing mitigation illustrated in Figure 11 should consist of a rational approach whereby adjustments are made to the proposed project to bring the effect in line with the goal, and the analysis technique used in Step 4 is rerun to test the effectiveness of the mitigation strategy. An illustrative example is the situation in which a project's indirect effects could conflict with the goal identified in Step 1 of creating a healthy and safe environment. In this example, the proposed transportation project is a new highway with a new interchange in an area with available land zoned for commercial uses. Discussions with individuals familiar with local real estate as

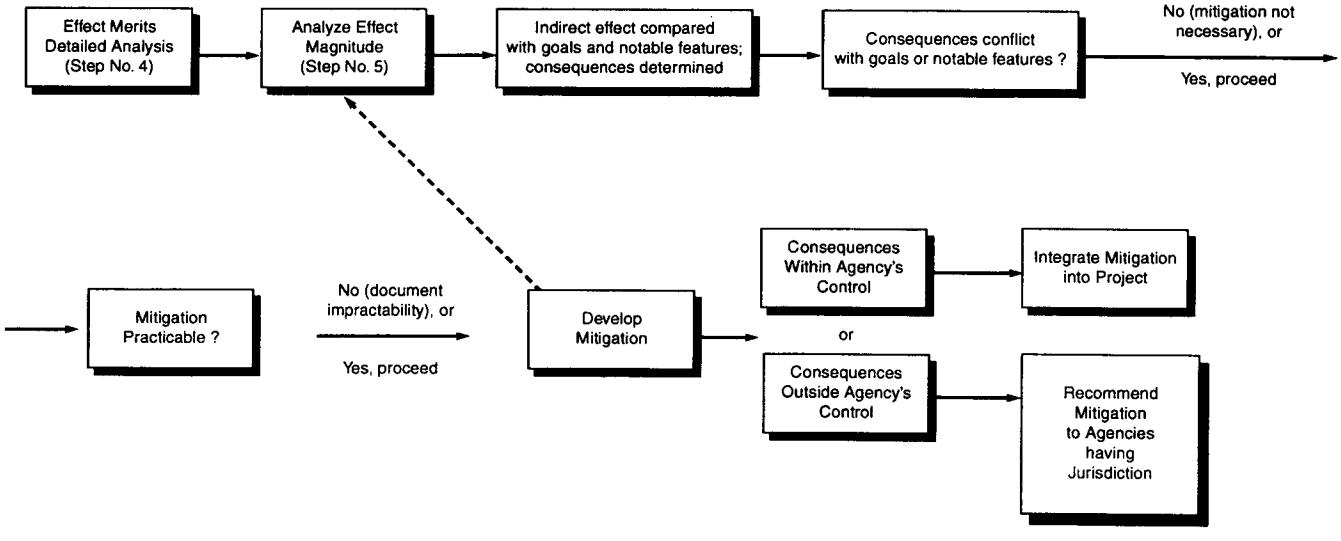

Figure 11. Method for assessing consequences and developing mitigation.

part of Step 4 indicate that the interchange will be a catalyst for land development in which a major activity center of office parks will be created. Traffic operational analysis conducted under Step 5 indicates that unacceptable travel conditions would exist at certain local intersections because of traffic using the activity center. Under Step 7, the highway agency analyzes what measures will be needed to achieve acceptable traffic conditions, when the measures will be needed, and what the measures will cost. The highway agency conveys this information to the local planning and engineering agencies for their use in future negotiations with developers and in planning for the identified local capital improvements. The highway agency notes in the project EIS that, contingent on action by others, the recommended mitigation will ameliorate this project effect to acceptable levels. Commitments to implement the mitigation should be obtained in situations where such commitments are needed to satisfy state or federal laws—e.g., federal Clean Water Act or federal Clean Air Act.

Step 7d: Product of Assessing the Consequences and Developing Mitigation

The product of assessing the consequences and developing mitigation should consist of documentation: comparison of indirect effects with the relevant goals and notable features (the determination of consequences), the mitigation strategy developed to address any unacceptable indirect effect, or mitigation considered and reasons why mitigation is not practicable. The documentation should note what the mitigation entails, its effectiveness, how it should be implemented, and who is responsible for implementation. It also should be shared with those who have a stakeholder interest in the studied effect and mitigation as well as with those responsible for ultimately implementing the mitigation, if different from the highway agency. All findings from Steps 1 to 7 are then to be integrated into the project EIS.

SAMPLE APPLICATION OF THE FRAMEWORK

The following hypothetical example is provided to illustrate application of the framework.

- Step 1: Identify the study area's directions and goals. A visioning session is used by the transportation agency to determine that the area's primary goals are to encourage economic growth at a level within the capacity of the environment to absorb the growth.
- Step 2: Inventory notable features. The transportation agency forms a collaborative task force comprising a transportation agency economist and an environmental specialist, an EPA representative, a state water resource agency representative, and a local planner. The project is in an area designated as a sole source aquifer under the Safe Drinking Water Act. The task force selects as the pertinent endpoint to maintain current rates of groundwater infiltration at an acceptable level of quality in groundwater recharge areas. These areas have been mapped by the local planning agency.
- Step 3: Identify project impact-causing actions. The project developed from the needs assessment is a proposed expressway connection that will link a town within a region experiencing population growth to an interstate highway. The transportation agency determines that the change in accessibility afforded by the connection, a direct effect of the project, could induce land-use conversion between the town and the proposed expressway/interstate interchange.
- Step 4: Identify indirect effects for analysis. Certain areas in the vicinity of the proposed interchange are mapped as being valuable for aquifer recharge. The area in the vicinity of the proposed interchange contains mixed low-density commercial-residential-agricultural development. Although the area is zoned for relatively low density office development, interviews with local real estate experts indicate that the project could induce pressure for higher density office development, of which there is a shortage in the region. Such development in the aquifer recharge areas would reduce infiltration and recharge. The transportation agency presents this information to the collaborative study team, which concludes that analysis of the consequences is needed. The transportation agency then develops an analysis approach in cooperation with the collaborative study team.
- Step 5: Analyze the indirect effect and consequences. The transportation agency uses multiple methods to analyze the potential induced growth and related effects. Multiple methods are used to analyze the effect. First, the project is categorized as one that could influence intraregional location decisions. Various comparable locations for land development in the region are identified and a matrix is developed to aid comparison of the various development-related attributes of the location with those of the project study area (e.g., availability of water and sewer, market preferences for type of development including parcel size, income levels, land availability and price, and potential development densities). The information in the matrix is used to develop a location attractiveness model, which indicates that the project area is more attractive for high-density office development than comparable locations in the region. Parcels within 0.8 km (0.5 mi) of the proposed interchange having the highest likelihood for land-use conversion are identified and mapped. The mapped development parcels are compared with the mapped recharge areas and overlaps are noted. From this analysis the transportation agency concludes a fairly high likelihood that development induced by the project will cause a measurable reduction in aquifer recharge. The transportation

agency presents the analysis results in a technical memorandum to the collaborative task force.
- Step 6: Evaluate the analysis results. The transportation agency explores how changes in allowable densities or parking ratios, items for which a developer could seek a variance, could alter the predicted effect on groundwater recharge. The predicted consequences from altering the assumptions are found to be comparable to those predicted by the original assumptions.
- Step 7: Develop mitigation. Based on analysis results, the transportation agency recommends that the local municipality mitigate the effect by requiring that developers in the area incorporate groundwater recharge measures into their site plans so that postdevelopment recharge matches predevelopment recharge.

CASE STUDY APPLICATION OF THE FRAMEWORK

Case studies for this research and application are found in Appendix E. Case studies were conducted on the following six transportation projects:

- Astoria (Oregon) bypass: small city highway bypass;
- Tasman (California) corridor: rapidly growing suburban area light-rail transit extension;
- Grand Rapids (Michigan) south beltline: rapidly growing metropolitan area near highway;
- Lackawanna Valley (Pennsylvania) industrial highway: new highway planned to aid an area's redevelopment from a natural resources-based economy to a light manufacturing economy;
- Stewart Airport (New York) properties development: development plan for office/light industrial uses on state-owned land adjacent to airport to aid airport's ascension to an important regional transportation facility; and
- Hudson–Bergen (New Jersey) light-rail transit system: new light-rail transit planned to aid an urban area's redevelopment from a manufacturing-based economy to a service-based economy.

Key conclusions of the case studies are as follows:

- Astoria bypass: The project-type highway bypass of a small city lends itself to analysis by the comparative case technique as there is often a base of similar previous projects of this type from which conclusions about probable indirect effects can be drawn. Indirect effects assessments of small city highway bypasses should take advantage of the base of comparable projects where appropriate.
- Tasman corridor, Hudson–Bergen light rail, and Grand Rapids south beltline: Anecdotal evidence indicates that development decisions on particular parcels were strongly influenced by these projects. Each of these projects was a new facility in a rapidly developing area. Certain development decisions occurred during project development. Where this phenomenon occurs, it can serve to indicate the potential strength of the link between a particular transportation project and development or the extent to which a project may accelerate development. The indirect effects assessment in such situations should take advantage of indicated trends.
- Grand Rapids south beltline: The case study illustrates the common situation in which land-use (or travel) effects of a project are modeled for a purpose unrelated to the project EIS, and the modeled effects are not identified or analyzed in the EIS. Indirect effects assessments should use project analyses developed for other purposes to the maximum extent possible—e.g., as the market feasibility study of the Stewart Airport property development was used to develop demographic forecasts.
- Stewart Airport properties, Lackawanna Valley industrial highway, and Grand Rapids south beltline: These case studies illustrate how the spatial limits of the indirect effects assessment should account for those activity centers (e.g., central business districts) that would be adversely affected by development shifts to an area made more attractive by a transportation investment.
- Tasman corridor and Hudson–Bergen light-rail transit: These case studies illustrate that the indirect effects assessment framework can be used to identify and resolve competing goals common to transit projects. These goals include increased development densities oriented to transit versus goals of providing adequate open space, maintaining existing affordable housing, and maintaining historic architectural contexts.
- Lackawanna Valley industrial highway: This case study illustrates the probable upper end in terms of level of effort and complexity related to indirect effects assessment. A separate indirect effects technical study was prepared to assess the project impacts and a comprehensive plan was developed for the area to guide development as mitigation for the project. The total cost of these efforts was on the order of $500,000.

Further details about these projects and applications of the framework to assess these projects are presented in Appendix E.

IMPLEMENTATION OF THE FRAMEWORK

Broad Considerations

Implementation of the framework will require some change in the typical modus operandi of transportation and regulatory/resource agencies with respect to consideration of the indirect effects of proposed transportation projects. Some

of the change relates to common phenomena that go beyond the sphere of indirect effects assessment. Barriers to early and effective interagency coordination on proposed projects would be included. Therefore, to be successfully implemented, it is necessary that the framework be integrated into agencies' overall project planning or review processes. For example, the findings indicate that some state departments of transportation have regular meetings with regulatory/resource agencies to discuss outstanding issues on projects. This process provides an ideal way to integrate the indirect effects assessment framework.

Successful implementation of the framework on a test case project will likely require a high-level commitment by all involved stakeholders to cooperate in its use, similar to the level of commitment of stakeholders on the Ozark Mountain Highroad EIS (*48*) and certain other projects that have used the collaborative study team approach to analyze indirect effects.

Because the framework places consideration of potential indirect effects early in project planning, much of its implementation may be done by local project sponsors or metropolitan planning organizations who have more responsibility for project planning because of the ISTEA planning regulations. Programming of resources for this purpose and training of personnel will be required where these entities do not have the expertise or resources for conducting multidisciplinary environmental analysis.

Resources Required

The findings indicate that the following are key variables for determining the level of effort for estimating the indirect effects of proposed transportation projects:

- Data availability: Steps 1 to 3 of the framework require data related to study area goals and trends, notable features, and project activities. Typically, much of the data needed for the indirect effects assessment will have been collected or developed for other purposes (e.g., project purpose and need, market feasibility, direct effects, and permit applications). On some occasions, however, extensive original data collection will be needed to complete Steps 1 to 3—i.e., where such information is not readily available.
- Number of potentially significant impacts: One of the intents of NEPA is to focus impact assessment on impacts that are considered potentially significant. The number of potentially significant impacts affects the level of effort associated with Step 4—identify potentially significant indirect effects (and concomitant cause–effect relationships). This variable also affects Step 7—assess the consequences of the indirect effects (and, where appropriate, develop mitigation).
- Appropriate technique: Steps 5 and 6 relate to analyzing the magnitude of the potentially significant effects. Findings indicate that detailed qualitative or simple quantitative techniques typically satisfy analysis requirements regardless of potential impact significance. Under certain circumstances, however, a detailed quantitative technique (e.g., travel demand or land-use forecasting) is needed to improve precision to a finer level of detail.
- Extensiveness of effect: Findings indicate that the spatial effect is primarily a function of project type and maturity of the regional transportation system and land development. Greater effects are associated with new facilities relative to expansion of existing facilities. Further, linear projects (e.g., new highways or fixed transit guideways) typically have the most extensive effects compared with new interchanges, transit stations, or bridges or with new ports, airports, and related facilities.

Table 39 illustrates in matrix form the range of staff hours estimated to undertake the framework steps for various project types and level-of-effort scenarios. Table 40 illustrates the estimated duration to complete the assessment for the various project types and scenarios. The values in Tables 39 and 40 are intended for generic cost-estimating and scheduling purposes and should be adjusted by agencies to match project-specific circumstances. It should be noted that for the schedule estimates in Table 40, it was assumed that the more complex the assessment the more individuals would be assigned to it. The time and schedule estimates illustrated in Tables 39 and 40 are consistent with levels of effort for indirect effects assessments indicated by interviews and case studies.

Implementation Plan

Dissemination of the information learned and the planning tools developed for this report could be integrated into planning practice and course materials designed to improve the comprehensiveness and the accurateness of the EIS/EA process. It is suggested that an implementation program include issuing updated transportation and regulatory/resource agency field guidance, introduction of indirect effects into course material, targeted publications, and use of new information technology.

No matter which of these avenues for implementation is followed it is critical that the information be more routinely updated as it matures in the planning environment. Too often we make significant advances in the state-of-the-art for planning only to have that knowledge base left in its original form as the practical planning needs evolve in more complex environments. There is certainly a level of responsibility the various planning and transportation universities and institutes have for assuring that this information and these tools continuously evolve to meet the needs of a dynamic planning environment.

TABLE 39 Time estimates to use the framework

STEPS	ACTIVITY	EFFORT DISCRIMINATOR	EFFORT	ESTIMATED STAFF HOURS BY PROJECT TYPE: NEW INTERCHANGE/ TRANSIT STATION	NEW HIGHWAY/ GUIDEWAY	PORT/ AIRPORT AND RELATED FACILITIES
1-3	COLLECT DATA	DATA AVAILABILITY				
		VERY GOOD	MINIMUM	20	100	60
		GOOD	MOST LIKELY	40	240	160
		POOR	MAXIMUM	80	800	400
4	EVALUATE CAUSE-EFFECT	# POTENTIAL SIGNIFICANT IMPACTS				
		0 OR 1	MINIMUM	20	60	40
		2 OR 3	MOST LIKELY	60	240	160
		5 OR MORE	MAXIMUM	120	480	300
5-6	ANALYZE EFFECT	APPROPRIATE TECHNIQUE				
		SIMPLE	MINIMUM	40	100	80
		MODERATE	MOST LIKELY	100	240	180
		HIGHLY QUANTITATIVE	MAXIMUM	180	2000	1200
7	ASSESS EFFECT	# POTENTIAL SIGNIFICANT IMPACTS				
		0 OR 1	MINIMUM	20	100	80
		2 OR 3	MOST LIKELY	40	240	160
		5 OR MORE	MAXIMUM	80	800	320
ESTIMATED RANGE OF HOURS TO COMPLETE ASSESSMENT			MINIMUM	100	360	260
			MOST LIKELY	240	960	660
			MAXIMUM	460	4080	2220

TABLE 40 Schedule estimates to use the framework

STEPS	EFFORT	ESTIMATED ASSESSMENT DURATION BY PROJECT TYPE (IN WEEKS) NEW INTERCHANGE/ TRANSIT STATION	NEW HIGHWAY/ GUIDEWAY	PORT/ AIRPORT AND RELATED FACILITIES
1-3	MINIMUM	0.6	3.1	1.8
	MOST LIKELY	0.9	5.2	3.5
	MAXIMUM	1.1	11.1	5.6
4	MINIMUM	0.6	1.8	1.2
	MOST LIKELY	1.3	5.2	3.5
	MAXIMUM	1.7	6.7	4.2
5-6	MINIMUM	1.2	3.1	2.4
	MOST LIKELY	2.2	5.2	3.9
	MAXIMUM	2.5	27.8	16.7
7	MINIMUM	0.6	3.1	2.4
	MOST LIKELY	0.9	5.2	3.5
	MAXIMUM	1.1	11.1	4.4
TOTAL ESTIMATED DURATION (WEKS)	MINIMUM	3	11	8
	MOST LIKELY	5	21	14
	MAXIMUM	6	57	31

ASSUMED REQUIRED FULL-TIME STAFFING EQUIVALENT (PERSONS)	MINIMUM	1.25
	MOST LIKELY	1.75
	MAXIMUM	2.75

The information assembled in this report and the planning tools developed could have direct applicability to planning courses targeting currently practicing planners as well as planning students at the undergraduate and graduate level.

The National Highway Institute (NHI) and the National Transit Institute (NTI) offer transportation planning courses geared at updating the skills of current practitioners. NHI's relationship with the state departments of transportation and NTI's outreach to metropolitan planning organizations and local planning groups provide excellent coverage for reaching planning professionals. NTI's current development of a course curriculum for a transportation and land-use class is an excellent example of where this information could have direct and immediate use.

The checklists presented in this report could be important additions to course material. Their availability via electronic medium (i.e., computer diskette) will enhance their usability for both course work and actual project application.

The survey form in Appendix B and the accompanying EIS review checklist are useful examples of information-gathering tools that could be used in accumulation of information relative to indirect effects. The survey forms also have value as prototype planning tools for other, similar research efforts.

The case law presented in Chapter 2 highlights current interpretation of planning disputes involving consideration of indirect effects. As there is no singular formula that can be applied to all evaluations of indirect effects, it is critical that this information be considered for inclusion in the course material.

The planning tools developed as part of this report also could be shared with the university transportation consortiums through DOT's Research and Special Programs Administration office. This will provide a direct link to the current pool of graduate and undergraduate students on the verge of entering the job market. Consideration of indirect

effects could become an integral part of their education and their subsequent professional practice.

It may be useful to issue technical guidance to FHWA and FTA field offices to establish a definition of terms about indirect effects. As reflected in the report there are a broad range of definitions for indirect effects. This technical guidance, through FHWA's field guidance and FTA's circulars, should distinguish between direct, indirect, and secondary impacts as reflected in the report. This technical guidance could also look at 23 CFR Part 771 to clarify that indirect effects should be considered part of the scoping work required by NEPA. There is additional opportunity for clarifying the planning process as integration of the planning regulations and pending environmental regulation are updated to meet major investment study requirements under ISTEA.

Successful implementation of the framework on a long-range planning or project-level basis will require cooperation and coordination among transportation and regulatory/resource agencies. Cooperation and coordination will be facilitated by headquarters policy-level agreement on framework application. The interagency cooperative effort, which produced the document *Applying the Section 404 Permit Process to Federal-Aid Highway Projects* (*88*) could be a model for this purpose.

Subsections of this report could be presented as stand-alone reports distributed through industry-specific journals (i.e., planning law) or association committees and task forces. The review of case law could be developed as a submission to any of several journals regularly referenced in land-use case law. Appropriate publication sources include the *Journal of the American Planning Association*, *Environmental Impact Assessment Review*, and *Impact Assessment.*

There are several professional associations with active committees that could advance the discussion of indirect effects. AASHTO's standing committee on planning is charged with reporting on, among other areas, the interaction of transportation and land use. The American Public Transit Association's strategic planning subcommittee and the legislative committee are two key avenues for advancing this discussion in the transit community. There are also numerous professional journals published by the American Planning Association and the Institute for Traffic Engineers—two widely respected organizations that could be explored for publication of discrete subareas of the indirect effects report.

The surge of electronic bulletin boards at both the national and local level appear to provide an opportunity for a relatively expedient dissemination of the information contained in this report. This could be particularly applicable to the metropolitan planning organizations in large urban areas who are responsible for many of the major investment studies now under way. It may be useful to investigate opportunities for disseminating information from this study electronically (e.g., by e-mail). Sharing this most current thinking with budding transportation professionals is essential to integrating it into their future practice.

CHAPTER 5

CONCLUSIONS AND SUGGESTED RESEARCH

CONCLUSIONS

The research conducted for this study, reported in Chapter 2, demonstrated the need for guidance, procedures, and supporting methods for estimating indirect effects of proposed transportation projects. This need is primarily based on two factors:

- There are different interpretations of the CEQ definition of an indirect effect; and
- Many promising tools for analyzing indirect effects suggested in the literature generally are not applied in practice.

The research conducted for this study indicates that indirect effects differ from direct effects in certain fundamental ways; direct effects can be characterized as typical or inevitable and indirect effects can be characterized as reasonably foreseeable or probable. In other words, direct effects are predictable and indirect effects are uncertain. Indirect effects are uncertain because they occur in the future and because many dynamic forces are involved in determining the ultimate consequence of the indirect effect. This uncertainty has important implications for selecting tools to identify and analyze indirect effects.

Indirect effects occur in three basic forms:

- Those that alter the behavior and functioning of the affected environment because of project encroachment (physical, chemical, or biological) on the environment;
- Those that induce economic growth and land-use conversion; and
- Those related to project-induced growth.

Indirect effects meet the following two tests:

- There is a rational nexus between the project activity and the effect through a direct effect (i.e., it is caused by the proposed transportation project); and
- The effect is manifested by other transportation projects in similar settings (i.e., it is reasonably foreseeable or probable).

Case law indicates that knowing whether an effect is significant is more important than knowing whether it is direct, indirect, or cumulative. Case law provides three questions for distinguishing indirect effects that are potentially significant from those that are trivial. These are as follows:

- With what confidence can one say that the impact is likely to occur?
- Is there sufficient specific knowledge about the impact to make its consideration useful?
- Is there a need to know about the impact now?

These questions focus on the uncertain and future-oriented natures of indirect effects, and they help frame the suggested approach for assessing indirect effects.

Recognizing that transportation projects can have essentially innumerable indirect effects, the suggested framework takes a top-down approach for narrowing the broad range of effects to those that are important issues. First, to have a context for assessing the ultimate indirect consequences of a transportation project, it is necessary to define the affected area's desired future. This can be done by examining documents like the area's comprehensive plan, if they exist, or by using one of several public involvement techniques (in particular, visioning) for establishing an area's needs and goals. These needs and goals commonly include, among others, growth encouragement, growth management, environmental protection, and maintenance of character.

It is suggested that notable features then be selected as specific indicators of the needs and goals. Notable features are settings or populations commonly afforded special attention with respect to change. These settings or populations could be unique, valued, or vulnerable. Notable features provide measures for assessing the consequences of indirect effects. If the consequence of an estimated indirect effect on a notable feature is unacceptable, then there may be a need to reassess the project as proposed.

It is suggested that identification of a proposed project's indirect effects begin with a detailed listing of the project's impact-causing actions. Transportation agency analysts can then explore cause–effect relationships between the impact-causing actions and important goals or notable features. These relationships can be diagrammed on flow networks, maps, or matrices. Such relationships are indicative of the project's indirect consequences.

The boundaries of the project study area or region of influence for purposes of indirect effects assessment depends on boundaries of the level(s) of ecologic, social, or political hierarchy at which the consequences are likely to occur.

For projects that induce growth, the region of influence is also a function of the areal extent of the proposed project's land-use conversion effect. Generally, transportation projects can influence land-development location decisions in three ways:

- The project and land development can be functionally interdependent, as in the case of a highway interchange or transit station proposed to serve a stadium. This situation generally applies to highway and transit modes.
- The project and land development can be functionally complementary, as in the case of retail services at highway interchanges and transit stations, cargo and parking areas near airports, and terminal facilities at ports. This situation applies to all transportation modes.
- The project can influence general intraregional land development location decisions for office buildings, warehouse/distribution facilities, and industry and residential development. This situation generally applies to highway and transit modes. Each type of induced growth effect occurs because of a unique set of variables. The variables can be particularly dynamic and complex for the intraregional development shifts type of effects, an aspect that makes analysis of this type of effect problematic.

A number of traditional forecasting tools lend themselves to analyzing indirect effects. Included are relatively straightforward trend extrapolation technologies to the more complex dynamic models. No single tool is suitable for all indirect effects analysis situations; selection of the tool depends in part on the type of information available to the analyst. Because they involve consensus building and exploration of uncertainty, the qualitative Delphi technique or quantitative risk analysis has potential for indirect effects analysis. However, each technique has its limitations, not the least of which are potential difficulties in comprehending their results and the need for skilled facilitators. The accuracy of the forecasting tools depends on the amount and type of data available to feed into the forecast. Much of these data, including cause–effect relationships, can be developed through the process of building networks, matrices, or maps during the step of identifying indirect effects. Forecast certainty generally can be improved by combining several tools into the analysis approach. In communicating the analysis results to the public and decision makers, it is suggested that some indication of the level of confidence associated with the results be provided. In addition, the results should be compared with the previously selected notable features. In this way, the indirect effects can be assessed in the context of local or regional goals. Further, decisions on project formulation considering indirect effects as a factor can be made accordingly.

SUGGESTED RESEARCH

Case Studies

Case studies can be used to test the practicality, cost, and effectiveness of the suggested framework. Case studies should be applied over a variety of transportation modes and project settings as a test of the framework's performance in a variety of circumstances. The contractor will screen upcoming transportation projects with federal or state transportation agencies to identify those having potential for indirect effects. The final list of case study projects will be representative of a cross section of transportation projects and settings. The contractor will work with the case study transportation agencies in identifying pertinent data sources, stakeholders, and tools and in developing an overall scope for indirect effects assessment of the case study projects. The contractor will periodically monitor the progress of the indirect effects assessment of each project and prepare a case study report of each project. The case study report will describe the project background, the process of implementing various aspects of the framework, the acceptability of the framework to the practitioners, and the cost of implementing the framework. Results of the various case study reports will be compiled by the contractor and suggestions will be made for revising the framework. This will require approximately 2 to 4 years.

Before-and-After Studies

Many of those interviewed as part of the research for this study indicated a need for before-and-after studies of environments affected by transportation projects. Information from such studies could be used to help reduce the uncertainty in estimating indirect effects. It also could be used to assess the accuracy of estimated effects of particular projects. With adequate information about preconstruction conditions, this research will require a study period of approximately 2 years (although it is appropriate to examine the environment at least 8 to 10 years after project construction).

Compile and Assess Recent Research on Transportation–Land-Use Relationships

The relationship between transportation access and land use has been the subject of considerable research over the past 3 decades, particularly in the 1960s and 1970s when the consequences of the interstate highway system began to materialize. Many of the patterns regarding the transportation system's effect on growth and land-use conversion observed in previous research may no longer be valid given that the transportation systems in many areas of the country are now mature and given changes in demographic, economic, and other factors over time. A synthesis of recent research on this topic might be a valuable aid to those assessing this type of indirect effect in that it could improve forecasting confidence. It is particularly important to gather research on how changes in employee commuting and in transportation technology (e.g., intelligent transportation systems) could affect transportation–land-use relationships. This research requires a study period of approximately 1.5 to 2 years.

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GLOSSARY

Accessibility. The ease of movement between places. As movement between any two places becomes less costly—in terms of either money or time—accessibility increases. The propensity for interaction between any two places increases as the cost of movement between them decreases. Accessibility also is defined as the attractiveness of a place as an origin (how easy it is to get from there to all other destinations) and as a destination (how easy it is to get to there from all other destinations). Consequently, the structure and capacity of the transportation network affect the level of accessibility within a given area. The accessibility of places has a major impact on their land values (and hence the use to which the land is put); the location of a place within the transportation network determines its accessibility.

Alternative Futures/Visions. Qualitative modeling based on broad visionary forecasts oriented on a particular problem or issue.

Attractiveness. The opportunities or activities that are located in a given place.

Biodiversity. Biological diversity or the variety of life and its processes.

Citizen Survey. This technique is used to assess widespread pubic opinion by a survey given to a sample group of citizens via written questionnaire or through interviews in person, by phone, or by electronic media.

Comparative Case Analysis. A comparative study involves comparing a like area where a similar project has been completed with the area of concern where a project is proposed. The two projects and areas must be similar in size; project type, location, and design; and geographic and other pertinent characteristics.

Component Analysis. This requires conceptualization of possible impacts but is less structured than the matrix.

Context. The interrelated conditions in which something exists or occurs—e.g., society as a whole, affected interests, the affected region, or the locality.

Council on Environmental Quality (CEQ). Created by NEPA and given the responsibility for environmental policy development and oversight of federal agencies implementing NEPA. CEQ is part of the Executive Office of the President and can issue NEPA regulations to federal agencies.

CEQ Regulations. The CEQ regulations for implementing NEPA (40 CFR 1500–1508).

Cumulative Impact. The impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions.

Delphi Technique. A qualitative forecasting technique that is the systematic solicitation of expert opinion, which achieves consensus through a carefully designed program of sequential individual analyses subject to peer review.

Direct Effect. According to the CEQ definition, direct effects are caused by the action and occur at the same time and place.

Draft Environmental Impact Statement (DEIS). This must contain all the required contents specified in NEPA and the CEQ NEPA regulations and must disclose and discuss all major points of view on the environmental impacts of the alternatives.

Dynamic Models. These focus on system behavior, or functional process, and define relationships within a system.

Ecosystem. The sum total of physical features and organisms in a given area.

Ecosystem Stability. A function of resistance and recovery. This concept of ecosystem stability is useful for assessing indirect effects.

Effect. Something that follows or is caused by an activity. According to the CEQ regulation, effect and impact are synonymous.

Environment. Surroundings. The complex factors that act on an organism or an ecologic community and ultimately determine its form and survival; the aggregate of social and cultural conditions that influence the life of an individual or community.

Environmental Assessment (EA). A concise public document that a lead agency prepares when a project is not covered by a categorical exclusion, and the lead agency does not know whether the impacts will be significant.

Environmental Impact Statement EIS. NEPA requires EIS preparation for proposals for legislation and other major federal actions significantly affecting the quality of the human environment. A document that assesses the impacts on the environment of a major federal action.

Final Environmental Impact Statement (FEIS). Prepared after comments on the DEIS are received and reviewed. It must contain the lead agency's responses to all comments and must discuss any opposing views on issues raised.

Focus Groups. A tool to gauge public opinion and identify citizen concerns, needs, wants, and expectations. A focus group is a small group discussion with professional leadership.

Goal. The end toward which effort is directed; the expressed status (socially, ecologically, environmentally, economically, culturally, politically) where a group of people (e.g., municipality or region) wish to be at some future point.

Indirect Effect. According to the CEQ definition, indirect effects are caused by the action and occur later in time or farther removed in distance but still are reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems including ecosystems.

Induce. To lead on or move by persuasion or influence; to call forth or bring about by influence or stimulation.

Induced Growth. Changes in the intensity of the use to which land is put that are caused by the action/project. These changes do not occur if the action/project does not occur. For transportation projects, induced growth is attributed to changes in accessibility caused by the project.

Input–Output Modeling. This shows the transfer of goods and services in an economy in monetary terms.

Intensity. Refers to the severity of the impact based on beneficial effects, public health, unique characteristics, degree of controversy, cumulative effect, cultural and historical resources, special-status species, violation of environmental laws, precedent-setting effect, and unique characteristics.

Intermodal Surface Transportation Efficiency Act (ISTEA). In meeting the demands of current and future transportation system users, the planning process must address the results of the management systems as well as other factors specified by ISTEA. These factors include the overall effects of transportation decisions, the effects of these decisions on land use and land development, and the consistency of transportation plans with land-use and land-development plans. ISTEA recognizes the linkage between transportation and land use and between transportation and an area's development.

Lead Agency. The federal agency with primary responsibility for preparing an EIS. Typically, it is the agency considering the major federal action.

Major Activity Center (MAC, Activity Center). A geographic area characterized by a large transient population and heavy traffic volumes and densities; for example, central business district, major air terminal, large university, large shopping center, industrial park, or sports arena.

Major Federal Action (Action). Actions that are potentially subject to federal control and responsibility if these actions have effects that may be significant. Actions include licensing or permitting the proposed project, such as construction of a highway, port, or airport, or federal assistance to a project.

Matrix. A method for accessing probable impacts of actions. An example of a matrix is the Leopold matrix, which lists actions that impact the environment on one axis and the existing environmental conditions that may be affected on the other axis.

Mitigation. Action to cause an effect to become less adverse.

Mode Choice. A process by which an individual selects a transportation mode for use on a trip, given the trip's purpose, origin, and destination.

Model. Simplified representation of the real, complex systems that may be affected by a project. A mathematical or conceptual presentation of relationships and actions within a system. It is used for analysis of the system or its evaluation under various conditions; examples include land use, economic, socioeconomic, and transportation. A mathematical description of a real life situation that uses data on past and present conditions to make a projection about the future.

National Environmental Policy Act (NEPA). Establishes environmental policy for the nation, provides an interdisciplinary framework for federal agencies to prevent environmental damage, and contains action-enforcing procedures to ensure that federal agency decision makers take environmental factors into account. This act requires preparation of an EIS for all major federal actions significantly affecting the quality of the human environment.

Networks. Also known as systems diagrams, networks can be used to classify, organize, and display problems, processes, and interactions and to produce a causal analysis of the indirect effects situation.

Notable Features. Elements of the affected environment that are unique, valued, or vulnerable.

Probabilistic Forecasting. These techniques involve development, testing, and use of mathematical stochastic models to predict the future behavior of phenomena that are presumed to behave in a random manner.

Qualitative. Comprehensive discussions of effects without using models or numerical results. Professional judgment is an example of qualitative analysis.

Qualitative Inference. This involves a case study description of the area of concern (e.g., habitat or neighborhood) and an identification based on professional judgment of the possible changes the proposed project may entail.

Quantitative. Analysis that involves measurements or estimates in numeric terms. Traffic and land-use modeling are examples of quantitative analysis.

Record of Decision. A written public record explaining why a federal agency has taken a particular course of action.

Recovery. The ability of the system to bounce back or return after being changed.

Resistance. The ability of the system, when subjected to an environmental change or potential disturbance, to withstand or resist variation.

Risk Analysis. This includes a family of forecasting techniques and planning process used to examine risk and uncertainty in alternative courses of action. Attempts to distinguish the probable implications from the improbable.

Scenario Writing. A qualitative forecasting technique, which is the process of imaging outcomes given a set of assumptions about the present and a sequence of events that occur in an interim period.

Segmentation. Process of dividing an action into component parts, each involving action with insignificant environmental effects. An EA or EIS cannot engage in segmentation of a project's effects.

Sensitivity Analysis. This procedure involves changing forecast assumptions one at a time to test the sensitivity of effects to the particular assumptions. The purpose of this analysis is to test whether slight shifts in the analytical assumptions will cause larger changes in the effect and to help clarify degrees of confidence in estimating effects.

Significant. The significance of an action is defined by its context and intensity. An EA or EIS must be prepared when a proposed project or action is deemed to have a significant effect.

Stochastic. Any phenomenon that obeys no discernible cause–effect relationship but that varies within limits.

Structural Models. These focus on selection of the components of a system, explicitly stating the interactions between them, and on intersectoral linkages and identification of critical paths.

Systems Analysis. This entails a systematic exploration, analysis, and evaluation of all the possible consequences the proposed alternatives can impose on ecologic, spatial, or socioeconomic systems.

Traffic Assignment. A process by which trips, or flows among geographic units (zones), are allocated to feasible routes (paths) through a network.

Trend Correlation. Designed to test relationships between two or more trends and a third and to determine the most likely future state or direction.

Trend Extrapolation. Three widely used trend extrapolation techniques are simple extrapolation, curve fitting, and trend curves. Simple extrapolation is based on the assumption that whatever trends existed in the past will continue into the future. Curve fitting allows for judgment in forecasting the trend and accepts that the trend may not be linear in nature. Trend curves examine a trend by looking at its relationship to two or more other trends.

Trip Attraction. The process of attracting trips to a geographic unit (zone). A trip terminating or originating in a zone whose existence is due to an activity carried out in the zone is said to be attracted. Trip attraction is generally a function of the land uses in a zone.

Trip Distribution. The process of determining trip exchanges—i.e., the number of trips between each pair of designated geographic units (zones).

Trip Generation. The process of determining the number of trip origins and destinations associated with a given set of activities in a given area, usually by applying trip rates (or a cross-classification or regression model) to a land-use inventory or projection. In a regional travel demand study, trip generation is done at the zone level and requires detailed descriptions or projections of land use for each zone.

Trip Production. The process of producing trips from a geographic unit (zone). A trip originating or terminating in a zone whose existence is due to the traveler's residence in the zone is said to be produced there (the terminology is less clear for non-home-based trips). Trip production is generally a function of the residential land uses in a zone.

Visioning. This technique typically consists of a series of meetings focused on long-range issues. It accounts for the relationship between issues and how one problem's solution may generate other problems (e.g., indirect effects).

APPENDIXES A–D

Appendixes A through D as submitted by the research agency are not published herein but are available for loan on request to the NCHRP.

Appendix A—Working Plan
Appendix B—Initial Survey Form and Results
Appendix C—EISs Reviewed and Review Checklist Form
Appendix D—Interview Survey Form and Interviewees

APPENDIX E

CASE STUDIES

E-1 CASE STUDY REPORTS OVERVIEW

The basic purpose of the case studies was to examine indirect effects of actual proposed transportation projects involving different transportation modes and different settings. First, six proposed projects were selected for case study from the larger list of projects that were examined in the research phase of the overall study. The larger list of projects is provided in Appendix C. The six case study projects are as follows:

- Astoria (OR) Bypass—small city highway bypass.
- Tasman (CA) Corridor—rapidly growing suburban area light rail transit extension.
- Grand Rapids (MI) South Beltline—rapidly growing metropolitan area near highway.
- Lackawanna Valley (PA) Industrial Highway—new highway planned to aid an area's redevelopment from a natural resources-based economy to a light manufacturing economy.
- Stewart Airport (NY) Properties Development—development plan for office/light industrial uses on state-owned land adjacent to airport to aid airport's ascension to an important regional transportation facility.
- Hudson-Bergen (NJ) Light Rail Transit System—new light rail transit planned to aid an urban area's redevelopment from a manufacturing-based economy to a service-based economy.

The methodology for each case study report is as follows:

The background, context and alternatives of each proposed project are described. Then the case study examines how the project's environmental impact statement identified, defined and addressed indirect effects.

Next, the proposed project was assessed through application of the framework. The purpose of the framework application was to test the basic utility of the framework, and not to conduct an indirect effects assessment of each project using the framework. The framework application consisted of supplementing the project EIS content with additional information about the project obtained through examination of local plans, interviews with project planners and local officials, and visits to project corridors. The information compiled was used to apply the checklists developed as part of the overall research to help reveal goals, notable features, impact-causing activities, and indirect effects chains-of-causality. Framework decision tools were used to decide which indirect effects would merit detailed analysis. The case study then discusses conceptually how analysis tools appropriate to the situation could be applied to evaluate the magnitude of the indirect effects. Framework decision tools were then used to assess the consequences and identify possible circumstances requiring mitigation.

The framework application in each case study includes comparisons between project EIS approaches/conclusions, and project framework application approaches/conclusions. The comparisons are for illustrative purposes; they are in no way intended to judge the transportation agencies responsible for the project's development or environmental impact statements.

The case study reports help answer the questions that are fundamental to estimating the indirect effects of proposed transportation projects, including:

- How to define indirect effects?
- How to analyze and assess the effects?
- How to distinguish project effects from other effects?
- How to define transportation agency responsibilities with regard to assessing indirect effects?

The case studies demonstrate the basic utility of the framework.

Lessons from the framework applications led to the refinement of the framework tools. These refinements are reflected in the framework as presented in Section Four of the main report.

E-2 CASE STUDY REPORT: ASTORIA (OR) BYPASS

1.0 PROJECT DESCRIPTION

1.1 Introduction

Astoria, the largest community in Clatsop County, Oregon, is a terminus for three highways: 1) the Lower Columbia River Highway (US 30), 2) the Oregon Coastal Highway (US 101/26); and, 3) Oregon Highway 202. Together, these three routes funnel considerable traffic into downtown Astoria, particularly in the summer months, creating concerns for the safety of pedestrians, bicyclists, and motorists (see Figure E-1). Presently, US 30 is the primary route to Astoria from Portland and Washington State.

To relieve growing traffic congestion, particularly truck traffic, in downtown Astoria, the Oregon Department of Transportation (ODOT) proposed the construction of an alternate route from the John Day Bridge to Youngs Bay Bridge that would reroute through traffic from US 30 traffic away from downtown Astoria (see location map in Figure

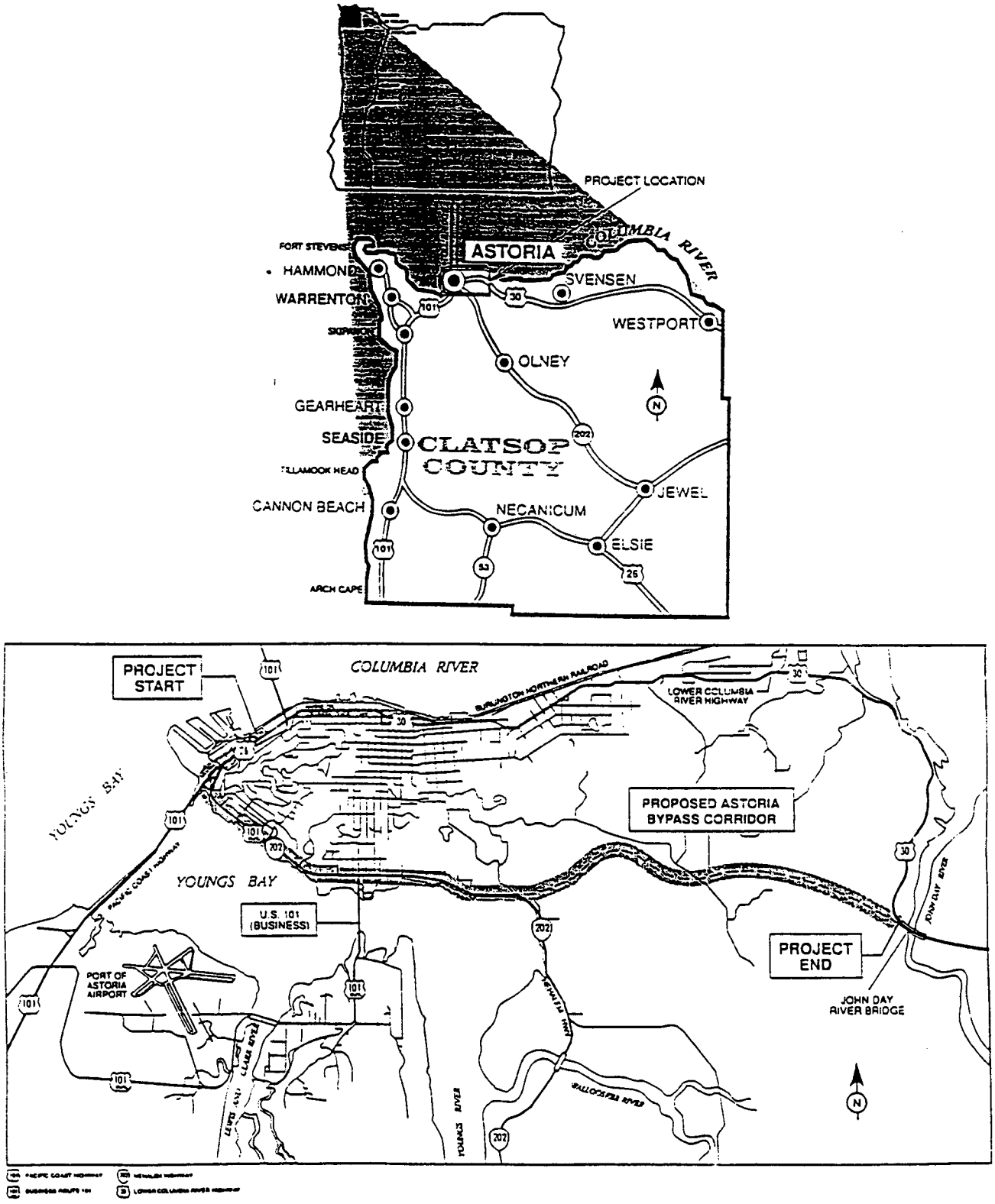

Figure E-1. Location of the Astoria Bypass project.

E-1). The Astoria Bypass, as this project is called, would depart from the existing US 30 near the John Day River Bridge and proceed west over the new alignment through the Clatsop State Forest, joining the existing Nehalem Highway (OR 202) near the southeastern edge of Astoria, then following OR 202 to the Oregon Coast Highway (US 101/US 26) at Smith Point.

The project would pass mostly through rural forest land outside Astoria's city limits and through semi-urban and urban lands within the city limits. The Clatsop State Forest segment of the roadway will be two-travel lanes. The US 101 and westernmost segment of the Nehalem Highway would have four lanes with a raised median and selected left-turn refuges.

The six-mile bypass would decrease the travel distance between the two bridges by about one mile. The cost for this proposed bypass is estimated to be $36.2 million in 1993 dollars. This cost includes approximately $5 million for the right-of-way acquisition of 78 acres, of which 57 acres is state-owned forest land. The roadway was expected to affect 130 properties in takings and parking area acquisitions, displacing 35 to 40 residences and six businesses. These takings have been decreased in subsequent alignment design revisions.

The ODOT completed a Draft Environmental Impact Statement (DEIS) in 1993 to assess direct and indirect impacts of the proposed project. Due to uncertain funding for the project, a FEIS has not been completed and the bypass project is currently on hold. This case study will examine how project indirect effects were identified and analyzed in the environmental impact statement process and will also apply to the project the suggested framework for assessing indirect effects. The Astoria Bypass was chosen for analysis as an example of what indirect effects may result from a small city road bypass and how the project was handled in Oregon's progressive land use planning process.

1.2 Purpose and Need

The stated goals of the project are to:

- Reduce the amount of truck traffic in downtown Astoria;
- Reduce the amount of overall traffic congestion in downtown Astoria;
- Improve safety;
- Promote the expeditious and safe movement of vehicle traffic in and out of the Port of Astoria; and
- Provide a second east-west route in and out of Astoria (DEIS, p2-1).

Although the DEIS does not explicitly state that the bypass is intended to increase economic development in the region, it is alluded to in the document. The project supports the city's goals to encourage tourism to diversify the city's traditional economic base of fish processing and lumber-exporting industries. The DEIS acknowledges the city's economic development goals in stating:

> The Columbia River and associated waterfront adjacent to downtown Astoria have tremendous potential for development, both commercially and as an attraction. The existing US 30 now acts as a semi-barrier between the river tourist front and the city core areas. With increasing traffic and the required expansion of existing US 30, the barrier effect would become more pronounced. The Astoria Bypass would divert much of the traffic and congestion from the downtown area, and the existing US 30 segment through the downtown area could revert to the City of Astoria, thus reducing the barrier effect (DEIS, p1-7).

The DEIS also states that:

> This project would improve the efficiency of economic activity in and near the City of Astoria, and would foster orderly economic development in and near the existing and proposed corridors (DEIS, p5-18).

Therefore, while the goal of the project is not to prompt economic development, the project does aim to serve the city's goal for increased economic development vis-a-vis rerouting of through traffic.

1.3 Affected Environment and Alternatives Considered

The affected environment from the proposed bypass will be portions of Clatsop County, the City of Astoria, the largest community in the county, and portions of the Clatsop State Forest. The City of Astoria developed in the early 1800s as a trading post with a thriving fishing industry. With a population of about 10,000 residents, the city is experiencing decline in population. Presently, the city's economy relies largely on fish processing and lumber industries which have declined in recent years. Goods moving through the Port of Astoria have also declined. To diversify the local economy, the city plans to develop its waterfront as a tourist destination. The existing Columbia River Maritime Museum on the Astoria waterfront was developed as part of this plan.

Regionally, Clatsop County is host to tourist-destination cities such as Seaside and Cannon Beach on the Pacific coastline. While tourism is becoming increasingly important in the county, the lumber industry is still a major player in the county's economy as the majority of land in the county is prime coniferous forest land. The bypass will go through the Clatsop State Forest, which is publicly owned and managed by the State Forest Service. The study area is host to diverse wildlife including significant elk, deer and beaver populations and rare birds, such as the state-protected great blue heron and the federally-protected bald eagle.

Two alignments of the Build-Alternative and a No-Build Alternative were considered for this project. The build and

no-build alternatives were evaluated in each area of environmental and economic impact analysis. The impetus for the project was traffic modeling which forecast that average daily traffic downtown would increase to 25,000 vehicles including 1,060 trucks in 2015 from 20,000 vehicles including 900 trucks currently without the bypass.

The DEIS dedicated a section in the report for alternatives considered but not advanced for detailed environmental assessment. In this section, various alignments were quickly analyzed for level of downtown traffic abatement, constructing and right-of-way costs, length, geotechnical feasibility and environmental impact. Many of the alignment alternatives failed to address the basic goal of reducing traffic through the downtown as the alternatives entailed a longer road length than the existing US 30, thereby discouraging use.

2.0 IDENTIFICATION OF INDIRECT EFFECTS

The working definitions for direct versus indirect were defined in the document as:

> Direct impacts are those which occur in, along, or close to the project right-of-way as a result of construction. Typical of these are the acquisition of the land on which the project is built and the displacements within the-right-of-way [DEIS, p 5-6].
>
> Generally, indirect impacts are observed after the project has been completed and continue for years afterward. They are not limited to the immediate vicinity of the project corridor, but occur over considerably wider areas [DEIS, p5-6].

The report also considered cumulative impacts and defined them as:

> [I]mpacts on the environment which result from the incremental impact of an action when added to other past, present and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time [DEIS, p 5-12].

The indirect effects in the DEIS were identified using professional judgement and discussed qualitatively. As the working definition of indirect effects for this project's DEIS does not include the CEQ definitional criteria that the effect be "reasonably foreseeable" or *probable*, the indirect effects identified are discussed in the DEIS as effects that are *possible* without evaluation as to the likelihood for their occurrence. Seven indirect effects were identified in the DEIS. Cumulative effects were also examined and are summarized below with indirect effects.

SOCIOECONOMICS

- *Local Economy.* Indirect. Decreased traffic congestion downtown from the project may increase the attractiveness of land outlined by the Astoria Comprehensive Plan as vacant and suitable for development. Continued stagnation in the local economy may be compounded from diverted traffic as a result of the bypass. Cumulative economic effects from the bypass together with other transportation projects would be to "increase the area's attractiveness for businesses serving the needs of retirees and tourists, and to facilitate shipments of products of resource-based businesses. There are also cumulative effects of the bypass with other projects such as construction of national chain stores in Astoria or Warrenton, construction of a factory outlet mall in Warrenton and other tourism plans. The report makes clear that level of these cumulative effects would depend on the growth in local population, incomes, market demand, price, the availability of vacant buildable land relative to elsewhere in the county and local zoning policy.
- *Population, Community Cohesion and Community Facilities.* Indirect. The build alternative may result in more local development which may generate traffic which may impact sensitive populations, impact communities, safety and community cohesion. Cumulative. Other projects would add to increased traffic that may affect these areas.

LAND USE

- *Land Use.* Indirect. Land values may increase as a result of improved circulation in Astoria, which combined with the lack of developable land in the city due to the prevalence of steep topography, may create pressure to rezone certain areas for higher density zoning. Moreover, since Astoria's city limits extend past its urban growth boundary, an Oregon planning designation which limits urban uses outside of an urban growth boundary, there may be pressure for the city to seek an extension to its urban growth boundary to allow development along the eastern portion of the bypass. The bypass may restrict logging near the roadway as Oregon Forest Practices Act requires scenic buffers adjacent onto highways in forested areas.

  Cumulative. The following items were considered for cumulative impacts to the project.

1. Past and proposed highway projects. Cumulative effect with the proposed project would improve circulation in western Clatsop County.
2. Improvements to the Port of Astoria. Cumulative effect would be to worsen downtown traffic under the no-build alternative. The build alternative would accommodate the expansion.
3. Addition of a resident ship to U.S. Coast Guard headquarters. The cumulative effect would be increased traffic from families that would relocate to Astoria. The build alternative would accommodate the increase in traffic volume.

4. Development of a marine industrial park in Astoria. The increased traffic impacts would be greater under the no-build alternative. The build alternative would accommodate the expansion.
5. Plans to expand sewer and water service. Inducements to growth are expected from the infrastructure expansions. These actions would increase growth whether or not the bypass was built.
6. Aims to incorporate the bypass within the Astoria's urban growth boundary. This may stimulate growth.
7. Plans for city development of the waterfront. The bypass would facilitate this development.

The analysis on cumulative effects, while identifying various relevant projects, did not present a summary assessment of the cumulative effect from all the projects combined with the bypass.

WATER RESOURCES

- *Water Quality.* Indirect. Polluted runoff from vehicles and built land uses is expected to increase. Conversion of forest land to urban uses will also decrease recharge areas, which may bring an increase in flash flooding. Cumulative impacts would include the polluted runoff effects of other transportation projects and increased recreational use of the waterfront.

WETLANDS

- *Wetlands.* Indirect. The project is not expected to permanently alter the hydrology of the adjacent wetlands. Areas where surface water flows may be interrupted will be mitigated using culverts or structures. Cumulative. The study identified other projects with impacts to wetlands including US 30, US 101, South Tongue Industrial Park, improvements to the area's bay bridges, dredge disposal, pier filling and private development project in Warrenton. The 25 acres of wetland impacts from these projects would be significant added to the 13 acres of direct impacts from the bypass project.

TERRESTRIAL ECOLOGY

- *Wildlife.* Indirect. The study area is host to a nesting colony on treetops, or a rookery, for the great blue heron, a state-protected bird and five bald eagle nesting pairs, a federally-protected species. Direct impacts to these birds include visual and noise impacts from human and construction activity that may interrupt nesting activities. Agency comments to the DEIS stated that an indirect effect of the taking of trees surrounding the rookery would be to decrease the windfirmness of the stand and increase incidences of nest blowdowns from the treetops. Cumulative. The cumulative impact from the change in hydrology and riparian vegetation identified in the document would be the degradation of wildlife habitat.

OTHER

- *Cultural Resources.* Indirect and Cumulative were discussed together for impacts to historic resources. The bypass project, which includes the widening of US 101 adjacent to some historic properties, may result in "some loss of historic integrity." For an historic motel, the road widening will reduce the motel setback and could decrease the attractiveness of the motel, making it less economically viable. Potential development pressures may also cause future displacement of historic properties. The positive non-direct effects to historic structures in areas not adjacent to the bypass is that the reduced traffic will increase the historic qualities of these areas.

Overall, the project indirect effects were identified using professional judgement to scope causal relationships from the project and cumulative effect as a result of the project when combined with other projects. Spatial boundaries for their effects were detailed in the socioeconomic disciplines where vacant land, zoning, an urban growth boundary, the nature of existing businesses indicate where vitality may increase or decrease. The spatial boundaries for water quality impacts were difficult to define yet the source of the impacts were specifically defined as along the proposed roadways and from the potential induced development sites. The temporal boundaries for the identified indirect effects were not discussed.

3.0 FRAMEWORK APPLIED TO THE PROJECT

Step 1. Identify Study Area's Needs and Goals

Local plans must conform to 19 statewide planning goals, such as the preservation of natural resources, open space and forest land for forest uses. The comprehensive plans for the City of Astoria and Clatsop County are "acknowledged" by the state planning agency and are the controlling document for land use in the area.

The review of plans and interviews with local planners brought to light the city's goal to encourage tourism. To diversify its declining economic base, Astoria developed a waterfront development plan to encourage tourism activity. Downtown traffic congestion is seen as a detriment to tourism and a risk to safety. Decreasing this congestion is a major goal of Astoria. Major goals for the county include the protection of forest land for forest uses, as well as natural

resources such as habitats for state and federally-protected wildlife.

As part of this step, these goals can be listed in a comprehensive goals checklist, such as Table E-2. The exercise of completing the checklist can help in framing issues relevant to the area and may offer insight to defining the study area boundaries.

Product: Completion of Goals checklist, such as Tables E-1 and E-2.

Step 2. Inventory Notable Features

This step entails identifying environments that are key to the goal and needs of the study area that may be at risk from the project. Referring to Table E-3, notable features of the area include ecosystem and socioeconomic characteristics. The following features were identified from field visits, published statistics, interviews, and comprehensive plans.

TABLE E-1
ORGANIZATION AND TABULATION OF GOALS CHART
(Check where applicable)

Project Name: *Astoria Bypass* Location: *Astoria, OR* Analyst: *A. Cheng* Date: *3/1/96*

		Notes
	Social Health and Well-Being Goals	
√	Achieve adequate, appropriate and accessible open space and recreation	
___	Comply with state and federal water and air quality laws	
√	Preserve or create multicultural diversity	
√	Preserve heritage	
√	Provide choice of affordable residential locations	
___	Provide urban environment for those with special needs	
___	Promote land use patterns with sense of community	
___	Provide a range of services accessible to all	
___	Promote a healthy and safe environment	
___	Provide sound management of solid and hazardous waste	
___	Other _____	
	Economic Opportunity Goals	
√	Support activities to meet changing economic conditions	
√	Provide energy-efficient transportation	
___	Provide developments with transit-supported capabilities	
√	Target economic export activities	
___	Attract and maintain workforce	
√	Promote infill of smaller, passed-over sites	
√	Encourage redevelopment of older areas for new purposes	
___	Other _____	
	Ecosystem Protection Goals	
√	Protect ecosystems	
√	Minimize fragmentation	
___	Promote native species	
√	Protect rare and keystone species	
√	Protect sensitive environments	
√	Maintain natural processes	
√	Maintain natural structural diversity	
√	Protect genetic diversity	
___	Restore modified ecosystems	
___	Other _____	

Reviewed by:

Name	Affiliation	Date

TABLE E-2
STUDY AREA DIRECTIONS AND GOALS CHECKLIST
(Check where applicable)

Project Name: *Astoria Bypass* Location: *Astoria, OR* Analyst: *A. Cheng* Date: *3/1/96*

1. **Generalized Setting**

Within Metropolitan Statistical Area (Identify MSA)	____
Outside of MSA	____
Both Inside and Outside MSA	√

Indicate Distance to Nearest Metropolitan Center ____

2. **Characteristics of Transportation System** (Note: These items are not intended to cover entire transportation need but rather to use information from more detailed assessments to provide a preliminary indication of existing accessibility, service and modal interrelationship characteristics, i.e., factors relevant to subsequent indirect effects analysis).

- Identify missing links in transportation system ____.
- Map and describe existing level of service on minor and principal arterials and their access characteristics.
- Indicate distance to nearest interstate highway if not in study area.
- Map and describe existing transit routes and demand.
- Map and describe major concentrations of existing and planned development.
- Describe modal interrelationships including competing and complementary characteristics.

3.

Population	Trend	Projection
Declining	____	____
Static (±1%/10 years)	√	√
Slow Growth	____	____
Rapid Growth (>10%/10 years)	____	____

Employment	Trend	Projection
Declining	√	____
Static (±1%/10 years)	____	√
Slow Growth	____	____
Rapid Growth (>10%/10 years)	____	____

4. **Planning Context**

	Yes	No	If yes, identify by title, agency and date
Zoning	√	____	*Local ordinance*
State Master Plan	√	____	*Oregon Statewide Planning Goals 1995*
County/Regional Master Plan	√	____	*Clatsop County Comprehensive Goals 1994*
Municipal Master Plan	√	____	*Astoria Comprehensive Plan 1992*
Growth Management Plan	____	√	
Water Quality Management Plan	____	√	
Other Natural Resources Management Plan	____	√	

5. **For each plan identified in No. 3, summarize key goals, elements and linkages to other plans (specify, in particular, elements related to economic development, land use development, the transportation system, and natural resource protection).** *Protect natural resources, forest land and wildlife habitats. Encourage tourism-oriented development in Astoria.*

6. **Describe any efforts to elicit local needs and goals from residents and/or agencies (source and result).** *Interviewed local planners and inspected local planning documents.*

7. **Describe known plans for major new or expanded activity centers including public facilities.** *Astoria plans to redevelop waterfront sections for tourism-oriented activity.*

Is the activity center dependent on transportation system improvement? Yes √ No ____

8. **Is the transportation need linked to economic growth and land development?** Yes ____ No √

If yes, is the nature of the linkage to:

Serve the needs of planned growth ____ or
Channelize growth ____ or
Stimulate growth ____ or

9. **Based on information obtained, are there any apparent conflicts between transportation and other needs that could result in controversy? (Describe).**

Yes ____ Possible √ No ____

Reviewed by:

Name	Affiliation	Date

TABLE E-3
NOTABLE FEATURES CHECKLIST
(Check where applicable)

Project Name: *Astoria Bypass* Location: *Astoria, OR* Analyst: *A. Cheng* Date: *3/1/96*

Ecosystem Features	Specify
√ Regional habitats of concern/critical areas	
√ Rare, threatened or endangered species and associated habitat	
√ Species requiring high survival rates	
√ Species whose intrinsic rates of increase fluctuate greatly	
___ Communities with vulnerable keystone predators or materialists	
___ Other _____	
Socioeconomic Features	
___ Substandard amounts of open space and recreation	
___ Non-compliance with state and federal environmental laws	
___ High concentration of uncontrolled solid and hazardous waste sites	
___ Inadequate affordable housing	
___ Inadequate access to amenities	
√ Economically distressed areas	
___ Lack of institutional land use controls	
√ High proportion of population consisting of:	
___ Minorities	
√ Low-income residents	
√ Elderly	
___ Young	
___ Disabled	
___ Low proportion of long-term residents	
___ Locations of poor traffic flow	
___ Other _____	

Reviewed by: Name Affiliation Date

- *Ecosystem Features.* The study area is rich in natural resources, wildlife diversity and scenic vistas. The City of Astoria, which is partly built on steep cliffs, overlooks Youngs Bay and the Columbia River. The Clatsop State Forest, outside the City of Astoria, is a productive forest with prime woods. The area is also home to large mammals, such as deer and elk populations, as well as rare and protected birds, such as the bald eagle and the great blue heron. There are five nesting pairs of bald eagles in the project vicinity and a 29-acre mature stand which holds the great blue heron rookery. The DEIS states that only one of the bald eagle pairs forage near the project area. The bald eagle is a federal threatened and endangered species. Although the great blue heron is not federally-protected as a threatened and endangered species, they receive special status classification by the Oregon Department of Fish and Wildlife. The rookeries are also given special consideration from the Oregon Department of Forestry.
- *Socioeconomic Features.* Astoria, the largest city in Clatsop County, developed as a shipping point for the area's natural resources, primarily lumber and fish. The contraction of these regional core industries has suppressed growth in the city and there are vacant sites, zoned industrial, on the waterfront open for redevelopment. Population has remained static at about 10,000 persons. Much of the county's affordable housing is in Astoria.

The aim of this step is to inventory notable features of the study area, such as features that are unique or at risk or vulnerable. Two notable features of this study area are the diversity of the natural environment and the weakness in the local economy.

Product: List of notable features for the indirect effects assessment, with an accompanying map illustrating the location and the extent of the feature, where appropriate. Completion of Tables E-3 and E-4.

Step 3. Identify Impact-Causing Activities of the Proposed Actions and Alternatives

The purpose of the bypass is to relieve existing and projected traffic congestion by diverting non-destination traffic away from downtown Astoria. A potential effect of this diverted traffic is the possible decline in economic activity, perhaps temporary, for local businesses dependent on through traffic. This includes businesses which serve non-local customers such as lodging establishments, gas stations, restaurants, antique stores and gift shops.

Table E-5 can be used to detail the impact-causing activities as a result of the project. Impact-causing activities from the project include the acquisition of 78 acres of right-of-way which include 57 acres of forest land, construction operations and maintenance operations.

Product: A comprehensive list of the impact-causing actions of the proposed plan or project and alternatives, in as much detail as possible. Table E-5 is an example.

TABLE E-4
NOTABLE FEATURES ADDRESSED BY FEDERAL STATUTES
(Check where applicable)

Project Name: *Astoria Bypass* Location: *Astoria, OR* Analyst: *A. Cheng* Date: *3/1/96*

Resource Type or Area	Statute/Order	Source of Information and Map Locations
√ Section 4(f) Resources ___ Public Parks and Recreational Lands √ Wildlife and Waterfowl Refuges ___ Historic Sites ___ Historic Districts ___ Archaeological Remains √ Historic Structure	Department of Transportation Act	Local Parks or Recreation Officials, State Historic Preservation Office or local historic preservation organizations
___ Coastal Zone	Coastal Zone Management Act	State Coastal Zone Management Office
___ Waters of the United States	Clean Water Act; E.O. 11990	State Fish and Game Commission; U.S. Fish and Wildlife Service
___ Sole Source Aquifer	Safe Drinking Water Act	State Natural Resources Agency; U.S. Environmental Protection Agency
___ Areas of Known Contamination	Comprehensive Env. Response Compensation Liability Act	State environmental protection agency; U.S. Environmental Protection Agency
___ Floodplains	E.O. 11988	Federal Emergency Management Agency
√ Range or Habitat of Threatened or Endangered Species	Endangered Species Act	State Fish and Game Commission; U.S. Fish and Wildlife Service
___ Wild, Scenic or Recreational River	Wild and Scenic Rivers Act	U.S. National Parks Service
___ Prime or Unique Farmland	Farmland Protection Act	U.S. Soil Conservation Service
___ Sensitive Receptor	Clean Air Act; Noise Control Act	State environmental protection agency
___ Nonattainment or Maintenance Areas	Clean Air Act	State and local air and transportation agencies; metropolitan planning organizations; state implementation plans; conformity determinations of transportation plans, programs and projects.
√ Residential or Commercial Establishments	Uniform Relocation Act; E.O. 12898	Local governments

Reviewed by: Name Affiliation Date

TABLE E-5
PROJECT IMPACT-CAUSING ACTIVITIES CHECKLIST

Project Name: *Astoria Bypass* Location: *Astoria, OR* Analyst: *A. Cheng* Date: *3/1/96*

	Yes	No	If Yes, Describe Generally (Breadth, Duration, Location and Type)
Modification of Regime			
Exotic Flora Introduction		√	
Modification of Habitat	√		
Alteration of Ground Cover	√		
Alteration of Groundwater Hydrology	√		
Alteration of Drainage	√		
River Control and Flow Modification		√	
Channelization		√	
Noise and Vibration	√		
Land Transformation and Construction			
New or Expanded Transportation Facility	√		
Service or Support Sites and Buildings		√	
New or Expanded Service or Frontage Roads		√	
Ancillary Transmission Lines, Pipelines and Corridors		√	
Barriers, Including Fencing	√		
Channel Dredging and Straightening		√	
Channel Revetments		√	
Canals		√	
Bulkheads or Seawalls		√	
Cut and Fill		√	
Resource Extraction			
Surface Excavation	√		
Subsurface Excavation		√	
Dredging		√	
Processing			
Product Storage		√	
Land Alteration			
Erosion Control and Terracing	√		
Mine Sealing and Waste Control		√	
Landscaping	√		
Wetland or Open Water Fill and Drainage		√	
Harbor Dredging		√	

Resource Renewal			
Reforestation		√	
Groundwater Recharge	√		
Waste Recycling		√	
Site Remediation		√	
Changes in Traffic (including adjoining facilities)			
Railroad		√	
Transit (Bus)		√	
Transit (Fixed Guideway)		√	
Automobile	√		
Trucking	√		
Aircraft		√	
River and Canal Traffic		√	
Pleasure Boating		√	
Communication		√	
Operational or Service Charge		√	
Waste Emplacement and Treatment			
Landfill		√	
Emplacement of Spoil and Overburden	√		
Underground Storage		√	
Sanitary Waste Discharge		√	
Septic Tanks		√	
Stack and Exhaust Emission	√		
Chemical Treatment			
Fertilization	√		
Chemical Deicing	√		
Chemical Soil Stabilization	√		
Weed Control		√	
Pest Control		√	
Access Alteration			
New or Expanded Access to Activity Center	√		
New or Expanded Access to Undeveloped Land		√	
Alter Travel Circulation Patterns	√		
Alter Travel Times between Major Trip Productions and Attractions	√		
Alter Travel Costs between Major Trip Productions and Attractions	√		
Others			
_____			
_____			
_____			

	Name	Affiliation	Date
Reviewed by:			

Step 4. Identify Indirect Effects for Analysis

The objective of this step is to compare the list of project impact-causing actions with the lists of goals and notable features to explore possible cause-effect relationships and establish issues of concern for subsequent analysis. The methods that may be applicable for identifying indirect effects as a result of the proposed project can include a mix of the following techniques—presentational matrix, networks or system diagrams, cartographic techniques, qualitative inference or comparative case study analysis. Cartographic techniques may also be used for visualizing potential indirect effects to wildlife habitats as a result of alterations to the physical environment. A comparative case study of other cities in Clatsop County previously bypassed by a new road, such as Cannon Beach, can shed light on key potential indirect effects.

Indirect effects ferreted from the above techniques should fulfill the following criteria before they are warranted for analysis. Case law suggests three considerations for the analysis of indirect effects: 1) they must be likely to occur, or probable; 2) knowledge exists to analyze the impact; and, 3) there must be a need-to-know impetus for the impact. Two indirect effects fulfill those criteria, the possible impacts to the great blue heron rookery and a bald eagle nest and the potential economic diversion impact to through-traffic businesses as a result from the bypass.

Concerning impacts to the bald eagles, the DEIS states that no nests or foraging area would be taken as a result of the project. Moreover, noise and construction from the project were not expected to impact the pair foraging near the study area. The report states:

> The Williamsburg pair is currently subjected to considerable noise and visual disturbance at the nest, so this pair is probably acclimated to levels of disturbance greater than most other pairs. As a result, it is unlikely that this pair would be disturbed at their foraging area by general construction activities occurring a mile away (DEIS, p 5-98).

The DEIS did not consider this potential foraging impact to be an indirect effect. ODOT proposed a four-step conservation program, which has been approved by the USFWS, that includes re-examination of nesting sites prior to construction and limits on construction and blasting during nesting periods.

The issues addressed in the DEIS in relation to the great blue heron rookery include the reduction of the 29-acre stand, which surround a two-acre nesting area, to 13 acres, possible noise and visual disturbance impact. The Oregon Fish and Wildlife Department expressed concern the windfirmness of the stand would be impacted, which would result in an increase in nest blowdowns. The taking of trees from the stand would also decrease buffer to noise. In response, ODOT has modified the alignment in the Williamsport area to minimize taking of the stand. This shift in alignment mitigation has been accepted by the Oregon Fish and Wildlife Department.

Given the resolution of these indirect effects issues, the remaining efforts of this case study will focus on indirect economic effects as a result of the bypass. This effect was addressed in the DEIS:

> [L]ower traffic volumes in downtown Astoria could contribute to fewer customers and economic difficulties for businesses highly dependent on through traffic, more empty storefronts, lower assessed values, and decreased property tax revenues. Conversely, less congestion in downtown Astoria could contribute to increased desirability for businesses in downtown Astoria, which in turn could contribute to fewer empty storefronts, higher assessed valuations, and increase property tax revenues. Additionally, property taxes associated with new development or redevelopment in the project area would help offset losses in tax revenues that would result from acquisition of right-of-way or reduced business activity in downtown Astoria (DEIS, p5-47)

The report acknowledges that:

> Successful efforts to revitalize Astoria's economy would contribute positive effects for bypassed businesses. Conversely, continued stagnation in the local economy would compound potentially adverse effects associated with the build alternative (DEIS, p5-56).

The critical indirect effects research questions are: Under what scenarios will the bypass result in diverted economic activity for Astoria? What can be learned from bypasses in other areas of Clatsop County? What mitigation, if any, can be applied to the project?

Other questions relating to indirect effects are:

- *Induced Growth Effects.* Under what scenarios will the bypass induce growth along the road alignment and in Astoria? How likely are these scenarios?

Product: Completion of Tables E-6 and E-7. A technical memorandum that lists the indirect effects that warrant further analysis and presents the scope of analysis to be conducted in Step 5.

Step 5. Analyze Indirect Effects

This suggested framework emphasizes targeting those effects that have a degree of certainty to their occurrence, a specificity to the extent of the occurrence and a need-to-know impetus. For this case study application of the framework, we will address one indirect effect.

Two key questions need to be answered about concerning the potential for an indirect economic diversion effect. First, under what scenarios will this effect materialize? Second, what is the expected size of this effect? The authors of the DEIS suggested scenarios for this diversion. Continued eco-

TABLE E-6
CHECKLIST FOR ASSESSING STUDY AREA'S POTENTIAL FOR INDUCED GROWTH

Project Name: *Astoria Bypass* Location: *Astoria, OR* Analyst: *A. Cheng* Date: *3/1/96*

Regional Study Area Conditions

[A yes answer indicates that conditions generally favor growth; the more yes answers, the higher the certainty that regional conditions generally favor growth.]

1. Is the regional population increasing rapidly (generally, >5% per 10 years)? *N*
2. Is the region considered favorable for receiving FHA/VA loans? *DK*
3. Are there any major growth generators (e.g., universities, military installations, industries, tourist attractions) in the region? *Y*
4. Is the regional office/commercial market characterized by low (generally, <10%) vacancy rates in any class of space? *DK*
5. Is the region's business and civic leadership committed to rapid development? *N*
6. Is the region an exporter of natural resources? *Y*

Local Study Area Conditions

[If it is concluded that regional conditions generally favor growth, then proceed with the next series of questions. A yes answer indicates that the area in the immediate project vicinity has land use conversion potential; the more yes answers, the higher the certainty that land use conversion will be induced by the project to its immediate vicinity.]

General indicators

7. Is the regional path of development in the direction of the local study area? *N*
8. Is the project within 5 miles of a growing community (generally, >5% per 10 years)? *N*
9. Is the local study area characterized by middle and/or high income levels? *N*
10. Is the local study area free of moratoriums on development (e.g., sewer moratoriums, growth restrictions)? *Y*

Indicators of conditions favorable to conversion to lower density development

11. Is the local study area within a 30-minute drive of a major employment center? *N*
12. Does the local study area have relatively high land availability/low land prices (generally <one-third of larger parcels developed)? *DK*
13. Is the vacant land characterized by relatively large parcels? *Y*
14. Is the local study area characterized predominantly by level land (generally, <5% slope)? *N*
15. Is the project's Potential Impact Area characterized by soils suitable for development? *N*
16. Is the project's Potential Impact Area predominantly free of flooding or wetlands? *Y*

Indicators of conditions favorable to conversion to higher density development

17. Does the local study area have relatively low land availability/high land prices (generally >two-thirds of larger parcels developed)? *DK*
18. Is the local study area served by existing principal arterials and water/sewer systems? *Y*
19. Is the local study area covered by relatively few governmental jurisdictions? *Y*
20. Is the local study area characterized by poorly enforced zoning regulations? *DK*
21. Does the local study area lack recent (generally, <10 years old) master plans? *N*

Reviewed by: Name Affiliation Date

TABLE E-7
EVALUATION MATRIX FOR PROJECT INDIRECT EFFECTS OF CONCERN

Project Name: *Astoria Bypass* Location: *Astoria, OR* Analyst: *A. Cheng* Date: *3/1/96*

Indirect Effect Type	Direct Effects from Impact-Causing Activities	Indirect Effects from Direct Effects (List)	Potential Manifestation of Indirect Effects (List)	Link between Indirect Effect and Goal or Notable Feature that Meets Assessment Criteria[1]	
				Yes (Go to Step 5)	No (Assessment Complete)
Encroachment-Alteration	Ecosystem-related			√	
	Socioeconomic-related			√	
Induced Growth (Access-Alteration)		Serves specific development			√
		Stimulates complementary development			√
		Influences location decisions			√
Effects Related to Induced Growth			Ecosystem-related		√
			Socioeconomic-related		√

[1] Assessment criteria = (1) Confidence that the effect is likely to occur; (2) Know enough about indirect effect to make consideration useful; and (3) Need to know about the impact now.

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nomic decline, under a build alternative, would preclude growth inducement as an indirect effect of the project. The bypass would also compound the economic decline.

Other bypass projects in the state, such as the Cannon Beach bypass in Clatsop County on the Oregon Coast, should be examined to lend mitigation techniques to this project. Under a growth scenario and successful development of Astoria as a tourist destination, the economic effects may differ in the short term versus the long term. The short term effects of decline in sales for businesses servicing non-local as well as local clients may be over-ridden in the long-term by growth in tourism-related spending, supported by the congestion-reducing impacts of the bypass.

Transportation planning and modeling tools may be useful in defining the size of the impact in the short term. Origin and destination surveys of travelers through downtown can gauge the level of through traffic that will be averted as a result of the bypass. Tourism research in the area may also lend light to these effects. The DEIS points to a survey of businesses in three coastal regions which suggested that 16-25 percent of all total sales were from non-local clients (DEIS, p5-54). The degree to which project area businesses depend on non-local versus local customers was not assessed in the DEIS. If the survey figures of 16-25 percent were applied to Astoria, the indirect impact of diverted economic activity could be a significant impact of the project.

Product: A technical memorandum that describes the indirect effects, the chosen analysis methods, and the analysis results.

Step 6. Evaluate Analysis Results

The objective of this step is to present the completed analysis to policy makers and the public for comment and consideration. Sensitivity analysis and risk analysis may be useful in evaluating the importance and the certainty of the identified indirect effects. In conducting a sensitivity analysis, the relevant questions are: How likely are the situations which may divert through-traffic economic activity from the area? How realistic are the underlying assumptions? What is the estimated extent of the effect?

The analysis should distinguish what are short-term effects versus long-term effects. Mitigation for this negative economic impact may include signage at the fork by the John Day Bridge for US 30 and the bypass to indicate amenities in Astoria for gas, food and sites of interest.

Product: Technical memorandum combining steps 1 through 5.

Step 7: Develop Mitigation

The objective of this step is to develop strategies to minimize or avoid unacceptable indirect effects. If this indirect effect is considered by policy makers and the business community to be significant and worthy of mitigation, officials may want to propose improved signage at the John Day Bridge intersection with the new road to direct travelers needing food, gas, and/or lodging to Astoria.

Product: Develop mitigation for reducing through-traffic business.

4.0 CONCLUSION

The common chain of causality linking growth inducement to road projects did not apply to this project because of three factors. First, the nature of land being accessed is critical in assessing growth inducement. Second, the existing lack of economic and population growth in the area is also an indicator that land inducement may be unlikely. If economic development efforts succeed, it is more likely that land inducement will occur in serviced land within Astoria before there is pressure for it to occur outside the urban growth boundary. Third, access from the bypass is an important variable. Access points from the bypass would be tightly controlled in this project, largely eliminating the potential for growth inducement.

The definition of indirect effects is critical to their identification. As the indirect effects were not defined as needing to be "reasonably foreseeable" or probable, identified indirect effects were discussed in terms of being possible events. Their probability of occurrence was not discussed in the DEIS. Adhering to the CEQ definition to include the "reasonably foreseeable" criteria may limit the scope of effects that require attention. This limit in effects may provide more resources for the evaluation of effects that are indeed probable and have a need-to-know consequence associated with them.

5.0 REFERENCES

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Biological Resources Technical Report, John Day River Bridge-New Youngs Bay Bridge (Astoria Bypass) Lower Columbia River Highway, Clatsop County, Robin Leighty, September 1993.

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Socioeconomic Report, John Day River Bridge-New Youngs Bay Bridge (Astoria Bypass) Lower Columbia River Highway, Clatsop County, September 1992.

Wetland Report, John Day River Bridge-New Youngs Bay Bridge (Astoria Bypass) Lower Columbia River Highway, Clatsop County, Beak Consultants, February 1993.

E-3 CASE STUDY REPORT: TASMAN CORRIDOR (CA) LIGHT-RAIL TRANSIT

1.0 PROJECT DESCRIPTION

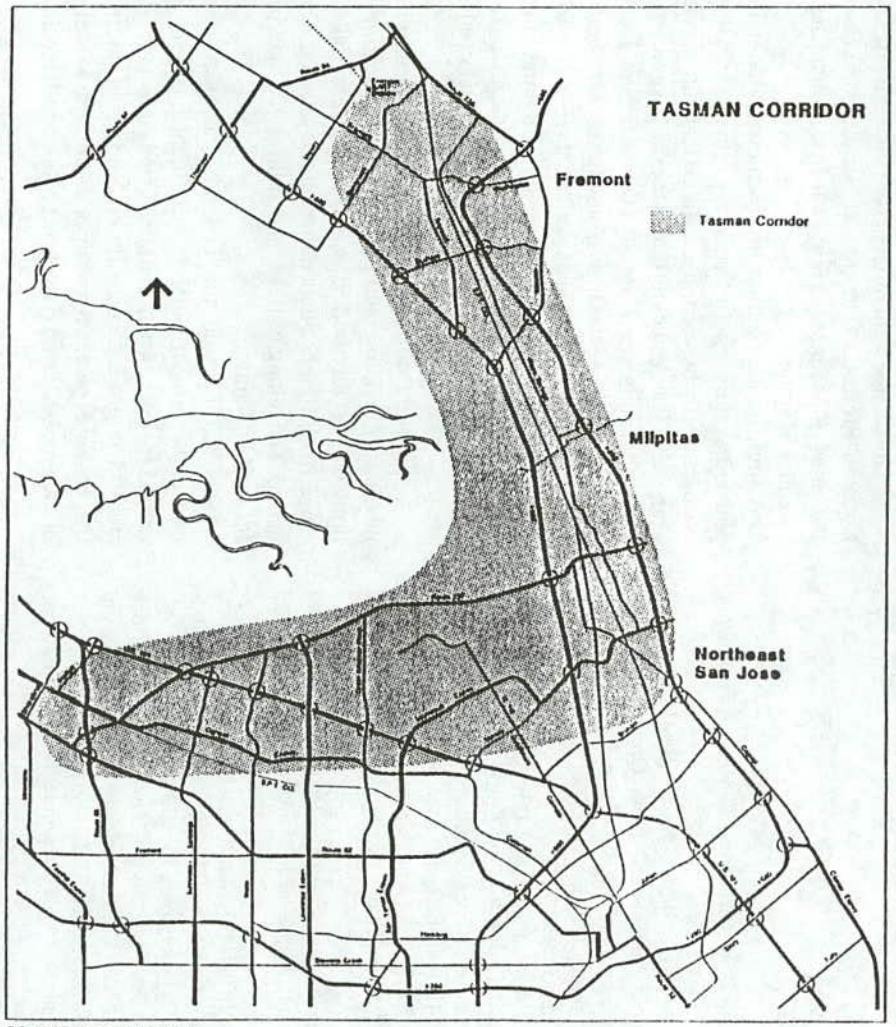
1.1 Introduction

The Tasman Corridor Light Rail Project stems from concerns over rising traffic congestion in Silicon Valley, California along the Tasman Corridor, which extends from residential areas in southern Alameda County to employment areas in Santa Clara County (see Figure E-2). Traffic congestion was at nearly 15,000 hours in 1985 on Santa Clara County freeways. The county conducted an alternatives analysis to examine traffic mitigation under various congestion management scenarios from a no-build alternative to various build alternatives which include improved bus service, construction of additional high-occupancy vehicle (HOV) lanes and expansion to an existing light rail system. The light rail expansion was selected as the preferred alternative. The Santa Clara County Transit Agency (SCCTA) proposed a 13-mile east-west extension of the existing north-south Guadalupe light rail line (see Figure E-3). The Tasman Corridor Project, as the project is called, traverses through the cities of Mountain View, San Jose, Santa Clara, Sunnyvale and Milpitas.

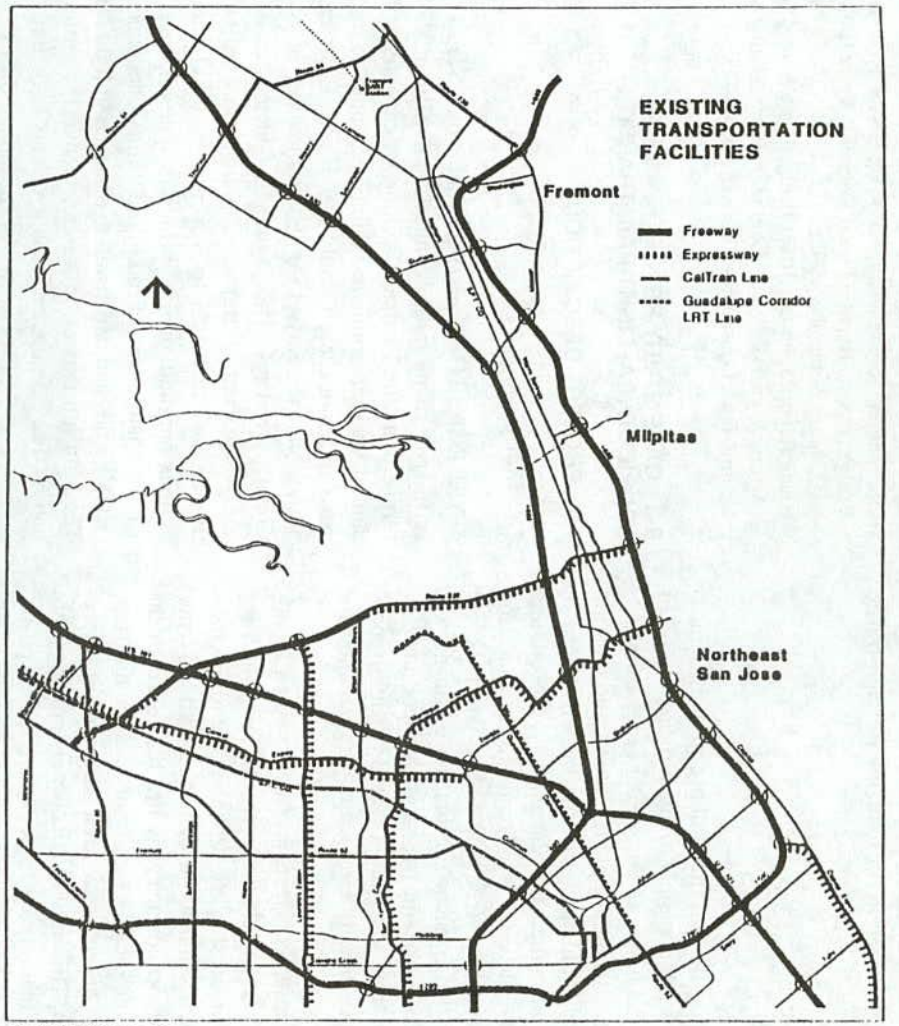
A multi-modal station in downtown Mountain View is planned as the western terminus for the light rail, providing connection to buses and existing CalTrain service to San Francisco. The eastern terminus for the Tasman light rail line was to terminate at Central Avenue in San Jose just past I-680. Eighteen new stations, mostly at grade, were proposed between the two termini as well as three park and ride lots. Planned station sites are at employment areas such as Middlefield Industrial Park, NASA Ames Research Center, Moffett Field Naval Air Station, and the Lockheed industrial area.

As the light rail line is designed for operation from the medians of existing and planned roadways, minor dislocations will be required. Business and residential dislocation range from 10 to 21 depending on the selected design alternative. The taking of trees on certain streets will be required for road widening.

The SCCTA and the Federal Transit Administration, issued the project Final Environmental Impact Statement (FEIS) in 1992, which will be reviewed as part of this case study. The project, currently on hold given uncertain funding, is now expected to incorporate only the western segment of the proposal from downtown Mountain View to the exist-



SOURCE: DKS Associates



SOURCE: DKS Associates

Figure E-2. Tasman Corridor (left) and existing Transportation facilities.

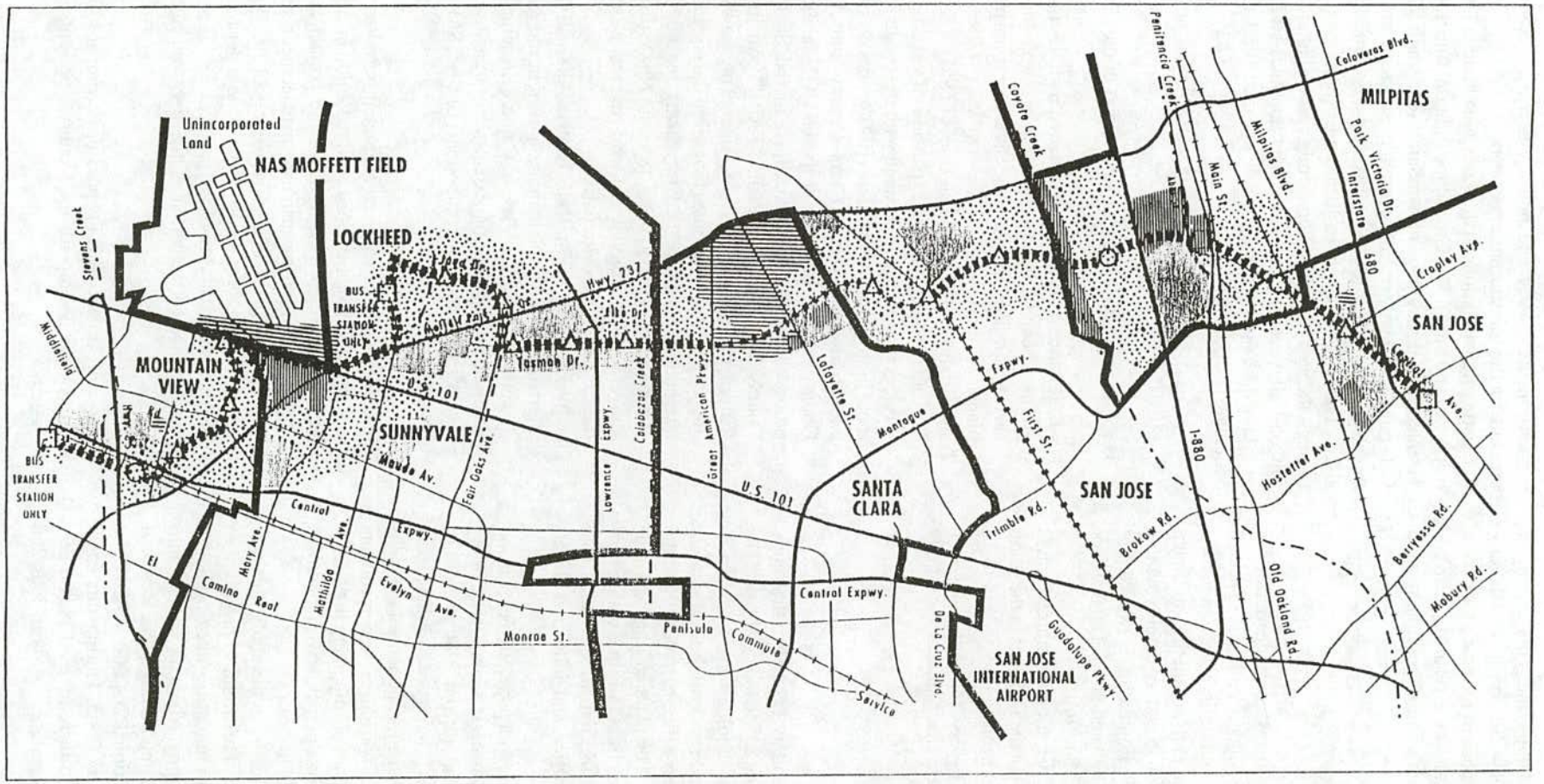


Figure E-3. Existing Zoning Designations.

ing western terminus of the Guadalupe line. This alignment would traverse only Mountain View, Sunnyvale and the city of Santa Clara. This project was chosen for case study for a close look at how indirect impacts as a result of a fixed-guideway transit project on a suburban environment were identified and evaluated.

1.2 Purpose and Need

The Tasman Corridor, home of many computer and semiconductor industries in the area's Silicon Valley, is expected to have increased commuter automobile congestion as a result of increased employment and population in Santa Clara County. A 33 percent growth in county employment is expected between 1990 and 2010. Population is expected to increase eight percent between 1990 and 2000. The need for the project is explained in the FEIS as follows:

Caltrans has estimated that to serve unconstrained travel demands in the year 2005, several of the facilities in the study area (I-880 and U.S. 101) would need to be widened to 14 lanes. . . . Providing improved public transit is needed to ensure that a transportation system that balances the supply and demand is provided [FEIS, p1-1].

1.3 Affected Environment

The study area corridor is bound by US 101 to the south, I-880 and 680 to the east and Route 237 to the northwest. The "Golden Triangle," as this high-technology area is known, is experiencing growth in office and residential development. Tasman Drive is the site of various office complexes and the Santa Clara Convention Center. The planned light rail connects with the existing Guadalupe light rail line, which runs primarily north-south along North First Street, which also has a strong concentration of office and industrial development.

The study corridor experienced rapid population expansion led by growth in the high-tech industries. Santa Clara County has grown 15.6 percent in population from 1980 to 1990 to approximately 1.5 million persons. The city of Milpitas, at the eastern end of the proposed alignment, experienced the highest population growth in the study corridor at 36 percent during this same period. The intensity of development in the Tasman Corridor is relatively suburban in nature with land uses primarily dispersed and limited in height.

Jobs currently outnumber residents in the study corridor, as well as in the county overall. This trend is projected to continue, resulting in higher commutation rates primarily from residential areas in adjoining Alameda County into Santa Clara County and the Tasman study area. Regional projections forecast that an additional 264,000 jobs will be added to the county economy by 2005. During this same period, local labor is expected to increase by 135,000 persons, maintaining the current imbalance between jobs and workers in the county and putting increasing commuting pressure on the transportation network.

Existing transit options in the study area include light rail, heavy rail and buses. The Guadalupe light rail line runs from Tasman Drive through downtown San Jose to south San Jose. CalTrains, the heavy rail line, provides service from downtown Mountain View to Palo Alto and downtown San Francisco. The SCCTA operates local and express bus service through the study corridor connecting residential areas with Silicon Valley employment areas, the Fremont BART station in Alameda County, the light rail line and the CalTrains Mountain View Station.

1.4 Alternatives Considered

Three alternatives were evaluated as part of the FEIS:

No-Build Alternative. This alternative includes only programmed capital improvements in highway and transit services, reflecting agencies' five-year transportation plans.

Transportation Systems Management (TSM) Alternative. This alternative includes expansion of existing transit services to meet future demand with the construction of more high-occupancy vehicle (HOV) lanes on freeways and highways in Santa Clara County and Alameda County, express buses on proposed HOV facilities and proposed improvements outlined in the Santa Clara County Transportation Plan, "T2010". An important feature of this alternative is increasing service frequency on 19 transit routes that serve the corridor. This alternative would include increasing the bus fleet to 495, an increase of 30 buses from the No-Action Alternative. Three additional park-and-ride lots were examined as part of this alternative.

Locally-Preferred Light Rail Transit Alternative. This alternative is the implementation of light rail east from downtown Mountain View to Capital/Hostetter in East San Jose and includes the expansion of transit service to meet demand and the components of the TSM alternative discussed above.

The above alternatives were evaluated based on capital cost, operation and maintenance cost, reduction in congested vehicle-miles traveled as a result of the project, average-weighted minutes for the transit trip, displacements required, resultant noise impacts, cost-effectiveness of the system as defined as the incremental cost of the system per new rider, and the financial feasibility of the project.

The rationales for selection of the light rail alternative include:

Light rail transit (LRT) provides compatibility and increased ridership for the County's present light rail system.

The light rail alternative would provide higher transit ridership than any of the other alternatives studied.
The light rail alternative is only somewhat more costly to operate and maintain than the No-Build and TSM alternatives.
The light rail provides the greatest amount of congestion relief in the corridor.
The light rail alternatives provide the greatest transit travel times savings of any of the alternatives studied. [FEIS p 2-10]

The significant direct impacts as a result of the build alternative after mitigation are identified as:

- preclusion of commuter vehicular lanes in the median for a segment of roadway design;
- aesthetic impacts from the removal of trees along segments of Tasman Drive;
- conversion of 23.5 acres of farmland to transit use; and,
- impacts two properties eligible for National Historic Register designation.

2.0 IDENTIFICATION OF INDIRECT EFFECTS

With the exception of employment effects, the indirect effects were identified using professional judgement and were discussed qualitatively. Five indirect effects were identified:

SOCIOECONOMICS

- *Employment.* The construction and operations of the light rail system are expected to generate direct and indirect increases in employment. Using economic base theory, an economic multiplier effect was applied to the project to obtain direct and indirect employment increases from the three alternatives. The highest level of generated direct and indirect employment was for the light rail alternative.
- *Community/Neighborhood Cohesion.* Indirect community impacts were identified as noise and traffic impacts from vehicles traveling to the light rail stations with park and ride facilities. No direct or indirect impacts on neighborhood cohesion were identified by the report.

LAND USE

- *Land Use.* Based on experience with the existing Guadalupe light rail line, the project sponsors do not anticipate extensive growth as a result of the proposed project, but expect to see higher-density development along the project alignment. In effect, they anticipate a redistribution of growth within the area rather than a net increase in development. In accordance to the California Environmental Quality Act, this impact was discussed in a separate section entitled "Growth-Inducing Impacts."
- *Aesthetic/Visual Quality.* Increasing urbanization as a result of the project may negatively impact the landscape and result in a higher loss of trees.

TERRESTRIAL ECOLOGY

- *Vegetation/Habitat.* Project authors state: "Secondary impacts would occur on the vegetation both during and after project completion. The process of transporting, grading and compacting fill material would have an impact on areas adjacent to the LPA alignment. Heavy equipment would cause soil compaction and disrupt soils beyond the construction area." The term secondary impact is used interchangeably with indirect effect in the FEIS. Both terms are left undefined in the discussion.

The California Environmental Quality Act requires that cumulative impacts of committed, approved and reasonably anticipated projects be addressed with the proposed project. Using professional judgement, municipal and transportation plans were identified together with proposed residential, commercial and office developments. Increased employment, degradation of existing visual resources, adverse water quality and increased energy demand were identified as the cumulative effects of all the projects proposed in the Tasman study area.

3.0 FRAMEWORK APPLIED TO THE PROJECT

Step 1. Identify Study Area's Needs and Goals

Local planners were interviewed and recent local comprehensive plans were examined for goals important to the study area. Given the county's high growth in employment, managing growth, providing housing and reducing traffic congestion are major concerns for Santa Clara County and the study area's cities. Toward these ends, local governments have implemented zoning to encourage compact development and higher-density development along transit corridors. Zoning for a more urban and mixed-use development pattern is hoped to decrease automobile dependency, decrease commute times and enhance the feasibility of transit.

The lack of diverse housing options has been a serious concern in the county, as the problem is linked to traffic congestion as workers unable to find affordable housing live further away, adding burden to the county's roadways. Historically, the availability of housing in the county has not kept up with the rise in employment. The county plan states that the supply, location and affordability of housing in Santa Clara have been three of the county's most intractable problems for over two decades. For example, the average Sunny-

vale resident with an estimated income of $46,700 in 1988 could not afford to buy the average priced single-family detached home for sale ($249,500). The plan encourages the development of more housing units, including rental and affordable units, and the preservation of existing affordable housing.

Air pollution was identified as one of the area's most serious environmental problems. The county's topography between the Santa Cruz and Diablo mountain ranges, prevailing wind pattern and frequent air inversions combine to hold air pollutants from automobiles and stationary sources. While air quality has improved in recent years, further growth and automobile dependency may reverse this trend.

Santa Clara County's vision for the future, if its goals are pursued, include the following physical characteristics:

- Growth Accommodated through Infill Development
- Creation and Revitalization of Urban Centers
- Vitality of Neighborhoods and Communities Enhanced
- A Diverse, High Quality Housing Supply
- More Alternatives to the Automobile
- Hillsides and Other Rural Lands Maintained in Open Space
- Interconnected System of Parks, Trails and Other Public Open Space Lands
- A Cleaner, Healthier Environment

These issues of concern were incorporated in a directions and goals checklist. Visioning sessions may be useful to gather up-to-date needs and goals of the municipalities in relation to the proposed light rail project.

Product: Completion of Goals checklist (Tables E-8 and E-9).

Step 2. Identify Notable Features

Referring to Table E-10, notable features of the area include ecosystem and socioeconomic characteristics. The following features were identified from field visits, interviews with local planners and comprehensive plans.

- *Ecosystem Features.* While the study area is primarily suburban in nature, there are small areas of riparian woodlands, freshwater/brackish channels, orchards and agricultural lands in the study area. These resources are narrow, relatively sparse in vegetation and degraded. The agricultural lands in the project alignment are not under state protection. The developed nature of the area generally precludes habitation by species protected by state and federal law.
- *Socioeconomic Features.* The study area is known for both the lack of affordable and middle-high income housing to accommodate the high employment growth in the region. This is known as a jobs/housing imbalance. A second notable socioeconomic feature of the study area is the presence of four mobile home parks in Sunnyvale along the proposed light rail alignment. Local planners indicate that these mobile home parks are occupied by predominately elderly and low-income tenants.

Product: List of notable features for the indirect effects assessment, with an accompanying map illustrating the location and the extent of the feature, where appropriate. Completion of Tables E-10 and E-11.

Step 3. Identify Impact-Causing Activities of the Proposed Actions and Alternatives

The proposed light rail extension aims to reduce existing and project commuter traffic congestion. A project-impact checklist, such as Table E-12, should be used to detail the impact-causing activities as a result of the project. The FEIS reports that the significant impacts as a result of the project are primarily aesthetic and visual in nature, largely through the taking of trees and some residences for the alignment. The preclusion of commuter lanes in the roadway median without purchase of additional right-of-way was also a significant impact. Other significant impacts include the loss of 23.5 acres of farmland, the loss of two sites eligible for the National Register of Historic Places and the cumulative loss of agricultural land and non-urban views.

Product: A comprehensive list of the impact-causing actions of the project and alternatives, in as much detail as possible. Table E-12 is an example.

Step 4. Identify Indirect Effects for Analysis

The methods applicable for identifying indirect effects as a result of the proposed project include informational matrices, comparative case analysis using the Guadalupe light rail project, and qualitative inference. The chains of causality can be used to identify possible off-site and later-in-time effects from the project. The identified indirect effect discussed below is a result of qualitative inference in interviews with local planners.

Local governments hope that the alignment of the light rail will act as an economic development tool to encourage activity along the alignment. The Middlefield Industrial Park, the birthplace of Silicon Valley, is now dated by current standards for high-tech use. To encourage use in that area, Mountain View rezoned a parcel in the industrial park adjacent to a proposed light rail station for high-density residential development.

In addition to bringing new uses to infill areas, light rail is also seen as a reason for intensifying use. The San Jose General Plan calls for the "intensification" of use along the Guadalupe corridor to encourage pedestrian-oriented villages alongside the light rail line. These corridors are defined as areas within 500 feet from the transit alignment. The Tas-

TABLE E-8
ORGANIZATION AND TABULATION OF GOALS CHART

(Check where applicable)

Project Name: *Tasman Light Rail* Location: *Santa Clara County, CA* Analyst: *A. Cheng* Date: *2/1/96*

	Notes
Social Health and Well-Being Goals	
___ Achieve adequate, appropriate and accessible open space and recreation	
___ Comply with state and federal water and air quality laws	
_√_ Preserve or create multicultural diversity	
___ Preserve heritage	
_√_ Provide choice of affordable residential locations	
___ Provide urban environment for those with special needs	
___ Promote land use patterns with sense of community	
___ Provide a range of services accessible to all	
___ Promote a healthy and safe environment	
___ Provide sound management of solid and hazardous waste	
___ Other _____	
Economic Opportunity Goals	
___ Support activities to meet changing economic conditions	
_√_ Provide energy-efficient transportation	
_√_ Provide developments with transit-supported capabilities	
___ Target economic export activities	
___ Attract and maintain workforce	
_√_ Promote infill of smaller, passed-over sites	
_√_ Encourage redevelopment of older areas for new purposes	
___ Other _____	
Ecosystem Protection Goals	
___ Protect ecosystems	
___ Minimize fragmentation	
___ Promote native species	
___ Protect rare and keystone species	
___ Protect sensitive environments	
___ Maintain natural processes	
___ Maintain natural structural diversity	
___ Protect genetic diversity	
___ Restore modified ecosystems	
___ Other _____	

Reviewed by: Name | Affiliation | Date

man Corridor project may encourage higher zoning along the alignment to develop activity nodes for transit use.

A possible indirect effect requiring analysis based on criteria established in case law (likelihood for occurrence, knowledge exists to analyze effect, need-to-know basis) is the displacement of vulnerable populations. The local goals and needs examined indicate that the proposed project is compatible with all the stated goals except, possibly, the goal to preserve existing affordable housing units. Existing affordable housing may be at risk if higher-density redevelopment is encouraged for areas adjacent to the light rail.

This goal is relevant to this project as the alignment of the Tasman light rail will bypass four mobile home communities along Tasman Drive in Sunnyvale, possibly impacting 15,000 residents. These communities presently serve as affordable housing for primarily elderly residents. Some res-

TABLE E-9
STUDY AREA DIRECTIONS AND GOALS CHECKLIST
(Check where applicable)

Project Name: *Tasman Light Rail* Location: *Santa Clara County, CA* Analyst: *A. Cheng* Date: *2/1/96*

1. **Generalized Setting**

Within Metropolitan Statistical Area (Identify MSA)	√
Outside of MSA	
Both Inside and Outside MSA	

Indicate Distance to Nearest Metropolitan Center ____

2. **Characteristics of Transportation System** (Note: These items are not intended to cover entire transportation need but rather to use information from more detailed assessments to provide a preliminary indication of existing accessibility, service and modal interrelationship characteristics, i.e., factors relevant to subsequent indirect effects analysis).

- Identify missing links in transportation system ____.
- Map and describe existing level of service on minor and principal arterials and their access characteristics.
- Indicate distance to nearest interstate highway if not in study area.
- Map and describe existing transit routes and demand.
- Map and describe major concentrations of existing and planned development.
- Describe modal interrelationships including competing and complementary characteristics.

3.

Population	Trend	Projection
Declining		
Static (±1%/10 years)		
Slow Growth		√
Rapid Growth (>10%/10 years)	√	

Employment	Trend	Projection
Declining		
Static (±1%/10 years)		
Slow Growth		√
Rapid Growth (>10%/10 years)	√	

4. **Planning Context**

	Yes	No	If yes, identify by title, agency and date
Zoning	√		
State Master Plan		√	
County/Regional Master Plan	√		*Santa Clara County General Plan 1994*
Municipal Master Plan	√		*Mt. View, Sunnyvale, Santa Clara, San Jose, Milpitas*
Growth Management Plan		√	
Water Quality Management Plan		√	
Other Natural Resources Management Plan	√		*Air Quality, 1994 Clean Air Plan adopted by Bay Area Air Quality Management District*

5. **For each plan identified in No. 4, summarize key goals, elements and linkages to other plans (specify, in particular, elements related to economic development, land use development, the transportation system, and natural resource protection).** *Mitigate traffic congestion and air pollution, promote alternatives to the automobile, provide housing, preserve and increase affordable housing units.*

6. **Describe any efforts to elicit local needs and goals from residents and/or agencies (source and result).** *Interview with local plans.*

7. **Describe known plans for major new or expanded activity centers including public facilities.** *Approved high-density residential development in Middlefield Industrial Park proximate to a proposed light-rail station.*

Is the activity center dependent on transportation system improvement? Yes ____ No √

8. **Is the transportation need linked to economic growth and land development?** Yes √ No ____

If yes, is the nature of the linkage to:

Serve the needs of planned growth	√	and
Channelize growth	√	or
Stimulate growth		or

9. **Based on information obtained, are there any apparent conflicts between transportation and other needs that could result in controversy? (Describe).**

Yes ____ Possible √ No ____

Reviewed by: Name Affiliation Date

TABLE E-10
NOTABLE FEATURES CHECKLIST
(Check where applicable)
Project Name: *Tasman Light Rail* Location: *Santa Clara County, CA* Analyst: *A. Cheng* Date: *2/1/96*

Ecosystem Features	Specify
___ Regional habitats of concern/critical areas	
___ Rare, threatened or endangered species and associated habitat	
___ Species requiring high survival rates	
___ Species whose intrinsic rates of increase fluctuate greatly	
___ Communities with vulnerable keystone predators or materialists	
___ Other _____	
Socioeconomic Features	
___ Substandard amounts of open space and recreation	
√ Non-compliance with state and federal environmental laws	*Clean Air Act*
___ High concentration of uncontrolled solid and hazardous waste sites	
√ Inadequate affordable housing	
___ Inadequate access to amenities	
___ Economically distressed areas	
___ Lack of institutional land use controls	
√ High proportion of population consisting of:	*Mobile home parks*
___ Minorities	
√ Low-income residents	
√ Elderly	
___ Young	
___ Disabled	
___ Low proportion of long-term residents	
___ Locations of poor traffic flow	
___ Other _____	

Reviewed by: Name Affiliation Date

idents have expressed concern that the light rail system will drive land prices upward such that owners of the mobile home parks will convert the use of the land to higher rent uses. New high-density residential development is occurring on Tasman Drive. One townhouse community has recently been built and a luxury apartment complex is planned.

The possible indirect relocation of these vulnerable communities was not addressed in the FEIS. The impacts on mobile home parks addressed in the FEIS were direct in nature.

Aesthetic impacts from the removal of trees and vibrations concerns were the major concerns on the part of residents.

The critical indirect effect research questions for this project, given the area's needs and goals are: Under what scenarios, if any, will the project prompt redevelopment along Tasman Drive such that existing mobile home communities will be uprooted? How likely is such a scenario? What mitigation/prevention measures can be implemented?

Other questions relating to indirect effects are:

- *Encroachment-Alteration Effects.* Will the conversion of farmland into transit use significantly impact the level of aquifer recharge for the study area?
- *Induced Growth Effects.* Although the FEIS states that the proposed project will not induce growth but, rather, redistribute growth, increasing allowable residential densities on part of municipalities to provide transit nodes will increase resident populations in the study area. Has the Guadalupe light rail line attracted growth to the alignment? If so, what was the zoning where growth occurred? Were the local cities able to accommodate that growth?

Product: Completion of Tables E-13 and E-14. A technical memorandum that lists the indirect effects that warrant further analysis and presents the scope of analysis to be conducted in Task 5.

Step 5. Analyze Indirect Effects

Scenario forecasting is a qualitative method that could be helpful to this project. Local planners, real estate professionals and concerned citizens can be gathered together by the transportation agency for the sole purpose of identifying the situations that would encourage the realization of this above indirect effect.

The key questions to assess the likelihood and the extent of possible indirect relocation effects are:

- *What is the process to convert mobile home parks in the study area?* Sunnyvale has adopted a policy of protecting existing mobile home communities. The city has designated mobile home communities as a distinct land use and adopted ordinances governing their conversion. Moreover, Sunnyvale community planners say that it is

TABLE E-11
NOTABLE FEATURES ADDRESSED BY FEDERAL STATUTES
(Check where applicable)

Project Name: *Tasman Light Rail* Location: *Santa Clara County, CA* Analyst: *A. Cheng* Date: *2/1/96*

Resource Type or Area	Statute/Order	Source of Information and Map Locations
___ Section 4(f) Resources ___ Public Parks and Recreational Lands ___ Wildlife and Waterfowl Refuges ___ Historic Sites ___ Historic Districts ___ Archaeological Remains ___ Historic Structure	Department of Transportation Act	Local Parks or Recreation Officials, State Historic Preservation Office or local historic preservation organizations
___ Coastal Zone	Coastal Zone Management Act	State Coastal Zone Management Office
___ Waters of the United States	Clean Water Act; E.O. 11990	State Fish and Game Commission; U.S. Fish and Wildlife Service
___ Sole Source Aquifer	Safe Drinking Water Act	State Natural Resources Agency; U.S. Environmental Protection Agency
___ Areas of Known Contamination	Comprehensive Env. Response Compensation Liability Act	State environmental protection agency; U.S. Environmental Protection Agency
___ Floodplains	E.O. 11988	Federal Emergency Management Agency
___ Range or Habitat of Threatened or Endangered Species	Endangered Species Act	State Fish and Game Commission; U.S. Fish and Wildlife Service
___ Wild, Scenic or Recreational River	Wild and Scenic Rivers Act	U.S. National Parks Service
___ Prime or Unique Farmland	Farmland Protection Act	U.S. Soil Conservation Service
___ Sensitive Receptor	Clean Air Act; Noise Control Act	State environmental protection agency
√ Nonattainment or Maintenance Areas	Clean Air Act	State and local air and transportation agencies; metropolitan planning organizations; state implementation plans; conformity determinations of transportation plans, programs and projects.
___ Residential or Commercial Establishments	Uniform Relocation Act; E.O. 12898	Local governments

Reviewed by: Name Affiliation Date

highly unlikely that the owners of mobile home parks would seek a conversion in use as the businesses are highly profitable. While there has been one case where a mobile home park has changed ownership, there is no instance of a mobile home park land use conversion in Sunnyvale.

- *What is the likelihood that light rail would increase the value of adjoining land, as to encourage a change of use?* There is no consensus in the academic literature that fixed-rail transit affects the value of proximate real estate. Studies suggest that changes in real estate value as a result of fixed-rail transit depend largely on site specific factors such as the level of noise generated from the facility, the upkeep and designs of neighborhood stations and the scale/usefulness of the transit system.
- *What are other variables that may encourage land use changes to mobile home parks?* As the value of land is linked to market supply and demand, the continued growth in employment and population in the area may place increased price pressure on land.

These questions can be asked in visioning sessions or scenario writing sessions with local planners and concerned residents.

Product: A technical memorandum that describes the indirect effects, the chosen analysis methods, and the analysis results.

Step 6. Evaluate Analysis Results

Given the established scenarios that may trigger the indirect effect, public officials, together with the transportation agency and the concerned public can assess the likelihood for the realization of this indirect effect. In conducting a sensitivity analysis, the relevant questions are: How likely are the situations which may prompt displacement of the mobile home communities? How realistic are the underlying assumptions?

Local planners interviewed for this case study suggest that real estate economics will likely lend more impact to possible conversions of the study area's mobile home communities than the presence of the Tasman light rail. Relevant literature appears to support local planning conclusions. Much of the literature suggest that land value impacts as a result of the project are minimal compared with the existing trends in the real estate market. Sunnyvale's policy on protecting mobile home communities makes a conversion of these uses difficult.

Product: Technical memorandum combining steps 1 through 5.

Step 7. Develop Mitigation

If this indirect effect is considered by policy makers to be significant and worthy of mitigation, local officials may want to implement stronger land use measures to prevent the conversion of mobile home communities providing affordable housing.

Product: Develop process for ensuring that vulnerable populations are not displaced.

4.0 CONCLUSION

4.1 Lessons from the Project

What did we learn from the project on the identification and evaluation of indirect effects?

Indirect effects may be inter-correlated with other forces apart from the proposed project, making their identification problematic. The chain of causality for an indirect relocation effect on sensitive populations requires the following events: construction of new transportation facility -> change in access -> increase in real estate values -> change in land use/density to capture full value of land -> dismantlement of mobile home parks. Common examples of access changes are highway construction and access construction for a limited-access freeway. The change in access as a result of the light rail required for this chain of causality for the effect to materialize is questionable as the system is largely proposed along existing roadway medians. Given the questionable change in access, the change in real estate values is also debatable as high existing growth may overshadow whatever influence a transportation amenity may have on the area. The likelihood of land use conversion is also unlikely given the city's policy on mobile home park preservation. Sunnyvale's tools to implement that policy make it apparent that mobile home conversion as an indirect effect of the Tasman light rail project was not reasonably foreseeable.

The analysis techniques employed in the project environmental assessment process were primarily qualitative in nature. The exception to this is the analysis of economic impacts. The use of economic base theory and the application of an economic base multiplier to direct project spending into estimating the direct and indirect number of jobs that would be generated as a result of the three alternatives examined. The spatial and temporal boundaries for the indirect effects identified were not detailed in the FEIS. The economic indirect effects, which were discussed in greatest detail, did state that indirect effects will occur during the construction and operation of the light rail, i.e. the temporal, but did not address where the effects may occur, i.e. the spatial boundary.

The lack of a clear definition for indirect effects for this project may be a result of a lack of federal agency guidance as to indirect effects identification and evaluation. The lack of an indirect effects definition for this project may have rendered identification and analysis of these effects more difficult.

4.2 Lessons from the Framework

What did we learn from the framework as applied to the project?

TABLE E-12
PROJECT IMPACT-CAUSING ACTIVITIES CHECKLIST

Project Name: *Tasman Light Rail* Location: *Santa Clara County, CA* Analyst: *A. Cheng* Date: *2/1/96*

	Yes	No	If Yes, Describe Generally (Breadth, Duration, Location and Type)
Modification of Regime			
Exotic Flora Introduction		√	
Modification of Habitat	√		
Alteration of Ground Cover	√		
Alteration of Groundwater Hydrology	√		
Alteration of Drainage	√		
River Control and Flow Modification		√	
Channelization		√	
Noise and Vibration	√		
Land Transformation and Construction			
New or Expanded Transportation Facility	√		
Service or Support Sites and Buildings	√		
New or Expanded Service or Frontage Roads	√		
Ancillary Transmission Lines, Pipelines and Corridors	√		
Barriers, Including Fencing	√		
Channel Dredging and Straightening		√	
Channel Revetments		√	
Canals		√	
Bulkheads or Seawalls		√	
Cut and Fill		√	
Resource Extraction			
Surface Excavation	√		
Subsurface Excavation		√	
Dredging		√	
Processing			
Product Storage		√	
Land Alteration			
Erosion Control and Terracing	√		
Mine Sealing and Waste Control		√	
Landscaping	√		
Wetland or Open Water Fill and Drainage		√	
Harbor Dredging		√	
Resource Renewal			
Reforestation		√	
Groundwater Recharge	√		
Waste Recycling		√	
Site Remediation		√	

Changes in Traffic (including adjoining facilities)			
Railroad		√	
Transit (Bus)		√	
Transit (Fixed Guideway)	√		
Automobile	√		
Trucking	√		
Aircraft		√	
River and Canal Traffic		√	
Pleasure Boating		√	
Communication		√	
Operational or Service Charge		√	
Waste Emplacement and Treatment			
Landfill		√	
Emplacement of Spoil and Overburden	√		
Underground Storage		√	
Sanitary Waste Discharge		√	
Septic Tanks		√	
Stack and Exhaust Emission		√	
Chemical Treatment			
Fertilization		√	
Chemical Deicing		√	
Chemical Soil Stabilization		√	
Weed Control		√	
Pest Control		√	
Access Alteration			
New or Expanded Access to Activity Center	√		
New or Expanded Access to Undeveloped Land	√		
Alter Travel Circulation Patterns	√		
Alter Travel Times between Major Trip Productions and Attractions	√		
Alter Travel Costs between Major Trip Productions and Attractions	√		
Others			
_____			
_____			
_____			

	Name	Affiliation	Date
Reviewed by:			

TABLE E-13
CHECKLIST FOR ASSESSING STUDY AREA'S POTENTIAL FOR INDUCED GROWTH

Project Name: *Tasman Light Rail* Location: *Santa Clara County, CA* Analyst: *A. Cheng* Date: *2/1/96*

Regional Study Area Conditions

[A yes answer indicates that conditions generally favor growth; the more yes answers, the higher the certainty that regional conditions generally favor growth.]

1. Is the regional population increasing rapidly (generally, >5% per 10 years)? *Y*
2. Is the region considered favorable for receiving FHA/VA loans? *DK*
3. Are there any major growth generators (e.g., universities, military installations, industries, tourist attractions) in the region? *Y*
4. Is the regional office/commercial market characterized by low (generally, <10%) vacancy rates in any class of space? *DK*
5. Is the region's business and civic leadership committed to rapid development? *Y*
6. Is the region an exporter of natural resources? *N*

Local Study Area Conditions

[If it is concluded that regional conditions generally favor growth, then proceed with the next series of questions. A yes answer indicates that the area in the immediate project vicinity has land use conversion potential; the more yes answers, the higher the certainty that land use conversion will be induced by the project to its immediate vicinity.]

General indicators

7. Is the regional path of development in the direction of the local study area? *Y*
8. Is the project within 5 miles of a growing community (generally, >5% per 10 years)? *Y*
9. Is the local study area characterized by middle and/or high income levels? *Y*
10. Is the local study area free of moratoriums on development (e.g., sewer moratoriums, growth restrictions)? *Y*

Indicators of conditions favorable to conversion to lower density development

11. Is the local study area within a 30-minute drive of a major employment center? *Y*
12. Does the local study area have relatively high land availability/low land prices (generally <one-third of larger parcels developed)? *DK*
13. Is the vacant land characterized by relatively large parcels? *DK*
14. Is the local study area characterized predominantly by level land (generally, <5% slope)? *Y*
15. Is the project's Potential Impact Area characterized by soils suitable for development? *Y*
16. Is the project's Potential Impact Area predominantly free of flooding or wetlands? *Y*

Indicators of conditions favorable to conversion to higher density development

17. Does the local study area have relatively low land availability/high land prices (generally >two-thirds of larger parcels developed)? *DK*
18. Is the local study area served by existing principal arterials and water/sewer systems? *Y*
19. Is the local study area covered by relatively few governmental jurisdictions? *N*
20. Is the local study area characterized by poorly enforced zoning regulations? *N*
21. Does the local study area lack recent (generally, <10 years old) master plans? *N*

Name Affiliation Date

Reviewed by:

TABLE E-14
EVALUATION MATRIX FOR PROJECT INDIRECT EFFECTS OF CONCERN

Project Name: *Tasman Light Rail* Location: *Santa Clara County, CA* Analyst: *A. Cheng* Date: *2/1/96*

Indirect Effect Type	Direct Effects from Impact-Causing Activities	Indirect Effects from Direct Effects (List)	Potential Manifestation of Indirect Effects (List)	Link between Indirect Effect and Goal or Notable Feature that Meets Assessment Criteria[1]	
				Yes (Go to Step 5)	No (Assessment Complete)
Encroachment-Alteration	Ecosystem-related				√
	Socioeconomic-related				√
Induced Growth (Access-Alteration)		Serves specific development			√
		Stimulates complementary development			√
		Influences location decisions		√	
Effects Related to Induced Growth			Ecosystem-related		√
			Socioeconomic-related	√	

[1] Assessment criteria = (1) Confidence that the effect is likely to occur; (2) Know enough about indirect effect to make consideration useful; and (3) Need to know about the impact now.

	Name	Affiliation	Date
Reviewed by:			

The project setting can be an important variable in whether indirect effects are likely to be a major concern as a result of the project. Rapid employment growth in this area will be a critical barometer of real estate values, making the presence of other amenities such as additional transit a minor, and perhaps insignificant, factor to real estate values. Greater real estate impacts are more probable for high-speed commuter trains connecting residential communities with high-density urban employment centers with scarce parking facilities. Low-speed light rail in a dispersed environment with ample parking at trip origins and destinations may have limited effect on real estate as the access afforded by the facility for car owners is questionable.

The level of planning effort in the study area is a strong determinant on whether detailed analysis of the project given the area's needs and goals is examined, as it was for this project. Continued growth in the San Jose area has resulted in the frequent updates to planning documents and zoning ordinances to ensure that plans, and projects, are compatible with current needs. The California Environmental Quality Act, which requires proposed projects to be compatible with plans and mandates analysis of growth inducement and cumulative effects, has also raised the environmental awareness of project planning effort at all levels of governmental involvement. The framework's strength in this project application lie in the identification of indirect effects. The lack of a clear definition for the effects on part of the project sponsors may have impeded the efficiency and the efficacy on the identification process.

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E-4 CASE STUDY REPORT: GRAND RAPIDS (MI) SOUTH BELTLINE

1.0 PROJECT DESCRIPTION

1.1 Introduction

The Grand Rapids South Beltline, located in the Grand Rapids metropolitan area, is a proposed twenty mile, four lane freeway with grade separated interchanges connecting Route 196 in the west to Route 96 in the east. This project is located in both Kent and Ottawa Counties which have been the fastest growing areas in southern Michigan for the past two decades, and new major industrial parks have accelerated the growth and development in this region. The construction and implementation of an east-west, high speed, limited access highway in the southern Grand Rapids area has been studied for the past two decades. This project is part of the Long Range Transportation Plan for the Grand Valley Metropolitan Council (the Metropolitan Planning Organization).

The 1993 Grand Rapids South Beltline FEIS reviewed for this case study addressed the construction of a four lane, limited access freeway to serve as a bypass around the city of Grand Rapids (Figure E-4). This case study will examine how project indirect impacts were identified and examined in the environmental impact statement process and will apply the suggested framework for accessing indirect effects. The Grand Rapids South Beltline project was chosen for application of the suggested indirect effects framework as it consists of a new highway (beltway) to serve suburban growth in a rapidly growing metropolitan area.

Currently, this project has been stalled by the lack of funding. A proposed gasoline tax was supposed to fund this and other projects, but the tax was not approved. MDOT is still negotiating with land owners to purchase property in the right-of-way.

1.2 Purpose and Need of the Project

The major need for this project is caused by the changes in the type and intensity of land use in this area and the resulting travel activity. Traffic projections predict that there would be severe congestion (Level-of-Service E and F) on the east-west roadways. (Level of Service is a set of metrics or qualitative descriptors of a transportation system's performance.) "If a major east-west facility is not developed in the 60th to 68th Street vicinity, one of the major east-west roadways such as 52nd, 60th or 68th Street may develop accident and congestion problems similar to those of 28th Street, where rapid development has placed large travel demands on this free-access facility" (FEIS, 1993: 2-6). In addition, the travel times will be reduced with the operation of the Beltline. This road will serve as bypass for Grand Rapids and divert traffic from 44th Street, 28th Street and Interstate 196, thus reducing congestion on these arterials. Finally, the project can divert long distance truck traffic away from the local road network.

1.3 Affected Environment and Alternatives Considered

The South Beltline study area encompasses portions of the cities of Wyoming, Grandville, and Kentwood and most of Byron, Cascade, Gaines, Lowell, Boone, and Caledonia Townships in Kent County and Jamestown and Georgetown Townships and the City of Hudsonville in Ottawa County. These areas are experiencing the largest amount of growth in the Grand Rapids metropolitan area. The transition from a rural environment to a suburban one with significant medium- and low-density office and industrial development is prompting the increase in both employment and population. The population in the study area in 1980 was 56,100, while the 1979 employment level was 13,900. The population estimate for year 2010 is 120,000 people, while the employment forecast for the year 2010 is 69,000.

The FEIS examined four alternatives in detail: the no build, transportation systems management, limited access freeway, and controlled access boulevard. The no action alternative consisted of regular maintenance of existing highway facilities and local roads. There would be no changes in existing roadways. "The projected increase in traffic vol-

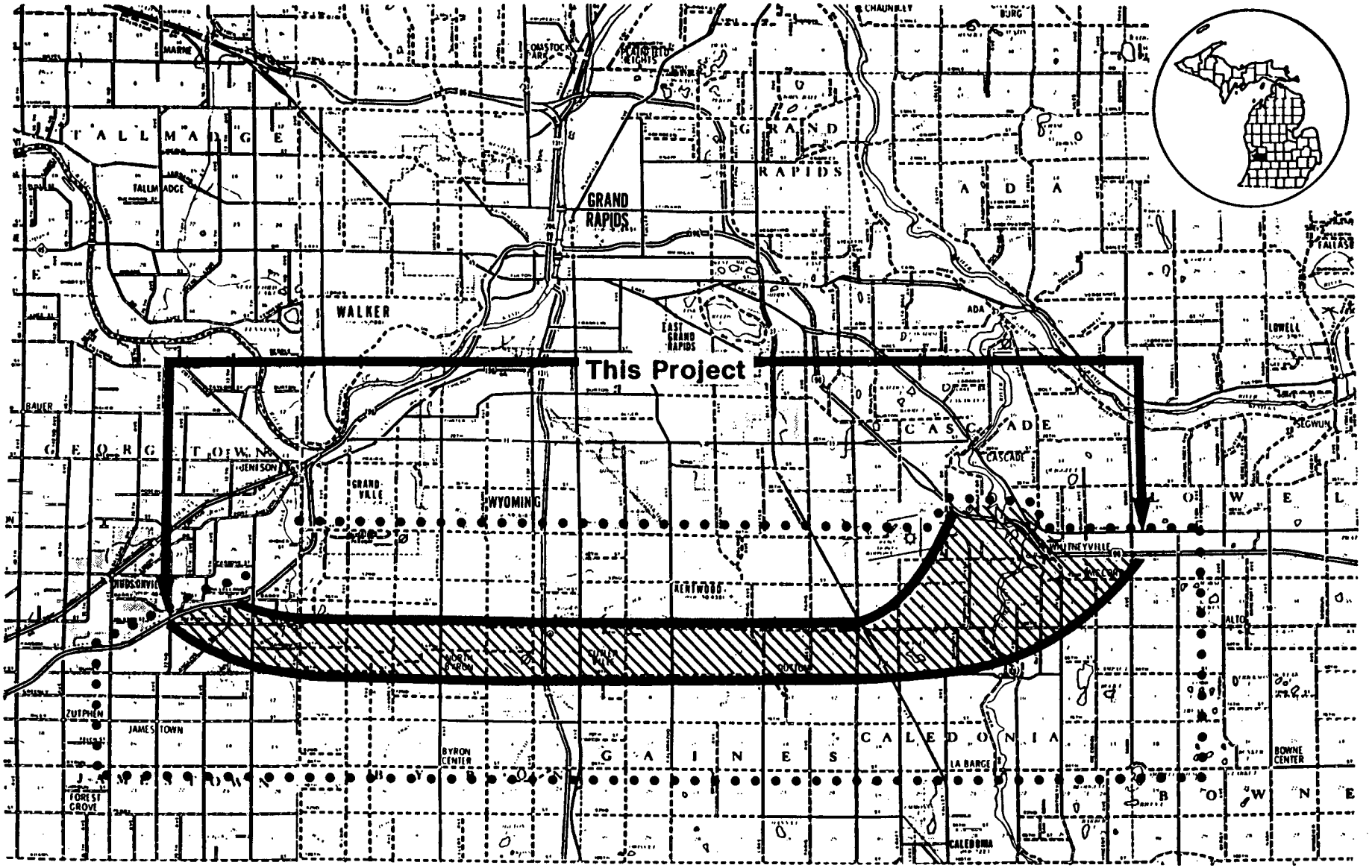

Figure E-4. Grand Rapids South Beltline FEIS.

umes was shown to result in increased highway congestion, with unacceptable levels of traffic during peak periods" (FEIS, 1993: 3-10).

The transportation system management assumed that seven two-lane roads would be widened to four-lane roads.

The limited access freeway alternative proposed a 416 foot wide right of way which would allow for the construction of a four lane roadway. There would be grade separated interchanges connecting the freeway to major north-south arterials, such as US 131. This alternative was divided into three segments (Figure E-5). The western segment consisted of three potential alignments, the middle segment consisted of two potential alignments, and the eastern segment consisted of three potential alignments. The preferred alternative for this project consists of segment W2, M1 and E2.

The controlled access boulevard required a minimum of a 250 foot wide right of way which would also have two lanes in each direction. There would be at-grade intersections with most of the north-south one mile roads. As with the Freeway alternative, the road was divided into three segments and had similar alignments. The boulevard alternative was not chosen because this alternative would not reduce traffic congestion to the same degree as the freeway alternative, and have a lower peak hour level of service at interchanges. The boulevard alternative would also provide higher travel times through the corridor compared to the freeway alternative.

2.0 IDENTIFICATION OF INDIRECT EFFECTS IN THE FEIS

The FEIS addressed the indirect effects of potential induced growth in the following manner:

> "The latter point of secondary development at the intersections or interchanges has becomes a critical issue with the permitting agencies including U.S. EPA, U.S. Fish and Wildlife Service (F&WS), and the MDNR [Michigan Department of Natural Resources]. They are requesting that controls be in place that regulate the development that will occur at major interchanges or intersections to minimize the impact on the natural environment, primarily wetlands. Efforts are underway in Kent and Ottawa Counties to oversee and coordinate development activities which are regulated by the cities and townships. . ..The Federal and State agencies have no legal authority for such regulation" (FEIS, 1993: 1-13).

There is also a chain of causality for indirect land use impacts at freeway interchanges and boulevard intersections:

> "The potential for secondary development was determined to be high where there was substantial vacant land; a compatible pattern of existing land uses; an important intersecting north/south arterial, and the absence of apparent wetland and topographic constraints. One or more of these factors was considered to represent a significant constraint for interchanges and intersections rated as having low potential" (FEIS, 1993; 5-3).

Six indirect effects were identified in the FEIS and are summarized below.

SOCIOECONOMIC

- *Economic Development.* The FEIS provided information on both freeway and boulevard land requirements. Both direct and indirect land takings were calculated: "[T]he total acres and number of parcels which would be required for each segment (direct takings) are presented . . . as well as the land-locked parcels and acreage (indirect takings)" (FEIS, 1993: 5-3). This is an example of an induced growth indirect effect.

LAND USE

- *Land Use.* Professional judgement was used to determine that induced development at freeway interchanges rather than boulevard intersections was most compatible with existing land use patterns, zoning, and the land use plan for Gaines Township. In addition, secondary development is greatest where there is vacant land and compatible land uses near interchange areas. The FEIS briefly mentioned the conversion (direct and indirect) of agricultural land. These are examples of induced growth indirect effects.
- *Parks, Recreation, and Open Space.* Creekside Park is the only park in the project area that may be indirectly impacted, since the freeway will be immediately north of the park. The FEIS did not say how this park could be impacted by this project encroachment indirect effect.
- *Transportation/Traffic.* A positive indirect effect related to the induced growth of constructing the bypass is that parallel roadways would have less traffic and congestion thus facilitating local movements.

WETLANDS

- *Wetlands.* The greatest discussion of indirect effects relating to project encroachment involved the issue of wetlands. Permitting agencies wanted the impacts to wetlands addressed in the FEIS. These agencies did not want rampant development occurring at the interchanges/intersections which is one of the major reasons why the freeway alternative was picked. "Secondary and cumulative impacts to wetland resources would undoubtedly result from uncontrolled development associated with the boulevard alternative" (FEIS, 1993: 5-66). Permitting agencies also wanted the avoidance of wetlands to the greatest extent possible, since construc-

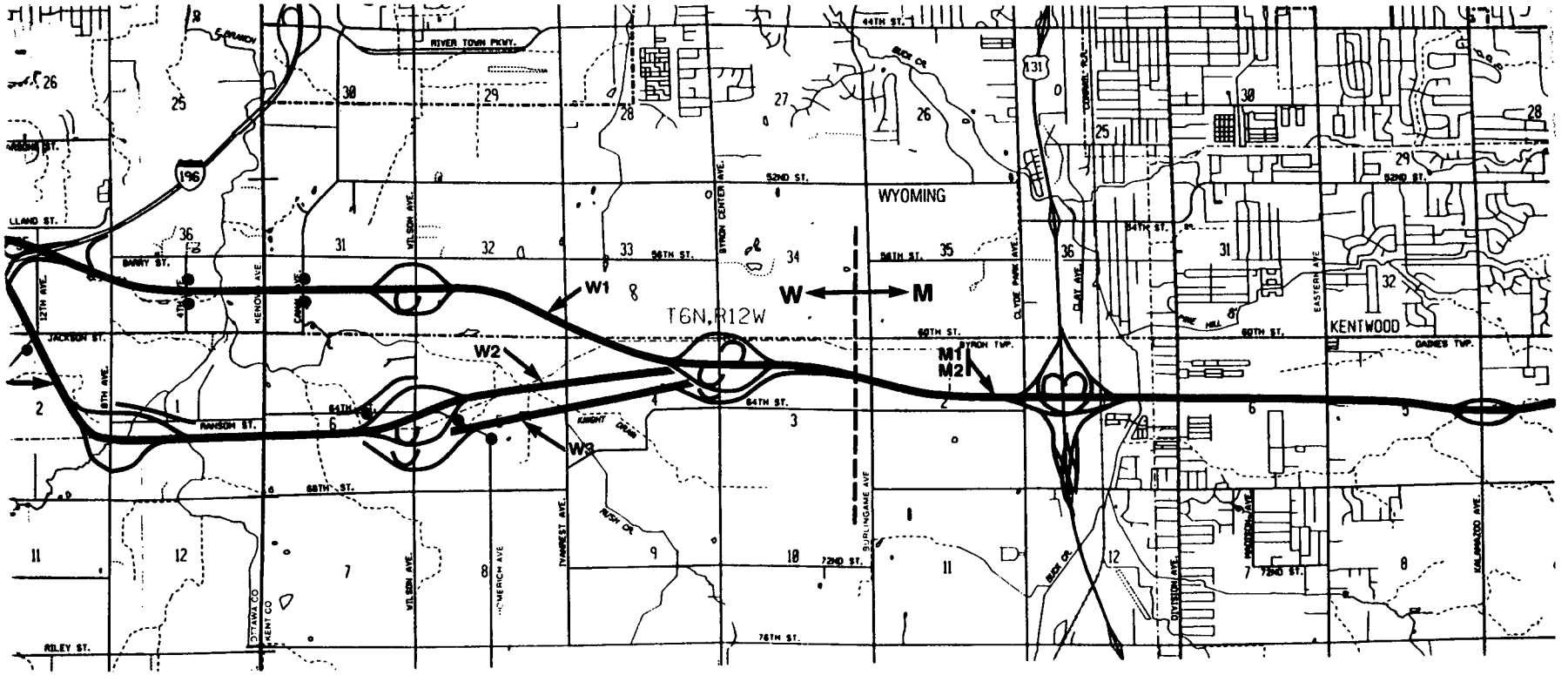

Figure E-5. Grand Rapids South Beltline Study area. (*continued*)

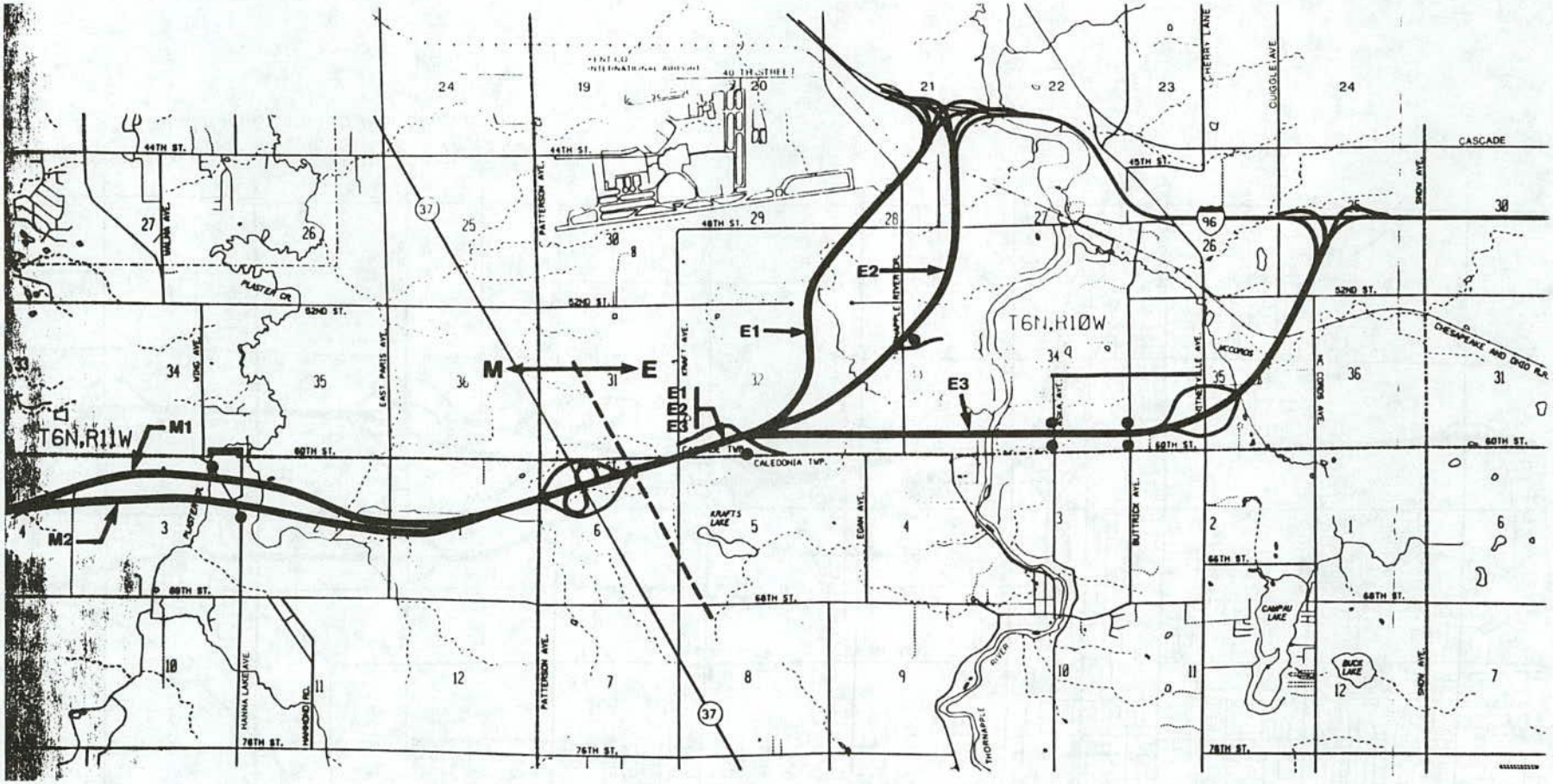

Figure E-5. Continued.

tion practices could increase surface water runoff, alter groundwater hydrology, and increase sedimentation, all of which could impact wetlands.

AESTHETIC AND VISUAL CHARACTER

- *Aesthetic and Visual Character.* The aesthetic and visual character may be impacted from secondary development at the interchanges, yet the FEIS did not elaborate on this indirect effect relating to induced growth.

3.0 FRAMEWORK APPLIED TO PROJECT

Step 1. Identify Study Area's Needs and Goals

In 1992, the Grand Valley Metropolitan Council undertook a study of metropolitan wide growth patterns and trends, aimed toward developing a "common vision" for the future growth of the metropolitan area. The metro blueprint has three central themes:

1. In directing growth, the area should strive to develop "compact, livable communities."
2. The area's industrial and commercial growth should be encouraged to develop in "compact centers of regional economic activity."
3. An initiative should be undertaken to identify and preserve a network of open lands and greenways throughout the metro area (Ada Township, 1995: 29).

The Blueprint also suggests a variety of action strategies to be undertaken. Several relevant strategies are:

- Modify the route structure of the area's public transit system to provide better service between emerging employment centers and workers in need of transportation.
- Define the area's current and regional employment and activity centers and locate probable future centers.
- Convene a committee of public and private sector planners to devise ways to encourage compact livable communities. (Ada Township, 1995: 29).

The City of Hudsonville incorporated the Beltline into their master plan. The Beltline is considered to be beneficial to Hudsonville in many ways:

> "[T]he Southbelt will provide more convenient access to major employment centers in the southeast Grand Rapids area. Trips that currently take from 30 to 40 minutes will be reduced to 20 minutes on the Southbelt. This situation will make Hudsonville more attractive to persons working some distance away but who desire a 'small town' living environment. Similarly, Hudsonville's business and industries will be more accessible to customers and employees living in a larger areas, and industrial demand should increase because of the larger employment base which will be created due to reduced travel time. It is anticipated that the advent of this latest major improvement will help to write the next chapter in Hudsonville's development" (Hudsonville, 1989: 55)

In addition, Hudsonville has several goals relevant to the Beltline including encouraging "future residential, commercial, and industrial development in a compatible manner, while maintaining the city's strong single-family residential character" (Hudsonville, 1989: 59). Another relevant goal is that "commercial development in the interchange area should be controlled to the extent it does not undermine the economic vitality of the central business district" (Hudsonville, 1989: 65).

Ottawa County's Development Plan also has several relevant goals in relation to this project. First, a land use pattern should create a balance between natural resources and future growth and development (Ottawa, 1992: 6). Growth should be directed to areas where there are existing roads, utilities and other infrastructure, and not in environmentally sensitive areas. Second, the intensity of land use along major corridors should be controlled so there is a balance between access to land use and the need to move traffic along major roadways (Ottawa, 1992: 7).

By completing Tables E-15 and E-16, the study area's goals and directions become more obvious. The Grand Rapids area has many social health and well-being goals which include: achieving adequate open space, preserving heritage, promoting a healthy and safe environment, and complying with state and federal water and air quality laws. The economic opportunity goals include: supporting activities to meet changing economic conditions, targeting economic export activities, and attracting and maintaining a work force. The ecosystem protection goals include: protecting ecosystems, minimizing fragmentation, and promoting native species. In addition, both the population and employment are projected to have rapid growth, there are zoning and municipal zoning plans, and the transportation will serve the needs of planned growth.

Product: Completion of Goals checklist, such as Tables E-15 and E-16.

Step 2. Identify Notable Features

Referring to Table E-17, notable features of the area include ecosystem and socioeconomic characteristics. The following features were identified from field visits, interviews with local planners and comprehensive plans.

The notable features in the study area include: regional habitats of concern/critical areas (wetlands and beech forests), rare, threatened, or endangered species and associated habitat (Peregrine falcon, Indiana bat, common loon, red

TABLE E-15
ORGANIZATION AND TABULATION OF GOALS CHART
(Check where applicable)

Project Name: *Grand Rapids South Beltline* Location: Grand Rapids, MI Analyst: *J. Parry* Date: *3/14/96*

		Notes
Social Health and Well-Being Goals		
√	Achieve adequate, appropriate and accessible open space and recreation	
√	Comply with state and federal water and air quality laws	*Ozone*
	Preserve or create multicultural diversity	
√	Preserve heritage	*Archaeological sites*
	Provide choice of affordable residential locations	
	Provide urban environment for those with special needs	
	Promote land use patterns with sense of community	
	Provide a range of services accessible to all	
√	Promote a healthy and safe environment	
	Provide sound management of solid and hazardous waste	
	Other	
Economic Opportunity Goals		
√	Support activities to meet changing economic conditions	
	Provide energy-efficient transportation	
	Provide developments with transit-supported capabilities	
√	Target economic export activities	*Industrial parks*
√	Attract and maintain workforce	
	Promote infill of smaller, passed-over sites	
	Encourage redevelopment of older areas for new purposes	
	Other	
Ecosystem Protection Goals		
√	Protect ecosystems	*Wetlands, rare species habitat*
√	Minimize fragmentation	*Wetlands, rare species habitat*
√	Promote native species	*Indiana bat*
	Protect rare and keystone species	
	Protect sensitive environments	
	Maintain natural processes	
	Maintain natural structural diversity	
	Protect genetic diversity	
	Restore modified ecosystems	
	Other	

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shouldered hawk). The study area is in non-compliance with the Clean Air Act Amendments (ozone), and there are locations of poor traffic, such as 28th and 44th Avenues. Section 4(f) resources include public parks and recreational lands and archeological sites. In addition, there may be notable features relating to the following laws: Endangered Species Act, Farmland Protection Act, Clean Air Act, Noise Control Act, Uniform Relocation Act.

Product: List of notable features for the indirect effects assessment, with an accompanying map illustrating the location and the extent of the feature, where appropriate. Completion of Tables E-17 and E-18.

Step 3. Identify Impact-Causing Activities of Proposed Actions and Alternatives

The proposed Beltline aims to reduce congestion in the Grand Rapids metropolitan area. Once the road is constructed, traffic congestion on the major interstates and arterials in the project areas will be relieved which will reduce

travel times. The reduction of travel times will create new opportunities for development, as noted in the city of Hudsonville's master plan. Also, the Beltline will have several interchanges with major north-south arterials which will spur development around these interchanges.

In addition to inducing development, the GRSB could create several other impact causing activities. The construction of the road will modify both the regime and habitat and alter the ground cover. This new transportation facility will create both land transformation and construction. There will also be land alteration including: erosion control, stormwater management, and wetland impacts. The completion of the road will change both automobile and truck traffic patterns in the region. In addition, there will be emplacement of spoil and overburden. Finally, the chemical deicing and chemical runoff from the road could also cause an indirect impact (see Table E-19).

Product: A comprehensive list of the impact-causing actions of the proposed plan or project and alternatives, in as much detail as possible. Table E-19 is an example.

Step 4. Identify Indirect Effects for Analysis

The indirect effect from this project with a high need-to-know factor is the possible diversion of economic activities and development from elsewhere in the region to areas adjacent to the proposed highway. The Beltline will provide access to the region's transportation network in areas which previously had no connections which will create pressure to develop these areas. In addition, there will be development pressures to have high intensity land use at the interchange areas, and existing businesses may be prompted to move to the areas surrounding the Beltline due to increased access and lower cost of land.

The critical land use indirect effect research question for the project, given the local plans and goals is: To what extent will the construction and operation of the Grand Rapids South Beltline shift development patterns in the region? How can development around the interchange areas be controlled?

Other questions relating to indirect effects are:

- *Socioeconomic*: Will the induced development create suburban sprawl and land speculation? Where will development locate? Will development relocate from existing downtowns?
- *Ecological Effects*: To what extent will wetlands be indirectly impacted from the construction and operation of this roadway? How will habitat fragmentation affect the region's natural resources? What will be the impacts from runoff and air and noise pollution?
- *Induced Growth*: The project is likely to influence interregional land development locations. What will be the effects on land use, property values, and land availability? To what degree will this project stimulate land development having complementary functions?

Table E-20 was applied to this project. This checklist is an example of a qualitative inference which can measure a region's potential for induced growth. The majority of the answers to the questions relating to the regional study area conditions are "yes" indicating that the regional conditions generally favor growth. The local study area conditions also indicate that there is a high certainty that land use conversion will be induced by the project due to its immediate vicinity.

Product: Completion of Tables E-20 and E-21. A technical memorandum that lists the indirect effects that warrant further analysis and presents the scope of analysis to be conducted in Step 5.

Step 5. Analyze Indirect Effect

The suggested framework emphasizes targeting those effects that have a degree of certainty to their occurrence. Given the Grand Valley Metropolitan Council, City of Hudsonville, and Ottawa County's stated goals of having development occur in an orderly managed manner, the possible effects of the relocation of existing and new development to the area around the Beltline warrant indirect effect analysis.

To examine these indirect effects, both quantitative and qualitative analysis would be useful. Land use modeling would be one method to analyze future land use for the study area as was done in the 1985 *Grand Rapids South Beltline Urban Area Impact Study*. This study provided a detailed analysis on possible locations and roadway types (such as free access, boulevard, and freeway) and impacts of the Beltline on development patterns, tax revenue, public expenditures, employment, transportation, environment, consistency with state and local plans, and the role of the Beltline in development plans. SLAM (Simplified Land Allocation Model) was used to measure future land use in the study region, while the MDOT free flow unconstrained transportation model was used to determine future vehicular traffic volumes. Indirect effects on roads and water quality were discussed in this study. This study would have to be updated and then it could be used to analyze effects (possibly using GIS) given the size of the study area.

An assessment of existing downtowns would also be useful to determine the vacancy rate and the effects of the proposed project on the central business districts. One could also use information about land speculation in response to the project planning as an indicator of possible induced effects. Rapidly increasing property values indicate location attractiveness. The vacancy rates of commercial and

TABLE E-16
STUDY AREA DIRECTIONS AND GOALS CHECKLIST
(Check where applicable)

Project Name: *Grand Rapids South Beltline* Location: Grand Rapids, MI Analyst: *J. Parry* Date: *3/14/96*

1. **Generalized Setting**

Within Metropolitan Statistical Area (Identify MSA)	√	
Outside of MSA		
Both Inside and Outside MSA	*Grand Rapids*	Indicate Distance to Nearest Metropolitan Center *adjacent*

2. **Characteristics of Transportation System** (Note: These items are not intended to cover entire transportation need but rather to use information from more detailed assessments to provide a preliminary indication of existing accessibility, service and modal interrelationship characteristics, i.e., factors relevant to subsequent indirect effects analysis).

- Identify missing links in transportation system _____.
- Map and describe existing level of service on minor and principal arterials and their access characteristics.
- Indicate distance to nearest interstate highway if not in study area.
- Map and describe existing transit routes and demand.
- Map and describe major concentrations of existing and planned development.
- Describe modal interrelationships including competing and complementary characteristics.

3.

Population	Trend	Projection
Declining		
Static (±1%/10 years)		
Slow Growth		
Rapid Growth (>10%/10 years)	√	√

Employment	Trend	Projection
Declining		
Static (±1%/10 years)		
Slow Growth		
Rapid Growth (>10%/10 years)	√	√

4. **Planning Context**

	Yes	No	If yes, identify by title, agency and date
Zoning	√		*Various municipalities*
State Master Plan		√	
County/Regional Master Plan	√		*Ottowa County Development Plan, Planning Commission 1992*
Municipal Master Plan	√		*Various municipalities*
Growth Management Plan		√	
Water Quality Management Plan		√	
Other Natural Resources Management Plan		√	

5. **For each plan identified in No. 3, summarize key goals, elements and linkages to other plans (specify, in particular, elements related to economic development, land use development, the transportation system, and natural resource protection).** *Develop livable communities, encourage industrial and commercial growth to develop in compact centers of regional economic activity, preserve open lands and greenways*

6. **Describe any efforts to elicit local needs and goals from residents and/or agencies (source and result).** *Public meetings, GRETS*

7. **Describe known plans for major new or expanded activity centers including public facilities.** *Expansion of Steelcase Industries*

Is the activity center dependent on transportation system improvement? Yes ____ No √

8. **Is the transportation need linked to economic growth and land development?** Yes √ No ____

If yes, is the nature of the linkage to:

Serve the needs of planned growth √ or

Channelize growth ____ or

Stimulate growth ____ or

9. **Based on information obtained, are there any apparent conflicts between transportation and other needs that could result in controversy? (Describe).**

Yes ____ Possible √ No ____

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TABLE E-17
NOTABLE FEATURES CHECKLIST
(Check where applicable)
Project Name: *Grand Rapids South Beltline* Location: Grand Rapids, MI Analyst: *J. Parry* Date: *3/14/96*

	Ecosystem Features	Specify
√	Regional habitats of concern/critical areas	*Wetlands, beech trees*
√	Rare, threatened or endangered species and associated habitat	*Peregrine Falcon, Indiana bat, common loon, Red-Shouldered Hawk*
___	Species requiring high survival rates	
___	Species whose intrinsic rates of increase fluctuate greatly	
___	Communities with vulnerable keystone predators or materialists	
___	Other _____	
	Socioeconomic Features	
___	Substandard amounts of open space and recreation	
√	Non-compliance with state and federal environmental laws	*Ozone*
___	High concentration of uncontrolled solid and hazardous waste sites	
___	Inadequate affordable housing	
___	Inadequate access to amenities	
___	Economically distressed areas	
___	Lack of institutional land use controls	
___	High proportion of population consisting of:	
	___ Minorities	
	___ Low-income residents	
	___ Elderly	
	___ Young	
	___ Disabled	
___	Low proportion of long-term residents	
√	Locations of poor traffic flow	*28th, 44th Avenues*
___	Other _____	

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industrial properties and the amount of vacant developable land should be compiled. In addition, the use of the Delphi technique to analyze the effect would also be useful on this project. This technique is directed toward the systematic solicitation and organization of expert intuitive thinking from a group of knowledgeable people. These experts could be officials from: the municipalities in the study area, the City of Grand Rapids (the largest urban area in the region and outside the study area), the Grand Valley Metropolitan Council (the MPO), MDOT, MDNR, US EPA, and US F&WS.

Product: A technical memorandum that describes the indirect effects, the chosen analysis methods, and the analysis results.

Step 6. Evaluate Analysis Results

There appears to be uncertainty in what growth and development could be attributed to the proposed project and what could be attributed to general economic growth in the region. The pace of development may have intensified around the proposed interchange areas. However, growth is occurring from other factors as well, such as the airport, the Routes 131, 96 & 196, and general growth expansion south within the Grand Rapids metropolitan area.

Product: Technical memorandum combining steps 1 through 5.

Step 7. Assess the Consequences and Develop Mitigation

Depending on the consequences, mitigation of the effect may be necessary. This project could provide the impetus for growth controls at the interchange areas. These controls could be developed by MDOT in cooperation with other stakeholders and suggested for adoption by local municipalities.

Product: Develop mitigation for controlling growth along the Beltline.

4.0 CONCLUSION

The framework provided a structure for assessing the indirect effects of this project. An analysis of intraregional development shifts would have been useful on this project. This analysis would have required examining a study area larger than the immediate corridor to include the effects on other activity centers in the region (e.g., the city of Grand Rapids CBD). In this way, the consequences of the effects could be examined in a regional context.

TABLE E-18
NOTABLE FEATURES ADDRESSED BY FEDERAL STATUTES
(Check where applicable)

Project Name: *Grand Rapids South Beltline* Location: Grand Rapids, MI Analyst: *J. Parry* Date: *3/14/96*

Resource Type or Area	Statute/Order	Source of Information and Map Locations
√ Section 4(f) Resources √ Public Parks and Recreational Lands ___ Wildlife and Waterfowl Refuges ___ Historic Sites ___ Historic Districts √ Archaeological Remains ___ Historic Structure	Department of Transportation Act	Local Parks or Recreation Officials, State Historic Preservation Office or local historic preservation organizations
___ Coastal Zone	Coastal Zone Management Act	State Coastal Zone Management Office
___ Waters of the United States	Clean Water Act; E.O. 11990	State Fish and Game Commission; U.S. Fish and Wildlife Service
___ Sole Source Aquifer	Safe Drinking Water Act	State Natural Resources Agency; U.S. Environmental Protection Agency
___ Areas of Known Contamination	Comprehensive Env. Response Compensation Liability Act	State environmental protection agency; U.S. Environmental Protection Agency
___ Floodplains	E.O. 11988	Federal Emergency Management Agency
√ Range or Habitat of Threatened or Endangered Species	Endangered Species Act	State Fish and Game Commission; U.S. Fish and Wildlife Service
___ Wild, Scenic or Recreational River	Wild and Scenic Rivers Act	U.S. National Parks Service
√ Prime or Unique Farmland	Farmland Protection Act	U.S. Soil Conservation Service
√ Sensitive Receptor	Clean Air Act; Noise Control Act	State environmental protection agency
√ Nonattainment or Maintenance Areas	Clean Air Act	State and local air and transportation agencies; metropolitan planning organizations; state implementation plans; conformity determinations of transportation plans, programs and projects.
√ Residential or Commercial Establishments	Uniform Relocation Act; E.O. 12898	Local governments

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TABLE E-19
PROJECT IMPACT-CAUSING ACTIVITIES CHECKLIST

Project Name: *Grand Rapids South Beltline* Location: Grand Rapids, MI Analyst: *J. Parry* Date: *3/14/96*

	Yes	No	If Yes, Describe Generally (Breadth, Duration, Location and Type)
Modification of Regime			
Exotic Flora Introduction		√	
Modification of Habitat	√		
Alteration of Ground Cover	√		
Alteration of Groundwater Hydrology	√		
Alteration of Drainage	√		
River Control and Flow Modification		√	
Channelization		√	
Noise and Vibration	√		
Land Transformation and Construction			
New or Expanded Transportation Facility	√		
Service or Support Sites and Buildings		√	
New or Expanded Service or Frontage Roads		√	
Ancillary Transmission Lines, Pipelines and Corridors		√	
Barriers, Including Fencing		√	
Channel Dredging and Straightening		√	
Channel Revetments		√	
Canals		√	
Bulkheads or Seawalls		√	
Cut and Fill		√	
Resource Extraction			
Surface Excavation	√		
Subsurface Excavation		√	
Dredging		√	
Processing			
Product Storage		√	
Land Alteration			
Erosion Control and Terracing		√	
Mine Sealing and Waste Control		√	
Landscaping	√		
Wetland or Open Water Fill and Drainage		√	
Harbor Dredging		√	

Resource Renewal			
Reforestation		√	
Groundwater Recharge		√	
Waste Recycling		√	
Site Remediation		√	
Changes in Traffic (including adjoining facilities)			
Railroad		√	
Transit (Bus)		√	
Transit (Fixed Guideway)		√	
Automobile	√		
Trucking	√		
Aircraft		√	
River and Canal Traffic		√	
Pleasure Boating		√	
Communication		√	
Operational or Service Charge		√	
Waste Emplacement and Treatment			
Landfill		√	
Emplacement of Spoil and Overburden	√		
Underground Storage		√	
Sanitary Waste Discharge		√	
Septic Tanks		√	
Stack and Exhaust Emission		√	
Chemical Treatment			
Fertilization		√	
Chemical Deicing	√		
Chemical Soil Stabilization		√	
Weed Control		√	
Pest Control		√	
Access Alteration			
New or Expanded Access to Activity Center		√	
New or Expanded Access to Undeveloped Land	√		
Alter Travel Circulation Patterns	√		
Alter Travel Times between Major Trip Productions and Attractions	√		
Alter Travel Costs between Major Trip Productions and Attractions	√		
Others			
_____			
_____			
_____			

Reviewed by:	Name	Affiliation	Date

TABLE E-20
CHECKLIST FOR ASSESSING STUDY AREA'S POTENTIAL FOR INDUCED GROWTH

Project Name: *Grand Rapids South Beltline* Location: Grand Rapids, MI Analyst: *J. Parry* Date: *3/14/96*

Regional Study Area Conditions

[A yes answer indicates that conditions generally favor growth; the more yes answers, the higher the certainty that regional conditions generally favor growth.]

1. Is the regional population increasing rapidly (generally, >5% per 10 years)? *Y*
2. Is the region considered favorable for receiving FHA/VA loans? *?*
3. Are there any major growth generators (e.g., universities, military installations, industries, tourist attractions) in the region? *Y*
4. Is the regional office/commercial market characterized by low (generally, <10%) vacancy rates in any class of space? *Y*
5. Is the region's business and civic leadership committed to rapid development? *Y*
6. Is the region an exporter of natural resources? *N*

Local Study Area Conditions

[If it is concluded that regional conditions generally favor growth, then proceed with the next series of questions. A yes answer indicates that the area in the immediate project vicinity has land use conversion potential; the more yes answers, the higher the certainty that land use conversion will be induced by the project to its immediate vicinity.]

General indicators

7. Is the regional path of development in the direction of the local study area? *Y*
8. Is the project within 5 miles of a growing community (generally, >5% per 10 years)? *Y*
9. Is the local study area characterized by middle and/or high income levels? *Y*
10. Is the local study area free of moratoriums on development (e.g., sewer moratoriums, growth restrictions)? *?*

Indicators of conditions favorable to conversion to lower density development

11. Is the local study area within a 30-minute drive of a major employment center? *Y*
12. Does the local study area have relatively high land availability/low land prices (generally <one-third of larger parcels developed)? *Y*
13. Is the vacant land characterized by relatively large parcels? *Y*
14. Is the local study area characterized predominantly by level land (generally, <5% slope)? *N*
15. Is the project's Potential Impact Area characterized by soils suitable for development? *Y*
16. Is the project's Potential Impact Area predominantly free of flooding or wetlands? *Y*

Indicators of conditions favorable to conversion to higher density development

17. Does the local study area have relatively low land availability/high land prices (generally >two-thirds of larger parcels developed)? *Y*
18. Is the local study area served by existing principal arterials and water/sewer systems? *Y*
19. Is the local study area covered by relatively few governmental jurisdictions? *N*
20. Is the local study area characterized by poorly enforced zoning regulations? *N*
21. Does the local study area lack recent (generally, <10 years old) master plans? *N*

Reviewed by:

Name	Affiliation	Date

TABLE E-21
EVALUATION MATRIX FOR PROJECT INDIRECT EFFECTS OF CONCERN

Project Name: *Grand Rapids South Beltline* Location: Grand Rapids, MI Analyst: *J. Parry* Date: *3/14/96*

Indirect Effect Type	Direct Effects from Impact-Causing Activities	Indirect Effects from Direct Effects (List)	Potential Manifestation of Indirect Effects (List)	Link between Indirect Effect and Goal or Notable Feature that Meets Assessment Criteria[1]	
				Yes (Go to Step 5)	No (Assessment Complete)
Encroachment-Alteration	Ecosystem-related	*Wetlands*		√	
	Socioeconomic-related				
Induced Growth (Access-Alteration)		Serves specific development			
		Stimulates complementary development	*Induced development*	√	
		Influences location decisions			
Effects Related to Induced Growth			Ecosystem-related		
			Socioeconomic-related		

Assessment criteria = (1) Confidence that the effect is likely to occur; (2) Know enough about indirect effect to make consideration useful; and (3) Need to know about the impact now.

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5.0 REFERENCES

Ada Township. Master Plan, Beta Design Group, adopted 1995.

City of Hudsonville, Master Plan, The WBDC Group, adopted 1989.

Final Environmental Impact Statement, Section 4(f) Evaluation, Grand Rapids South Beltline, from I-196 to I-96 in Ottawa and Kent Counties, Michigan, Michigan Department of Transportation, 1993.

Grand Rapids South Beltline Urban Area Impact Study, Schimpeter-Corradino Associates, 1985.

Ottawa County Development Plan, Design Plus, P.C. & The WBDC Group, adopted 1992.

E-5 CASE STUDY REPORT: LACKAWANNA VALLEY (PA) INDUSTRIAL HIGHWAY

1.0 PROJECT DESCRIPTION

1.1 Introduction

The Lackawanna Valley Industrial Highway (LVIH) is a proposed 15 mile, four lane, limited access highway from Interstate 81 in Dunmore to U.S. Route 6 in Carbondale, Pennsylvania, and this case study examines how the project's indirect effects were identified and analyzed in the environmental impact statement process. In addition, the suggested framework for assessing indirect effects is also applied to this proposed project. This highway is an example of a transportation project developed to stimulate economic and land development. The FEIS performed a detailed analysis of secondary impacts. For these reasons, the Lackawanna Valley Industrial Highway was chosen for application of the suggested indirect effects framework. Finally, the Lackawanna Valley Planning Commission has just finished a plan developed to minimize the indirect effects caused by this project.

This highway is located in Lackawanna County, Pennsylvania (northeastern Pennsylvania) and the project area is not well connected to major arterials, such as I-80, I-81, I-84/380, I-88, and the Northeast Extension of the Pennsylvania Turnpike. The project area for this project includes twelve municipalities (Archbald, Blakely, Dickson City, Dunmore, Jermyn, Jessup, Mayfield, Olyphant, and Throop Boroughs, Carbondale and Fell Townships, and the City of Carbondale) and is located north of the Wilkes-Barre/Scranton urban areas. This region has historically been based on coal extraction, both deep and surface mining, and manufacturing. Since the 1950s, the Valley has suffered an economic decline due to the decrease of these industries.

In June 1992, the Pennsylvania Department of Transportation (PennDOT), in cooperation with the Federal Highway Administration, prepared a three volume Draft Environmental Impact Statement for the Lackawanna Valley Industrial Highway (LVIH). In October 1992, PennDOT completed the two volume Final EIS with an accompanying technical memorandum. In addition to constructing a limited access highway, this project will also include the reconstruc-

tion of the adjoining I-81/84/380 interchange and additional lanes on I-81 south to the Central Scranton Expressway. According to the FEIS, "noting the economic development needs of the area, Governor Robert Casey designated the Lackawanna Valley as a top priority project for the Commonwealth" (FEIS, 1992: 1).

The LVIH is currently being constructed in 14 sections; the first section was completed in March 1994 and the last section will be completed in May of 1999. PennDOT expects to spend $360 million and has already spent $187 million to complete this highway. The earthwork and interchange areas have already been constructed (Figures E-6 and E-7).

1.2 Purpose and Need of Project

The construction of the LVIH is planned to fulfill four major needs related to improved access in the Lackawanna Valley. Currently, this region is not served adequately by the interstate highway system which limits access to the valley's 70,000 people and twelve municipalities. Due to the steep topography and mining activities, development in the valley has concentrated in densely developed towns on the Valley floor. The Valley's road system was constructed prior to the advent of the automobile which has resulted in tight curves and steep grades and buildings with little or no setback adjacent to the roadway. In addition, the major roadways in the Valley pass through the local grid network of the municipalities. U.S. Route 6, a boulevard with at-grade interchanges located on the western side of the Valley, has become the major roadway for the Valley, running north-south, and is the principal arterial highway and locus of current strip commercial development.

The first need is to improve access to complement economic development in the Lackawanna Valley. Over the last few decades there has been an economic decline primarily due to obsolescence of the traditional industries and long-term loss of these types of jobs. According to the FEIS, "a direct connection into the regional expressway network is vital to reestablishing the Valley's competitiveness in attracting new businesses and retaining those already located within the study area" (FEIS, 1992: I-6). Improving the infrastructure to help support new development has become vital to the future of the area.

The second need is to improve traffic flow conditions on U.S. Route 6 and other roadways in the Valley. Since the employment growth within the Valley is stagnant, residents have to travel outside of the Valley for employment which leads to heavy congestion during peak hours on the existing transportation network. There is heavy peak congestion along U.S. Route 6, O'Neil Highway, and other two lane roadways. If no relief is provided, traffic volumes on U.S. Route 6 and the secondary roadways are projected to increase 14% by 1998 and 54% over the next 25 years (FEIS, 1992: I-12).

The third need is to improve traffic safety conditions on U.S. Route 6 and other Valley roadways. The accident rates of major roadways in the Valley are high compared to state highways. These accidents appear to be a result of high traffic flows combined with conflicting traffic patterns.

The fourth need is to improve emergency vehicle access and response time. Due to the traffic congestion and capacity problems, emergency service has been compromised.

In addition to these needs, there is also a need to protect community and environmental resources. The location and configuration of the LVIH and its interchanges was planned to avoid these resources while maximizing service benefits and minimizing impacts. The Lackawanna Heritage Valley Plan can also be complemented by the LVIH. This plan is to conserve the Valley's mining and industrial heritage and its natural resources as a major generator of visitation and recreation. Mitigation efforts for the highway project may be able to reinforce resources and opportunity areas identified in that plan (FEIS, 1992; 3).

1.3 Affected Environment and Alternatives Considered

The LVIH corridor is approximately 15 miles in length and is on the side of the valley opposite Route 6. Present day Lackawanna County is a reflection of its past history. The industrialization of the Valley, through extraction of the mineral and natural resources, was followed by the economic decline of these industries. Most of the twelve municipalities have densely developed central business districts with residential development surrounding the downtowns. Recent residential development occurs mostly on reclaimed mining areas, and new commercial development occurs in highway corridors.

In the process of determining viable alternatives, "initially over 25 corridor options for the LVIH were laid out through the Valley to provide access and connection choices while avoiding major engineering and environmental constraints" (FEIS, 1992: 4). These options were then evaluated based on: meeting project needs, access benefits, engineering and construction suitability, recognized environmental impacts, estimated costs, and public acceptability. This selection process resulted in three Alternatives (A, B, and C) being chosen for further detail within the Draft EIS. These three alternatives had relatively high transportation effectiveness, fewer engineering problems, and relatively low involvement with environmental resources or constraints. In addition, the project area was also divided into four segments to achieve optimum overall alignment. Within each segment, some alternatives had several alignments (Figure E-8). The preferred alternative consisted of a combination of the three alternatives and their respective segments. (The preferred alignment consisted of Alternative A-2 in segment 1, A-1, B-1, and C-1 on segment 2, C on segment 3, and C on segment 4.) The selected alternative had the same alignment in Segments 1 and 3 and differed from the preferred alternative, since the proposed roadway was shifted away from the town of Mayfield (Figure E-9). "This selection ultimately reflects the

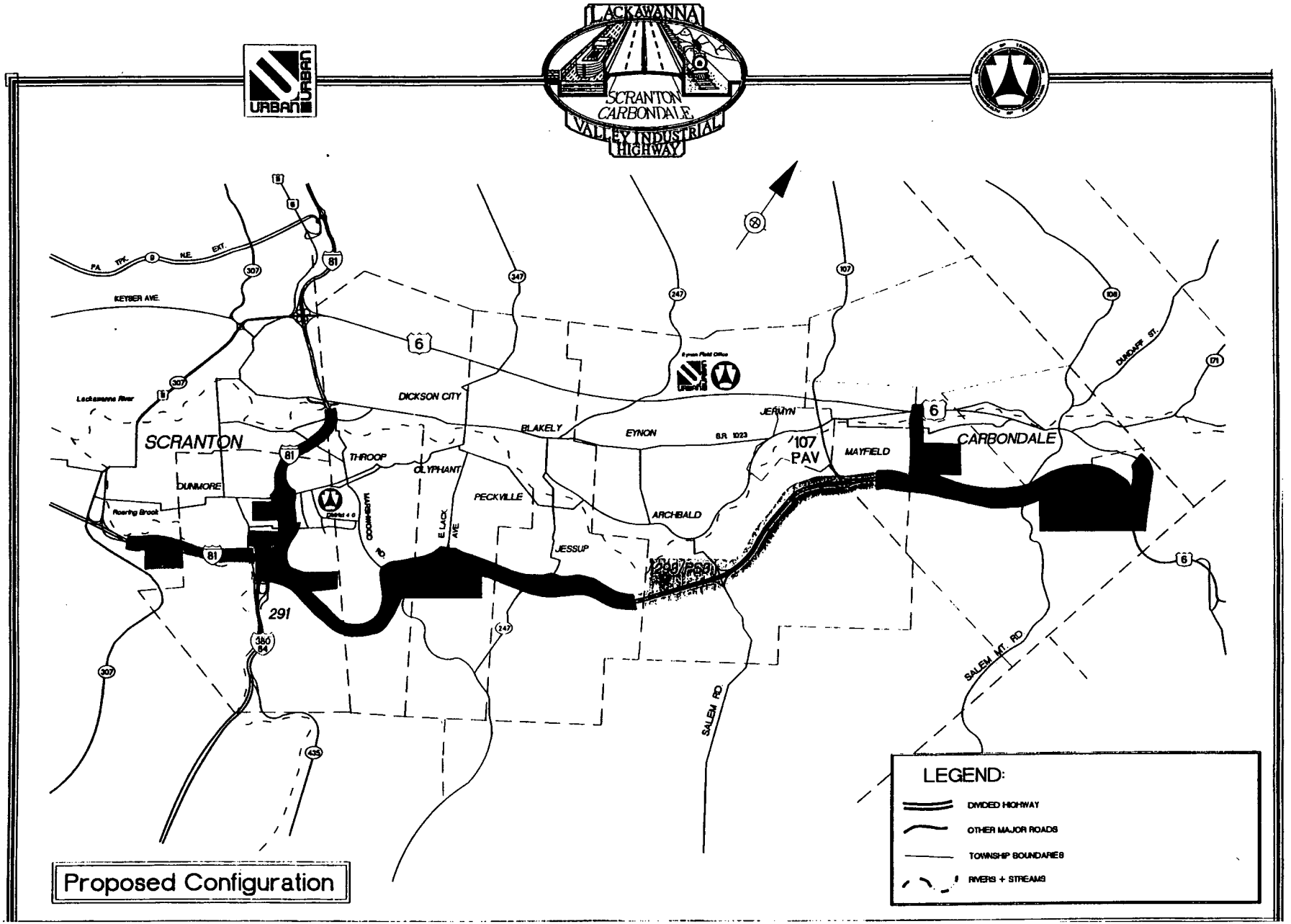

Figure E-6. Lakawanna Valley Industrial Highway (LVIH) EIS.

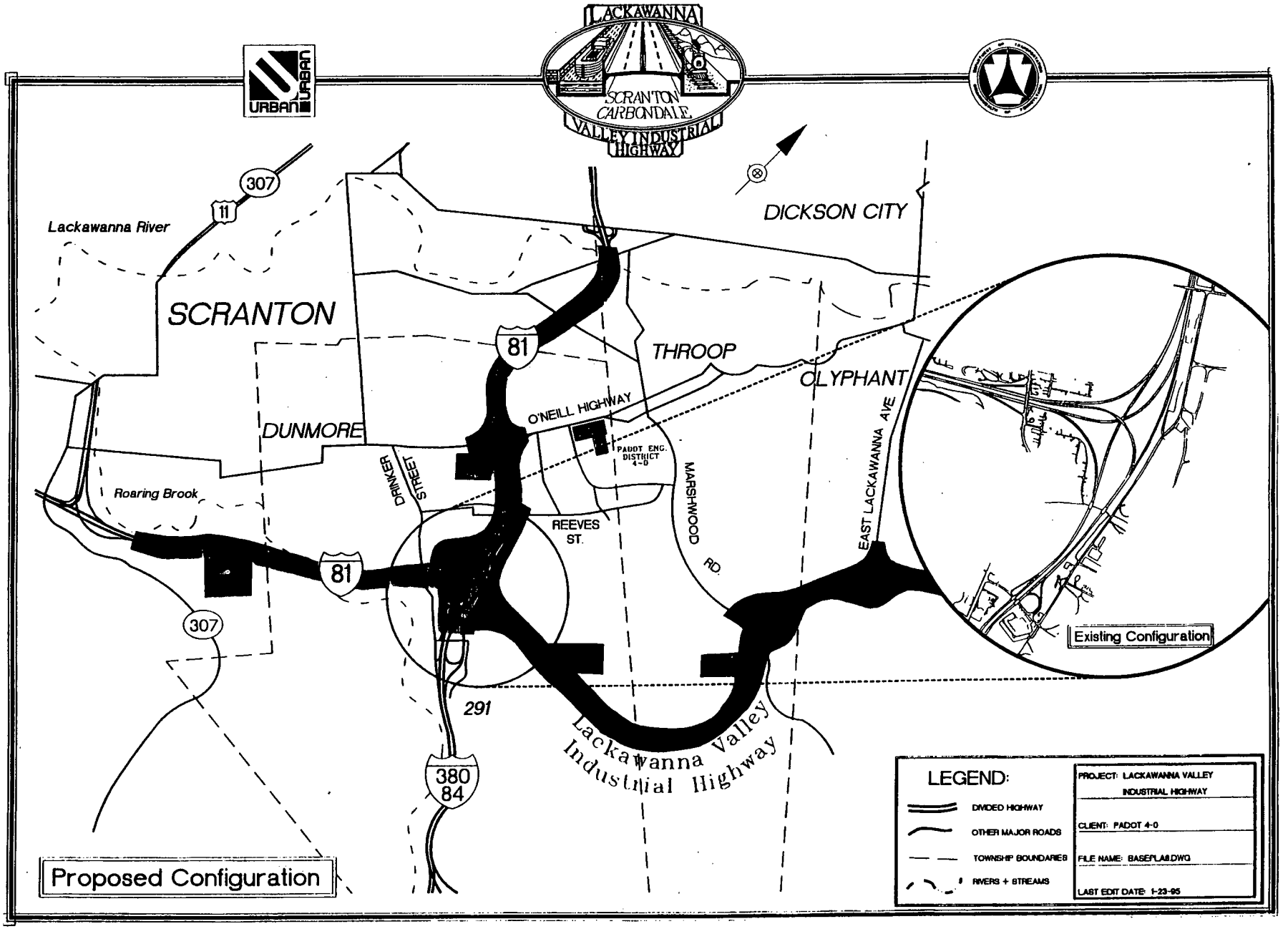

Figure E-7. Detail of LVIH EIS.

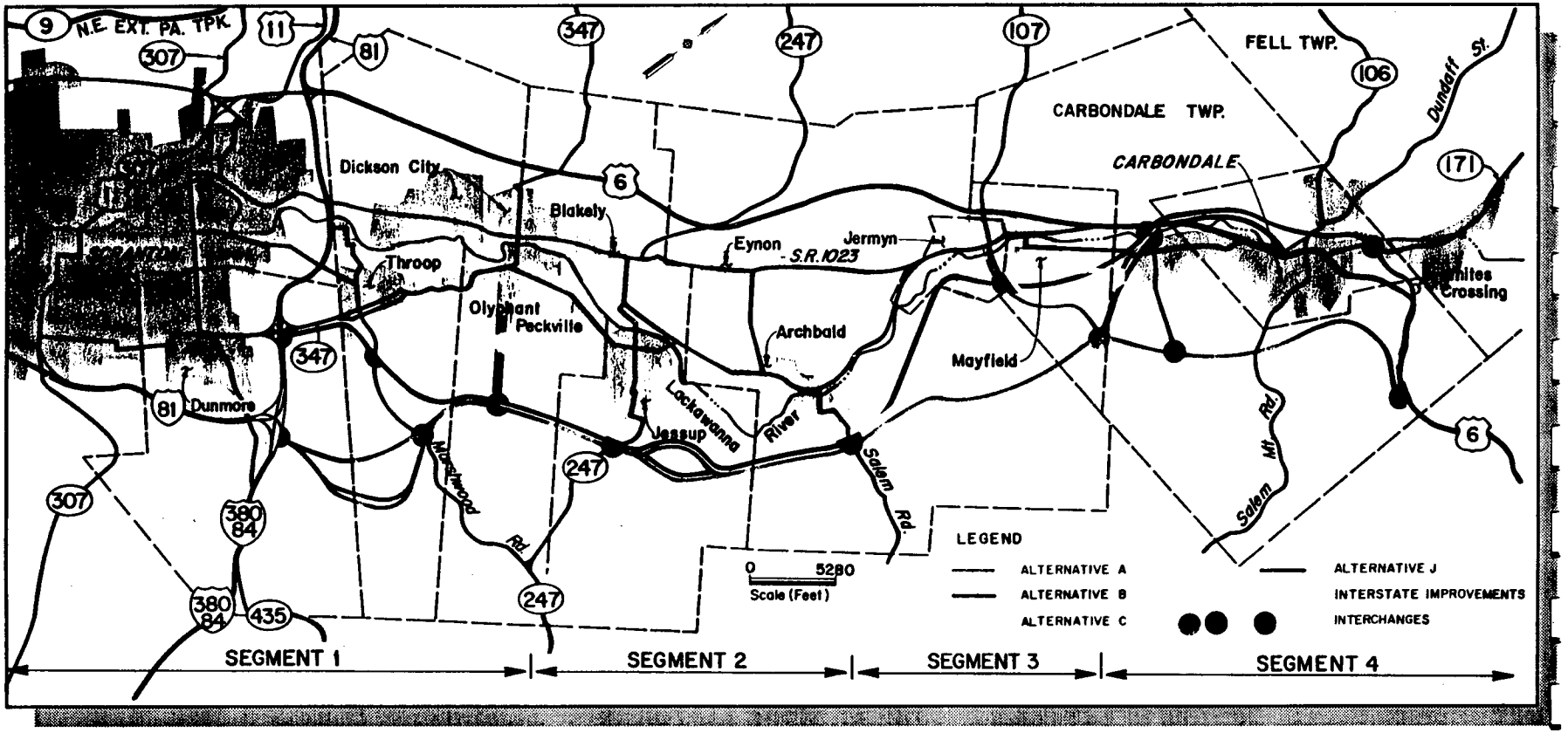

Figure E-8. Alternative studied in detail in the DEIS.

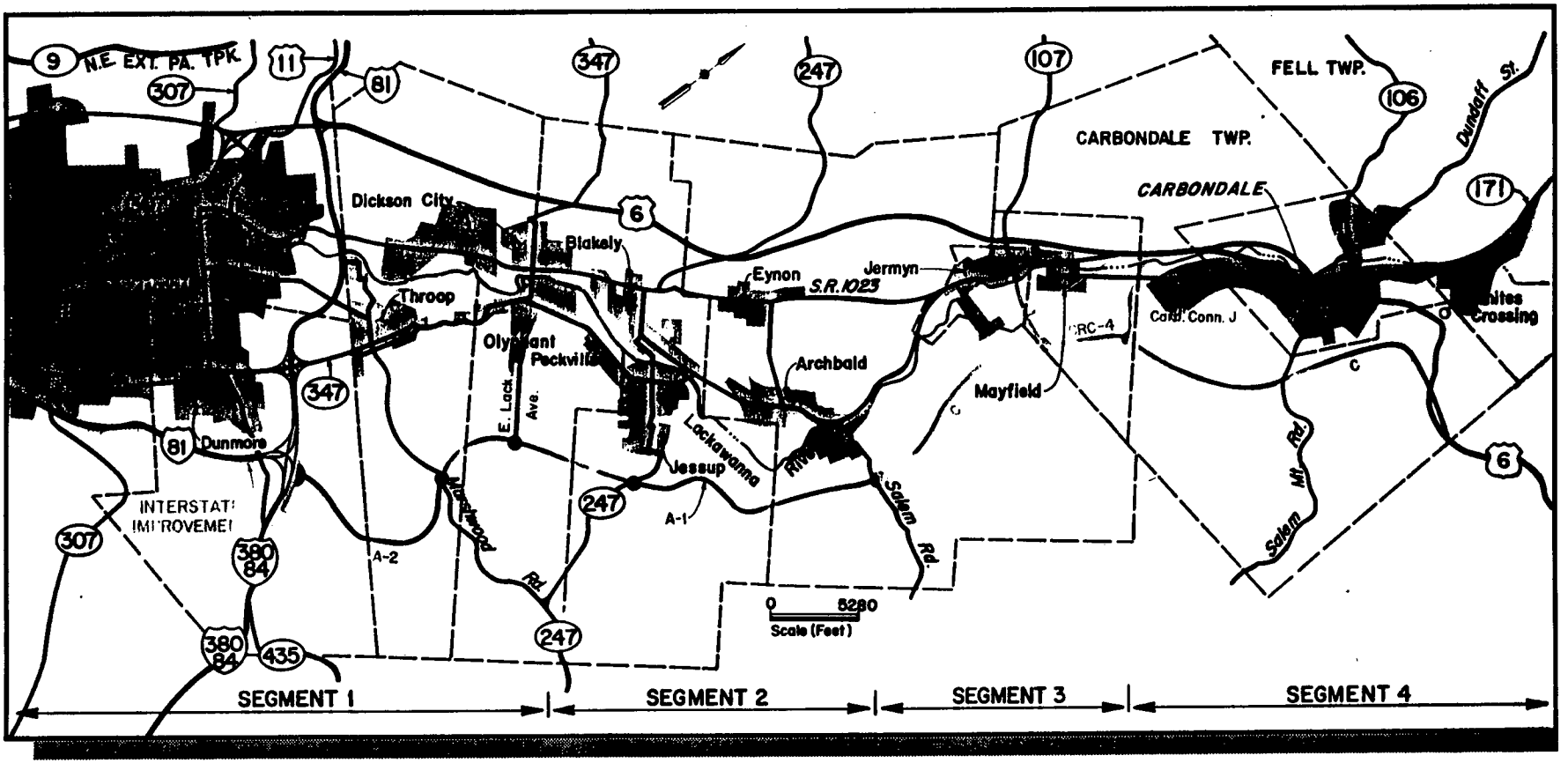

Figure E-9. Alternatives selected in the FEIS.

comparative advantages of this alternative location away from the developed area and the minimization of the adverse impacts. In general, the public's input was an important consideration in the recommendation of the selected alternative" (FEIS, 1992:10).

In addition to these alternatives, the FEIS also discussed the no Build alternative. According to the FEIS, this alternative assumes that there will be no new roadway construction resulting in deteriorated traffic conditions and longer and more intense congestion.

2.0 IDENTIFICATION OF INDIRECT EFFECTS IN FEIS

The FEIS provided a detailed analysis on indirect effects; a 102-page technical memorandum was prepared assessing the project's indirect effects on both the natural and cultural environments. The indirect effects analyzed in this memorandum are examples of project induced growth indirect effects. As the FEIS notes:

> "Much of the assessment is qualitative in nature. For this assessment, potential development areas were evaluated for overall environmental impact. This provides an evaluation that could assist local planners and developers in their appraisal and selection of sites for development." (FEIS, 1992: V-2).

The technical memorandum uses the CEQ definition of secondary effects and describes the rationale for assessing indirect effects:

> "Guidelines, prepared by the Council on Environmental Quality (CEQ) for implementing NEPA, broadly define secondary effects as those that are 'caused by an action and are later in time or farther removed in distance but are still reasonably foreseeable' (40 CFR 1508.8). In order to fulfill the general NEPA mandate of environmental sensitive decision-making, the FHWA and PennDOT have directed that secondary impact issues be incorporated into the highway development process for the LVIH.
>
> One of the key points of the LVIH project need is defined as the need to provide direct access to the existing regional highway system from the Valley to better realize economic development opportunities... Therefore, development induced by the construction of the LVIH is not only anticipated but also desired. The induced development may in turn impact the regional environmental resources which would constitute a secondary impact of the LVIH. Because of the indirect nature of secondary impacts. this examination focuses primarily upon the 'functional relationship' between the specific environmental resources within the larger environmental system" (Technical Memorandum, 1992:1).

As another example, impacts to aquatic resources were described as:

> "Direct effects, as define here, would occur if the stream was located within the boundaries of the site. Direct impacts include bridging, culverting, and surface water runoff and dewatering effluent associated with development construction. A stream located adjacent to a secondary development site would be the recipient of indirect impacts. An indirect impact, as defined here, would include increased surface water runoff to the stream during and following development" (Technical Memorandum 1992: 29).

The basis for this secondary impact analysis was development projections which were based on a review of national and local econometric data and development plans. Growth was modeled for a twenty year period. There was a minimum projected development in which 13% of the land in the valley would be developed, and a maximum projected development in which 44% of the land in the valley would be developed. The minimum growth was based on current national and local trends for industrial growth and the assumption that the LVIH facility would attract much of the regional development efforts to the valley. The maximum growth was also based on current national and local trends, but the assumption was that the LVIH would attract all of the regional development. The growth scenarios were predicted for industrial, commercial, and residential.

In addition to these growth assumptions, there were also assumptions about where different types of growth would locate. It was assumed that industrial development would occur near or adjacent to the LVIH. Further, residential development would locate through infilling and expansions of previously existing residential areas. Commercial development would locate via expansion of existing commercial areas and new areas centered around the LVIH interchanges.

The study area for the development projections and analyses of secondary impacts was limited to the municipalities that are traversed by the proposed alternatives. In addition, each of these municipalities has secondary development sites which would be affected by the LVIH, so there is a total of 35 potential secondary development sites in nine municipalities. These development sites were identified by the local municipality, the Scranton-Lackawanna Industrial Building Company (the development arm of the Greater Scranton Chamber of Commerce), and by professional judgement. For each of these sites, the preparers of the FEIS assessed the impacts on thirteen areas: wetlands, biodiversity, stream water quality, air quality, noise, solid waste sites, solid/ geology, mine hazards cultural resources, water supply, waste water management, stormwater management, and transportation system. Each site was rated either High, Moderate, or Low for the potential to affect each resource.

The following discussion summarizes how each of these issues was assessed:

WETLANDS

- *Hydrology.* The wetland analysis for secondary development was conducted using existing information (such as NWI mapping, wetland data collected for the LVIH Lackawanna County Soil Survey, and field reconnais-

sance) and a limited field view. The number of wetlands, acres of wetlands, acres of hydric solid and acres of hydric component soil were estimated for each development site.

BIODIVERSITY

- *Species Diversity.* This analysis used both existing historical information (USGS mapping Anderson Land Cover/Land Use Mapping and critical habitat mapping) and field view. Biodiversity was evaluated at two different levels, beta diversity (species diversity between community types within one specific site) and gamma diversity (species diversity among communities over a geographic region).

TERRESTRIAL HABITAT

- *Vegetative and Animal Communities.* This analysis was based upon Anderson land cover, existing vegetative communities, critical habits and representative wildlife. In addition, each secondary development site was visited to determine the types of vegetative communities present. The vegetative communities, critical habitat and land cover mapping were evaluated to determine which species would utilize the habitat in each development site.

SPECIES OF SPECIAL CONCERN

- *Endangered, Threatened and Rare Species.* This analysis utilized information from the Pennsylvania Natural Diversity Inventory data base and related publications. The purpose of this analysis was to determine the potential occurrences and the existence of preferred habitat of species of special concern within the sites.

SURFACE WATER AND AQUATIC RESOURCES

- *Surface Water Resources.* USGS mapping, U.S. EPA STORET data, U.S. ACOE's Lackawanna River Basin Report and Pennsylvania Game and Wildlife stream data and other reports were analyzed to determine both direct and indirect effects. Existing stream quality was examined to determine if any development impact could have adverse effects to the stream.
- *Aquatic.* The aquatic survey included flow measurements, chemical analysis, electrofishing studies, and substrate composition analysis to determine quality rating. This rating and the geographical relationship to the proposed development sites were used to rank the potential impact to the streams.

AIR QUALITY

- A qualitative analysis was done using information on industries that have expressed an interest in locating in the Valley, including the type of industry, and on traffic associated with this new development. Potential development sites were evaluated on the proximity to receptors and likely development for that site.

NOISE

- According to the Technical Memorandum noise impacts will be minimal. New residential areas are not expected to generate noise and commercial and industrial areas are not near sensitive receptors.

MUNICIPAL, INDUSTRIAL, AND HAZARDOUS WASTE FACILITIES

- The evaluation of potential for hazardous waste sites and landfills was based on data acquired during the LVIH corridor evaluation. State and federal data bases were reviewed to locate known hazardous waste sites. "A qualitative assessment of a given site's potential to contain hazardous materials or relative impact was therefore performed on the basis of this information" (Technical Memorandum, 1992: 49). The acres of landfill and acres and cubic yards of trash were calculated to determine the impact rating for each site.

SOILS AND GEOLOGY

- Both aerial photography and soil survey data were used to determine soil erodibility. For each development site, both the percentage areal coverage and the percentage of land adjacent to water (wetlands and streams) were calculated for both erodible soils and unsuitable soils. Where there are large deposits of culm and silt, the secondary impact (i.e. development) will be positive, since these deposits will be stabilized or reclaimed. In addition, existing sources of erosion and sediment pollution can be corrected either by stabilization or elimination.

MINING AND MINE HAZARDS

- Both surface and deep mining information for the 35 development sites were obtained from Penn. Department of Environmental Resources Bureau of Abandoned Mines Reclamation and Office of Surface Mines. From this data, the following percentages of total land area for each site were calculated: surface mine, reclaimed, subsidence, and deep mine. A positive impact of developing a strip mined area would be recla-

mation, which would reduce environmental impacts, such as soil erosion.

CULTURAL RESOURCES

- Both historic structures and archeological resources were inventoried for each potential secondary development site. For each site, a historic inventory was performed determining what major structures historically existed in the area. In addition, known historic and archeological sites with their existence/status (i.e. if the site was located during field reconnaissance) and significance were determined by using maps, aerial photographs and field reconnaissance.

INFRASTRUCTURE

- *Ground Water and Public Water Supplies.* For each development site, the percentage of the site within the watershed and the percentage of the site within the public water supply was calculated. The local water company helped to provide information accessing the impacts to the water supply and to determine the constraints to the water supply, such as requiring pumping/storage facilities to overcome elevations.
- *Wastewater Collection, Treatment, and Disposal.* Wastewater collection flows were calculated from NPDES permits and operation reports for both development scenarios and compared to the existing hydric capacities at the two local treatment plants. Sites were also evaluated in terms ease of connection to the collection system.
- *Natural Gas Distribution and Supply and Electrical Power Distribution Supply.* These issues were discussed very briefly and there was no impact for any of the development sites.
- *Transportation System.* For this analysis, areal photographs were used to determine the roadway extensions from the development sites to connector roadways. Depending on the terrain (severe terrain is 2.5 times more expensive to construct), the cost to construct the connector roads was calculated.
- *Stormwater and Floodplain Management.* Existing drainage problems, location of floodplains and existing institutional controls were evaluated to determine the impact rating for each development site.

ECONOMY

- *Economic Development.* Due to the development of the LVIH, additional income will increase. The minimum development scenario predicts that there will be 9,000 additional jobs, while the maximum development scenarios predicts that there will be 14,000 additional jobs. An average salary of $20,000 was multiplied by the increase in jobs to obtain additional income desired.
- *Tax Base.* The following data were used to perform the assessment of the project on the county, municipal, and school district tax base: market value of taxable property, total assessed value by municipality, total tax revenues, municipal millage rates and common level ratio. Then the estimated percentage in real estate taxes was calculated for both the projected minimum and maximum development and the no build scenario at the county, municipal, and school district level for the following land uses: undeveloped, residential, commercial, and industrial.

3.0 FRAMEWORK APPLIED TO THE PROJECT

Step 1. Identify Study Area's Needs and Goals

In 1991, the Plan for the Lackawanna Heritage Valley was published for this region. A partnership among all levels of government created the Lackawanna Heritage Valley, a type of regional conservation and development area. The goals of this plan include:

- enhance cooperation between communities to develop recreational, preservation, and educational opportunities in the valley;
- develop preservation mechanisms to help Valley communities protect their historic, cultural, and folklife resources, interpret the resources and stories of the Lackawanna Valley;
- interpret the resources and stories of the Lackawanna Valley and integrate the Valley's heritage into local educational programs;
- integrate the Heritage Park into the lives of the people who live in the Valley;
- develop a program for economic revitalization that uses the Valley's heritage to promote increased tourism and other private reinvestment in key buildings and districts;
- link major Valley resources physically and interpretatively using cooperative strategies (Plan, 1991:9).

While the focus of this plan was to create a unified region centered on heritage and tourism, the economic revitalization goal has direct relevance to the Lackawanna Valley Industrial Highway. This plan calls for Economic revitalization by targeting key areas for immediate redevelopment and by encouraging "economic growth in a positive planned way to maintain current quality and green landscape of the Valley" (Plan, 1991: 45).

In addition, Tables E-22 and E-23 were completed to help identify the study area's goals and objectives. Table E-22 reveals multiple health and well being goals, such as preserving heritage, promoting land use patterns with a sense of community, and achieving adequate, appropriate open space and recreation. Economic opportunity goals include trigger-

TABLE E-22
ORGANIZATION AND TABULATION OF GOALS CHART
(Check where applicable)

Project Name: *LVIH* Location: *Scranton, PA* Analyst: *J. Parry* Date: *3/14/96*

		Notes
Social Health and Well-Being Goals		
√	Achieve adequate, appropriate and accessible open space and recreation	*Preserve hillsides*
√	Comply with state and federal water and air quality laws	*Ozone*
	Preserve or create multicultural diversity	
√	Preserve heritage	*Lackawanna Valley Heritage Park*
	Provide choice of affordable residential locations	
	Provide urban environment for those with special needs	
√	Promote land use patterns with sense of community	
	Provide a range of services accessible to all	
√	Promote a healthy and safe environment	
	Provide sound management of solid and hazardous waste	
	Other	
Economic Opportunity Goals		
√	Support activities to meet changing economic conditions	*Industrial parks, tourism*
	Provide energy-efficient transportation	
	Provide developments with transit-supported capabilities	
√	Target economic export activities	*Industrial parks*
√	Attract and maintain workforce	
√	Promote infill of smaller, passed-over sites	*Residential development*
√	Encourage redevelopment of older areas for new purposes	*Rehabilitation of older building and reclamation*
	Other	
Ecosystem Protection Goals		
√	Protect ecosystems	*Wetlands, rhododendron, birch*
	Minimize fragmentation	
√	Promote native species	*Snowshoe hare*
	Protect rare and keystone species	
√	Protect sensitive environments	*Hillsides*
	Maintain natural processes	
	Maintain natural structural diversity	
	Protect genetic diversity	
√	Restore modified ecosystems	*Abandoned strip mines, coal spoils*
	Other	

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ing economic export activities, attracting a work force, and encouraging redevelopment of older areas for new purposes. Ecosystem protection goals include protecting ecosystems, protecting sensitive environments and restoring modified ecosystems. Table E-23 indicates that declining population and employment in the Valley, as well as zoning, municipal master plans, a Stormwater Management Plan and Lackawanna River Citizens Master Plan provide directions to the future of the Lackawanna Valley.

Product: Completion of Goals checklist, such as Tables E-22 and E-23.

Step 2. Identify Notable Features

Referring to Table E-24, notable features of the area include ecosystem and socioeconomic characteristics. The following features were identified from field visits, interviews with local planners and comprehensive plans.

As seen by completing Tables E-24 and E-25, the project can impact several notable features. There are several ecosystem features, such as critical habitats (wetlands, rhododendron bottoms, evergreen stands, and shrub brush) and species of special concern (snowshoe hare) in the Valley. In addition, there are many socioeconomic features such as non compliance with state and federal laws, inadequate affordable housing, an economically distressed area, high proportion of low income and elderly residents, and locations of poor traffic flow. Furthermore, the notable features addressed by federal statutes include Section 4(f) resources (historic and archeological sites), sensitive receptors for air and noise, non-attainment for ozone, and residential or commercial establishments.

TABLE E-23
STUDY AREA DIRECTIONS AND GOALS CHECKLIST
(Check where applicable)

Project Name: *LVIH* Location: *Scranton, PA* Analyst: *J. Parry* Date: *3/14/96*

1. **Generalized Setting**
   Within Metropolitan Statistical Area (Identify MSA) √
   Outside of MSA
   Both Inside and Outside MSA *Scranton/Wilkes-Barre* Indicate Distance to Nearest Metropolitan Center *1.5 miles*

2. **Characteristics of Transportation System** (Note: These items are not intended to cover entire transportation need but rather to use information from more detailed assessments to provide a preliminary indication of existing accessibility, service and modal interrelationship characteristics, i.e., factors relevant to subsequent indirect effects analysis).

   - Identify missing links in transportation system _____.
   - Map and describe existing level of service on minor and principal arterials and their access characteristics.
   - Indicate distance to nearest interstate highway if not in study area.
   - Map and describe existing transit routes and demand.
   - Map and describe major concentrations of existing and planned development.
   - Describe modal interrelationships including competing and complementary characteristics.

3.

Population	Trend	Projection
Declining	√	
Static (±1%/10 years)		
Slow Growth		√
Rapid Growth (>10%/10 years)		

Employment	Trend	Projection
Declining	√	
Static (±1%/10 years)		
Slow Growth		√
Rapid Growth (>10%/10 years)		

4. **Planning Context**

	Yes	No	If yes, identify by title, agency and date
Zoning	√		*Various municipalities*
State Master Plan		√	
County/Regional Master Plan	√		*Lackawanna Heritage Valley, Lackawanna Valley Team, 1991*
Municipal Master Plan	√		*Various municipalities*
Growth Management Plan		√	
Water Quality Management Plan	√		*Stormwater Management Plan, Lackawanna County Planning Dept.*
Other Natural Resources Management Plan	√		*Lackawanna River Citizens Master Plan, 1990*

5. **For each plan identified in No. 3, summarize key goals, elements and linkages to other plans (specify, in particular, elements related to economic development, land use development, the transportation system, and natural resource protection).** *Develop recreational, preservation and educational opportunities, develop a program for economic revitalization, link major valley resources*

6. **Describe any efforts to elicit local needs and goals from residents and/or agencies (source and result).** *PennDOT, U.S. EPA, PADER, FHWA, Pennsylvania Game Commission*

7. **Describe known plans for major new or expanded activity centers including public facilities.** *Prison*

   Is the activity center dependent on transportation system improvement? Yes ____ No √

8. **Is the transportation need linked to economic growth and land development?** Yes √ No ____
   If yes, is the nature of the linkage to:
   Serve the needs of planned growth ____ or
   Channelize growth ____ or
   Stimulate growth √ or

9. **Based on information obtained, are there any apparent conflicts between transportation and other needs that could result in controversy? (Describe).**
   Yes √ Possible ____ No ____

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Product: List of notable features for the indirect effects assessment, with an accompanying map illustrating the location and the extent of the feature, where appropriate. Completion of Tables E-24 and E-25.

Step 3. Identify Impact-Causing Activities of Proposed Actions and Alternatives

The Lackawanna Valley Industrial Highway aims to promote economic development including new residential, commercial. and industrial uses. This project is being marketed for its strategic location since it is in close proximity to both interstate and regional highways. In addition, the Valley municipalities have skilled and experienced workers, stable communities, and a low cost of living and of doing business.

In addition to inducing development, the LVIH could create several other impact causing activities. The construction of the road will modify both the regime and habitat and alter the ground cover. This new transportation facility will create both land transformation and construction. There will also be land alteration including: erosion control, stormwater management, reclamation of strip mines and associated coal spoil

TABLE E-24
NOTABLE FEATURES CHECKLIST
(Check where applicable)

Project Name: *LVIH* Location: *Scranton, PA* Analyst: *J. Parry* Date: *3/14/96*

	Ecosystem Features	Specify
√	Regional habitats of concern/critical areas	*Wetlands, shrub brush, rhododendron bottoms*
√	Rare, threatened or endangered species and associated habitat	*Snowshoe hare*
___	Species requiring high survival rates	
___	Species whose intrinsic rates of increase fluctuate greatly	
___	Communities with vulnerable keystone predators or materialists	
___	Other ___	
	Socioeconomic Features	
___	Substandard amounts of open space and recreation	
√	Non-compliance with state and federal environmental laws	*Ozone*
√	High concentration of uncontrolled solid and hazardous waste sites	*Strip mines and coal spoil*
√	Inadequate affordable housing	
√	Inadequate access to amenities	
√	Economically distressed areas	
___	Lack of institutional land use controls	
√	High proportion of population consisting of:	
___	Minorities	
√	Low-income residents	*Majority of low-income are also elderly*
√	Elderly	
___	Young	
___	Disabled	
___	Low proportion of long-term residents	
√	Locations of poor traffic flow	*Route 6, O'Neil Highway, secondary streets*
___	Other ___	

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areas, and wetland impacts. The completion of the road will change both automobile and truck traffic patterns in the region. In addition, there will be emplacement of spoil and overburden. Finally, the chemical deicing and chemical runoff from the road could also cause an indirect impact (see Table E-26).

Product: A comprehensive list of the impact-causing actions of the proposed plan or project and alternatives, in as much detail as possible. Table E-26 is an example.

Step 4: Identify Indirect Effects for Analysis

The indirect effect from this project with a high need-to-know factor is the possible haphazard and unplanned development in the region. The improved access combined with land availability makes this region ripe for economic revitalization by having companies and residents relocate in close proximity to the roadway.

The critical land use indirect effect question for this project, given the region's stated goals and needs is: How will the projected economic growth and development comply with the needs of the Lackawanna Heritage Valley Plan? What controls need to be implemented so that the growth and development is orderly and preserves the green landscape of the Valley?

Other questions relating to indirect effects are:

- *Socioeconomic:* Will the induced development create suburban sprawl and sprawl up the hills of the Valley? Where will development locate? Will this new development adversely impact cultural and historic resources and recreation?
- *Ecological Effects:* How will habitat fragmentation affect the Valley's natural resources? What will be the impacts from runoff and air and noise pollution?
- *Induced Growth:* The project is likely to influence interregional land development location. What will be the effects on land use, property values, and land availability?

Table E-27 was applied to this project. The regional study area conditions indicate that the businesses and civic leadership are committed to rapid development and the industrial parks are potential major growth generators indicating that the conditions generally favor growth. The local study area conditions also indicate that there is the strong possibility that land use conversion will be induced by the project due to its immediate vicinity.

This corridor study confirms existing patterns, since the local officials and the regional Chamber of Commerce

TABLE E-25
NOTABLE FEATURES ADDRESSED BY FEDERAL STATUTES
(Check where applicable)

Project Name: *LVIH* Location: *Scranton, PA* Analyst: *J. Parry* Date: *3/14/96*

Resource Type or Area	Statute/Order	Source of Information and Map Locations
___ Section 4(f) Resources _√_ Public Parks and Recreational Lands ___ Wildlife and Waterfowl Refuges _√_ Historic Sites _√_ Historic Districts _√_ Archaeological Remains _√_ Historic Structure	Department of Transportation Act	Local Parks or Recreation Officials, State Historic Preservation Office or local historic preservation organizations
___ Coastal Zone	Coastal Zone Management Act	State Coastal Zone Management Office
___ Waters of the United States	Clean Water Act; E.O. 11990	State Fish and Game Commission; U.S. Fish and Wildlife Service
___ Sole Source Aquifer	Safe Drinking Water Act	State Natural Resources Agency; U.S. Environmental Protection Agency
_√_ Areas of Known Contamination	Comprehensive Env. Response Compensation Liability Act	State environmental protection agency; U.S. Environmental Protection Agency
___ Floodplains	E.O. 11988	Federal Emergency Management Agency
___ Range or Habitat of Threatened or Endangered Species	Endangered Species Act	State Fish and Game Commission; U.S. Fish and Wildlife Service
___ Wild, Scenic or Recreational River	Wild and Scenic Rivers Act	U.S. National Parks Service
___ Prime or Unique Farmland	Farmland Protection Act	U.S. Soil Conservation Service
_√_ Sensitive Receptor	Clean Air Act; Noise Control Act	State environmental protection agency
_√_ Nonattainment or Maintenance Areas	Clean Air Act	State and local air and transportation agencies; metropolitan planning organizations; state implementation plans; conformity determinations of transportation plans, programs and projects.
_√_ Residential or Commercial Establishments	Uniform Relocation Act; E.O. 12898	Local governments

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TABLE E-26
PROJECT IMPACT-CAUSING ACTIVITIES CHECKLIST

Project Name: *LVIH* Location: *Scranton, PA* Analyst: *J. Parry* Date: *3/14/96*

	Yes	No	If Yes, Describe Generally (Breadth, Duration, Location and Type)
Modification of Regime			
Exotic Flora Introduction		√	
Modification of Habitat	√		
Alteration of Ground Cover	√		
Alteration of Groundwater Hydrology		√	
Alteration of Drainage		√	
River Control and Flow Modification	√		
Channelization		√	
Noise and Vibration		√	
Land Transformation and Construction			
New or Expanded Transportation Facility	√		
Service or Support Sites and Buildings		√	
New or Expanded Service or Frontage Roads		√	
Ancillary Transmission Lines, Pipelines and Corridors		√	
Barriers, Including Fencing		√	
Channel Dredging and Straightening		√	
Channel Revetments		√	
Canals		√	
Bulkheads or Seawalls		√	
Cut and Fill		√	
Resource Extraction			
Surface Excavation	√		
Subsurface Excavation		√	
Dredging		√	
Processing			
Product Storage		√	
Land Alteration			
Erosion Control and Terracing		√	
Mine Sealing and Waste Control	√		
Landscaping		√	
Wetland or Open Water Fill and Drainage	√		
Harbor Dredging		√	
Resource Renewal			
Reforestation		√	
Groundwater Recharge		√	
Waste Recycling		√	
Site Remediation	√		

Changes in Traffic (including adjoining facilities)			
Railroad	—	√	
Transit (Bus)	—	√	
Transit (Fixed Guideway)	—	√	
Automobile	√	—	
Trucking	√	—	
Aircraft	—	√	
River and Canal Traffic	—	√	
Pleasure Boating	—	√	
Communication	—	√	
Operational or Service Charge	—	√	
Waste Emplacement and Treatment			
Landfill	—	√	
Emplacement of Spoil and Overburden	—	√	
Underground Storage	—	√	
Sanitary Waste Discharge	—	√	
Septic Tanks	—	√	
Stack and Exhaust Emission	—	√	
Chemical Treatment			
Fertilization	—	√	
Chemical Deicing	√	—	
Chemical Soil Stabilization	—	√	
Weed Control	√	—	
Pest Control	—	√	
Access Alteration			
New or Expanded Access to Activity Center	√	—	
New or Expanded Access to Undeveloped Land	√	—	
Alter Travel Circulation Patterns	√	—	
Alter Travel Times between Major Trip Productions and Attractions	√	—	
Alter Travel Costs between Major Trip Productions and Attractions	√	—	
Others			
_____	—	—	
_____	—	—	
_____	—	—	

	Name	Affiliation	Date
Reviewed by:			

picked most of the development sites which formed the basis for the analysis of secondary effects. The selection of these sites was outside the agency's (PennDOT) control and are examples of induced effects. The subsequent Lackawanna Valley Corridor Plan is an example of how different agencies (state, county and local) can work together to analyze the project's induced growth.

Product: Completion of Tables E-27 and E-28. A technical memorandum that lists the indirect effects that warrant further analysis and presents the scope of analysis to be conducted in Step 5.

Step 5: Analyze Indirect Effects

The suggested framework emphasizes targeting the effects that have a degree of certainty to their occurrence, a specificity to the extent of the occurrence and a need-to-know

TABLE E-27
CHECKLIST FOR ASSESSING STUDY AREA'S POTENTIAL FOR INDUCED GROWTH

Project Name: *LVIH* Location: *Scranton, PA* Analyst: *J. Parry* Date: *3/14/96*

Regional Study Area Conditions

[A yes answer indicates that conditions generally favor growth; the more yes answers, the higher the certainty that regional conditions generally favor growth.]

1.	Is the regional population increasing rapidly (generally, >5% per 10 years)?	*N*
2.	Is the region considered favorable for receiving FHA/VA loans?	*N*
3.	Are there any major growth generators (e.g., universities, military installations, industries, tourist attractions) in the region?	*Y*
4.	Is the regional office/commercial market characterized by low (generally, <10%) vacancy rates in any class of space?	*N*
5.	Is the region's business and civic leadership committed to rapid development?	*Y*
6.	Is the region an exporter of natural resources?	*N*

Local Study Area Conditions

[If it is concluded that regional conditions generally favor growth, then proceed with the next series of questions. A yes answer indicates that the area in the immediate project vicinity has land use conversion potential; the more yes answers, the higher the certainty that land use conversion will be induced by the project to its immediate vicinity.]

General indicators

7.	Is the regional path of development in the direction of the local study area?	*Y*
8.	Is the project within 5 miles of a growing community (generally, >5% per 10 years)?	*Y*
9.	Is the local study area characterized by middle and/or high income levels?	*N*
10.	Is the local study area free of moratoriums on development (e.g., sewer moratoriums, growth restrictions)?	*N*

Indicators of conditions favorable to conversion to lower density development

11.	Is the local study area within a 30-minute drive of a major employment center?	*Y*
12.	Does the local study area have relatively high land availability/low land prices (generally <one-third of larger parcels developed)?	*Y*
13.	Is the vacant land characterized by relatively large parcels?	*Y*
14.	Is the local study area characterized predominantly by level land (generally, <5% slope)?	*N*
15.	Is the project's Potential Impact Area characterized by soils suitable for development?	*N*
16.	Is the project's Potential Impact Area predominantly free of flooding or wetlands?	*Y*

Indicators of conditions favorable to conversion to higher density development

17.	Does the local study area have relatively low land availability/high land prices (generally >two-thirds of larger parcels developed)?	*N*
18.	Is the local study area served by existing principal arterials and water/sewer systems?	*Depends*
19.	Is the local study area covered by relatively few governmental jurisdictions?	*N*
20.	Is the local study area characterized by poorly enforced zoning regulations?	*N*
21.	Does the local study area lack recent (generally, <10 years old) master plans?	*Depends*

Reviewed by: Name Affiliation Date

impact. The methods, described in a preceding section and used in the Technical Memorandum of the FEIS, are consistent with the assessment framework. The preparers of the FEIS did a very detailed analysis of each proposed development site for each indirect effect. They used both qualitative tools, such as professional judgement, and quantitative techniques, such as trend analysis, to examine the indirect effects. They also looked at where development should occur so that it is planned and orderly.

There are several opportunity-threats associated with this project. For example, some anticipatory construction has taken place; industrial parks have located adjacent to the right-of-way of the proposed LVIH. There are also economic opportunity-threats, yet there appears to be no analysis of land speculation and change in property values. It would be useful to know about these issues to gauge if the proposed development is closer to the minimum or maximum level of development.

Product: A technical memorandum that describes the indirect effects, the chosen analysis methods, and the analysis results.

Step 6. Evaluate Analysis Results

The analysis using both the minimum and maximum level of development projected an overall picture of future development in the area. Assuming that even the minimum project-related development occurs, it will promote much needed economic growth in the area, help stimulate the local municipal economies, and provide new job opportunities.

Product: Technical memorandum combining steps 1 through 5.

Step 7. Access the Consequences and Develop Mitigation

If the county can implement a plan that guides where growth can occur and have the local municipalities adopt this plan, then indirect effects can be minimized. If the municipalities adopt this plan, then they would have to change their master plan and zoning ordinances to prevent random unplanned development and sprawl throughout the Valley and to relate to the needs of the Valley, such as maintaining the green landscape, preserving historical and cultural resources, and reclaiming abandoned strip mines and coal spoil areas.

There are gainers and losers in the construction and operation of the LVIH. The gainers are the municipalities and the people living in the Valley whose quality of life will be improved by the highway. They will have access to the interstate network which will create more accessibility which in turn will create economic development. The losers are those

TABLE E-28
EVALUATION MATRIX FOR PROJECT INDIRECT EFFECTS OF CONCERN
Project Name: *LVIH* Location: *Scranton, PA* Analyst: *J. Parry* Date: *3/14/96*

Indirect Effect Type	Direct Effects from Impact-Causing Activities	Indirect Effects from Direct Effects (List)	Potential Manifestation of Indirect Effects (List)	Link between Indirect Effect and Goal or Notable Feature that Meets Assessment Criteria[1]	
				Yes (Go to Step 5)	No (Assessment Complete)
Encroachment-Alteration	Ecosystem-related				
	Socioeconomic-related				
Induced Growth (Access-Alteration)		Serves specific development			
		Stimulates complementary development	*Development at interchanges, wetland loss, reclamation, fragmentation*	√	
		Influences location decisions			
Effects Related to Induced Growth			Ecosystem-related		
			Socioeconomic-related		

[1] Assessment criteria = (1) Confidence that the effect is likely to occur; (2) Know enough about indirect effect to make consideration useful; and (3) Need to know about the impact now.

Reviewed by: Name Affiliation Date

municipalities outside of the study area who will lose the new development when it locates adjacent to the LVIH.

In addition to being constructed, there has also been a plan (The Lackawanna Valley Corridor Plan) prepared to address the secondary impacts caused by this project. Although outside PennDOT's control, this agency coordinated a local effort to develop land use controls to minimize indirect effects consistent with Supreme Court decision. The FHWA and PennDOT provided $300,000 to prepare this plan. The following agencies provided assistance by serving on the technical committee agencies: FHWA, U.S. EPA, U.S. Army Corps of Engineers, PennDOT, Penn. Department of Community Affairs, Penn. Department of Environmental Resources, and Penn. Game Commission.

The Lackawanna Valley Corridor Plan was prepared as part of the approval process for this highway:

> "Review agencies for the FEIS were concerned with potential environmental consequences of the economic development expected to accompany the new highway. The federal and state agencies were looking for some assurance that development occurring as a result of the highway construction would take place in an environmentally-sensitive manner. In response, the Lackawanna County Regional Planning Commission proposed to the agencies that a study be undertaken to analyze the secondary impacts of the construction of the LVIH and that a framework for future land use in the Valley be devised, along with transportation improvements and land development regulations, to protect environmental resources and community character. The Lackawanna Valley Corridor Plan is that study."

The county and local officials worked together in preparing this plan. In addition, there was substantial citizen participation throughout the planning process. There were several different committees involved and three widely-advertised presentations were made over the course of the study, oriented to the public-at-large. In addition, newsletters were prepared during the study and mailed to Valley residents to keep them informed of progress on the Corridor Plan.

This plan prepared a framework for the future growth in this region. There are detailed recommendations in several areas which will be summarized below:

- *Cultural Historic. and Landscape Resources Conservation Plan.* The plan "proposed the sensitive integration of new small- to-moderate scaled commercial and residential additions to the historic communities in the Valley, thereby strengthening local economic opportunities and supporting the social organization of these places." The plan also calls for historic overlay zoning which will help municipalities protect their historic resources.
- *Housing Plan.* The housing plan divided the Valley into two regions: low growth and growth. Low growth areas included most of the sides of the Valley east of LVIH and west of Route 6, and are proposed primarily for resource conservation, environmental protection and very low density residential development. Growth areas are usually next to previously existing residential areas, and involve the clustering of development to preserve the hillsides of the Valley. The plan also suggests TDR options for landowners in the low growth areas. Medium to high density should occur close to central business districts and existing neighborhoods.
- *Circulation Plan.* The plan involved traffic modeling to determine the future traffic needs of the Valley. By implementing the plan, three major areas of traffic congestion will be relieved. Strategies to provide for future transportation needs include: traffic monitoring areas, traffic signals, new bridges and highway construction, and congestion management corridors.
- *Community Facilities Plan.* This plan briefly discusses the future needs of the schools, emergency services, and park and recreation facilities.
- *Environmental Protection.* This plan discusses storm water management and flood and erosion control by stating that "local regulations be promulgated in the Valley and in all surrounding municipalities be based on watershed-wide considerations." Wetlands can be protected "by directing development away from these areas, by encouraging clustered construction on higher ground surrounding wetlands, and by purchasing wetlands important to protecting local floodplains or ecological systems." Finally, development should be minimized and closely regulated in other environmentally sensitive areas, such as woodlands, steep slopes and areas with high water tables.
- *Reclamation Plan.* "The corridor plan emphasizes the reclamation of mine spoils for development areas for future industrial, commercial, institutional, residential and open space uses. . ..The most accessible sites to LVIH interchanges. . .may achieve a high enough evaluation to justify the expense of strip mine reclamation to prospective developers of business parks, shopping centers, or similar relatively high-intensity uses in the Valley."
- *Utilities Plan.* The plan encourages that central water and sewer service be limited to the ares designated for growth, which will prevent sprawl from occurring. New sewer lines will be constructed to reach the Interchange Activity Centers and other areas designated for new development.
- *Land Use Plan.* This plan is the heart of the Corridor Plan, since it determines where each type of land use will occur in the Valley.

  "The Land Use Plan, in combination with other parts of the Corridor Plan. . .presents a desired future land use pattern in the Lackawanna Valley for the year 2014, and reflects generally modest population growth, more substantial employment, a balanced land-use mix, conservation of natural and cultural resources, mine spoils

reclamation, and efficient utilization of existing water and sewer systems. The Plan is based upon a 2014 Valley population of between 65,000 and 75,000 persons, an increase of about 2,400 to 2,800 housing units above the present inventory, and a net increase of about 8,700 jobs."

Growth areas are concentrated in the Valley's floor while the Valley sides are to be preserved. There are six major identity areas:

- *Interchange Activity Centers.* These centers occur at the interchanges of the LVIH and concentrate commercial development at these areas, thus preventing sprawl up the sides of the Valley and along the highway. These centers will provide "one-stop" patronage of different facilities.
- *Resource Conservation.* These areas will conserve steep slopes, woodlands, aquifer recharge areas and cultural resources. Only low density uses will be permitted in these areas.
- *Commercial.* There are three types of commercial uses for this area, central business districts located in the municipalities, highway strip development located on Route 6, and Interchange Activity Centers.
- *Open Space, Parks.* These areas include parks, game lands, floodplains, wetlands, areas of steep slopes, and reservoir areas. Permitted uses would be low-intensity recreation and open space used, and limited agriculture and forest management. Open space buffers around growth areas are also included.
- *Growth Area Residential.* These areas are the location for new residential development which incorporate flexibility of housing types and densities to meet the future needs of the Valley.
- *Industrial.* Most of the industrial areas are to be located in the southern end of the LVIH which is close to the interstate highway system.

In order for this plan to be effective, the local municipalities have to endorse and follow through on the ideas presented in this plan. In order for this plan to be effective in controlling secondary development comprehensive plans and "zoning ordinance and subdivision and land development ordinance changes are among the most significant tools for the plan, translating its sometimes broad concepts into specific regulations with which to guide future development." As part of the Corridor Plan, model land development regulations were prepared which the municipalities can adapt to their own municipality. Also, the county planning department will provide assistance when the municipalities change their zoning, subdivision, land development ordinances and subdivision plans so that they are consistent and implement the ideas contained in the Corridor Study.

Product: Develop growth control measures and a regional plan to guide development in the Valley.

4.0 CONCLUSION

The FEIS for this project provided a very detailed analysis of secondary impacts which was primarily qualitative in nature. The approach to indirect effects assessment for this project was consistent with that suggested by this study's framework.

This project was innovative since both federal and state transportation agencies provided both money and technical assistance in developing a plan to mitigate the effects of the proposed highway. This regional plan, if adopted by all of the municipalities, will provide an excellent mechanism to ensure orderly growth and preserve the resources of the Valley while allowing economic development.

5.0 REFERENCES

Final Environmental Impact Statement and Section 4(f) Evaluation for the Lackawanna Valley Industrial Highway. PennDOT, 1992.

Technical Memorandum: Secondary Impacts Evaluation for the Lackawanna Valley Industrial Highway Environmental Impact Study, Skelly and Loy, Inc., 1992.

Plan for the Lackawanna Heritage Valley, The Lackawanna Valley Team, 1991.

Lackawanna Valley Corridor Plan, Lackawanna County Regional Planning Commission, no date.

E-6 CASE STUDY REPORT: STEWART AIRPORT PROPERTIES (NY) DEVELOPMENT

1.0 PROJECT DESCRIPTION

1.1 Introduction

Stewart International Airport in Orange County, New York is a general aviation facility at the junction of Interstates 84 and 87 (see Figure E-10). As part of efforts to relieve projected growing air traffic congestion at the New York City airports, the Federal Aviation Administration (FAA) encouraged the development of the state-owned Stewart Airport to serve as a passenger and air cargo facility for the Mid-Hudson Valley region. To increase demand for the airport, the New York State Department of Transportation (NYSDOT), which has operational jurisdiction for the facility, proposed the development of approximately 1,200 acres of the 10,000-acre airport property site for light industrial, warehouse/distribution and office uses.

The prime economic development goal of this project is to increase the level of regional business activity to provide demand for air travel at Stewart Airport. It is envisioned by the NYSDOT that the state-initiated development of the site through planned water and sewage infrastructure, tax incen-

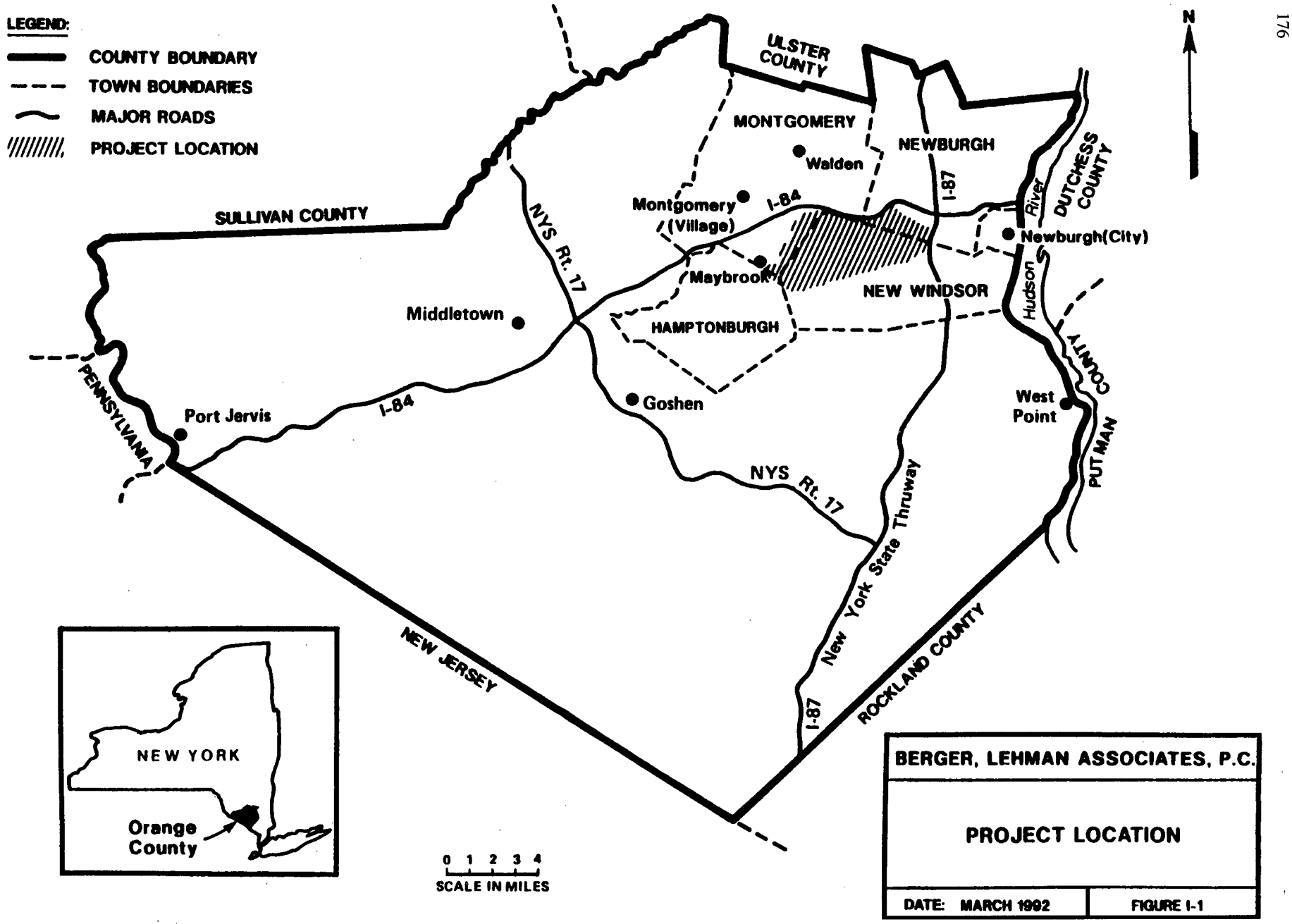

Figure E-10. Stewart International Airport study.

tives and subsidized energy would act as a catalyst for overall economic development in the region and spur demand for air travel at Stewart Airport. The economic development aims for Stewart Airport originated from the 1971 acquisition of over 8,000 acres of land from the local tax rolls to serve as noise buffer and expansion space for airport operations. To mitigate adverse economic impact to the local communities, the airport operations agency was given a legislative mandate to promote economic development for the communities in and around Stewart Airport and to provide payments-in-lieu-of-taxes to the affected communities for planned development.

The 1992 Stewart Airport Properties Final Environmental Impact Statement (FEIS) reviewed for this case study addresses the adoption and implementation of the master plan created to govern the future development of Stewart Airport and the adjacent Stewart Airport Properties. This case study will examine how project indirect effects were identified and analyzed in the environmental impact statement process and will also apply the suggested framework for assessing indirect effects. While this case study is unique in that the project is not directly a transportation project but rather a land development plan, it will be useful to transportation agencies as a sample of methods for assessing land development impacts, a common indirect effect of transportation projects. For this reason, the Stewart Airport Properties project was chosen for application of the suggested indirect effects framework.

1.2 Purpose and Need of Project

According to the FEIS for the Stewart International Airport Properties project, the purpose of the proposed project is to:

> "[D]evelop portions of the Stewart Properties that would promote the utilization of Stewart International Airport as a regional airport;
>
> - to generate revenues for the State of New York;
> - to promote economic development in the area of Stewart International Airport;
> - to accommodate projected regional commercial development demand in a sound and responsible manner; and
> - to return lost ratables through payments in lieu of taxes to local municipalities and school districts by providing for non-aviation, aviation compatible development on state-owned property (FEIS pII-1)."

The proposed project is to develop seven million square feet (MSF) of office, light industry, warehousing and flexible use space on land adjacent to Stewart Airport to generate approximately 20,000 resident business trips by air as well as attract 14,900 trips to businesses with operations at the airport. Of the seven MSF of planned development, approximately 26 percent of the space is allocated for office/commercial space. Approximately 1,000 acres presently house airport and airport-related buildings. The remainder of the site, the noise buffer, is used in the interim as a public cooperative hunting area operated by the New York State Department of Environmental Conservation and as farmland.

1.3 Affected Environment and Alternatives Considered.

The Stewart Airport Properties site is approximately 2.5 miles north-south and 6.5 miles east-west. Orange County experienced 32 percent population growth from 1970 to 1990 and was the center of population and housing growth in the ten-county New York-New Jersey region surrounding Stewart Airport. Employment growth, however, was centered in Bergen County, N.J. and Westchester County, N.Y. The site is host to various wildlife, wetlands and potential archaeological sites.

The FEIS examined a no-action alternative of no directed development on the Stewart Airport Properties and five build alternatives with various spatial development patterns devised under different assumptions and goals. The alternatives were:

- Alternative 1, the no-action alternative, examined what impacts an equal amount of planned development off-site may have on the environment.
- Alternative 2, the master-planned concept, assumed the availability of infrastructure as the prime indicator for development locations.
- Alternative 3, centralized development on the site to east of a major road on the assumption that concentrated development will minimize environmental impact and maximize the area remaining for continued recreational hunting on the cooperative.
- Alternative 4, the scattered site alternative, desired to maximize the area available for development without disturbing wetlands and other environmentally-sensitive areas.
- Alternative 5, the peripheral refinement of Alternative 2, focused development on northern part of the site.
- Alternative 6, the infrastructure-sensitive alternative, aimed to maximize development in areas proximate to existing or planned water and sewage systems.

The above alternatives were examined with respect to impacts to a physical environment as well as on a socioeconomic environment. The baseline analysis revealed that the primary areas of concern from the project were impacts on wetlands, hunting areas, agricultural land and potential archaeological sites. Many of the alternatives posed direct effects on wetlands and reduced recreational hunting areas, wildlife habitat areas, and agricultural land as well as requiring infrastructure improvements such as road building and

the provision of water and sewage services. Alternative five was selected as the preferred alternative for its level of wetland infilling avoidance, minimization of impacts on wildlife resources, and general preservation of the existing site in its current state.

The analysis of No-Action Alternative warrants discussion as the impact methodology employed here differs from those used in the Build Alternatives. The analysis of the No-Action Alternative is predicated on the assumption that a proportion of the projected demand for nonresidential space will continue to focus around Stewart Airport. In the absence of development in the Stewart Properties, that demand will be accommodated in the immediate vicinity of the airport. The report examined where approximately 6.25 MSF of development may occur if it is not accommodated at Stewart Airport Properties. The 6.25 MSF represents the total planned development minus the development area adjoining the airport that is specifically targeted to air cargo-related industries.

The analysis identified areas zoned for office/commercial or industrial use within the primary impact area towns of New Windsor, Hamptonburgh, Montgomery and Newburgh with a carrying capacity sufficient for 6.25 MSF of development. Local planners were interviewed concerning plans for future zoning changes. The planners did not anticipate that the development will cause rezoning pressures, in the No-Action Alternative or the Build Alternative, as the existing inventory of vacant land zoned office/commercial or industrial is expected to accommodate future development.

The No-Action Alternative examined 65 vacant sites in the primary impact areas for land use constraints such as the presence of wetlands. Constraints were deducted from the developable acreage of the 65 sites. Current and proposed water and sewer lines were mapped and overlaid on a base map of the vacant parcels. The sites were then ranked in terms of accessibility, visibility from the road, access to infrastructure, and distance from Stewart Airport. Fifteen sites were identified as being more competitive than the others and able to accommodate a total of 6.25 MSF of development. To provide a No-Action Alternative useful for comparison with the other alternatives, these sites were conceptually analyzed for impacts, such as those on hydrology, wildlife, surface water quality.

The most severe anticipated impact of the No-Action alternative is the extent of wetland filling as a result of untargeted development. The report states:

> It has been assumed that areas mapped either on the National Wetland Inventory (NWI) or NYSDEC wetland maps will not be developed. However, it has also been assumed that if current development practices continue, areas that are mapped as hydric soils, but do not correspond to NWI or NYSDEC wetlands will be developed in the same proportion as other non-wetland soil mapping units. . . . A level of illegal filling was anticipated under the No-Action Alternative although, theoretically, it should not occur [FEIS, pIII-13].

Moreover, impacts to potential archaeological resources was also a concern as only undertakings on federal property or those using funds fall under the provisions of Section 106 of the National Historic Preservation Act. Hence, private developers are under no federal obligation to protect archeological and historic resources. Therefore, the potential filling of 100 acres of wetlands and potential impacts on land having potential archaeological resources were the two prime impacts identified with the No-Action Alternative.

2.0 IDENTIFICATION OF INDIRECT EFFECTS IN FEIS

The FEIS identified and assessed a variety of indirect effects, including growth inducement effects from land development and effects on the physical environment. Differences were evident in the identification and evaluation of indirect effects and the study area of analysis between the social and the physical sciences. For the land inducement analysis, the indirect effects of the project on the local population were quantified in terms of new residents using modelling techniques. For the study of the physical environment, for example, wetlands and floodplains, the identification of indirect effects relied primarily on professional judgement and academic literature and was evaluated qualitatively. The FEIS did not present an overall methodology for the assessment of indirect effects. The selected methods of assessment for indirect effects were left to the tools familiar within the physical and socioeconomic disciplines.

The study area of analysis for indirect effects also differed between the social and the physical sciences. While the physical analysis examined indirect effects that were largely confined to the site, the analysis of growth inducement from the project was extended to the ten-county region surrounding Stewart Airport.

The definition of indirect effects was tailored and operationalized for various disciplines, using the CEQ definition. For example, the working definition for regional economic impacts was:

> "Project impacts include: (1) the direct impact-impact associated with the initial dollar expenditures generated at the construction site and from the operation of the business establishments; (2) the indirect impact-impact generated by the supporting industries which supply the materials, equipment, and services required to support the initial direct impact; and (3) the induced impact-impact generated by increase in consumer spending as a result of an increase in household income [FEIS pV-I]."

For an environmental use of the definition, impacts to vegetative resources were described as:

> Direct impacts are those that result from actions taking place at a specific location and that physically impact that location (i.e. the cutting of a forest). Indirect impacts are associated with actions that take place at one location, but

that affect nearby adjacent locations (i.e. increased sediment accumulation in a streambed that is downslope of a recently cleared forest). Cumulative impacts are impacts that occur at the landscape level and are not confined to the project site (i.e. the piecemeal removal of a resource, such as forest acreage, to a point where the land can no longer support all elements of the forest community) [FEIS pV-168].

Impacts to wildlife were defined as:

The direct impacts to wildlife will result from habitat destruction. Indirect impacts are associated with the obstruction of migratory and movement corridors within and between habitats, habitat isolation, physical encroachment, landscape fragmentation and water quality degradation [FEIS pV-180].

It should be noted that these definitions of indirect effects are lacking the "reasonable foreseeable" criteria outlined in the CEQ definition. Ten indirect effects were identified in the FEIS and are summarized below.

SOCIOECONOMIC

- *Economic Development.* This is a desired and planned effect of the project. Regional economic benefits are expected to result from both the temporary construction of the developments and the permanent operations of new industries and offices operating on the site in terms of new jobs, income, output and tax revenues for the state and local municipalities. The indirect jobs and income generated from the construction of the developments were derived using a regional economic input-output model.
- *Employment.* The level of employment from the project was translated directly from the planned square footage of development based on square foot requirements per employee by industrial uses, office use and flexible space use from industry standards and an Orange County business survey. The direct employment from the planned development was used to gauge the indirect growth on-site employment would have on regional employment using a regional economic input-output model. The input-output model projected the secondary regional employment that would result from the proposed project to give a total employment forecast as a result of the project.
- *Population.* The induced growth in population as a result of the project was estimated by multiplying the total employment predicted from the above analysis with the average household size of the county. The total population extrapolated from total employment was then dispersed into the region using a population allocation model based on a probability matrix of travel times between zones which assumed that long commute times were undesirable. The end result was a forecast of population growth by town in the primary impact area and by county.
- *Fiscal Impact.* The fiscal impact analysis focused on the revenue and cost associated with the proposed nonresidential development. Information such as the historical cost of constructing various industrial, flex and office structures in Orange County was gathered together with information on existing municipal tax rates and existing payment-in-lieu-of-taxes formulae. Using this model, fiscal impacts were quantified for each town. While the induced residential growth will have fiscal impacts on the local communities, the costs of providing these services were not assessed although the analysis did go as far as suggesting impacts to schools by identifying the population additions to the affected towns by age cohort.
- *Crime.* The induced growth in population is expected to bring about a commensurate increase in criminal offenses. The study applied the per capita rate of offenses in 1987 to the build out population in 2010 to derive a figure of criminal offenses from the induced population.

WATER RESOURCES

- *Surface Water Hydrology.* The indirect impact to surface water hydrology will be the change in drainage patterns within the eight major sub-basins as a result of regrading of the site topography. This impact would create increases in the rate of stormwater runoff to one subbasin while decreasing the rate of stormwater runoff to another. This would also affect the hydrology of the wetlands on-site.
- *Floodplain.* The floodplains analysis revealed that the direct effect of Alternative Five, which necessitates the construction of a stream crossing, may increase the 100-year water surface elevations upstream of the stream crossing. The indirect effect is that the placement of fill within the 100-year floodplain will result in reduction of floodplain storage volume. The analysis for floodplain effects notes that the NYSDEC Floodplain Management Criteria regulates non-direct project effects: "No project shall be undertaken unless it is demonstrated that the *cumulative* effect of the proposed project, when combined with all other *existing and anticipated development*, will not increase the water surface elevation of the base flood more than one foot at any point." The FEIS recommends that a detailed hydraulic analysis be conducted for the stream crossing design to maintain existing 100-year floodplain levels.

WETLANDS

- *Hydrology.* Direct and indirect impacts to hydrology were identified. The direct effect is the increased rate of

stormwater runoff as a result of the increased impervious area. The indirect effect is the change in drainage patterns that will result from the change in the topography of the site which will affect the hydrology of the wetlands.

TERRESTRIAL ECOLOGY

- *Vegetation.* The direct impacts to vegetation in Alternative 5 are the loss of 727 acres of farmland, orchards, shrubland and upland forests. The indirect effects to vegetation are expected to areas adjacent to wetlands from the change in hydrology as a result of vegetation loss.
- *Wildlife.* Habitat loss will occur under both alternatives from habitat destruction. The indirect effect of the direct loss is probable or possible in that noise and visually observed movements of people and machines may disturb feeding, mating, denning and/or nesting activities. The analysis did address and define cumulative impacts as "the loss of reproductive potential for animals displace by construction, the inability to breed, population losses among both breeding and wintering animals caused by increased mortality of displaced animals and by dispersal of some of the displace animals off site"[FEIS, pV-183]. The report stopped short of offering an evaluation, stating that the ability to analyze the magnitude of this impact is poor.

Overall, the ten indirect effects identified in the FEIS showed similarities in that the social effects identified were impacts to areas greater than five miles away from the project site and were quantitatively evaluated using modelling methods while the effects on the physical environment were at the site and were evaluated qualitatively through professional judgement.

3.0 FRAMEWORK APPLIED TO PROJECT

Step 1. Identify Study Area's Various Needs and Goals

Given the vicinity of interests, a visioning session with local and regional planners, representatives from chambers of commerce and concerned citizens should be conducted to assess needs and goals in Orange County. If funds and time are available, a citizen survey may also be useful to support visioning when more details about the directions and goals are required.

The previous goal assessment would assist the completion of Table E-30, a comprehensive checklist of the study area's various directions and goals. The following table is an example of a completed checklist based on the area's current plans (see Table E-30). The checklist helps frame the issues relevant to the area and may offer insight to defining the study area boundaries.

This case study application of the framework will use the goals stated in area master plans and concerns voiced in the public comment section of the project FEIS. The primary land use goal of the 1987 updated Orange County Comprehensive Development Plan is to encourage growth in the county's three cities - Newburgh, Middletown and Port Jervis - and to restrict growth in rural areas. The County Plan accepts the Stewart Airport Properties Master Plan and its plan for office/commercial and industrial development on the site. The municipal plans for the towns of Newburgh, New Windsor and Montgomery state similar goals to direct growth to existing villages while preserving the rural character of the town. These local plans also acknowledge the proposed Stewart Properties project. A major recreational goal of the study area is the preservation of the hunting cooperative on the Stewart Properties grounds managed by the NYSDEC. For the purposes of this case study, it is assumed that these goals are still valid.

Product: Completion of Goals checklist (Tables E-29 and E-30) and possibly technical memorandum for more complex situations.

Step 2. Inventory Notable Features

Referring to Table E-31, notable features of the area include ecosystem and socioeconomic characteristics. The following features were identified from field visits, published statistics and comprehensive plans.

Ecosystem Features

The following are wildlife features of the Stewart Properties site:

- Deer concentrations/wintering areas - significant habitat
- Heron rookeries - significant habitat
- Jefferson salamander - state special concern species
- Blue-Spotted Salamander - state special concern species
- Spotted Turtle - state special concern species
- Red-Shouldered Hawk - State threatened species
- Cooper's Hawk- state special concern species
- Upland Sandpiper - state special concern species
- Grasshopper Sparrow - state special concern species
- Eastern Bluebird - state special concern species

Socioeconomic Features

- Economically-distressed areas. The cities close to Stewart Properties are Newburgh, less than five miles from the airport and Middletown, approximately 15 miles

TABLE E-29
ORGANIZATION AND TABULATION OF GOALS CHART

(Check where applicable)

Project Name: *Stewart Properties* Location: *Orange County, NY* Analyst: *A. Cheng* Date: *1/2/96*

		Notes
Social Health and Well-Being Goals		
√	Achieve adequate, appropriate and accessible open space and recreation	
___	Comply with state and federal water and air quality laws	
___	Preserve or create multicultural diversity	
___	Preserve heritage	
___	Provide choice of affordable residential locations	
___	Provide urban environment for those with special needs	
√	Promote land use patterns with sense of community	
___	Provide a range of services accessible to all	
___	Promote a healthy and safe environment	
___	Provide sound management of solid and hazardous waste	
√	Other *Preserve rural land use and recreational hunting areas*	
Economic Opportunity Goals		
√	Support activities to meet changing economic conditions	
___	Provide energy-efficient transportation	
___	Provide developments with transit-supported capabilities	
___	Target economic export activities	
___	Attract and maintain workforce	
___	Promote infill of smaller, passed-over sites	
___	Encourage redevelopment of older areas for new purposes	
√	Other *Provide development with transportation-supported capabilities*	
Ecosystem Protection Goals		
√	Protect ecosystems	
√	Minimize fragmentation	
___	Promote native species	
___	Protect rare and keystone species	
___	Protect sensitive environments	
√	Maintain natural processes	
___	Maintain natural structural diversity	
___	Protect genetic diversity	
___	Restore modified ecosystems	
___	Other _____	

Reviewed by: Name Affiliation Date

from the Stewart Properties site. Both cities have industrial origins having developed from transportation access. Newburgh developed as a port for the Hudson River and is presently in severe economic distress. Middletown, situated at the intersection at two rail lines, is in economic decline. Both cities experienced a decline in population over the past two decades.

- Sensitive populations. Both cities have disproportionate numbers of low-income and minority residents.

Product: List of notable features for the indirect effects assessment, with an accompanying map illustrating the location and the extent of the feature, where appropriate (see Tables E-31 and E-32).

Step 3. Identify Impact-Causing Activities of the Proposed Action and Alternatives

The proposed development project aims to attract businesses to the project site, particularly warehouse/distribution, light industry, and office uses. Stewart Properties is being marketed for its strategic location of the site, at the juncture of two interstate highways and adjoining Stewart International Airport, with the attraction of planned infrastructure and tax incentives.

Table E-33 can be used to detail the impact-causing activities as a result of the project. The proposed project will cause on-site impacts such as impacts to natural features such as wetlands, floodplains and the hydrology of the site as well as

TABLE E-30
STUDY AREA DIRECTIONS AND GOALS CHECKLIST
(Check where applicable)

Project Name: *Stewart Properties* Location: *Orange County, NY* Analyst: *A. Cheng* Date: *1/2/96*

1. **Generalized Setting**

Within Metropolitan Statistical Area (Identify MSA)	___
Outside of MSA	√
Both Inside and Outside MSA	___

Indicate Distance to Nearest Metropolitan Center *5 miles, city of Newburgh*

2. **Characteristics of Transportation System** (Note: These items are not intended to cover entire transportation need but rather to use information from more detailed assessments to provide a preliminary indication of existing accessibility, service and modal interrelationship characteristics, i.e., factors relevant to subsequent indirect effects analysis).

- Identify missing links in transportation system _____.
- Map and describe existing level of service on minor and principal arterials and their access characteristics.
- Indicate distance to nearest interstate highway if not in study area.
- Map and describe existing transit routes and demand.
- Map and describe major concentrations of existing and planned development.
- Describe modal interrelationships including competing and complementary characteristics.

3.

Population	Trend	Projection
Declining	√	___
Static (±1%/10 years)	___	√
Slow Growth	___	___
Rapid Growth (>10%/10 years)	___	___

Employment	Trend	Projection
Declining	√	___
Static (±1%/10 years)	___	√
Slow Growth	___	___
Rapid Growth (>10%/10 years)	___	___

4. Planning Context

	Yes	No	If yes, identify by title, agency and date
Zoning	√		*Local municipalities*
State Master Plan		√	
County/Regional Master Plan	√		*1987 Orange County Comprehensive Development Plan*
Municipal Master Plan	√		*Newburgh 1991, Montgomery 1988, Windsor 1975*
Growth Management Plan		√	
Water Quality Management Plan		√	
Other Natural Resources Management Plan		√	

5. For each plan identified in No. 4, summarize key goals, elements and linkages to other plans (specify, in particular, elements related to economic development, land use development, the transportation system, and natural resource protection). *Preserve open space, focus development on existing towns and villages, support cities, reduce sprawl*

6. Describe any efforts to elicit local needs and goals from residents and/or agencies (source and result). *Inspection of local plans*

7. Describe known plans for major new or expanded activity centers including public facilities. _____

Is the activity center dependent on transportation system improvement? Yes √ No ____

8. Is the transportation need linked to economic growth and land development? Yes √ No ____

If yes, is the nature of the linkage to:

Serve the needs of planned growth ____ or

Channelize growth ____ or

Stimulate growth √ or

9. Based on information obtained, are there any apparent conflicts between transportation and other needs that could result in controversy? (Describe).

Yes ____ Possible √ No ____

Reviewed by:	Name	Affiliation	Date

TABLE E-31
NOTABLE FEATURES CHECKLIST
(Check where applicable)

Project Name: *Stewart Properties* Location: *Orange County, NY* Analyst: *A. Cheng* Date: *1/2/96*

	Ecosystem Features	Specify
√	Regional habitats of concern/critical areas	*Various sensitive wildlife in forested areas of Stewart Properties*
—	Rare, threatened or endangered species and associated habitat	
—	Species requiring high survival rates	
—	Species whose intrinsic rates of increase fluctuate greatly	
—	Communities with vulnerable keystone predators or materialists	
√	Other *Large hunting preserve*	*Interim use of Stewart Properties, managed by NYSDEC*
	Socioeconomic Features	
—	Substandard amounts of open space and recreation	
—	Non-compliance with state and federal environmental laws	
—	High concentration of uncontrolled solid and hazardous waste sites	
—	Inadequate affordable housing	
—	Inadequate access to amenities	
√	Economically distressed areas	*Primarily in county's cities, particularly the city of Newburgh*
—	Lack of institutional land use controls	
—	High proportion of population consisting of:	
	√ Minorities	
	√ Low-income residents	
	— Elderly	
	— Young	
	— Disabled	
—	Low proportion of long-term residents	
—	Locations of poor traffic flow	
—	Other _____	

Reviewed by: Name Affiliation Date

impacts to wildlife habitats. Off-site impacts include changes in vehicular access and needs, population growth and fiscal impacts to local towns.

Product: A comprehensive list of the impact-causing actions of the proposed plan or project and alternatives, in as much detail as possible. Table E-33 is an example.

Step 4. Identify Indirect Effects for Analysis

The methods that may be applicable for identifying indirect effects as a result of the proposed project include informational or ranking matrices, system networks, and/or qualitative inference. Informational matrices developed by Leopold, ranking matrices advocated by Hamilton and Vlacho's systems network approach all take a holistic approach to identifying impacts. The chains of causality can be used to identify possible off-site, later-in-time effects as a result of the project. An exercise in qualitative inference together with planners and real estate professional to evaluate possible socioeconomic and real estate changes to the study area as a result of the project would assist the identification efforts. Cartographic techniques may also be used for visualizing potential indirect effects to wildlife habitats as a result of alterations to the physical environment.

A possible indirect effect requiring analysis based on criteria established in case law (likelihood for occurrence, knowledge exists to analyze effect, need-to-know basis) is the possible diversion of economic activity from the local study area as well as other industrial parks in the county to the project site. The convenience of the site and possible tax incentives and energy subsidies associated with locating at the site may encourage existing businesses in the county to leave their present locations for new space at Stewart Properties. Existing warehouse tenants in the cities and tenants in the county's existing industrial parks may be prompted to move to enjoy improved access at the project site. The master plan specifically stated that the proposed development would alleviate pent-up local demand for office/warehouse space of up to 200,000 sq. ft.

Possible economic diversion from other areas in Orange County was not identified in the FEIS or the Stewart Properties master plan. Both documents based estimates on absorbable size of development on growth scenarios projected from the 1980's. The diversion of economic activity from elsewhere in the county to the site would most likely occur under slow economic growth. Project sponsors did not examine the project's possible effects given a scenario of economic contraction.

The critical land use indirect effects research question for the project, given the county's stated goals and needs is this: Under what scenarios, if any, will the project prompt the relocation of existing commercial and industrial tenants in the county from existing office and industrial parks into newer, subsidized space in Stewart Properties? How can this effect be prevented?

TABLE E-32
NOTABLE FEATURES ADDRESSED BY FEDERAL STATUTES
(Check where applicable)

Project Name: *Stewart Properties* Location: *Orange County, NY* Analyst: *A. Cheng* Date: *1/2/96*

Resource Type or Area	Statute/Order	Source of Information and Map Locations
√ Section 4(f) Resources ___ Public Parks and Recreational Lands ___ Wildlife and Waterfowl Refuges ___ Historic Sites ___ Historic Districts √ Archaeological Remains √ Historic Structure	Department of Transportation Act	Local Parks or Recreation Officials, State Historic Preservation Office or local historic preservation organizations
___ Coastal Zone	Coastal Zone Management Act	State Coastal Zone Management Office
___ Waters of the United States	Clean Water Act; E.O. 11990	State Fish and Game Commission; U.S. Fish and Wildlife Service
___ Sole Source Aquifer	Safe Drinking Water Act	State Natural Resources Agency; U.S. Environmental Protection Agency
___ Areas of Known Contamination	Comprehensive Env. Response Compensation Liability Act	State environmental protection agency; U.S. Environmental Protection Agency
√ Floodplains	E.O. 11988	Federal Emergency Management Agency
___ Range or Habitat of Threatened or Endangered Species	Endangered Species Act	State Fish and Game Commission; U.S. Fish and Wildlife Service
___ Wild, Scenic or Recreational River	Wild and Scenic Rivers Act	U.S. National Parks Service
√ Prime or Unique Farmland	Farmland Protection Act	U.S. Soil Conservation Service
___ Sensitive Receptor	Clean Air Act; Noise Control Act	State environmental protection agency
___ Nonattainment or Maintenance Areas	Clean Air Act	State and local air and transportation agencies; metropolitan planning organizations; state implementation plans; conformity determinations of transportation plans, programs and projects.
___ Residential or Commercial Establishments	Uniform Relocation Act; E.O. 12898	Local governments

Reviewed by: Name Affiliation Date

TABLE E-33
PROJECT IMPACT-CAUSING ACTIVITIES CHECKLIST

Project Name: *Stewart Properties* Location: *Orange County, NY* Analyst: *A. Cheng* Date: *1/2/96*

	Yes	No	If Yes, Describe Generally (Breadth, Duration, Location and Type)
Modification of Regime			
Exotic Flora Introduction		√	
Modification of Habitat	√		
Alteration of Ground Cover	√		
Alteration of Groundwater Hydrology	√		
Alteration of Drainage	√		
River Control and Flow Modification		√	
Channelization		√	
Noise and Vibration	√		
Land Transformation and Construction			
New or Expanded Transportation Facility		√	
Service or Support Sites and Buildings	√		
New or Expanded Service or Frontage Roads	√		
Ancillary Transmission Lines, Pipelines and Corridors	√		
Barriers, Including Fencing	√		
Channel Dredging and Straightening		√	
Channel Revetments		√	
Canals		√	
Bulkheads or Seawalls		√	
Cut and Fill	√		
Resource Extraction			
Surface Excavation	√		
Subsurface Excavation		√	
Dredging		√	
Processing			
Product Storage		√	
Land Alteration			
Erosion Control and Terracing	√		
Mine Sealing and Waste Control		√	
Landscaping	√		
Wetland or Open Water Fill and Drainage	√		
Harbor Dredging		√	

Resource Renewal			
Reforestation		√	
Groundwater Recharge	√		
Waste Recycling		√	
Site Remediation		√	
Changes in Traffic (including adjoining facilities)			
Railroad		√	
Transit (Bus)		√	
Transit (Fixed Guideway)		√	
Automobile	√		
Trucking	√		
Aircraft		√	
River and Canal Traffic		√	
Pleasure Boating		√	
Communication		√	
Operational or Service Charge		√	
Waste Emplacement and Treatment			
Landfill		√	
Emplacement of Spoil and Overburden		√	
Underground Storage		√	
Sanitary Waste Discharge	√		
Septic Tanks		√	
Stack and Exhaust Emission	√		
Chemical Treatment			
Fertilization	√		
Chemical Deicing	√		
Chemical Soil Stabilization	√		
Weed Control	√		
Pest Control	√		
Access Alteration			
New or Expanded Access to Activity Center			
New or Expanded Access to Undeveloped Land	√		
Alter Travel Circulation Patterns	√		
Alter Travel Times between Major Trip Productions and Attractions		√	
Alter Travel Costs between Major Trip Productions and Attractions		√	
Others			

Reviewed by:	Name	Affiliation	Date

Other questions relating to indirect effects are:

- *Encroachment-Alteration Effects:* What indirect impact, if any, would development have on wildlife habitats, e.g. fragmentation, foraging, increased road kills? Would the increased development indirect impact wildlife off-site?
- *Socioeconomic Effects:* Will the projected increase in population displace some lower-income households through redevelopment and/or increased property taxes? Will the projected increase in population and employment decrease the availability of affordable housing?
- *Induced Growth Effects:* What impact would induced growth as a result of the proposed project have on water supply and wastewater treatment capacity, as well as other municipal services such as schools, health care and emergency services?

Product: Completion of Tables E-34 and E-35. A technical memorandum that lists the indirect effects that warrant further analysis and presents the scope of analysis to be conducted in Task 5.

Step 5. Analyze the Identified Indirect Effect(s)

There may be many indirect effects as a consequence of a project, some which may be exceedingly difficult to assess. This suggested framework emphasizes targeting those effects that have a degree of certainty to their occurrence, a specificity to the extent of the occurrence and a need to know impetus. For this case study application of the framework, we will address one indirect effect. Given the county's goals to prevent further decline in its cities, the specificity of speculative development as part of the project and the existence of various industrial parks in the county, the possible impact of this development on existing industrial and office parks warrants analysis.

To examine this indirect effect, an assessment of the nature of existing urban downtowns and the local industrial parks in the county should be conducted. The vacancy rates of office buildings and vacant developable land in existing industrial parks should be compiled as well as data on square footage, rent, vacancy rates and age or class of facilities. High vacancy rates may indicate that the locally-generated demand for added industrial and office space is not strong. Trend analysis of rents and vacancy should be conducted. Modeling the relationship between rents and vacancy could shed light on the nature of real estate dynamics in the area and the possible effects government-subsidized development on Stewart Properties may have on private industrial parks in the county. Scenario writing by professionals knowledgeable with the area could outline possible futures and the assumptions/conditions necessary for their realization.

Product: A technical memorandum that describes the indirect effects, the chosen analysis methods, and the analysis results.

Step 6. Evaluate Analysis Results

The objective of this step is to present the completed analysis to policy makers and the public for comment and consideration. Sensitivity analysis and risk analysis may be useful in evaluating the importance and the certainty of the identified indirect effects.

Product: Technical memorandum combining steps 1 through 5.

Step 7. Develop Mitigation

The objective of this step is to develop strategies to minimize or avoid unacceptable indirect effects. If it is concluded that "development shifts" within the county may occur and its indirect effect may be significant, mitigation of this effect may be simple to implement. Managers of Stewart Properties can work together with local municipalities to design operating policies to prevent this indirect effect from occurring. The management of Stewart Properties can adopt a policy that Stewart office and industrial space will not be used to the detriment of local towns or other areas in the county by controlling leasing to businesses that are aviation-related or businesses that are locating into Orange County. Two ways to accomplish this objective are to discourage speculative development on Stewart Properties or stipulate, if possible, that tenants to speculative buildings/warehouse sites must either be non-Orange County businesses locating into the county or new businesses.

Product: Development of Stewart Properties policy and guidelines to discourage intra-county real estate competition at the site.

4.0 CONCLUSION

It was apparent from this FEIS that while professional judgement could identify the possible indirect effects as a consequence of the project, evaluating the extent of these effects proved to be a much larger task. For indirect socioeconomic effects, the questions of where induced development will occur, and as a result, which municipalities may be more severely impacted by needs for services from the incoming population, were left unanswered. The analysis, however, did employ tools that can be applied to assess school finance impacts as population impacts were assessed into the age-cohort model and local tax rate information was compiled for the projection fiscal impacts.

Using journey to work data Census data, the FEIS authors produced a model of where new workers as a result of the

TABLE E-34
CHECKLIST FOR ASSESSING STUDY AREA'S POTENTIAL FOR INDUCED GROWTH

Project Name: *Stewart Properties* Location: *Orange County, NY* Analyst: *A. Cheng* Date: *1/2/96*

Regional Study Area Conditions

[A yes answer indicates that conditions generally favor growth; the more yes answers, the higher the certainty that regional conditions generally favor growth.]

1. Is the regional population increasing rapidly (generally, >5% per 10 years)? *N*
2. Is the region considered favorable for receiving FHA/VA loans? *DK*
3. Are there any major growth generators (e.g., universities, military installations, industries, tourist attractions) in the region? *N*
4. Is the regional office/commercial market characterized by low (generally, <10%) vacancy rates in any class of space? *DK*
5. Is the region's business and civic leadership committed to rapid development? *N*
6. Is the region an exporter of natural resources? *N*

Local Study Area Conditions

[If it is concluded that regional conditions generally favor growth, then proceed with the next series of questions. A yes answer indicates that the area in the immediate project vicinity has land use conversion potential; the more yes answers, the higher the certainty that land use conversion will be induced by the project to its immediate vicinity.]

General indicators

7. Is the regional path of development in the direction of the local study area? *N*
8. Is the project within 5 miles of a growing community (generally, >5% per 10 years)? *Y*
9. Is the local study area characterized by middle and/or high income levels? *Y*
10. Is the local study area free of moratoriums on development (e.g., sewer moratoriums, growth restrictions)? *Y*

Indicators of conditions favorable to conversion to lower density development

11. Is the local study area within a 30-minute drive of a major employment center? *Y*
12. Does the local study area have relatively high land availability/low land prices (generally <one-third of larger parcels developed)? *DK*
13. Is the vacant land characterized by relatively large parcels? *DK*
14. Is the local study area characterized predominantly by level land (generally, <5% slope)? *Y*
15. Is the project's Potential Impact Area characterized by soils suitable for development? *Y*
16. Is the project's Potential Impact Area predominantly free of flooding or wetlands? *N*

Indicators of conditions favorable to conversion to higher density development

17. Does the local study area have relatively low land availability/high land prices (generally >two-thirds of larger parcels developed)? *DK*
18. Is the local study area served by existing principal arterials and water/sewer systems? *N*
19. Is the local study area covered by relatively few governmental jurisdictions? *N*
20. Is the local study area characterized by poorly enforced zoning regulations? *DK*
21. Does the local study area lack recent (generally, <10 years old) master plans? *New Windsor -Y; Newburgh -N; Montgomery -N*

Reviewed by:

Name	Affiliation	Date

TABLE E-35
EVALUATION MATRIX FOR PROJECT INDIRECT EFFECTS OF CONCERN
Project Name: *Stewart Properties* Location: *Orange County, NY* Analyst: *A. Cheng* Date: *1/2/96*

Indirect Effect Type	Direct Effects from Impact-Causing Activities	Indirect Effects from Direct Effects (List)	Potential Manifestation of Indirect Effects (List)	Link between Indirect Effect and Goal or Notable Feature that Meets Assessment Criteria*	
				Yes (Go to Step 5)	No (Assessment Complete)
Encroachment-Alteration	Ecosystem-related			√	
	Socioeconomic-related				√
Induced Growth (Access-Alteration)		Serves specific development			√
		Stimulates complementary development		√	
		Influences location decisions		√	
Effects Related to Induced Growth			Ecosystem-related	√	
			Socioeconomic-related	√	

* Assessment criteria = (1) Confidence that the effect is likely to occur; (2) Know enough about indirect effect to make consideration useful; and (3) Need to know about the impact now.

Reviewed by: Name Affiliation Date

indirect employment opportunities would live. The extrapolation of households and population from the total employment projections also provided a measure of the level of possible induced growth effects. Temporal boundaries on when these effects might take place were unidentified.

Spatial boundaries for indirect effects can be critical, as the framework reveals. Since the project process selected only the adjoining municipalities as the primary study area, economic diversion concerns of the City of Newburgh, a city under extreme economic distress about five miles from the Stewart Airport, were not addressed. As indirect effects can be manifested a distance from the site, the study area for indirect economic effects should have incorporated areas that are vulnerable economically and are at risk from the project.

5.0 REFERENCES

Comprehensive Development Plan for Orange County, New York, Orange County Department of Planning and Development, updated to 1987.

Stewart International Airport Properties, Final Federal Environmental Impact Statement, NYSDOT and FAA, July 1992.

Stewart International Airport Properties Master Plan, Cushman & Wakefield Inc. (undated).

Town of Montgomery, NY Master Plan, Garling Associates, adopted 1988.

Town of Newburgh, NY Master Plan, Garling Associates, adopted 1991.

Town of New Windsor, NY Master Proposed Development Plan, Manuel S. Emanuel Associates, 1975.

E-7 CASE STUDY REPORT: HUDSON-BERGEN (NJ) LIGHT-RAIL TRANSIT SYSTEM

1.0 PROJECT DESCRIPTION

1.1 Introduction

The Hudson River Waterfront Transportation Corridor traverses portions of Hudson County and Southeastern Bergen County in New Jersey (see Figures E-11 and E-12). The project study area is a peninsula. Its boundaries are the Hudson River on the east, the Kill Van Kull on the south, Newark Bay and Hackensack River on the west and the city lines of Edgewater, Ridgefield and North Bergen on the north. The municipalities included in the study area are Bayonne, Edgewater, Guttenberg, Hoboken, Jersey City, North Bergen, Ridgefield, Secaucus, Union City, Weehawken and West New York.

During the 1980s, New Jersey's Hudson River Waterfront saw unprecedented growth and redevelopment. Developers started converting abandoned railyards into large-scale commercial, residential and retail developments. These developments have been superimposed upon a transportation system that is inadequate, and often overwhelmed by motor vehicle congestion, particularly due to heavy traffic bound for Manhattan.

State and local officials are actively promoting growth on the Waterfront and understand the need for new infrastructure to foster the area's fullest realization, especially on sites not conveniently serviced by transit today. The Hudson

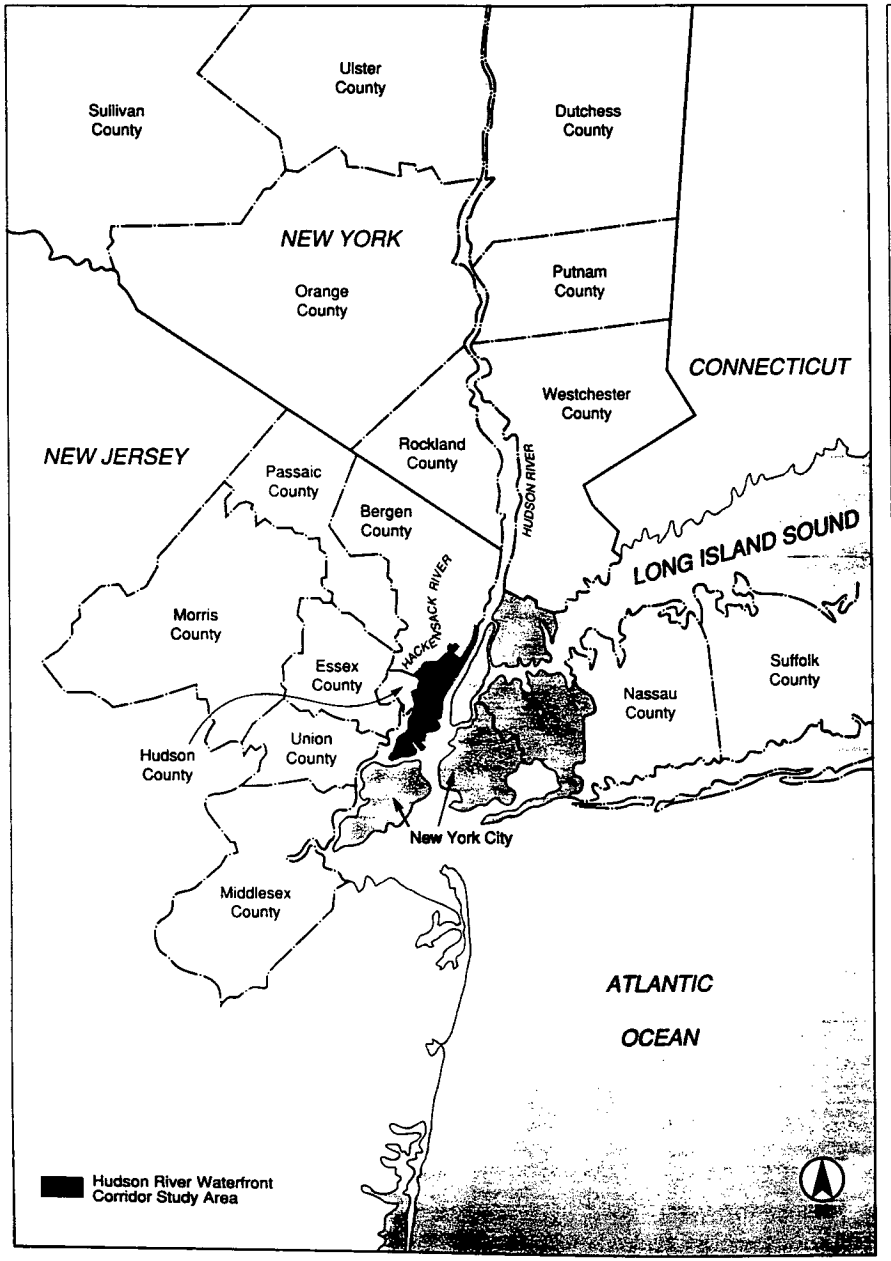

Figure E-11. Location of the Hudson River Waterfront corridor.

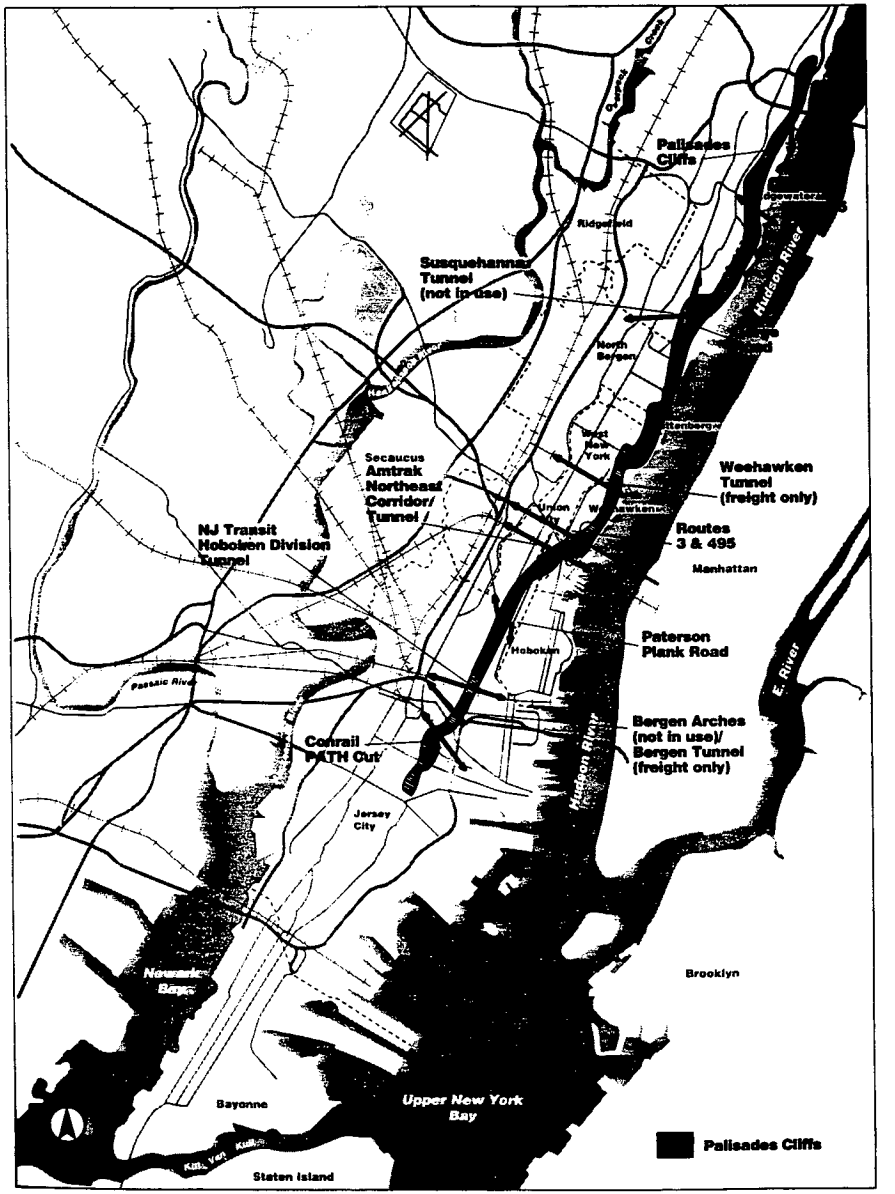

Figure E-12. Waterfront access constraints.

River Waterfront has been selected by the Governor's Transportation Executive Council as one of five urban areas, ripe for revitalization, to be supported by new transportation infrastructure investments. It has also been cited as an area in the recently adopted State Development and Redevelopment Plan where infrastructure investments should be directed.

The Alternatives Analysis/Draft Environmental Impact Statement (AA/DEIS), prepared in 1992 by NJ Transit (NJT) and the Federal Transit Administration (FTA), examined long-range transit and roadway improvements for the Hudson River Waterfront corridor. The study was needed to qualify for federal transit funding and was designed to lead to a sound decision by the NJT Board of Directors, in consultation with local interests, on the kind of transportation system that should be built. The study set as its goals that such a system should accommodate present and future office and residential development along the Waterfront and offer improved mobility for the citizens of Hudson County and southeastern Bergen County.

The AA/DEIS review and comment resulted in a decision by the NJT Board of Directors on a Locally Preferred Alternative (LPA). The LPA is designated the Hudson-Bergen Light Rail Transit System (HBLRTS). It will eventually span 20.5 miles from Bayonne in southern Hudson County to Ridgefield in Bergen County and serve up to 100,000 riders daily. A Final EIS was being prepared but not completed at the time of this case study report preparation. Consequently, the case study is based on information documented in the DEIS, as well as other relevant documents.

This project was selected for case study evaluation for several reasons. It is linked to the redevelopment of an older urban industrialized area. Specifically, the project is envisioned to help realize the study area's growth potential; economic growth is a project "selling point." The project traverses a number of settings including the state-designated coastal zone, older urban residential, dense multi-story office and residential complexes, again and/or abandoned industrial facilities, a large state-owned urban park, and portions of a large wetland system, the Hackensack Meadowlands. Finally, the project has involved a relatively high amount of coordination among NJT, other agencies and local municipalities.

1.2 Purpose and Need

The AA/DEIS found that diverse and overlapping markets must be served to improve transit mobility in the study area, and that the transportation improvements should address the following needs:

- to link Waterfront locations to each other, creating a new commercial center unified by transit;
- to improve access from new and established communities in the study area to the Waterfront's commercial core, creating better north-south mobility and increased transit reliance in the commercial district;
- to connect the Waterfront's new commercial core with the region's established residential areas outside the study area, also fostering greater transit reliance in the core; and
- to improve trans-Hudson work trips for residents in the adjacent study area when they can use the same system being designed for the Waterfront.

The goals adopted by this study in response to these needs and those articulated by residents of the study area are to:

- maximize mobility for area residents and workers;
- support the economic redevelopment of the Hudson River Waterfront;
- preserve and protect the environment;
- maximize the economic efficiency of the Waterfront transportation system; and
- develop a consensus for a transportation plan for the study area.

1.3 Affected Environment and Alternatives Considered

Transportation infrastructure and changes in transportation technology, combined with economic changes, have long played a dominant role in shaping land use patterns along the Hudson River Waterfront. A historical account from the DEIS (p. 3-71) provides the context for transportation-land use connections in the study area.

During the 17th, 18th and early 19th centuries, settlements in the area occurred mainly along the waterfront, with fishing and agriculture as the main industries. Goods including fish, oysters, fruits and vegetables, firewood, and building materials were transported to market in Manhattan by boat. Regular ferry service across the Hudson was established during the 18th century in Jersey City, Weehawken and Hoboken. During the 19th century, the New Jersey Waterfront, particularly in Hoboken and northern Edgewater, also became a popular resort for wealthy New Yorkers.

Growth accelerated with the progress of transportation in the area. By 1764, a regular stage was running between Paulus Hook, Jersey City and Philadelphia. The first railroad in the state—the Camden and Amboy—opened in 1832. In 1836, the Morris Canal was extended from Newark to Jersey City, supplying raw materials such as iron ore and coal to local glass and steel industries, and carrying manufactured goods inland.

After the Civil War, eight trunk railroads crossed the state and converged on the west bank of the Hudson, establishing major passenger hubs in Jersey City and Hoboken. Docks in Jersey City and Hoboken supported oceanic shipping. Until the 1890s, growth in the study area mainly occurred in these transportation routes. In the late 19th century, New Jersey

shipyards were increasingly busy, and New Jersey factories supplied a large proportion of the nation's chemicals and munitions. During World War I, industry surged, particularly in Jersey City and Bayonne, in response to the demand for explosives, textiles, steel and ships. The industries found a ready labor pool in the waves of European immigrants, and the migration of African-Americans from the South. Between 1900 and 1930, counties in the New York metropolitan area doubled in population, which also spurred residential development.

In the 20th century, trans-Hudson transportation improvements continued. In 1909, the Hudson and Manhattan Railroad began operations through its newly completed tunnel from jersey City to its massive Hudson Terminal in southern Manhattan. The following year, the Pennsylvania Railroad completed its own tunnel under the Hudson River to its terminal of 34th Street in New York City. The Holland Tunnel was completed in 1927, the George Washington Bridge was opened in 1931, and the Lincoln Tunnel was built between 1934 and 1957.

Growth in Bergen County was slow until the 19th century. Following the provision of rail access through the Palisades and the provision of electrical power in the 1890s, industrial development expanded rapidly through the 1920s. The Palisades Cliffs, with elevations up to 150 feet from approximately mean sea level at the Hudson River, run parallel to the Hudson River through the center of the study area. The cliffs are a barrier to regional and local traffic traveling west to east to the Waterfront and New York City. The cliffs contain primarily residential development with population densities among the highest in the country. The cliffs were served by a trolley system until the late 1940s.

Until recently, the waterfront from Edgewater to Bayonne was almost exclusively occupied by railroads, piers and factories. However, after World War II, the area declined rapidly as the old factories became outmoded, and trucking concentrated near highways west of the Palisades overtook shipping by rail and water. Regionally, the economic pattern was one of a declining industrial base, and an expanding service economy. Much of the area was cleared for redevelopment.

The first stages of redevelopment began in the late 1970s, in the century-old neighborhoods in Hoboken and Jersey City. These architecturally distinguished residential communities, clustered near the Port Authority Trans-Hudson (PATH) rapid transit system (e.g., the former Hudson and Manhattan Railroad), have excellent access to jobs in Manhattan. During the latter half of the 1980s, there was a burst of new development on the Waterfront. Some 3,595 housing units, 5.1 million square feet of office space, and a 1.5-million-square-foot shopping mall were built. Eighty percent of the area's office development and 65 percent of the housing has been built within a short walk to PATH.

Up to 35 million square feet of additional office space, 42,000 new housing units, and four million square feet of retail space would line the Waterfront if all developers' plans were completed. This development would create a north-south linear city along the river shoreline. The Waterfront's internal functioning and its relationship to the neighborhoods nearby is still evolving. However, the Waterfront's commercial, residential and retail developments are separated from each other, because the area's infrastructure is discontinuous and incomplete. North-south movement in the corridor is very difficult. Physical barriers, such as vacant railyards, NJT's active railyards in Hoboken, and waterbodies, such as the Morris Canal Basin and the Long Slip in Jersey City, serve as impediments. No arterial highway runs the length of the Waterfront. Roads are discontinuous, narrow and congested. Traffic blockages to north-south movement exist near the approaches to the Holland Tunnel in Jersey City and at some of the local roads to the Lincoln Tunnel in Weehawken. The Waterfront's new development is also somewhat isolated from existing residential and commercial centers surrounding it.

It was against this backdrop that the following alternatives were developed and evaluated in the AA/DEIS:

- **Alternative I: No-Build**—Maintains current transit service plus transit and roadway improvements committed for implementation by the year 2005. These projects are assumed in all other alternatives. The inclusion of this alternative is required by FTA regulation.
- **Alternative II: Transportation Systems Management (TSM)**—Includes relatively low-cost transit and traffic improvements. This alternative is required by FTA as a baseline for cost-effectiveness comparisons.
- **Alternative III: Core Light Rail Transit (LRT)**—Includes an 8.3-mile LRT line between Port Imperial ferry on the north and a park-and-ride near Liberty State Park on the south using the existing Conrail right-of-way west of Hoboken, some TSM improvements and feeder bus service.
- **Alternative IV: Core Light rail (LRT) and Extensions**—Combines the LRT line described in Alternative III above with extensions to the west side of Jersey City and south to Bayonne's east side for a system 14.4 miles in length.
- **Alternative V: Core LRT and Weehawken Tunnel Transitway**—Includes a 9-mile LRT alignment from a park-and-ride near Tonnelle Avenue in North Bergen, through the Weehawken Tunnel (a to-be-abandoned freight rail tunnel under the Palisades), and south to a park-and-ride near Liberty State Park via the east side of Hoboken. Also offers a 6.3-mile bus transitway from the NJ Turnpike through the Weehawken Tunnel and south only as far as Lincoln Harbor in Weehawken, and vertical access facilities at both portals of the Weehawken Tunnel.
- **Alternative VI: Core LRT and Weehawken Tunnel Transitway with Ramps to Lincoln Tunnel**—Same as Alternative V except that it includes a bus-only connection from the Weehawken Tunnel Bus Transitway to the Lincoln Tunnel Toll Plaza.

- **Alternative VII: AGT/Monorail**—Similar to the Alternative III alignment, but uses computer-controlled vehicles operating on an exclusive right-of-way, elevated in built-up areas.
- **Alternative VIII: Neighborhood Express/Clean Bus**—Features neighborhood-originating bus service using low-pollution, advanced design buses on exclusive rights-of-way. It stretches 11 miles through the corridor from a Tonnelle Avenue Park-and-Ride in North Bergen through the Weehawken Tunnel, from Port Imperial ferry to a park-and-ride near Liberty State Park to Route 440 in western Jersey City. This alternative includes a Weehawken Tunnel Bus Transitway with a bus-only connection to the Lincoln Tunnel Toll Plaza, vertical access facilities at both tunnel portals, as well as at 12th Street in Hoboken and at the Palisades General Hospital, and ferry service between Exchange Place in Jersey City and Staten Island.
- **Alternative IX: Core LRT with Northern and Southern Extensions**—Features a 15.3-mile light rail system extending from the NJ Turnpike's Vince Lombardi Park-and-Ride in Ridgefield to Route 440 in southwestern Jersey City, along a similar route as Alternative VII. This alternative, a blend of promising elements of the existing eight alternatives, also includes a Weehawken Tunnel Bus Transitway that connects the NJ Turnpike to the Lincoln Tunnel Toll Plaza.
- **First Construction Stage: Hoboken Terminal to Route 440 Light Rail**—Features a 6.37-mile light rail system extending from the Hoboken Terminal south via the Liberty State Park Park-and-Ride along the West Side Industrial Track to a Route 440 Park-and-Ride.

2.0 IDENTIFICATION OF INDIRECT EFFECTS IN THE EIS

Two effects were noted in the EIS as being indirect effects, namely, indirect economic effects from construction-related materials expenditures and wages, and constructed-related energy consumption. Although typically referred to as "indirect" effects, these effects do not fall within the CEQ definition nor the typology developed from research for this study. These effects would occur at the same time as the project and are inevitable consequences of transportation capital construction. Their timing and inevitability make them direct effects under the CEQ definition.

Other effects, although not described as indicated in the EIS, do meet the CEQ definition of indirect effect. Included are the following:

- **Anticipated Impacts on Current Public Transportation (p. 4-33)**—Positive and negative impacts were described. The relative ease of movement afforded by a light rail transit system would encourage mass transit riders (from mode shifts and more trips), create more feeder opportunities for area routes, and would in places, permit services changes designed to generate operating cost savings. It also would likely divert some riders from existing transit services in the area (some of which are privately-operated). The reduction in bus trips would reduce the need for bus equipment for this market and reduce the need for additional bus capacity on approaches to the Lincoln Tunnel (e.g., the tunnel for Manhattan-bound bus commuters). This could lead to capital cost savings on equipment.
- **Impact on Auto Travel and Traffic Conditions (p. 4-34)**—Positive effect in that mode diversions caused by changes in travel costs and time would reduce auto trip-making and lead to reductions in congestion and delay. Related positive indirect effects would include improved freight movements by truck and improved emergency medical vehicle response. Conversely, traffic increases in the absence of the project with concomitant congestion and delay increases could hinder development as Waterfront traffic competes with non-Waterfront traffic for limited roadway capacity.
- **Transit-Induced Traffic Impacts (p. 4-42)**—It was predicted that impacts on traffic flow would occur from transit use of a portion of certain street rights-of-way. Mitigation was developed by examining split routes, rerouting, transit malls and local curbside management, and signal-timing optimization strategies.
- **Air Quality Impacts (p. 5-1)**—On a regional level, diversions from auto to transit would reduce pollutant burdens. On a local (i.e., micro-scale) level, some locations could experience a slight increase (e.g., violations) in carbon monoxide concentrations. This was attributed in part to transit use of street rights-of-way.
- **Land Use and Economic Activity - Corridor Level Impacts (p. 5-8)**—This section of the EIS merits reproduction in its entirety as it illustrates treatment of the complex induced growth issue.

"The transformation of the Waterfront represents an intriguing interplay between transit investment (existing and proposed) and real estate development. One can assert with confidence that a unifying transit system would have a positive effect (not readily quantified) by its enhancement of the area's attractiveness and competitiveness as a regional commercial center, and support and strengthening of trends already underway. All of the fixed guideway alternatives would have roughly the same effect, but those with the most permanent investment in new facilities and the greatest market coverage would have the best chance of influencing conditions at any given location. Nonetheless, it must be acknowledged that development also depends on a combination of factors, primarily the overall regional and market demand for development, the availability of developable land, the nature of adjacent land uses, the availability of financing, available water and sewer capacity, and favorable local land use plans/zoning ordinances and tax policies.

"At present, the Waterfront's most productive sites are the ones most easily accessible to the PATH system and the NJT

lines at Hoboken Terminal. The ability of these existing facilities to transport workers from points west of the Hackensack River and from New York City is vital to the success of any Waterfront commercial development. In addition, the redevelopment of the Waterfront has created new demands for transportation services in the north-south direction. The Waterfront's full development potential may only be realized with the construction of a north-south transit system and the transit hubs it expands.

"Although a Waterfront transit system would be a major public investment from a regional land use perspective, it could not dramatically reshape land use patterns and economic activity in a region as vast and complex as the New York-northern New Jersey metropolitan area. Yet it could have a perceptible effect in helping to draw private investment destined for the region to the Waterfront and in increasing the attractiveness with the Waterfront of sites beyond the existing PATH stations.

"From the perspective of the corridor's land uses, although Waterfront development is significant to the corridor's future economic health, its impact, by itself, will not alter the corridor's overall land use patterns, that are relatively established and mature. These general land use characteristics are likely to persist in the future without the project. With the project, some additional impacts could occur at in-between points on the Waterfront, and at state sites along the project's extensions into the corridor's older neighborhoods."

TABLE E-36
ORGANIZATION AND TABULATION OF GOALS CHART
(Check where applicable)

Project Name: *Hudson-Bergen Light Rail* Location: *NJ* Analyst: *L. Pesesky* Date: _____

		Notes
	Social Health and Well-Being Goals	
√	Achieve adequate, appropriate and accessible open space and recreation	
√	Comply with state and federal water and air quality laws	
	Preserve or create multicultural diversity	
√	Preserve heritage	
	Provide choice of affordable residential locations	
√	Provide urban environment for those with special needs	
√	Promote land use patterns with sense of community	
√	Provide a range of services accessible to all	
	Promote a healthy and safe environment	
√	Provide sound management of solid and hazardous waste	
	Other _____	
	Economic Opportunity Goals	
√	Support activities to meet changing economic conditions	
√	Provide energy-efficient transportation	
√	Provide developments with transit-supported capabilities	
	Target economic export activities	
√	Attract and maintain workforce	
	Promote infill of smaller, passed-over sites	
√	Encourage redevelopment of older areas for new purposes	
	Other _____	
	Ecosystem Protection Goals	
	Protect ecosystems	
	Minimize fragmentation	
	Promote native species	
	Protect rare and keystone species	
	Protect sensitive environments	
	Maintain natural processes	
	Maintain natural structural diversity	
	Protect genetic diversity	
√	Restore modified ecosystems	
	Other _____	

Name Affiliation Date

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TABLE E-37
STUDY AREA DIRECTIONS AND GOALS CHECKLIST
(Check where applicable)

Project Name: *Hudson-Bergen Light Rail* Location: *NJ* Analyst: *L. Pesesky* Date: _____

1. **Generalized Setting**

Within Metropolitan Statistical Area (Identify MSA)	*NYC-Northern NJ*
Outside of MSA	___
Both Inside and Outside MSA	___

Indicate Distance to Nearest Metropolitan Center *Within*

2. **Characteristics of Transportation System** (Note: These items are not intended to cover entire transportation need but rather to use information from more detailed assessments to provide a preliminary indication of existing accessibility, service and modal interrelationship characteristics, i.e., factors relevant to subsequent indirect effects analysis).

- Identify missing links in transportation system *connection between activity centers and transportation hubs*.
- Map and describe existing level of service on minor and principal arterials and their access characteristics.
- Indicate distance to nearest interstate highway if not in study area.
- Map and describe existing transit routes and demand.
- Map and describe major concentrations of existing and planned development.
- Describe modal interrelationships including competing and complementary characteristics.

3.

Population	Trend	Projection
Declining	___	___
Static (±1%/10 years)	√	___
Slow Growth	___	√
Rapid Growth (>10%/10 years)	___	___

Employment	Trend	Projection
Declining	___	___
Static (±1%/10 years)	√	___
Slow Growth	___	√
Rapid Growth (>10%/10 years)	___	___

4. **Planning Context**

	Yes	No	If yes, identify by title, agency and date
Zoning	√		*All municipalities*
State Master Plan	√		*State Development and Redevelopment Plan*
County/Regional Master Plan	√		*Two counties*
Municipal Master Plan	√		*All municipalities*
Growth Management Plan			
Water Quality Management Plan			
Other Natural Resources Management Plan	√		*Coastal Zone Plan; Palisades Conservation Plan*

5. **For each plan identified in No. 3, summarize key goals, elements and linkages to other plans (specify, in particular, elements related to economic development, land use development, the transportation system, and natural resource protection).** *Generally, oriented to growth and land development to increase tax ratables*

6. **Describe any efforts to elicit local needs and goals from residents and/or agencies (source and result).** *75-member Alternatives Analysis Advisory Committee*

7. **Describe known plans for major new or expanded activity centers including public facilities.** *Liberty State Park Master Plan; Jersey City Medical Center Relocation; Port Imperial Mixed Use*

Is the activity center dependent on transportation system improvement? Yes ____ No √

8. **Is the transportation need linked to economic growth and land development?** Yes √ No ____

If yes, is the nature of the linkage to:

Serve the needs of planned growth √ or

Channelize growth √ or

Stimulate growth ____ or

9. **Based on information obtained, are there any apparent conflicts between transportation and other needs that could result in controversy? (Describe).**

Yes ____ Possible ____ No √

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Name	Affiliation	Date

- **Site-Specific Development Impacts (p. 5-9)**—The EIS qualitatively analyzed how specific development projects and development sites could be affected where specific transit alignments, stations and transfer hubs are located. In general, it was noted that increased accessibility should also generally affect land values (although how land values would respond and the consequences of this effect were not noted). It was noted that increased accessibility could have a potentially substantial effect on the feasibility of a proposed mixed-use development on undeveloped land surrounding a proposed transit hub. It was noted that the timing of the development would not necessarily be influenced by the timing of a transit improvement's construction (p. 5-10).

Another site-specific chain-of-causality described was the effect of an enhanced transit system on the pace and shape of development vis-a-vis the forestalling of increased traffic congestion and parking demand. Sites beyond walking distance from existing transit hubs are auto dependent. The EIS (p.5-11) noted:

> "Any transit improvements that encourage people from within and outside the corridor to reach the area by transit will leave more Waterfront land available for a greater density of investment and less for low-value parking. Thus, a Waterfront transit system, accompanied by appropriate pedestrian and local roadway links, would provide the area with social and economic cohesiveness, increase the opportunity for density, and add to the attractiveness of a number of the "in-between" sites. In addition, the growth of more densely concentrated housing off the Waterfront but adjacent to stations on the outer reaches of a fixed guideway system will add to the Waterfront's already strong transit orientation."

It was noted that improved accessibility to Liberty State Park via a transit connection could be crucial to the park's full completion.

The level of confidence about the project's effect on land development varied. The magnitude of the effect and the level of confidence were higher in areas already experiencing redevelopment and lower in areas where redevelopment has yet to occur.

- **Community Facilities and Services (p. 5-12)**—It was noted that general development trends in the area, which would be enhanced by the project, are resulting in new and safer buildings, but may also require adjustments in fire-fighting equipment due to the large number of high-rise structures.
- **Local Tax Base Effects (p.5-13)**—Tax revenues from accelerated development in the corridor, to the extent that it is promoted by the project, was mentioned. The magnitude of this effect was expressed in terms of more than offsetting the direct tax revenue losses from the acquisition of private property for new rights-of-way.
- **Employment Impacts (p. 5-14)**—There was mention, but no analysis of, increased mobility from the project possibly having effects on local development projects, and productivity increases accruing to local businesses.
- **Impacts on Community Character (p. 5-17)**—It was noted that the project would tend to faster interaction and opportunity through increased accessibility, particularly in the lower income communities of the corridor that would benefit from the proximity of new transit services from the higher density, or more fully developed communities of the corridor. Physically, a new transit system would provide much-needed cohesion, especially along the Waterfront where residential and commercial activities would be reinforced, and a transit alignment could act as an organizing framework for additional development.
- **Impacts on Vegetation and Wildlife (p. 5-33)**—It was noted that the project could affect the value of wildlife habitat in an area through increased noise, vegetation destruction and habitat fragmentation.
- **Impacts on Water Quality (p. 5-33)**—The lower automobile use from the project would result in lower pollutant loadings.

3.0 EVALUATION OF PROJECT WITH FRAMEWORK

Step No. 1. Identify Study Area's Directions and Goals

As indicated in Table E-36 completed for this project's case study, the corridor's needs and goals are primarily of socioeconomic orientation. This is not surprising given the corridor's urban orientation. Municipalities in the corridor are intensely interested in new economic development primarily to increase tax ratables and plan the municipalities in improved fiscal positions. Indeed, as reflected by official plans and policies, state and local officials understand the need for new infrastructure to fasten the area's fullest realization. The State Development and Redevelopment Guide Plan noted the corridor as one where infrastructure investments shall be directed. The state feels that infrastructure investment in such urban core areas is needed to counteract the negative externalities of suburban sprawl that was indicative of the 1970s and 1980s real estate boom in the state. The combination of new major population and employment growth, relatively high existing transit usage, existing traffic congestion, and relatively high land rents leading to high development densities represents an opportunity to create commercial and residential center-oriented toward and linked by transit (see Table E-37).

Other major needs and goals within the corridor relate to open space and recreation, and preservation of heritage. The percentage of public open space and recreation areas in the corridor is generally inadequate, particularly in the extremely dense smaller municipalities on the Palisades Cliffs. In addi-

tion to representing redevelopment opportunities, the vast cleared tracts on the Waterfront represent an opportunity to increase the quantity of public open space in the corridor. Indeed, the state's officially adopted Coastal Zone Management Plan encourages new or expanded public or private open space development at locations compatible or supportive of adjacent and surrounding land uses. Adequate open space on the Waterfront has become an issue in certain corridor municipalities. In addition, the state's "Hudson Waterfront Walkway Plan and Design Guidelines" designates the location of a continuous 18-mile-long Waterfront walkway and related improvements.

Preservation of the area's heritage is also an important local need and goal. This heritage is indicated by several architecturally important historic structures and districts, as well as the Waterfront, the Hudson River, New York Harbor and the Manhattan skyline views. The conservation of views to and from the Palisades Cliffs was an important component of the unofficial "Palisades Conservation Plan" prepared by the Regional Plan Association and the Trust for Public Land.

Step No. 2. Inventory Study Area's Notable Features

High population densities and low-income neighborhoods are common characteristics to several municipalities in the corridor. Population densities in several smaller municipalities in the study area (e.g., Union City, West New York) are among the highest in the country, as high as 44,000 per square mile. The communities in the study area have historically been among the poorest in the region. Hudson County's per capita income in 1987 was $11,465, the second lowest for any county in the New York-New Jersey region. Almost 20 percent of the population of Hudson County, which makes up most of the study area, live below the poverty level.

Based on the population and income data, minority status strongly correlates with low income in the corridor. The dominant race in the corridor is white, but sizable concentrations of other racial and ethnic groups exist, most notably African-American, Hispanic and Asian. The greatest concentration of African-Americans in the corridor is in Jersey City, where this group represents 30 percent of the population. Union City and West New York, two lower-income communities, have a Hispanic population of more than 70 percent.

The study area contains seven municipalities that are classified as distressed and receive special state aid; they have been determined to be financially unable to meet their governmental obligations. Indicators of this condition are low percentage of tax collections, cash deficits and high tax delinquency rates.

The study area's notable features are documented in Tables E-38 and E-39.

Step No. 3. Identify Impact-Causing Activities of Proposed Action and Alternatives

As indicated by Table E-40, this project's impact-causing activities are primarily related to changes in traffic and

TABLE E-38
NOTABLE FEATURES CHECKLIST
(Check where applicable)

Project Name: *Hudson-Bergen Light Rail* Location: *NJ* Analyst: *L. Pesesky* Date:

		Specify
Ecosystem Features		
√	Regional habitats of concern/critical areas	*Hackensack Meadowlands*
	Rare, threatened or endangered species and associated habitat	
	Species requiring high survival rates	
	Species whose intrinsic rates of increase fluctuate greatly	
	Communities with vulnerable keystone predators or materialists	
	Other	
Socioeconomic Features		
√	Substandard amounts of open space and recreation	*Due to high population densities*
	Non-compliance with state and federal environmental laws	
	High concentration of uncontrolled solid and hazardous waste sites	
	Inadequate affordable housing	
	Inadequate access to amenities	
√	Economically distressed areas	*Seven municipalities in corridor*
	Lack of institutional land use controls	
	High proportion of population consisting of:	
√	Minorities	*Several municipalities have high % minority populations*
√	Low-income residents	*20% of population below poverty level*
	Elderly	
	Young	
	Disabled	
	Low proportion of long-term residents	
√	Locations of poor traffic flow	*Primarily due to physical constraints: narrow roads*
	Other	

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TABLE E-39
NOTABLE FEATURES ADDRESSED BY FEDERAL STATUTES
(Check where applicable)

Project Name: *Hudson-Bergen Light Rail* Location: *NJ* Analyst: *L. Pesesky* Date: _____

Resource Type or Area	Statute/Order	Source of Information and Map Locations
___ Section 4(f) Resources _√_ Public Parks and Recreational Lands ___ Wildlife and Waterfowl Refuges _√_ Historic Sites _√_ Historic Districts ___ Archaeological Remains _√_ Historic Structure	Department of Transportation Act	Local Parks or Recreation Officials, State Historic Preservation Office or local historic preservation organizations
_√_ Coastal Zone	Coastal Zone Management Act	State Coastal Zone Management Office
_√_ Waters of the United States	Clean Water Act; E.O. 11990	State Fish and Game Commission; U.S. Fish and Wildlife Service
___ Sole Source Aquifer	Safe Drinking Water Act	State Natural Resources Agency; U.S. Environmental Protection Agency
_√_ Areas of Known Contamination	Comprehensive Env. Response Compensation Liability Act	State environmental protection agency; U.S. Environmental Protection Agency
_√_ Floodplains	E.O. 11988	Federal Emergency Management Agency
___ Range or Habitat of Threatened or Endangered Species	Endangered Species Act	State Fish and Game Commission; U.S. Fish and Wildlife Service
___ Wild, Scenic or Recreational River	Wild and Scenic Rivers Act	U.S. National Parks Service
___ Prime or Unique Farmland	Farmland Protection Act	U.S. Soil Conservation Service
_√_ Sensitive Receptor	Clean Air Act; Noise Control Act	State environmental protection agency
_√_ Nonattainment or Maintenance Areas	Clean Air Act	State and local air and transportation agencies; metropolitan planning organizations; state implementation plans; conformity determinations of transportation plans, programs and projects.
_√_ Residential or Commercial Establishments	Uniform Relocation Act; E.O. 12898	Local governments

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TABLE E-40
PROJECT IMPACT-CAUSING ACTIVITIES CHECKLIST

Project Name: *Hudson-Bergen Light Rail* Location: *NJ* Analyst: *L. Pesesky* Date: _____

	Yes	No	If Yes, Describe Generally (Breadth, Duration, Location and Type)
Modification of Regime			
Exotic Flora Introduction			
Modification of Habitat	√		
Alteration of Ground Cover			
Alteration of Groundwater Hydrology			
Alteration of Drainage	√		
River Control and Flow Modification			
Channelization			
Noise and Vibration	√		
Land Transformation and Construction			
New or Expanded Transportation Facility	√		
Service or Support Sites and Buildings	√		
New or Expanded Service or Frontage Roads			
Ancillary Transmission Lines, Pipelines and Corridors			
Barriers, Including Fencing			
Channel Dredging and Straightening			
Channel Revetments			
Canals			
Bulkheads or Seawalls			
Cut and Fill	√		
Resource Extraction			
Surface Excavation			
Subsurface Excavation			
Dredging			
Processing			
Product Storage			
Land Alteration			
Erosion Control and Terracing			
Mine Sealing and Waste Control			
Landscaping			
Wetland or Open Water Fill and Drainage	√		
Harbor Dredging			
Resource Renewal			
Reforestation			
Groundwater Recharge			
Waste Recycling			
Site Remediation	√		

Changes in Traffic (including adjoining facilities)			
Railroad	√		
Transit (Bus)	√		
Transit (Fixed Guideway)	√		
Automobile	√		
Trucking	√		
Aircraft			
River and Canal Traffic			
Pleasure Boating			
Communication			
Operational or Service Charge			
Waste Emplacement and Treatment			
Landfill			
Emplacement of Spoil and Overburden			
Underground Storage			
Sanitary Waste Discharge			
Septic Tanks			
Stack and Exhaust Emission			
Chemical Treatment			
Fertilization			
Chemical Deicing			
Chemical Soil Stabilization			
Weed Control			
Pest Control			
Access Alteration			
New or Expanded Access to Activity Center	√		
New or Expanded Access to Undeveloped Land	√		
Alter Travel Circulation Patterns	√		
Alter Travel Times between Major Trip Productions and Attractions	√		
Alter Travel Costs between Major Trip Productions and Attractions	√		
Others			
_____			
_____			
_____			

	Name	Affiliation	Date
Reviewed by:			

access. Encroachment-related impacts are relatively limited because much of the project would be constructed within existing transportation rights-of-way (streets, abandoned railroad). Indeed, the EIS's treatment of transportation impacts in a separate chapter including changes in accessibility as a direct impact is consistent with the framework. The transportation impacts of this project are part and parcel of the project description.

Step No. 4. Identify Indirect Effects for Analysis

Section 2.0 of the Case Study Report identified a number of chains-of-causality leading from project activities to indirect effects. One example can be illustrated in a network diagram as follows:

Project Construction
↓
Improvement Access
↓
Improved Social and Economic
↓
Cohesiveness
↓
Increased Attractiveness of "In-Between Station" sites and Sites Adjacent to Stations
↓
Reinforce Transit Orientation of Area

In this case, the network diagram is a useful tool for illustrating indirect effect chains-of-causality.

As mentioned under Step No. 3, there would be few indirect effects associated with project encroachment on the environment. It can be said with relatively high confidence that those encroachment-alteration effects that would occur would not conflict with any of the goals or notable features of Steps 1 and 2. Consequently, further assessment of any such effects is not warranted.

As discussed in Section 2, there is a high potential for some induced growth as a result of this project. Possible effects are discussed in relatively general terms in the EIS and are related to existing or planned development sites. To quantify such effects or to distinguish such effects from growth independent of the project would be difficult. Indeed, Table E-41 indicates that the project would not have a major influence on land development. Therefore, as shown on the attached Table E-42, the induced growth effect does not warrant detailed analysis because not enough is known about the indirect effect to make its consideration useful. Further, any induced growth effect would be consistent with adopted goals and plans.

Although not quantifiable, a project "selling point" is increased opportunity for concentrated development (higher densities). More concentrated development could possibly conflict with the goals of providing adequate open space and preserving the area's architectural heritage. There is confidence that some induced growth would occur because of the project. Further, given the pace of development in the corridor, there is a high need-to-know about the impact now. Consequently, effects related to project-induced growth on open space and heritage preservation goals merit further analysis.

Step No. 5. Analyze Indirect Effect

The question for the indirect effect analysis of this project is: what would be the magnitude of project-induced growth on open space and heritage preservation goals? Although individual municipalities in the corridor have open space formulas in their zoning ordinances, a possible consequence of a piecemeal approach, combined with transit-influenced higher development densities, could be a failure to improve what is generally substandard per capita open space in the corridor.

The analysis of this potential effect is suited to trend analysis and cartographic analysis. Trend analysis could be used to evaluate trends in the percentage of built and approved developed site in the corridor set aside for open space and recreation use by the public (open space acreage/total site acreage). This information could be tabulated at the corridor, corridor-segment, or municipal level. A likely development scenario without the project could be developed (acreage of development) to which the trend open space ratio could be applied. The future per capita open space ratio could then be compared to the existing ratio to roughly determine the increase (or decline). Assuming an increase in per capita open space ratio, a tolerable reduction in this increase due to transit-influenced higher concentrations could be estimated. Spatial analysis could be applied to correlate development areas with existing areas underserved by open space to identify areas of concern at the micro-level. The spatial analysis could also be used to correlate future development areas with important viewsheds and areas of historic architectural significance.

Step No. 6. Evaluate the Analysis Results

Uncertainty about the results from Step No. 5 could be related to assumptions about past trends continuing into the future. One factor that should be explored is the propensity of local municipalities to grant density variances. Another factor to examine is the assumption about mode splits (i.e., auto/transit) that could affect development densities. The percent split to transit used in site plan assessments could increase over time if transit captures a larger share than anticipated after the project is built.

Step No. 7. Assess Consequences and Develop Mitigation

Using the framework as guidance, a mitigation strategy should be developed for an indirect effect that would make an existing unacceptable condition worse or would make a

TABLE E-41
CHECKLIST FOR ASSESSING STUDY AREA'S POTENTIAL FOR INDUCED GROWTH

Project Name: *Hudson-Bergen Light Rail* Location: *NJ* Analyst: *L. Pesesky* Date: _____

Regional Study Area Conditions

[A yes answer indicates that conditions generally favor growth; the more yes answers, the higher the certainty that regional conditions generally favor growth.]

1. Is the regional population increasing rapidly (generally, >5% per 10 years)? *N*
2. Is the region considered favorable for receiving FHA/VA loans? *y*
3. Are there any major growth generators (e.g., universities, military installations, industries, tourist attractions) in the region? *Y*
4. Is the regional office/commercial market characterized by low (generally, <10%) vacancy rates in any class of space? *N*
5. Is the region's business and civic leadership committed to rapid development? *Y*
6. Is the region an exporter of natural resources? *N*

Local Study Area Conditions

[If it is concluded that regional conditions generally favor growth, then proceed with the next series of questions. A yes answer indicates that the area in the immediate project vicinity has land use conversion potential; the more yes answers, the higher the certainty that land use conversion will be induced by the project to its immediate vicinity.]

General indicators

7. Is the regional path of development in the direction of the local study area? *Y*
8. Is the project within 5 miles of a growing community (generally, >5% per 10 years)? *Yes, downtown Jersey City*
9. Is the local study area characterized by middle and/or high income levels? *N*
10. Is the local study area free of moratoriums on development (e.g., sewer moratoriums, growth restrictions)? *Generally, yes*

Indicators of conditions favorable to conversion to lower density development

11. Is the local study area within a 30-minute drive of a major employment center? *Within*
12. Does the local study area have relatively high land availability/low land prices (generally <one-third of larger parcels developed)? *N*
13. Is the vacant land characterized by relatively large parcels? *Generally, no*
14. Is the local study area characterized predominantly by level land (generally, <5% slope)? *Waterfront, yes*
15. Is the project's Potential Impact Area characterized by soils suitable for development? *Y*
16. Is the project's Potential Impact Area predominantly free of flooding or wetlands? *Y*

Indicators of conditions favorable to conversion to higher density development

17. Does the local study area have relatively low land availability/high land prices (generally >two-thirds of larger parcels developed)? *Y*
18. Is the local study area served by existing principal arterials and water/sewer systems? *Principal arterials, no*
    Water/sewer, yes
19. Is the local study area covered by relatively few governmental jurisdictions? *N*
20. Is the local study area characterized by poorly enforced zoning regulations? *N*
21. Does the local study area lack recent (generally, <10 years old) master plans? *N*

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TABLE E-42
EVALUATION MATRIX FOR PROJECT INDIRECT EFFECTS OF CONCERN

Project Name: *Hudson-Bergen Light Rail* Location: *NJ* Analyst: *L. Pesesky* Date: _____

Indirect Effect Type	Direct Effects from Impact-Causing Activities	Indirect Effects from Direct Effects (List)	Potential Manifestation of Indirect Effects (List)	Link between Indirect Effect and Goal or Notable Feature that Meets Assessment Criteria[1]	
				Yes (Go to Step 5)	No (Assessment Complete)
Encroachment-Alteration	Ecosystem-related				√
	Socioeconomic-related				√
Induced Growth (Access-Alteration)		Serves specific development			√
		Stimulates complementary development			√
		Influences location decisions	*Potentially, higher-density development*		√
Effects Related to Induced Growth			Ecosystem-related		√
			Socioeconomic-related *open space; visual*	√	

[1] Assessment criteria = (1) Confidence that the effect is likely to occur; (2) Know enough about indirect effect to make consideration useful; and (3) Need to know about the impact now.

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valued notable feature ordinary. In this case, if the analysis shows that a higher development concentration induced by the project could worsen the unacceptable per capita open space ratio, then the project sponsor should develop a strategy for ameliorating the effect. However, land use is outside the control of the project sponsor. Therefore, the project sponsor's responsibility would be limited to recommending the strategy to local municipalities who do have control over land use. The same would be true if the analysis showed that induced growth effects would render valued notable features, i.e., viewsheds or historic settings, ordinary.

4.0 CONCLUSIONS

The Hudson-Bergen Light Rail Transit System project was selected for case study evaluation as it is a project for which there is a strong link between urban redevelopment and a transportation project. The case study reported that study area land use patterns have historically been linked to the transportation system. Presently, a transformation is occurring in the study area in which the urban fabric of a manufacturing-based economy has changed to that of a service-based economy. A corresponding transformation has occurred in transportation system needs from that oriented primarily toward moving goods to one needed to move people. Redevelopment of the area is an important goal both locally and at the state level. Local and state officials recognize the importance of transportation system improvements to fully meet this goal.

The project EIS noted a number of effects that meet the interpretation of the term "indirect effect" in the framework. However, these effects were not distinguished as indirect in the framework.

The framework application showed how the project could be evaluated using the framework structure of checklists, typologies, and decision processes. The framework application was useful in that it revealed an important study area goal that was not discussed in the project DEIS, i.e., provide adequate open space and recreation. Subsequently, the framework identified two issues of concern related to a higher development concentration because of the project:

1. effects on opportunities to increase open space; and
2. effects on viewsheds and architectural resources of historic importance.

Although the project-induced growth cannot be quantified, the case study showed how the framework could be used to analyze the magnitude of these effects, assess the consequences of the effects, and mitigate the effect (if necessary).

5.0 REFERENCES

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APPENDIX F

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Abbreviations used without definitions in TRB publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
SAE	Society of Automotive Engineers
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
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