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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Report 403

Guidance for Estimating the Indirect Effects of Proposed Transportation Projects

LOUIS BERGER & ASSOCIATES, INC.
East Orange, NJ

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

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Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Research Council was projected by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as it maintains an extensive committee structure from which authorities in any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state and local governmental agencies, universities, and industry; its relationship to the National Research Council is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters in bringing the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the National Research Council and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the National Research Council and the Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.
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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/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 factors
  - Supporting analytical methods; and
- Impact significance more important than whether it is direct or indirect.
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 ecological).
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 this 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 displace 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. Thus 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 impact on the scenic east of Brooklyn?

This chain of events recapitulates 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. If

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 suburban and from rural areas and small towns to larger cities. At the same time, businesses moved from small towns to larger 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 contact 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 likely 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, 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
(e) The types of case studies that would be used to demonstrate the applicability of the process
(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). The case studies are intended to evaluate the applicability of the tasks previously performed.

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 comprehensive definition of the term indirect effects 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 EIS's 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 indirect effects were conducted to discuss agency practices and perspectives with regard to conducting or reviewing EIS's analyses of indirect effects both of the EIS's investigated in the current analysis of this study and in general.

Data collection for this study was preceded by a mail survey that was distributed to 350 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 objective of the survey was to determine how federal and state transportation and environmental agencies and academic institutions and environmental organizations handled the indirect effects of their transportation projects.

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 filled 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 included 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 EIS's.

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 scrutinized 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 EIS's. To a much lesser extent, ancillary indirect impact issues concerning Section 4(d) 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 methods of identifying, defining, and estimating indirect effects from a primarily academic perspective. In addition to the literature on indirect effects, material 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 EIS's, 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 EIS's are also easier to identify and obtain than categorical exclusions or EAs. To the Federal Register, the notices of availability of all NEPA EIS's 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 EIS's was compiled. A total of 303 projects were identified. From these EIS's, 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 56 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. Each 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 3 through 5 of the checklist included 21 questions relating in 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., discipline or environment types) was developed.

Six Berger professionals from various environmental disciplines reviewed the EISs. To ensure consistency and quality of results, detailed instructions were attached to the checklists. The EISs were obtained 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 qualitative 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, permits, 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; chi-square tests for nominal and ordinal data; and, where appropriate, other non-parametric 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 chi-square 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, interviewers beyond those survey respondents contacted were contacted. 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: 31 in person and the remaining 6 by telephone (Appendix D). The on-site interviews were almost invariably attended by two or more agency staff. Highways-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 included 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 PAA and the PTA and one regional PTA 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 transporta- tion 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 clause 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 the responsibility of the federal government to assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings;...retain the widest range of beneficial uses of the environment without degradation, risk to health or...environmental impacts...[and] preserve intact...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 or other major Federal action significantly affecting the quality of the 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; 4332 Section 102(2)]

The meaning of these sections was clarified when the CEQ issued its NEPA regulations in 1978 as part of a broader effort 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 at a later time or in another place but is not reasonably foreseeable.” [2; 45 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 regulations—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’” [151.1C, 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 effects “...impact directly from impacts in that they are related to the action yet originate after the action. This use is inconsistent with the CEQ terminology in that indirect impacts are “...further 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 impact 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 secondary 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 6604.0A on the types of secondary effects that should be discussed in the preparation of documents. “These areas generally involve resources that exist before project activities...things like the social and economic structure of a community, floodplains, and arable 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 not 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 “induced or other impacts.” The Advisory Council on Historic Preservation uses the term indirect impact but defines it only by differentiating it from direct impacts without specific [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.” [11]. It should be noted that these guidelines implement Section 404(b)(1) of the Clean Water Act, not NEPA. In other words, that term 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 actions and are removed from the direct effect, the later 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 analysis are typically used for NEPA documents 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.

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 those 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 pollutants 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 [16; 40 CFR 1502].

Another aspect of this integrated approach is involvement of all appropriate “Federal, state, and local agencies,” tribes, and “other interested persons” [40 CFR 1501.7]. The regulations clarify that the likely cooperating agencies to be included are those with “jurisdiction by law or special expertise” [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 or environmental grounds)” [40 CFR 1501.7]. Public involvement is to be “encouraged and facilitated” [40 CFR 1500.2].

The time of place in the planning process at which integration should take place is stated as “the earliest possible time” [40 CFR 1501.2; 40 CFR 1201.3] or “the earliest time possible” [40 CFR 1501.6]. Other statements, such as
integrating NEPA into the "early planning process" (3; 40 CFR 1505.5), 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 pre-scaping, 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.

**TABLE I Examples of indirect or secondary effects by various agencies.**

<table>
<thead>
<tr>
<th>Agency</th>
<th>Source Document</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal Highway Administration (FHWA)</td>
<td>Posting Paper: Secondary and Cumulative Impact Assessment in the Highway Project Development Process, FHWA, April 1992.</td>
<td>Changes in land use, water quality, economic vitality and population density; impacts on endangered species; effects of the ability to realize cultural and economic benefits; and impacts of increased traffic, e.g., traffic treatment plant needs were revised because of more pollutants due to proposed secondary and induced development.</td>
</tr>
<tr>
<td>Federal Transit Administration (FTA)</td>
<td>Procedures and Technical Methods for Transit Project Planning, September 1988.</td>
<td>Increased congestion resulting from development; impact on parking and highway traffic; increased demand for housing near a rail system could have the effect of raising rents and driving our process; accessibility of commercial space could be affected by changes in residence pattern; increased access to buildings, parks, transit stops, etc., all due to construction, secondary and induced development.</td>
</tr>
<tr>
<td>Federal Aviation Administration (FAA)</td>
<td>Order 5020-44 Airport Environmental Handbook, U.S. DOT, FAA, October 1981.</td>
<td>Shifts in patterns of population movement and growth, public service demand, and changes in business and economic activity due to impact development; regional growth and development, spin-off jobs, induced impact on natural environment.</td>
</tr>
<tr>
<td>U.S. Parks and Wildlife Service (USFWS)</td>
<td>USFWS, NEPA Handbook, Released 30-6-88, September 1983.</td>
<td>Vegetation management causing a change in plant species which can result in a change in grazing patterns and natural populations; changes in native fish stock due to artificial fish farming which incurs food demand (by predators) in that area.</td>
</tr>
<tr>
<td>U.S. Environmental Protection Agency (U.S. EPA)</td>
<td>U.S. EPA Draft or Final Regulations, 4000(U) Guidelines, Section 23B.110(b).</td>
<td>For an ecosystem: Running water levels to an impoundment and downstream association with the operations of a dam, septic tank leaching and surface runoff from residential or commercial developments on fill, soil erosion and runoff from a sanitary landfill located in waters of the United States.</td>
</tr>
</tbody>
</table>

These statutes require a continuing, comprehensive, and cooperative, and coordinated analysis of metropolitan transportation impacts. 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. The regulation also requires coordination with environmental, resource, and energy 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 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 and federal air quality implementation plans. The transportation 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 particulars, and carbon monoxide).

The implication of the transportation conformity regulation for indirect effects assessment is primarily through the transportation-land-use linkage. The conformity determinations must be based on the current and future plans, 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 by the act.
- A dependence on 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 short, the transportation conformity regulation means that conformity determinations include assessments of the interaction between transportation decisions and land use and...
Transportation Agency Documents

The FAA guidelines on the economic effects of airports (4, p. 19) delineate specific steps to determine the indirect effects 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 guideline caution that: the distinction between those who come to the region simply because of the airport and those who would have 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 more general than that of the FAA (F). 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 thus provided with several examples. Part of this table is presented as Table 2.

<table>
<thead>
<tr>
<th>Generally Not Significant</th>
<th>Possibly Significant</th>
<th>Generally Significant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposed project may generate a demand for secondary development, but evaluation by local planning agencies indicates that, if such a development occurs, it will be duplicative and in conformity with adopted public land use plans.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary development would require a change in zoning that is supported by local planning agencies.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed project would induce secondary development that is in accordance with the comprehensive plan and surrounding development.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public infrastructure is not adequate to support anticipated secondary development.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 (J). 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

<table>
<thead>
<tr>
<th>No.</th>
<th>Impacts may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that the effect will be beneficial.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>The degree to which the proposed action affects public health or safety.</td>
</tr>
<tr>
<td>3</td>
<td>Unique characteristics of the geographic area, such as proximity to historic or cultural resources, parklands, prime fisheries, wetlands, wild and scenic rivers, or ecologically critical areas.</td>
</tr>
<tr>
<td>4</td>
<td>The degree to which the effects on the quality of the human environment are likely to be highly controversial.</td>
</tr>
<tr>
<td>5</td>
<td>The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown state.</td>
</tr>
<tr>
<td>6</td>
<td>The degree to which the action may establish a precedent for future actions with significant effects or expresses a decision in principle about a future consideration.</td>
</tr>
<tr>
<td>7</td>
<td>Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance cannot be avoided by trimming an action &quot;temporarily&quot; or breaking it down into small component parts.</td>
</tr>
<tr>
<td>8</td>
<td>The degree to which the action may adversely affect districts, sites, highways, structures, or other list entities listed on the National Register of Historic Places, or may cause loss or destruction of significant scientific, cultural, or historic resources.</td>
</tr>
<tr>
<td>9</td>
<td>The degree to which the action may seriously affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973.</td>
</tr>
<tr>
<td>10</td>
<td>Whether the action threatens a violation of Federal law, state, or local law or requirements imposed for the protection of the environment.</td>
</tr>
</tbody>
</table>

Source: NEPA Regulation, 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 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" (123), 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 habitats;
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" (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 avoid fragmentation into smaller, less significant actions (191 at 1341, 1443), 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 (191 at 1307).

The question at issue is whether the agency's decision was "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law" (191 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 to be considered, 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. (72 U.S. at 29, 43, S.Ct. at 856, 1807)

It should be noted that judicial rulings in recent 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 (19, 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 assessing whether the agency considered the environmental consequences of its proposed action (18, 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 provides the necessary process (cease and desist). 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 unification—rather than refuse—agency action. (20, U.S. at 332, 351; S.Ct. at 1833, 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 interpretation of foreseeability.

**Context**

As a whole, 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.

If 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 implicit in this rule of reason is the overriding statutory requirement that the 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 deny what is, fairly speaking, essentially necessary.

The court must consider the extent to which environmental effects are foreseeable. The proper test for foreseeability is whether a reasonable person in the agency's position could have made their assessment of the probable environmental consequences at the time the agency's responsibilities under NEPA arise. The court, not the agency, determines whether a reasonable person in the position of the responsible agency would have been aware of the environmental consequences of the proposed action. The court must determine what is, fairly speaking, not meaningfully uncertain.

The question then thus becomes operative when agency actions substantially affect the environment. A partie with no environmental consequences upon 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 circumstances. It will often be possible to consider the likely purchasers and 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, even if trends are uncertain or potential purchasers have made themselves known. The agency cannot ignore these uncertain, but possible, effects of its decisions. (19 at 1833).

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 extent to which the site is 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 (10, 40 CFR 1508.27).

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

Distinguishing 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., Atomic Energy Commission (22 at 1079).

One 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 deny what is, fairly speaking, essentially necessary. This implies that if there is any basis to reasonably speculate about the identity of future land owners or the nature of future land uses, then it is not reasonable to label as "crystal ball inquiry."" But implicit in this rule of reason is the overriding statutory requirement that the 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.
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 legally defective, we cannot 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. (13 at 1235, nos. 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 systems; and (3) the impact upon development and population growth. (24 at 1224)

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 give "sufficient specificity" to such increased development, with its consequent increase in population and demand for state, county, and municipal services, such as schools, police and fire protection and sewage 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 878) reviewed a matter involving a proposal to build a port and causeway on a rural island in Maine. The EA resulted in a FEIS. Using the CEA regulation as a guide, the court set forth the following questions to be asked to determine whether a specific part 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 866).

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 induce growth. Therefore, putting off an EIS for a later time would result in the development of the rest of the island could prove irresistible.

The EIS in that matter... of the impact statement. The court stated that... that the impact statement would not be... of the project's... to proceed. This three-point—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... must be evaluated in a manner that 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 argued that the EIS was inadequate. The court agreed that the EIS failed to predict the impact of long-term development on the island, but... for the environmental impact to be analyzed along with that of the road. The court found that argument to be unavailing.

This court, in... that the EIS was inadequate. The court upheld the EIS as a reason... of the agency's evaluation. In... taxpayers brought an action to enjoin construction of a timber road in a roadless area in a former national forest. An EA prepared for this agency resulted in a PONS.

In support of the PONS, 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 be unavailing.

Case Law on Growth-Induced Indirect Effects

The question of confidence in and specificity of types of induced growth or secondary impacts is not new. In Sierra Club v. Marsh, the court held that indirect effects were inadequately treated.

The administrative record revealed water and sewage treatment facilities on the island were inadequate to sustain heavy industry. Furthermore, the cost of upping the water line to sustain heavy industry was prohibitive. Local officials and property owners desired their marketing toward... dry and heavy industry. The court held that

NEPA requires an EIS to identify 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 waste processing, petroleum, and cement, because the likelihood of such industries developing on Sears Island is too speculative to be reasonably foreseeable. (27 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 reason... on the agencies' evaluation. In... plaintiffs brought an action to enjoin construction of a timber road in a roadless area in a former national forest. An EA prepared for this agency resulted in a PONS.

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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 explore some of these divergent holdings.

In Muffels v. Skinner (31 at 904), property owners brought an action challenging the project's issuance of a permit to build 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 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 is that if there were zoning changes which would 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 consisted 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. Goldstein (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, total development of the study area with little evidence 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 in the next logical area for development. As such, the political context, the political process, all the evidence indicates that the Land Use Plan is, and will continue to be, enforced (32 at 368-369).

There is no question that such effects are reasonable and must be reviewed. On that review, reasonable criteria as foresaw NEPA and must be included in the EIS. First, the court examined the discussion concerning the 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 the 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 in its nature, and with growth will come growth's problems: increased population, increased traffic, increased pollution, increased demands for services such as schools, 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 Responsibility for Nonfederal Indirect Effects

Even 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 that proposed facility.

The court acknowledged NEPA's mandate is requiring an EIS for major federal actions significantly affecting the quality of the human environment. However, it recognized that "whether the shorelines 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 shorelines 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 complimentary but distinct functions. This matter was distinguished from instances in which certain segments of highway construction projects were designated as state and state or federal action when taken as a whole. That project was 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 with a federal NEPA action.

First, the shorelines facilities are completely state-funded. As the court observed in State of Hawaii v. Andrus (35) at 537, 541 (9th Cir. 1979), "where 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). Lack of both Federal funding and Federal supervision over the development of the facilities, the construction of the shorelines 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 discuss the shorelines facilities as part of the Federal action. The environmental effects of the state actions were not analyzed, 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 shorelines facilities be included in the analysis of the EIS because the ACOG included the economic benefits of a harbor with shorelines facilities in its cost-benefit 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 (23 at 1372, footnote 11).
The question of mitigation by local entities was addressed by the U.S. Supreme Court in Robinson v. Mendenhall 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 main deer herd. The court acknowledged that, although NEPA and the CEQ regulation both require detailed analysis of on- and off-site mitigation measures, this was 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 332; 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 Davis v. Marsh, which distinguished federal and state jurisdiction in NEPA reporting.

In this case, the off-site effects on air quality and the main deer herd cannot be mitigated unless non-Federal Government agencies take appropriate action. Since it is 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 332; 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 339; 5 Cl. at 1850).

It can be concluded that NEPA remains a procedural law that requires federal agencies to inform the decision maker and the public 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

[Direct 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.]

Secondary impacts of highway improvements can be seen as expanding rings of chain reactions, of "ripple effects" extending outward in ever increasing, but less severe cycles of internalized consequences. (4, p. 3-22)

He also wrote that

[Secondary 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 some sense indirect possible consequences starggered by the construction or sustained use of a highway project but not in themselves "necessary" to the project. (4, p. 3-22)

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.

Vlachos defines the CEQ definition of indirect effects as his emphasis on the effects being part of another cycle or series. 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 Vlachos’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 Vlachos’s paper discussed effects from the interstate highway system as a whole and not project-specific effects.

Vlachos defines induced effects as effects 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 example given for this interpretation of induced effects include disposal of cars at the end of their life cycle, use of petroleum necessary in 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>
<thead>
<tr>
<th>TABLE 4 Vlachos’s characteristics of indirect and secondary effects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Effect</strong></td>
</tr>
<tr>
<td>INDIRECT</td>
</tr>
<tr>
<td>Order</td>
</tr>
<tr>
<td>Space</td>
</tr>
<tr>
<td>Timeframe</td>
</tr>
<tr>
<td>Scope</td>
</tr>
<tr>
<td>Secondary</td>
</tr>
<tr>
<td>Duration</td>
</tr>
</tbody>
</table>

Source: Vlachos, p. 3-12.
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 effects 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 further removed in distance specification. Where he departs from the latter is 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 impacts. In “Measuring Impacts of Land Development,” Schenman and Muller use the term spills over 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 spills over 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. 76).

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 spills over 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 spills over or secondary effects.

In “Transportation Decision-Making: A Guide to Social and Environmental Considerations,” Machen 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 non-direct (i.e., indirect, secondary, spills over, 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 allows 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 material 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 prompts 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

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 ecological systems. Leopold proposed a matrix technique to identify and evaluate potential impacts from a project. Studies by Vlachos and by Gensburg and Frankenberger 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 58 environmental characteristics at the vertical axis. Overall, Leopold’s matrix allows for 8,400 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 in 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., ecological 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 Gensburg and Frankenberger (see Appendix P), 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

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

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**TABLE 5:** Beale’s time–distance differentiation of various impact categories

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Direct Impacts</th>
<th>Indirect Impacts</th>
<th>Cumulative Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location of Impact</td>
<td>Same Place</td>
<td>Removed in Distance</td>
<td>Removed in Distance</td>
</tr>
<tr>
<td>Timing of Impact</td>
<td>Same Time</td>
<td>Later</td>
<td>Later</td>
</tr>
<tr>
<td>Probability of Impact</td>
<td>Highly Predictable</td>
<td>Reasonably Foreseeable</td>
<td>Reasonably Foreseeable</td>
</tr>
<tr>
<td>Cause of Impact</td>
<td>Highway Project</td>
<td>Highway Project &amp; Effects of Isolated Intermediate Actions</td>
<td>Highway Project &amp; Effects of Buffered Intermediate Actions, Actions &amp; Other Prox, Prox &amp; Reasonable Foreseeable Future Actions</td>
</tr>
</tbody>
</table>

Source: Beale, p. 5.
<table>
<thead>
<tr>
<th>Source</th>
<th>Direct Effects</th>
<th>Indirect Effects</th>
<th>Secondary or Induced Effects</th>
<th>Examples of Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viachen, 1976</td>
<td>Effects which are caused by the action and occur at the same time and place.</td>
<td>Effects that are caused by the action and are later in time or further removed in distance, but are still reasonably foreseeable.</td>
<td>Secondary effect: Derivatives of primary effect, being either induced or stemming from the primary effect.</td>
<td>Direct effect: Induced changes in land use, population density or growth.</td>
</tr>
<tr>
<td>Hamilton, 1968</td>
<td>The direct results of the construction and operation of roads. Use of the roads by cars is also a direct impact.</td>
<td>Induced effect: Effect resulting from concentrations caused by the increment highway system.</td>
<td>Secondary effect: Potential for population growth, potential for sprawl and urbanized development.</td>
<td></td>
</tr>
<tr>
<td>Heise, 1993</td>
<td>Usually occur within an adjustment and can be more widespread or delayed.</td>
<td>Effects caused by the action later in time than direct effect but still reasonably foreseeable.</td>
<td>Incorporates CERQ example for indirect effect by reference.</td>
<td></td>
</tr>
<tr>
<td>Schoneman and Medley, 1974</td>
<td>Significant environmental and economic effects beyond the boundaries of the project (split-over effects).</td>
<td>Spill-over effect: Greater-than-local development impact such as water and air pollution.</td>
<td>Secondary effect: Additional construction from increasing residential and commercial development.</td>
<td></td>
</tr>
<tr>
<td>Madetoia, et al., 1975</td>
<td>Impacts that have ramifications beyond their primary consequences.</td>
<td>Impact:</td>
<td>Changes in activity distribution patterns, travel demand, ecological relationships and neighborhood characteristics.</td>
<td></td>
</tr>
</tbody>
</table>

**System Analysis**

Viachen's approach to systems analysis emphasizes the identification of the following elements:

1. Definition of objectives and goals as well as alternatives.
2. Description of the system (background).
3. Development of a hierarchical, causal diagram of the system elements and their interrelationships.
5. Evaluation of the performance of the system.

**Methodology**

Viachen suggests a systematic exploration of the system, identifying potential causal pathways, and examining the potential for the occurrence of positive or negative feedback loops. The method is designed to be applied to individual project development.

**Virtual Systems**

Virtual systems approach causal reasoning about the system. The approach identifies the causal linkages between different components of the system, allowing for a more comprehensive understanding of the system's behavior.

**Table 6: Definitions and examples for direct and indirect impacts by source**

<table>
<thead>
<tr>
<th>Source</th>
<th>Direct Effects</th>
<th>Indirect Effects</th>
<th>Secondary or Induced Effects</th>
<th>Examples of Effects</th>
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<td>Viachen, 1976</td>
<td>Effects which are caused by the action and occur at the same time and place.</td>
<td>Effects that are caused by the action and are later in time or further removed in distance, but are still reasonably foreseeable.</td>
<td>Secondary effect: Derivatives of primary effect, being either induced or stemming from the primary effect.</td>
<td>Direct effect: Induced changes in land use, population density or growth.</td>
</tr>
<tr>
<td>Hamilton, 1968</td>
<td>The direct results of the construction and operation of roads. Use of the roads by cars is also a direct impact.</td>
<td>Induced effect: Effect resulting from concentrations caused by the increment highway system.</td>
<td>Secondary effect: Potential for population growth, potential for sprawl and urbanized development.</td>
<td></td>
</tr>
<tr>
<td>Heise, 1993</td>
<td>Usually occur within an adjustment and can be more widespread or delayed.</td>
<td>Effects caused by the action later in time than direct effect but still reasonably foreseeable.</td>
<td>Incorporates CERQ example for indirect effect by reference.</td>
<td></td>
</tr>
<tr>
<td>Schoneman and Medley, 1974</td>
<td>Significant environmental and economic effects beyond the boundaries of the project (split-over effects).</td>
<td>Spill-over effect: Greater-than-local development impact such as water and air pollution.</td>
<td>Secondary effect: Additional construction from increasing residential and commercial development.</td>
<td></td>
</tr>
<tr>
<td>Madetoia, et al., 1975</td>
<td>Impacts that have ramifications beyond their primary consequences.</td>
<td>Impact:</td>
<td>Changes in activity distribution patterns, travel demand, ecological relationships and neighborhood characteristics.</td>
<td></td>
</tr>
</tbody>
</table>
TABLE 9 Viček’s component analysis approach

<table>
<thead>
<tr>
<th>COMPONENTS</th>
<th>IMPACTS</th>
<th>CONSEQUENCES (long-range ramifications)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological</td>
<td>Physical</td>
<td>Social disturbances</td>
</tr>
<tr>
<td></td>
<td>Biological</td>
<td>Ecological stability</td>
</tr>
<tr>
<td>Social</td>
<td>Demographic</td>
<td>Modification of regime</td>
</tr>
<tr>
<td></td>
<td>Spatial/Human Ecology/Protonic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Community/Institutional</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cultural/Normative</td>
<td></td>
</tr>
<tr>
<td>Economic</td>
<td>Consumption of influences</td>
<td>Distribution and redistribution of resources</td>
</tr>
<tr>
<td></td>
<td>Employment and income</td>
<td></td>
</tr>
<tr>
<td>Aggregate</td>
<td>Quality of life</td>
<td>Morphological transformations</td>
</tr>
<tr>
<td></td>
<td>Social well-being</td>
<td>Structural differentiation’s</td>
</tr>
<tr>
<td></td>
<td>&quot;Cultural&quot; sustainment</td>
<td>Protonic transfigurations</td>
</tr>
</tbody>
</table>


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, seasonal—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 these 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 importance 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 development 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 or 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 Granting and Freudenburg’s conceptual approach

<table>
<thead>
<tr>
<th>System Affected</th>
<th>Opportunity-Threat</th>
<th>Development/Event</th>
<th>Adaptation/Post-Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical</td>
<td>Anticipatory constriction or lack of maintenance, delay of existing structures and facilities.</td>
<td>Potential massive alteration of the physical environment, construction of new and upgrading of existing facilities.</td>
<td>Creation of development-specific facilities, deterioration of alternative productive facilities, disorganization of environment.</td>
</tr>
<tr>
<td>Cultural</td>
<td>Initial contact, new ideas, potential loss of cultural continuity.</td>
<td>Suspension of activities that assure cultural continuity (e.g., maintenance harvests).</td>
<td>Gradual losses of cultural identity, loss of unique knowledge, skills, and/or perspectives.</td>
</tr>
<tr>
<td>Social</td>
<td>Organizational changes, investment of time, money, or energy for support or resistance; differential construction of risk.</td>
<td>Population increase, influx of outside individuals, decline in density of acquaintance, change in social structure.</td>
<td>Gradual losses of social human capital (e.g., organizational networks and skills, replacements having limited optimal applications).</td>
</tr>
<tr>
<td>Political/Legal</td>
<td>Litigation to force or block proposed development, heightened political claim-making.</td>
<td>Invasion of development activity into community politics, litigation and conflict over activity impacts.</td>
<td>Zeal in regulatory changes in search of new development, new devastating in response to impacts.</td>
</tr>
<tr>
<td>Economic</td>
<td>Decline or increase in property values, specialization, investment.</td>
<td>Traditional boom/bust effects, inflation, recession, expansion, and contraction.</td>
<td>Loss of economic flexibility, specialization of business.</td>
</tr>
<tr>
<td>Psychological</td>
<td>Anxiety, stress, anger; gain or loss in perceived efficacy.</td>
<td>Stress associated with rapid growth, psychological pathology, loss of efficacy.</td>
<td>Acquisition of coping strategies that are potentially maladaptive under future scenarios.</td>
</tr>
</tbody>
</table>

Source: Granting and Freudenburg, p. 218.

TABLE 11 Hamilton’s ranking approach

<table>
<thead>
<tr>
<th>Hamilton’s Alternative 1: Classes and Types of Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact</td>
</tr>
<tr>
<td>Direct</td>
</tr>
<tr>
<td>Noise level increase</td>
</tr>
<tr>
<td>Wildlife</td>
</tr>
<tr>
<td>Wetlands</td>
</tr>
<tr>
<td>Land loss</td>
</tr>
<tr>
<td>Soil erosion</td>
</tr>
<tr>
<td>Vegetative modification</td>
</tr>
<tr>
<td>Air pollution</td>
</tr>
<tr>
<td>Water pollution</td>
</tr>
<tr>
<td>Land alienation</td>
</tr>
<tr>
<td>Cultural resources</td>
</tr>
<tr>
<td>Indirect</td>
</tr>
<tr>
<td>Shift change</td>
</tr>
<tr>
<td>Shift development</td>
</tr>
<tr>
<td>Urban alteration</td>
</tr>
<tr>
<td>Auto manufacturers</td>
</tr>
<tr>
<td>Permissible production</td>
</tr>
<tr>
<td>Public works</td>
</tr>
</tbody>
</table>

Hamilton’s Alternative 2: Impacts Grouped by Source

<table>
<thead>
<tr>
<th>Impact</th>
<th>Source of Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct</td>
<td>Development of Adjacent Lands</td>
</tr>
<tr>
<td>Noise level increase</td>
<td>Road Construction</td>
</tr>
<tr>
<td>Wildlife</td>
<td>X</td>
</tr>
<tr>
<td>Wetlands</td>
<td>X</td>
</tr>
<tr>
<td>Land loss</td>
<td>X</td>
</tr>
<tr>
<td>Soil erosion</td>
<td>X</td>
</tr>
<tr>
<td>Vegetative modification</td>
<td>X</td>
</tr>
<tr>
<td>Air pollution</td>
<td>X</td>
</tr>
<tr>
<td>Water pollution</td>
<td>X</td>
</tr>
<tr>
<td>Land alienation</td>
<td>X</td>
</tr>
<tr>
<td>Cultural resources</td>
<td>X</td>
</tr>
<tr>
<td>Indirect</td>
<td>X</td>
</tr>
<tr>
<td>Shift change</td>
<td>X</td>
</tr>
<tr>
<td>Shift development</td>
<td>X</td>
</tr>
<tr>
<td>Urban alteration</td>
<td>X</td>
</tr>
<tr>
<td>Auto manufacturers</td>
<td>X</td>
</tr>
<tr>
<td>Permissible production</td>
<td>X</td>
</tr>
<tr>
<td>Public works</td>
<td>X</td>
</tr>
</tbody>
</table>

NOTE: P = permanent, T = temporary.

Source: Hamilton, TRB 1164, p. 5 & 7.
TABLE 13 Indicators used to measure effects of land development

<table>
<thead>
<tr>
<th>Impacted Factor</th>
<th>Variable</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological</td>
<td>Public Fiscal Balance</td>
<td>1) Net change in government fiscal flow.</td>
</tr>
<tr>
<td></td>
<td>Employment</td>
<td>2) Number of new long-term and short-term jobs provided.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3) Change in numbers and percent employed, unemployed, and underemployed.</td>
</tr>
<tr>
<td></td>
<td>Wealth</td>
<td>4) Change in land values.</td>
</tr>
<tr>
<td></td>
<td>Air Pollution</td>
<td>5) Change in level of air pollutants and change in number of people at risk or harmed by pollutants.</td>
</tr>
<tr>
<td></td>
<td>Water Pollution</td>
<td>6) Change in level of water pollutants, change in sicker types of use, and number of persons affected for each body of water.</td>
</tr>
<tr>
<td></td>
<td>Noise Pollution</td>
<td>7) Change in noise and vibration levels, and the number of people bothered by excessive noise and vibration.</td>
</tr>
<tr>
<td>Natural Environment</td>
<td>Greener and Open Space</td>
<td>8) Amount and person change in greenery and open space.</td>
</tr>
<tr>
<td></td>
<td>Wildlife and Vegetation</td>
<td>9) Number and types of rare or endangered species that will be threatened.</td>
</tr>
<tr>
<td></td>
<td>Source Resource Consumption</td>
<td>10) Change in the abundance and diversity of wildlife and vegetation in the development and community.</td>
</tr>
<tr>
<td></td>
<td>Natural Disasters</td>
<td>11) Change in the frequency, duration, and magnitude of shortages of critically scarce resources, and the number of persons affected.</td>
</tr>
<tr>
<td>Aesthetic and Cultural Values</td>
<td>Views</td>
<td>12) Change in number of people and value of property endangered by flooding, earthquakes, landslides, and other natural disasters.</td>
</tr>
<tr>
<td></td>
<td>Aesthetics</td>
<td>13) Visual appreciation of the development as rated by citizens and &quot;estates.&quot;</td>
</tr>
<tr>
<td></td>
<td>Landmarks</td>
<td>14) Visual appreciation of the development as rated by citizens and &quot;estates.&quot;</td>
</tr>
<tr>
<td>Public and Private Services</td>
<td>Recreational Demand</td>
<td>15) Percent of people who think the development improves or lessens overall neighborhood aesthetics, pleasantness, and uniqueness.</td>
</tr>
<tr>
<td></td>
<td>Crime Control</td>
<td>16) Change in crime rate in existing community of new development (or expert rating of change in hazard potential).</td>
</tr>
<tr>
<td></td>
<td>Fire Protection</td>
<td>17) Change in incident rate.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18) Change in use of fire protection and rescue services.</td>
</tr>
<tr>
<td></td>
<td>Transportation</td>
<td>19) Change in number and distance travel times between school zones and transport zone.</td>
</tr>
</tbody>
</table>

(continued)
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 (59, p. 33).

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 profiles 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 aspects of the model to forecast how land use will change as a consequence of a transportation improvement (49). 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 times is the primary 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 development 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 weighting 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 Vatchos, 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, Vatchos 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 judgments 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.
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 correctness 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 ecological—are considered.

**Probabilistic Forecasting**. In assessing 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.
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 in 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 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 desired 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 test in on the most important issue and developments;
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. Tiselin'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 technique because the process can smooth 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 development, 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 only limited 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 Opinion Model, DeSanto and Erickson’s use of the DOT model MitoUT, 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 need 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) EIS (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 Avenue project.

When wetlands and ecologic impacts were considered, however, the distinction between indirect and cumulative began to blur. Nonindirect wildlife impacts were referred to as indirect and cumulative.

As another place in the EISs, economic effects were divided into indirect and induced impacts. This distinction is 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 that are 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 Sturgeon, Maine, a port project. The Sears Island FEIS included the following definitions of primary, direct, indirect, secondary, and induced effects:

- "Primary" impact is the direct impact in the first round of expenditures, jobs, and other effects associated with the port's construction and operations.
- "Induced" impact is the second and successive rounds (multicyclic) of effects associated with the port's construction and operations.
- "Secondary" impacts are the impacts "induced" by and attributable to the port's facilities and operations. 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 sociocultural 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
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 trends 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 sample 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 statistically significant 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 ecological 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-
Figures 1 and 2: Indirect effects by DEIS year and project location, respectively.
ary. The DEIS and FEIS were prepared in 1992. The project also had a controversial indirect effects issue involving the potential for larger-than-expected recreational opportunities on an island near Juneau, Alaska. The evaluation of indirect effects concerning habitat and endangered species was presented in a detailed qualitative analysis covering fish, fish, game, animals, other species, and eagles. The primary method of evaluation was professional judgment on the part of a knowledgeable observer.

However, each individual indirect effects analysis was conducted 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 in 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 route. It considered in some detail several of the subjects normally included in a land development feasibility assessment: existing land use, 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 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 Truck Highway 371 new construction DEIS, a project near Brainerd, Minnesota. The purpose of this project was to ease traffic congestion, especially during the deer 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 in 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 course of this study. 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 studied 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. Socioeconomic impacts were frequently examined with land use in the EISs examined. However, for the purposes of this study, the two categories were separated. Because so many of the transportation projects were connected with economic development in some way (close to 40% 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 analysis, 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 here. The 181st Avenue to Sandy River project included an EIS for 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 recreational opportunities on an island near Juneau, Alaska. The evaluation of indirect effects concerning habitat and endangered species was presented in a detailed qualitative analysis covering fish, fish, game, animals, other species, and eagles. The primary method of evaluation was professional judgment on the part of a knowledgeable observer.

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of $55 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 developments from a variety of sources, direct, indirect, and induced and 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 round trips of purchases by all the interrelated sectors of the same 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 set generated by the consumption of goods and services made possible by payroll 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 economic 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 occur. Income of the projected work force was then estimated along with expenditures on goods and services by employees.

Subsequent sections of the Sears Island FEIS illustrate how indirect economic effects are spread into other socioeconomic areas. For example, 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 percent 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 (final 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 is especially 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 zones 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. These 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 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 2016 for no-action and project alternatives. An interactive process was then used to redistribute 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 project 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;
- 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, rezoning, and visual impact concerns were dealt with exclusively by qualitative means.

Qualitative 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/Payette 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 retarding traffic congestion and enhancing vehicular access. The Mon/Payette project was broken down into four EISs, the limits of which were defined using the logical terminus concept.

In the是一部 parts of the Mon/Payette EISs, a DEIS for the section from I-81 in West Virginia to State Route 6139 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 1.6 km (1 mi) of the proposed interchange. Potential development tracts were identified by extensive consultation with regional, municipal, and local planning officials, chambers of commerce, private developers, and economic development associations. Existing land-
Examples of projects that included comprehensive quanti-
tative land-use/indirect effects studies as well as detailed nat-
ural 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 (1-84) FEIS (Oregon). These projects employed extensive
mapping of land uses and projections based on numer-
ous consultations with local officials, planners, and develop-
ers. 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 wet-
land indirect effects. In the case 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
areal 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 farm-
lands, 9 were rated with moderate potential, and the remain-
ing 11 were rated with low potential.

Because of the U.S. Department of Agriculture require-
ment 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 type 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 overall value for the property. Cri-
teria 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. Mod-
dification 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 magnitudes of each alterna-
tive 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 design-
at. Because of the cost, these 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 cal-
culated. 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 dis-
cussed previously.

Geology, Soil, and Water Quality. Quantitative studies
of geology, soils, and water quality indirect effects were con-
ducted in only two instances among the sample projects, both
in Pennsylvania. These were the Lackawanna Valley indus-
trial 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 Val-
ley project was the potential effects of secondary develop-
ment 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 in-
volved 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 239 km²
(100 mi²) 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/mining hazards. To tie the problem
together, watersheds, groundwater, public water supplies,
and streamwater/groundwater management were also studied.
Each evaluation followed fundamentally the same proce-
dure, in which information was gathered and tabulated, cal-
culations 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 project.

The geology/soil study concentrated on mapping soil
units, identifying and measuring those that were erodible or
otherwise unstable, and identifying the potential for erodible
or unstable soils adjacent to water. The min-
ing/mine hazards study identified, mapped, and tabulated
formerly mined sites and recorded their status (reclamation
subsidience, stable) and the potential for reclamation. Surface
waters were evaluated by inventoring stream quality (phys-
ical/chemical and biological status), mapping, and measuring
subwatersheds, and identifying the percentage of each sub-
watershed within each secondary development site. Ground-
water 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, cur-
tent 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 quanti-
tative wetlands studies were undertaken in only three of
the projects: 181st Avenue to Sandy River (1-84) 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 analysis 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 (1-84) project is used here
as an example. The project consisted of a major widening of
1-84 in the eastern suburbs of Portland, Oregon, along 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,
well in with the regional and local land-use plans. Vacant
areas identified for future development in local
land-use plans were delineated and measured, yielding an area
study area of 110.5 km² (43,370 acres).

NWI maps were used to map wetlands within the vacant
lands zoned for development. Areas designated for protec-
tion in the local comprehensive plans were not included.
Hydrick soils were identified by using soils surveys, and
comprehensive-level field studies were carried out to sup-
plement the mapped information. Identified wetlands were
classified, tabulated, and summed. A detailed qualitative
discussion followed, in which judgments were made about
potential for impacts on the wetlands areas. All the wetlands
were also considered as a functioning unit to capture any
potential areawide effects, such as interruptions to wildlife
connection and changes to the area’s ability to absorb pollute-
tants from urban runoff.

Ecology. Habitat studies lend themselves to quantitative
methodological approaches because there are some commonly
used and well-understood quantitative techniques, such as the ecological
evaluation procedure (HEP). HEP studies can be carried out
on a broad regional level or for individual parcels, depend-

In 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 con-
sidered to be too specific and speculative for indirect effects
studies, and the number of quantitative habitat/wildlife stud-
ies was therefore limited in the project sample under study.

These projects that performed such studies were the same three
identified in the wetlands discussion. The 181st Avenue to Sandy River (1-84) project in
Portland, Oregon, is an example of this type of study. As noted in the wetlands discussion, potential secondary development
areas on wetland sites that were properly noted were identified in this FEIS. The habitat/wildlife analysis evaluated the same
110.5-km² 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 photo-
graph mosaic of the study area. The sample was used to gen-
eralize the cover type information for all the potential sec-
ondary 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 quan-
tified and presented in a matrix that considered the types of
habitat strata, their status, the strata area lost, and the per-
centage loss. A detailed qualitative discussion accompanied
the quantitative study.

Other Indirect Effects. These effects include air quality,
radiation, and cultural resources as well as several other types
such as energy, hazardous waste, and human health. Quantita-
tive 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 identify-
ing the types of industries and commercial establishments
that were most likely to locate in the secondary development
areas. This was based on consultations with and data from
planning and business organizations. The projects industries
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 saline impacts at
each site.

For cultural resources indirect effects studies, each sec-
ondary development site was evaluated for its potential
for cultural resources impacts by reviewing the current
catalogue of sites eligible for the National Register of Historic
Places. The sites were inventoried with secondary data from

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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 conditioned primarily by the details of local environmental, geographic, political, and social 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 EIS recognize the CEQ definitions of direct and indirect 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 consequences 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's 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 flood or erosion or dredging activities to the items for consideration under direct impacts. The ACEs and the state historic preservation office use a less certain standard in highway projects for defining 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 functions. 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 indirect impacts is generally used interchangeably with the concept of socioeconomic development indirectly. 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 project. There appears to be less difficulty and more uniformity among interviewers 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.
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 allocated 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 pressures, 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 readily obtained 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 adequate predictive force over time. In addition, neighborhood character and local value orientation were noted as being rarely addressed. Extensive local interviews with public officials, planning staff, representatives from chambers of commerce, professional associations, environmental organizations, and individual residents of communities were deemed by the interviewees critical to 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 traffic and indirect effects. One interviewee emphasized: "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 interviewers expressed this need 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 (CAAAs) are implemented and with them the need for rigorous and comprehensive analysis of indirect effects—in particular, those related to growth in vehicles miles of travel—and in growth of population and employment. The same is true in mustering conformity requirements of the CAAAs in assessment of maintenance areas. The apportioning of the burdens of reducing air pollutant emissions must be accomplished through a statewide interagency planning process. One federal agency interviewed stated 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 testament 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 habitat (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 help project people to 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;

- An element of field scoping is done by interagency teams in the project reviews.

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

The scale of transit systems and airports necessitates state and local agencies' involvement very early in the needs assessment process. The state, regional, and 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 modifications in project design may occur, and subsequent rounds of scoping may be needed. In a small number of states, scoping 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 alternative routes 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" (10).

It was generally reported that, in at least half the cases, pertinent comments and concerns about project 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 noncontentious.

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 references to the ongoing NEPA document efforts, but general business was also discussed. In areas where regular interagency meetings have occurred, the study indicated that there is a better understanding among agencies, reductions in 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 responsi-

bility appear to have merged somewhat over the years of prac-
tice. Projects are apparently designed with less contention.
In addition, the interaction required by Miss NEPA in states
such as Vermont (State Law 250) and Washington (SEDPA)
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 rep-
resentatives 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
delayed. 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 agen-
cies immediately before completion of the DEIS. Many rep-
resentatives 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 trans-
portation 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
responses. It was also noted by some transportation
agencies that certain other agencies occasionally nixed the

CHAPTER 3
INTERPRETATION, APPRAISAL, AND APPLICATIONS:
DEFINING THE TERM INDIRECT EFFECT

Excessive 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 definition. However, interpretation of what an indi-
rect effect is must use the CEQ definition as a point of depar-
ture because of the overriding requirement that federal proj-
ects comply with NEPA. However, as a practical matter, any
interpretation also should satisfy other statutory require-
ments to the extent possible to avoid redundant analyses
where applicable. The other statutes often include Section
404(h)(1) of the Clean Water Act (effects on waters of the
United States), Section 106 of the National Historic Preser-
vation 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 threat-
ened 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 lit-

erature preceded the CEQ or other regulatory definitions).
Control reviews of the EISs showed the same result. The con-
tent reviews and the interviews indicate that subsequent defi-
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 fol-
lowing aspects:

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

A conclusion from the findings is that there is little dis-
agreement 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 assess-
ing 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 dis-
cussed extensively in the interviews conducted for this study.

According to CEQ's Forty Most Asked Questions, reason-
ably 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 ratio-
nale. One decision interprets the term reasonably foreseeable
broadly, citing the agencies' "overriding statutory duty of com-
pliance with impact statement procedures to the full-
extent possible." Another decision defines the narrowest
limit of the term, requiring a "reasonably thorough dis-
cussion," 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 suf-
ficiently 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 find-
ings 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 con-
cluded 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

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natural systems or ecosystems. These effects also occur in neighborhoods (e.g., from segmentation) and in agricultural areas (e.g., from altering 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 (growing) 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, create 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 causal 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 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.

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**Table 17: Distinctions between types of effects**

<table>
<thead>
<tr>
<th>Type of Effect</th>
<th>Direct</th>
<th>Indirect</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of Effect</td>
<td>Reasonably foreseeable/ Probable</td>
<td>Reasonably foreseeable/ Probable</td>
<td>Reasonably foreseeable/ Probable</td>
</tr>
<tr>
<td>Cause of Effect</td>
<td>Project’s Direct and Indirect Effects</td>
<td>Project’s Direct and Indirect Effects with Other Activities</td>
<td></td>
</tr>
<tr>
<td>Timing of Effect</td>
<td>At Time of Project Construction or in the Future</td>
<td>At Time of Project Construction or in the Future</td>
<td></td>
</tr>
<tr>
<td>Location of Effect</td>
<td>Within Boundaries of Systems Affected by the Project</td>
<td>Within Boundaries of Systems Affected by the Project</td>
<td></td>
</tr>
</tbody>
</table>
The framework and guidelines for estimating indirect effects of proposed transportation projects provide a systematic approach to evaluate the impacts of projects beyond the direct effects. The key findings are as follows:

- Indirect effects are significant and can be substantial. The framework helps in identifying and quantifying these effects, which are crucial for a comprehensive understanding of a project's environmental impacts.

- The framework is based on a combination of project-specific knowledge, regulatory requirements, and established methodologies. It is adaptable to various project types and scales.

- There is a need for clear guidance on how to apply the framework in practice, including case studies and examples. This would enhance the usability of the framework and its adoption by practitioners.

- The framework emphasizes the importance of stakeholder engagement and collaboration throughout the project development process to ensure effective mitigation strategies are developed.

- Further research is needed to refine and improve the framework, particularly in areas where there is limited existing data or guidance.
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 ISTEIA 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 (23). Highway or transit projects in the category of major metropolitan transportation investments as defined by ISTEIA 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;
- Is in an area where one or more of the following conditions is present:

<table>
<thead>
<tr>
<th>Generic Impact Assessment: Ecological Impact Assessment:</th>
<th>Social Impact Assessment:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact Identification</td>
<td>Describe Proposed Action and Alternatives</td>
</tr>
<tr>
<td></td>
<td>Identify Human Environment and Economic Impacts</td>
</tr>
<tr>
<td>Impact Measurement</td>
<td>Identify Project Impacts</td>
</tr>
<tr>
<td></td>
<td>Evaluate Significant Elements of Affected Parties</td>
</tr>
<tr>
<td>Impact Interpretation</td>
<td>Identify Significant Changes in Proposed Action or Alternatives</td>
</tr>
<tr>
<td></td>
<td>Develop Monitoring Program</td>
</tr>
<tr>
<td>Impact Communication to Information Users</td>
<td>Identify Significant Changes in Proposed Action or Alternatives</td>
</tr>
<tr>
<td></td>
<td>Develop Monitoring Program</td>
</tr>
</tbody>
</table>

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 plen-
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, ecological, and growth oriented. Their consideration can help identify the long-term and temporal boundaries of indirect effects analysis (e.g., neighborhood versus community concerns).

This step is designed 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 expected through future 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 CRIQ NEPA regulation (2) requires an evaluation of project consistency with local plans. The findings and illustration indicate better understanding of the interactions 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).

Releve to ecological 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 sense, 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 been 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 local 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 direction of plans as to goals as well as to gather information on the area's direction and goals first hand 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 discussed evaluate appropriate public involvement techniques for this step.

The area's expressed goals give a point of the picture needed to understand potential indirect effects in a bigger picture context. It is also important to understand directions (i.e., where an area has been, where it is, and where it is going). Directions can be understood in part by identifying past, present, and anticipated socioeconomic, environmental quality, and land-development trends. Equally important in 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 available sources. Data collection should not be viewed as an end in itself but rather as a foundation for future steps. Data for this purpose can be both quantitative and qualitative. The checklist 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 bigger 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 (14) 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 context, a survey can capture the views of those who are not sufficiently informed or involved in the transportation process (including those who may not have the time to participate in visioning or other public
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 1a: 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 contract 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 notes the following other characteristics as being indicative of vulnerability:

- Species requiring high survival rates instead of high reproduction rates;
- Species whose intrinsic rates of increase fluctuate greatly; and
- Communities with vulnerable key species or habitats.

Irwin and Eades [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 term relative uniqueness and recovery time to measure 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 [55]. 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 CESQ regulations, which state that significance varies with context [2].

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>
<thead>
<tr>
<th>Project Name:</th>
<th>Location:</th>
<th>Analyst:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 needs but rather to use information from more detailed analyses 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 model interrelationships including competing and complementary characteristics.

3. **Population Trends**

<table>
<thead>
<tr>
<th>Type</th>
<th>Declining</th>
<th>Slow Growth</th>
<th>Rapid Growth (&gt;10% growth)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Declining</th>
<th>Slow Growth</th>
<th>Rapid Growth (&gt;10% growth)</th>
</tr>
</thead>
</table>

4. **Planning Context**

<table>
<thead>
<tr>
<th>Zoning</th>
<th>Yes</th>
<th>No</th>
<th>If yes, identify by title, agency, and date</th>
</tr>
</thead>
<tbody>
<tr>
<td>State Master Plan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>County/Regional Master Plan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Municipal Master Plan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth Management Plan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Quality Management Plan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Natural Resources Management Plan</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.

8. **Is the activity center dependent on transportation system improvement?**
   - Yes ____ No ____

9. **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

AR00030086
## Table 21: Ecosystem conditions inventory

<table>
<thead>
<tr>
<th>Setting</th>
<th>Describe/Characterize (Map Locations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suburbs</td>
<td>Landscapes, Remaining Infrastructure, Greenways, Ecological Populations, Wetlands and Riparian Zones, Soil, Natural Vegetation Diversity</td>
</tr>
<tr>
<td>Rural</td>
<td>Watersheds, Local Biomes, Riparian Corridors, Ecological and Migratory Species, Riparian and Forest Corridors, Hydrology, Landscape Patterns Diversity, Dispersal Routes</td>
</tr>
<tr>
<td>Wildlands</td>
<td>Regional Ecosystems, Resource Habitat, Complex Habitat, Habitat Interior Species, Unique Environments, Structural Components of Interior Habitats, Subpopulations, Movements</td>
</tr>
</tbody>
</table>

## Table 22: Socioeconomic conditions inventory

<table>
<thead>
<tr>
<th>Economic</th>
<th>Described/Characterize</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residents' occupational mix</td>
<td>Jobs in community (ness)</td>
</tr>
<tr>
<td>Income distribution (self-employment)</td>
<td>Mobility and travel characteristics</td>
</tr>
<tr>
<td>Journey to work ( Arbeit, public)</td>
<td>Number of people who travel by public transportation</td>
</tr>
<tr>
<td>Business ownership and services characteristics</td>
<td>Number of business establishments</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Demographic</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Population growth rate</td>
<td>Population age mix</td>
</tr>
<tr>
<td>Household types</td>
<td>Retired population percent</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Social</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Community cohesion</td>
<td>Crime rates</td>
</tr>
<tr>
<td>Clubs, sports and organization participation</td>
<td>Education levels for community</td>
</tr>
<tr>
<td>Tolerance for change</td>
<td>Balance of old and new community</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing stock mix and values</td>
<td>Green infrastructure</td>
</tr>
<tr>
<td>Town area and form</td>
<td>Transportation infrastructure</td>
</tr>
<tr>
<td>Separation from other activity centers</td>
<td>Residential density</td>
</tr>
<tr>
<td>Mix of land uses</td>
<td>Affordable housing</td>
</tr>
<tr>
<td>Town edge activity</td>
<td>Public and private spaces</td>
</tr>
<tr>
<td>Ecological sensitivity</td>
<td>Stormwater management</td>
</tr>
<tr>
<td>Natural resources</td>
<td>Trees and vegetation presence</td>
</tr>
<tr>
<td>Noise levels and quality</td>
<td>Lighting influence</td>
</tr>
</tbody>
</table>

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 (56) 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 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 issues through task force consensus;
- Detailed presentations of material and technical assistance for complete understanding of context and subject matter; and
- Social mechanisms to understand and deliberate the issues.

A collaborative task force can require relatively significant resources. Among these are an experienced, neutral facilita-
ter, 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 locations 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-Caus ing Activities of the Proposed Action and Alternatives**

**Step 3a: Objective of Identifying Impact-Caus ing 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 is the framework to go beyond the typical project description to substantiate those impact-causing activities that a project will entail. This is consistent 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-Caus ing 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 type 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 screen 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-Caus ing Activities**

Table 25 is a checklist developed primarily from Leopold et al. (39) to help substantiate typical impact-causing activities.
### TABLE 5: Project impact-causing activities checklist

<table>
<thead>
<tr>
<th>Project Name:</th>
<th>Location:</th>
<th>Analyze:</th>
<th>Date:</th>
<th>If Yes, Describe Generally (Briefly, Duration, Location and Type):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Modification of Species
- Exotic Flora Introduction
- Modification of Habitats
- Alteration of Ground Cover
- Alteration of Groundwater Hydrology
- Alteration of Drainage
- River Control and Flood Modification
- Channelization
- Noise and Vibration

#### Land Transformation and Conservation
- New or Expanded Transportation Facility
- Service or Support Sites and Buildings
- New or Expanded Service or Frontage Roads
- Auxiliary Transmission Lines, Pipelines and Corridors
- Barriers, Including Fencing
- Channel Dredging and Straightening
- Channel Revetments
- Canals
- Breakwaters or Seawalls
- Cut and Fill

#### Resource Extraction
- Surface Excavation
- Subsurface Excavation
- Dredging

#### Processes
- Product Storage

#### Land Alteration
- Erosion Control and Terracing
- Mole Sealing and Waste Control
- Landfilling
- Waste or Open Water Fill and Drainage
- Harbor Dredging

#### Resource Renewal
- Reclamation
- Groundwater Recharge
- Wastewater Recycling
- Site Remediation

#### Changes in Traffic (including adjacent facilities)
- Railroad
- Transit (Bus)
- Transit (Fixed Guideway)
- Automobile
- Modeling
- Aircraft
- River and Canal Traffic
- Pleasure Boating
- Communication
- Operation or Service Charge

#### Waste Management and Treatment
- Landfill
- Disposal of Spill and Overburden
- Underground Storage
- Sanitary Waste Discharge
- Septic Tanks
- Stack and Exhaust Emission

#### Chemical Treatment
- Fertilization
- Chemical Detergent
- Chemical Soil Stabilization
- Wood Control
- Pest Control

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

#### Others

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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 impacts 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 need 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 10(a)(2) 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 interrelationships of all components of the natural environment, particularly the profound influence of population growth, high density urbanization, industrial expansion, resource exploitation, 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 approach 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 list 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 embedded in CEQ's biodiversity document (1/2) recognizes the "fundamental interconnections within and among various levels of ecological organization." Ecologic organization is a hierarchically arranged continuum as illustrated in Table 26. Reductions of diversity at any level has effects at the other levels. Therefore, any 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 (19), 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>
<thead>
<tr>
<th>Table 26: Components of biological diversity</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Regional ecosystem diversity: The pattern of local ecosystems across the landscape, sometimes referred to as &quot;landscape diversity&quot; or &quot;large ecosystem diversity.&quot;</td>
</tr>
<tr>
<td>- Local ecosystem diversity: The diversity of all living and non-living components within a given area and their interrelationships. Ecosystems are the biological/ecological operating units in nature. A related term is &quot;community diversity,&quot; which refers to the variety of unique assemblages of plants and animals (communities). Individual species and plant communities exist as elements of local ecosystems, listed by processes such as succession and predation.</td>
</tr>
<tr>
<td>- Species Diversity: The variety of individual species, including animals, plants, fungi, and microorganisms.</td>
</tr>
<tr>
<td>- Genetic diversity: Variation within species. Genetic diversity measures species in service in a variety of different environments and allows them to evolve in response to changing environmental conditions.</td>
</tr>
</tbody>
</table>

The hierarchical nature of these components is an important concept. Regional ecosystem patterns form the basic unit for, and thus have important influences on, local ecosystems. Local ecosystems, in turn, form the basis for species and genetic diversity, which can in turn affect ecosystems 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 ecological 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 ecological consequences, neighborhood segmentation may increase residential mobility as well as increase conversion of single-family dwelling units to apartments or addition of new multi-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. Christiansen (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
- Aesthetics and cultural values

It was suggested that these variables be used to explore effects on 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 environments presented in Table 10 can be a useful tool for identifying socioecological 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 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 operations—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 will 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 environmental and 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 volumes), 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 location decisions about the location of growth and land development among various locations within a region, a phenomenon commonly referred to as intraregional developmental 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 effects of such projects on land use can be substantial (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 circumstancs 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) away from a freeway interchange; up to 3.2 to
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 aggregation of industrial and commercial activities; office and retail 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, manufacturers, 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 with 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 be improved 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 property controls 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, pressure to change (weakness) 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 conjuncti

![Figure 6. Highway investment impact on typical progress of urbanization.](image)

![Figure 7. Linkage of transportation access-land-use change.](image)

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

<table>
<thead>
<tr>
<th>Type of Change</th>
<th>Highway Proximity Comments</th>
<th>Transit Proximity Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Location</td>
<td>Weak Economic Factor in Location Decisions</td>
<td>Access to highway network typically considered after location decision has been assessed within a region; other elements of development typically are sacrificed to gain a highway site.</td>
</tr>
<tr>
<td>Manufacturing Trade Location</td>
<td>Weak Factor in Location Decisions</td>
<td>Generally, transit does not increase employment in improved access to jobs.</td>
</tr>
<tr>
<td>Wholesoom Trade Location</td>
<td>Moderate-Favorable Factor in Location Decisions</td>
<td>Concerned proximity to highway network adequate for shipping, though may be inadequate for a highway.</td>
</tr>
<tr>
<td>Retail Trade Location</td>
<td>Strong Factor in Location Decisions</td>
<td>Particularly sensitive to service access, costs, and form. Other highway-oriented rolinal characteristics.</td>
</tr>
<tr>
<td>Service Location</td>
<td>Moderate-Favorable Factor in Location Decisions</td>
<td>Generally, sensitive to highway, however, neighboring population shifts or the suburban city highway make the primary for service-based growth zones.</td>
</tr>
</tbody>
</table>
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 (46) 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 effects of transportation investments on air quality vis-a-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 1. General relationships between highway and transit proximity and changes in land value

<table>
<thead>
<tr>
<th>Type of Change</th>
<th>Highway Product</th>
<th>Transit Product</th>
<th>Comment</th>
</tr>
</thead>
</table>
| Land Value Appreciation | Other factors, i.e., appreciation is measured for land showing for highway and decline after highway is established; however, extenuation can be complicated. | Change in land use associated with highway proximity is important in determining appreciation. | Land value increases are most substantial after conversion to a more intensive use (e.g., residential) to a commercial use. Year of land sold for single family residence is on average not significantly affected by highway. |}

Note: NA = not applicable; T = 0.34

![Figure 8. Simplified model of various factors influencing development location decisions.](image-url)
(57) The data suggest that transportation investments incrementally affect the price 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 propensity 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 places or projects that involve the urban fringe (generally higher land availability and lower land prices in urbanizing areas).

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 prescriptive matrices or mathematical matrices. Prescriptive matrices include descriptive (54), symbolized (65), characterized (67), numeric (19,65,67), and combinative (65). Although of value for identifying direct effects, prescriptive matrices are inadequate consideration to indirect effects. Therefore, at best, the prescriptive 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 (65), and input–output (70–72). A critique of these various mathematical matrices by Shopley and Puggle (57) 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.
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 the 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 chain 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 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 ecological, 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

![Network diagram of transportation-land-use interactions and feedback loops.](image-url)
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 specialization 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 assessment 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 collecting the comparisons make the case study 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 disclosed to date and to make explicit the process used to determine which indirect effects should be carried forward to detailed analysis (Step 4). Table 4 was prepared for this purpose. Typically, a determination of impact magnitude 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 33, 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 key in forecasting is an underlying system of logic that can produce reproducible 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

- 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 (to 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 incurs 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

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Location</th>
<th>Analyst</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect Effect Type</td>
<td>Direct Effects from Impact-Causing Activities</td>
<td>Indirect Effects from Direct Effects (List)</td>
<td>Potential Manifestation of Indirect Effects (List)</td>
</tr>
<tr>
<td>Entrainment-Aversion</td>
<td>Ecosystem-related</td>
<td>Socioeconomic-related</td>
<td>Serves specific development</td>
</tr>
<tr>
<td>Induced Growth (Access-Altering)</td>
<td>ecosystem-related</td>
<td>Socioeconomic-related</td>
<td>Refer to Tables 34 and 35.</td>
</tr>
</tbody>
</table>

Step 5c: Methods for Analyzing Indirect Effects

Table 35 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 are components of building more comprehensive, formal models.

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 linkage 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 Piggott (57) 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 mone-
tary terms. Input–output modeling provides a way to quantiti-
atively link together a multitude of interactions in a complex econ-
omy; it is appealing as a device for showing the mutual interac-
tions of a number of societal activities. The difficulty is in the treat-
ment of societal sectors not involved in mone-
tary exchanges (e.g., ecologic variables). A number of eco-
nomical and demographic forecasting models use input–output tables as a basis of their construction. Stavik (76) dem-
nstrates the use of input–output analysis to understand eco-
omic-ecologic linkages and various consequences of develop-
ment.

The review of EIS for this study found that indirect effect anal-
yses have relied on existing models instead of creating new ones. This is likely because modeling is a resource-intensive procedure. Examples of frequently occur-
ing existing models used to support indirect effects analyses are the various land-use and travel-demand forecasting mod-
els (76). Some criticisms of these models include the typical use of exogeneons (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 terms ways socioeconomic and land-use changes feed back to affect the transportation system—e.g., the phe-
nomenon of supply-induced demand.

Dynamic modeling can involve making explicit assump-
tions 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. Limita-
tions 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 commu-
nication 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 prob-
lems 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 sensi-
tivity 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 coherency 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 3 years may lead to ridiculous relationships; and
- The idea that there is little proof to demonstrate that past forces will continue to support the trend so that extrap-
olations may, in many respects, 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 correla-
tion 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 dis-
cernably cause–effect relationship but that varies within limits. Numerical odds are assigned to all outcomes or combi-
nations of outcomes. On the basis of such odds, predictive statements can be made about the future behavior of a par-
ticular phenomenon studied. Probabilistic forecasts help dis-
cover where, how, and when a phenomenon may be most anticipated in the future and where nonpredictable occur-
rences must be accepted.

There are numerous probabilistic methods. Examples include point and interval estimation, Monte Carlo simula-
tion, Markov processes, parametric sensitivity analysis, quan-
tizing theory, decision analysis, risk analysis, and optim-
ization methods. In recent years, risk analysis has received
substantial attention as a forecasting, planning, and decision tool. Its potential for predicting 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 evident 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 tech-
ice that directed toward the systematic solicitation and orga-
nization of expert intuitive thinking from a group of knowl-
dgeable people (79). It provides a means for arriving at an
informed, objective judgment based on a variety of some-
times conflicting opinions. Instead of achieving consensus by open discussion, Delphi uses a carefully designed pro-
gram of sequential individual interrogations interspersed
with information and opinion feedback derived from con-
sensuses 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 sensi-
tivity for potential futures and opinions for delivering probable future actions. It can be used to obtain expert opin-
ion 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**
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 necessarily limited. Replogle (58) 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 causally 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 planning 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 (57) suggests a risk analysis approach that integrates networks and other causal models with risk analysis modeling and Monte Carlo simulation.

Analysis 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. Trends of land-use and related effects are probably best handled 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 function 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.

Various methods are 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 trend or 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 5a: 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 process must yield information that can be used to identify possible areas of conflict, and the public for consideration along with the results of the analysis. Similarly, information about areas of concurrence among stakeholders throughout the process also should be disclosed. Included are differences in goals, market conditions, and indirect effects pertaining analysis, and analysis techniques and results.

Step 6a: 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. Schraen (83) suggests that except when there is high confidence in the validity of the assumptions behind impact assessment, analyses should be made for the entire range of plausible assumptions. Further, where the results clearly indicate substantial indirect effects (substantial changes in endpoints) or, conversely, no substantial effect, then the sce-
sitivity analysis often can be done in the analyst’s head. However, where the analysis indicates great sensitivity of the outcome to particular inputs or questionable assumptions, a formal sensitivity analysis should be done and the results should be reported.

Sensitivity analysis is usually relatively inexpensive because it requires only a few calculations and no additional computer support. However, changing assumptions can readily be done with trend forecasts.

Lewin (82) notes several disadvantages of sensitivity analysis. For one, assumptions and judgments are typically varied by arbitrary amounts instead of by reference to realistic analysis of potential errors. Consequently, “slippery esurated 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 primacy 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.

Lewin (82) describes the three basic factors of sound risk analysis in (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 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 analyst 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 ecological 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>
<thead>
<tr>
<th>TABLE 38 Risk-analysis process</th>
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<td>Stage</td>
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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 attacks 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 reac-

tion to the effect regardless of the degree of uncertainty about whether the effect will really occur. As Lawshe (83) 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 trained 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 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 (bit.1) guidelines (82) 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 (67). These rules require that federal agencies make determinations that each of their agency’s federal actions conform to the statute 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 practically 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 Robinson v. M擢thaw Valley Citizens Council (30) to support this conclusion (this case is not 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 inconceivable to conclude that the Forest Service has no power to act [on issuing the permit] unless the local agencies have reached a final conclusion on its 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 list of distinguishing indirect effects presented in Chapter 3 and related in Chapter 9 is consistent with this approach. Specifically, encroachment-alteration effects can be equated 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 project to its overall 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 illustration, the airport expansion is a project that "would likely stimulate land development having substantial interaction with transportation system." 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 the project, including access provisions, is located;
- Those related to how the project is constructed—e.g., modification of regime, land transportation, 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 depositing, water 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 rem in to 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. Disagreements with individuals familiar with local real estate as 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 7 indicates that unacceptable traffic conditions, when the traffic 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 as unnecessary 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 affected effect and mitigation as well as 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 ground-water 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 high-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 effects and consequences. The transportation agency uses multiple methods to analyze the potential induced growth and related effects. Multiple methods are used to analyze the effects. First, the project is categorized as one that could influence intra-regional location decisions. Various comparable locations for land development in the region are identified and a matrix is developed to aid comparisons of the various development-related attributes of the locations with those of the project study area (e.g., availability of water and sewer, market preferences for type of development including parcel size, income level, land availability and price, and potential development densities). The information in the matrix is used to develop a location attraction 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 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 monograph 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 peak-velocity recharge matches predewater development recharge.

CASE STUDY APPLICATION OF THE FRAMEWORK

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

- Astoria (Oregon) bypass: small city highway bypass
- Turman (California) corridor: rapidly growing suburban area light-rail transit extension
- Grand Rapids (Michigan) southbelt line: 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 off-airport industrial uses on state-owned land adjacent to airport to aid airport's ascension to an important regional transportation facility; and
- Houston-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. In this case, indirect effects assessments of small city highway bypasses should take advantage of the base of comparable projects where appropriate.
- Turman corridor, Houston-Bergen light rail, and Grand Rapids southbelt line: Associational 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 southbelt line: 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 southbelt line: The case studies illustrate how the spatial limits of the indirect effects assessment should account for the activity centers (e.g., central business districts) that would otherwise be adversely affected by development shifts to an area made more attractive by a transportation investment.
- Turman corridor and Houston-Bergen light-rail transit: These case studies illustrate that indirect effects assessment framework can be used to identify and resolve competing goals common to transit projects. These goals include increased travel 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 effect 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 $200,000.

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

IMPLEMENTATION OF THE FRAMEWORK

Broad Considerations

Implementation of the framework will require some change in the typical modes of operations 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 Orkut 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 ESTEA 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 NDPAs 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 5—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.

Efficiency of effort: Findings indicate that the spatial effects is primarily a function of project type and maturity of the regional transportation system and land development. Other influences 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 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 assessment 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 EIRSEA 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 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 universes and institutes have for assuring that this information and these tools continue to evolve to meet the needs of a dynamic planning environment.

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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 (e.g., 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 consortia 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 and types of 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 permitting environmental regulation are updated to meet major investment study requirements under ISTEA.

Successful implementation of the framework on a long-term basis will require cooperation and coordination among transportation and regulatory/resource agencies. A framework for disseminating information from this study electronically (e.g., by e-mail). Sharing this most current thinking with building transportation professionals is essential to integrating it into their future practice.

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 building transportation professionals is essential to integrating it into their future practice.

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 sub-

mission 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 interactions 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 Institute and the Institute for Traffic Engineers—the two widely respected organizations that could be interested in publication of discrete subsets of the indirect effects report.

CHAPTER 5
CONCLUSIONS AND SUGGESTED RESEARCH

CONCLUSIONS

The research conducted for this study, reported in Chapter 2, demonstrated the need for guidance, procedures, and support 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 introduce economic growth and land-use conversions; 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 more 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 insurable 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 affected 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 boundary 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-use 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 extrapolation technologies to the more complex dynamic models. No single tool is suitable for all indirect effects analysis situations; selection of the tool depends partly 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 communicating 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 an 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 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 each case study project. 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 completion).

Compiles and Assesses 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 where 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 give 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 employer 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.

REFERENCES

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25. Sierra Club v. Murzak, 797 F. 2d (1st Cir. 1987).
26. Thomas v. Peterson, 753 F. 2d (9th Cir. 1985).
29. City of Davis v. Coleman, 321 F. 2d (9th Cir. 1973).
32. Erwin v. Marsh, 769 F. 2d (9th Cir. 1985).
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 them 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/Scenarios. 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 public 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 in less structured than the matrix.

Contrast. 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 is authorized to provide 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, in functional process, and delineate 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. Concept: this 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 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 appealing views or 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/structure. These changes do not occur if the action/structure 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 effects, 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 needs, 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 Centers). A geographic area characterized by a large transient population and heavy traffic volumes and densities, for example, central business districts, central air terminal, 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 system that may be affected by a project. A mathematical or conceptual representation 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 assumed 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 intersectional 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 ecological, 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 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.

Trib Attractions. 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.

Trib 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.

Visiting. This technique typically consists of a series of meetings focused on long-range issues. It assesses the relationship between issues and how one problem’s solution may generate other problems (e.g., indirect effects).
APPENDIXES A–D

Appendices 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 new 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 the 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 background information, interviews with project planners and local officials, and visits to project corridors. Information compiled was used to apply the checklists developed as part of the overall research to help reveal goals, troubles 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 statement.

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); and, 3) Oregon Highway 20. 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 route through traffic from US 30 traffic away from downtown Astoria (see location map in Figure
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.

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 expedient 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 waterfront and the city core areas. With increased 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 segments 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 via 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 coast. 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. Theimpacts for the project were traffic modeling which forecast that average daily traffic downtown would increase to 47,600 vehicles including 1,000 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 shattering, 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 acquisitions 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 area (DEIS, p5-6).

The report also considered cumulative impacts and defined them as:

[Impacts 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 parochial or local and do not extend to the regional level. Indirect effects identified are discussed in the DEIS as effects that are parochial or local and do not extend to the regional level. 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 from 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 levels of these cumulative effects would depend on the extent to which the bypass provided the increased traffic in local population, income, 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.

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. Changes 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 tree tops, or a rookery, for the great blue heron, 1000, 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 noted that an indirect effect of the taking of area surrounding the rookery would be to decrease the wildfowlness of the stand and increase incidences of nest blowdowns from the tree tops. Cumulative. The cumulative impact from the changes 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 in 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. Downriver traffic congestion is seen as a deterrent 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**

<table>
<thead>
<tr>
<th>Social Health and Well-Being Goals</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achieve adequate, appropriate and accessible open space and recreation</td>
<td></td>
</tr>
<tr>
<td>Comply with state and federal water and air quality laws</td>
<td></td>
</tr>
<tr>
<td>Preserve or create multicultural diversity</td>
<td></td>
</tr>
<tr>
<td>Preserve heritage</td>
<td></td>
</tr>
<tr>
<td>Provide choices of affordable residential locations</td>
<td></td>
</tr>
<tr>
<td>Provide green space for those with special needs</td>
<td></td>
</tr>
<tr>
<td>Promote land use patterns with sense of community</td>
<td></td>
</tr>
<tr>
<td>Provide a range of services accessible to all</td>
<td></td>
</tr>
<tr>
<td>Provide sound management of solid and hazardous waste</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

Economic Opportunity Goals

- Support activities in areas changing economic conditions
- Provide energy-efficient transportation
- Provide developments with transit-supported capabilities
- Target economic development opportunities
- Promote jobs in smaller, underserved areas
- Encourage development of other areas for new purposes
- Other

Ecosystem Protection Goals

- Protect open space
- Maintain water quality
- Preserve native species
- Protect rare and endangered species
- Protect sensitive environments
- Maintain natural processes
- Maintain natural and scenic diversity
- Protect genetic diversity
- Restore disturbed and degraded ecosystems
- Other

### TABLE E-2

**STUDY AREA DIRECTIONS AND GOALS CHECKLIST**

<table>
<thead>
<tr>
<th>Project Name: Astoria Bypass</th>
<th>Location: Astoria OR</th>
<th>Analyst: A. Cheng</th>
<th>Date: 3/1/96</th>
</tr>
</thead>
</table>

1. **Goal Statement**
   - West Multnomah District Area (Identify MSA)
   - Outside of MSA
   - Both sides of and outside MSA
   - Other

2. **Characteristics of Transportation System (Note)**
   - These items are not intended to serve as development goals but rather to use information from other service areas to provide a preliminary analysis of existing accessibility, service and modes intermodality characteristics, i.e., access to transit, to support the following analysis.
   - Identify existing land use and transportation systems
   - Map and describe existing land use patterns and principal areas and their access characteristics
   - Identify distance to nearest interchange highway if not in study area
   - Map out and describe existing transit routes and networks
   - Map out and describe existing land use and transportation systems
   - Describe land interrelationships including competing and complementary characteristics

3. **Planning Context**
   - Yes
   - No
   - If yes, identify by site, agency, and date

4. **Base Map Plan**
   - Yes
   - No
   - City and State: None
   - County and City: None
   - State: None
   - City: None
   - County and Region: None
   - Region: None
   - State: None
   - Region: None
   - State: None
   - Region: None
   - Other: None

5. **Future Planning (Note)**
   - Yes
   - No
   - If yes, identify by site, agency, and date

6. **Other Natural Resources**
   - Yes
   - No
   - If yes, identify by site, agency, and date

7. **Planning Goals**
   - Yes
   - No
   - If yes, identify by site, agency, and date

Reviewed by:

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE E-3
NOTABLE FEATURES CHECKLIST
(Choice where applicable)

<table>
<thead>
<tr>
<th>Ecosystem Features</th>
<th>Specify</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional habitats of concern/critical areas</td>
<td></td>
</tr>
<tr>
<td>Rare, threatened or endangered species and associated habitats</td>
<td></td>
</tr>
<tr>
<td>Species requiring high survival rates</td>
<td></td>
</tr>
<tr>
<td>Species whose critical areas of occurrence fluctuate greatly</td>
<td></td>
</tr>
<tr>
<td>Communities with vulnerable key resource producers or materialists</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Endo-economic Features</th>
<th>Specify</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substandard amounts of open space and recreation</td>
<td></td>
</tr>
<tr>
<td>Non-compliance with state and federal environmental laws</td>
<td></td>
</tr>
<tr>
<td>High concentration of uncontrolled solid and hazardous waste sites</td>
<td></td>
</tr>
<tr>
<td>Inadequate access to amenities</td>
<td></td>
</tr>
<tr>
<td>Economically distressed areas</td>
<td></td>
</tr>
<tr>
<td>Lack of institutional land use controls</td>
<td></td>
</tr>
<tr>
<td>High proportion of population consisting of:</td>
<td></td>
</tr>
<tr>
<td>Minorities</td>
<td></td>
</tr>
<tr>
<td>Low-income residents</td>
<td></td>
</tr>
<tr>
<td>Elderly</td>
<td></td>
</tr>
<tr>
<td>Young</td>
<td></td>
</tr>
<tr>
<td>Disabled</td>
<td></td>
</tr>
<tr>
<td>Low proportion of long-term residents</td>
<td></td>
</tr>
<tr>
<td>Locations of poor traffic flow</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

Product: List of notable features for the indirect effects assessment, with an accompanying map illustrating the location and 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 includes 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>
<thead>
<tr>
<th>Modification of Regions</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exotic Plants Introduction</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Modification of Habitat</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Alteration of Ground Cover</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Alteration of Groundwater Hydrology</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Alteration of Drainage</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>River Control and Flow Modification</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Channelization</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Noise and Vibration</td>
<td>F</td>
<td>F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Land Transformation and Construction</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>New or Expanded Transportation Facility</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Service or Support Sites and Buildings</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>New or Expanded Service or Provence Roads</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Auxiliary Transmission Lines, Pipelines and Corridors</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Barriers, including Fencing</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Channel Dredging and Strengthening</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Channel Revetments</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Canals</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Boulders or Seawalls</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Cut and Fill</td>
<td>F</td>
<td>F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Resource Extraction</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Excavation</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Subsurface Excavation</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Dredging</td>
<td>F</td>
<td>F</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Processing</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Storage</td>
<td>F</td>
<td>F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Land Alteration</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erosion Control and Terracing</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Mine Sealing and Waste Control</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Landscaping</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Wetland or Open Water Fill and Drainage</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Harbor Dredging</td>
<td>F</td>
<td>F</td>
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</table>

<table>
<thead>
<tr>
<th>Resource Renewal</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reclamation</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Groundwater Recharge</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Waste Recycling</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Site Remediation</td>
<td>F</td>
<td>F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Changes in Traffic (including adjoining facilities)</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Railroad</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Transit (Bus)</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Transit (Fixed Guideway)</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Automobiles</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Trucks</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Aircraft</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>River and Canal Traffic</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Pleasure Boating</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Communication</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Operational or Service Charge</td>
<td>F</td>
<td>F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Waste Management and Treatment</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfill</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Emplacement of Spill and Overburden</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Underground Storage</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Sanitary Waste Discharge</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Septic Tanks</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Sludge and Excess Emission</td>
<td>F</td>
<td>F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chemical Treatment</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilization</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Chemical Dusting</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Chemical Soil Stabilization</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Pest Control</td>
<td>F</td>
<td>F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Access Alteration</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>New or Expanded Access to Activity Center</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>New or Expanded Access to Undeveloped Land</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Alter Travel Circumstances Patterns</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Alter Travel Times between Major Trip Productions and Attractions</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Alter Travel Cess between Major Trip Productions and Attractions</td>
<td>F</td>
<td>F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Others</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>F</td>
</tr>
</tbody>
</table>

Reviewed by: | Name | Affiliation | Date |
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—pre-natal matrices, 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 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.

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 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 evaluation has been accepted by the Oregon Fish and Wildlife Department.

Given the resolution of these indirect effects issues, the remaining effects of this case study will focus on indirect economic effects as a result of the bypass. This effect was addressed in the DEIS:

"Lower traffic volumes in downtown Astoria could contribute to fewer accidents and economic difficulties for businesses highly dependent on tourists. 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 increased property tax revenues. For this framework, we are interested in studying 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."

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, p.56).

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Other questions relating to indirect effects are:

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**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.

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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.

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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 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.
### TABLE E.7
EVALUATION MATRIX FOR PROJECT INDIRECT EFFECTS OF CONCERN

<table>
<thead>
<tr>
<th>Indirect Effect Type</th>
<th>Direct Effects from Impact-Causing Activities</th>
<th>Indirect Effects from Direct Effects (LHS)</th>
<th>Potential Manifestations of Indirect Effects (LHS)</th>
<th>Link between Indirect Effect and Cost or Notable Environmental Concerns that Meet Assessment Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(1) Existence: fuel the effect is likely to occur; (2) Know enough about indirect effect to make consideration useful; and (3) Need to know about the impact more.</td>
</tr>
</tbody>
</table>

**Indirect Effects from Direct Effects (LHS)**
- Ecotourism-related
- Socioeconomic-related

**Potential Manifestations of Indirect Effects (LHS)**
- Increase in tourism-related development
- Stimulation of supply chain development
- Influence on location decisions

**Link between Indirect Effect and Cost or Notable Environmental Concerns that Meet Assessment Criteria**
- Yes
- No

**Assessment criteria**
- (1) Indicators 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 more.

---

**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.

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**5.0 REFERENCES**


Clatsop County Comprehensive Plan Goals and Policies, prepared by the Clatsop County Department of Planning and Development, June 1994.


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**6.3 CASE STUDY REPORT: TASMAN CORRIDOR (CA) LIGHT-RAIL TRANSIT**

**1.0 PROJECT DESCRIPTION**

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 in 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-
Figure E.2: Tammany 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 bounded 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 corridor has 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 commuting 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. CalTrain, 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 CalTrain 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, "TC101." 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 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 time savings of any of the alternatives studied (FEIS p2-10).

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 project. Project proponents 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 farther 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 County the city of Sunnyvale 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 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
- Hillside 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. Visiting 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 socio-economic 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/breaks 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 its 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 predominantly elderly and low-income tenants.

Product: List of notable features for the indirect effects assessment, with accompanying map illustrating the location and 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 commute 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 presence 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 relocated 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 "densification" 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 Tasman 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: J. Chen | Date: 2/1/96 |

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<th>Region</th>
<th>Description</th>
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**Reviewed by:**

- **Name:**
- **Affiliation:**
- **Date:**

**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 effects.

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 not.

- Are the mobile home parks located 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.
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results.

rect effects, the chosen analysis methods, and the analysis

nario writing sessions with local planners and concerned res-

the realization of this indirect effect. In conducting a sensi-

ble assumptions?

situations which may prompt displacement of the mobile

tivity analysis, the relevant questions are: How likely are the

agency and the concerned public can

assumptions?

in the academic literature

Studies suggest that changes in real estate value

as a result of fixed-rail transit depend largely on site-spe-
cific factors such as the level of noise generated from the

facility, the upkeep and designs of neighborhood sta-
tions 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 sce-

nario writing sessions with local planners and concerned res-

Product: A technical memorandum that describes the indi-

rect effects, the chosen analysis methods, and the analysis

results.

Step 6. Evaluate Analysis Results

Given the established scenarios that may trigger the indi-

rect 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 sensi-
tivity analysis, the relevant questions are: How likely are the

situations which may prompt displacement of the mobile

home communities? How realistic are the underlying assump-

ions?

Local planners interviewed for this case study suggest that

real estate economics will likely lend more impact to

growth in employment and population in the area may

linked to market supply and demand, the continued

growth in employment and population in the area may

place increased price pressure on land.

The analysis techniques employed in the project environ-

mental 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 identi-

cified were not detailed in the FEIS. The economic indirect

effects, which were discussed in greatest detail, did state that

indirect effects may have rendered

the Tasman light rail project was not reasonably foreseeable.

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<td>Groundwater Recharge</td>
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<td>Changes in Traffic (including adjoining facilities)</td>
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<td>Transit (Fixed Guideway)</td>
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<td>Alter Travel Times between Major Trip Productions and Attractions</td>
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<td>Alter Travel Costs between Major Trip Productions and Attractions</td>
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</table>
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. Chang
Date: 2/1/96

**National Study Area Conditions**
(1) Indicators 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 PHANA lassos? 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

**Regional 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 initiated by the project in its immediate vicinity.)

1. Is the regional predation increasing rapidly (generally, >5% per 10 years)? Y
2. Is the project within 5 miles of a growing community (generally, >5% per 10 years)? Y
3. Is the local study area characterized by midsize and/or high income levels? Y
4. Is the local study area free of concentrations of development (e.g., severe monocultures, growth restrictions)? Y
5. Is the local study area within a 30-minute drive of a major employment center? DK
6. Does the local study area have relatively high land availability/low land prices (generally <one-third of larger parcels developed)? DK
7. Is the present land characterized by relatively large parcels? DK
8. Is the local study area characterized predominantly by level land (generally, <5% slope)? Y
9. Is the project's Potential Impact Area characterized by soils suitable for development? Y
10. Is the project's Potential Impact Area predominantly free of flooding or wetlands? 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 present 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

**Local Study Area Conditions**

17. Is the regional predation increasing rapidly (generally, >5% per 10 years)? Y
18. Is the project within 5 miles of a growing community (generally, >5% per 10 years)? Y
19. Is the local study area characterized by midsize and/or high income levels? Y
20. Is the local study area free of concentrations of development (e.g., severe monocultures, growth restrictions)? Y
21. Is the local study area within a 30-minute drive of a major employment center? Y

**Indicators of conditions favorable to conversion to lower density development**

22. Does the local study area have relatively high land availability/low land prices (generally <one-third of larger parcels developed)? DK
23. Is the present land characterized by relatively large parcels? DK
24. Is the local study area characterized predominantly by level land (generally, <5% slope)? Y
25. Is the project's Potential Impact Area characterized by soils suitable for development? Y
26. Is the project's Potential Impact Area predominantly free of flooding or wetlands? Y

**Potential Manifestation of Indirect Effects (List)**

- Ecological-based
- Socioeconomic-based

**Indirect Growth (Ancestral-Induced)**

- Serve specific development
- Stimulate complementary development
- Influence location decision

**Effects Related to Induced Growth**

- Ecological-based
- Socioeconomic-based

**Assessment Criteria**

1. Confidence that the effect is likely to occur;
2. Knowledge about indirect effect to make consideration useful; and
3. Need to know about the impact now.

Reviewed by: [Name]
Affiliation: [Affiliation]
Date: [Date]

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 lies in the identification of indirect effects. The lack of a clear definition for the effects on past of the project sponsors may have impeded the efficiency and the efficacy on the identification process.

5.6 REFERENCES


City of Mountain View Economic Development Highlights, January 1996.

City of Mountain View Evelyn Avenue Corridor Precise Plan, adopted December 13, 1994.


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 description 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 operations 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 the townships of Byron, Cascade, Gaines, Lowell, Boone, and Caldenia 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-
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 in the intersection of interchanges has become a critical issue with the prevailing agencies including U.S. EPA, U.S. Fish and Wildlife Service (F&WWS), 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 interchanges to minimize the impact on the natural environment, especially 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 regulations" (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 comparable pattern of existing land uses; an important intersecting north-south arterial, and the absence of open space wetlands 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:

"The 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 use 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 contrac-
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 PUES 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: 26).

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:

"[The 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 at distances away but desire a 'small town' living environment. Similarly, Hudsonville's business and industries will be more accessible to customers and employees living in a larger area, 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: 35).

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. 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.

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, those 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
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 area 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 replacement 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, 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:

- *Sociodemographic:* Will the induced development create suburban sprawl and land speculation? Where, will the development occur? Will development relocate from existing downtowns?
- *Ecological:* To what extent will wetlands be impacted by the construction and operation of this road? How will habitat fragmentation affect the region’s natural resources? What will be the impacts from runoff and air and noise pollution?
- *Industrial:* The project is likely to influence inter-regional 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-15

**ORGANIZATION AND TABULATION OF GOALS CHART**

<table>
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<tr>
<th>Social Health and Well-Being Goals</th>
<th>Economic Opportunity Goals</th>
<th>Environmental Protection Goals</th>
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<tr>
<td>Acknowledge appropriate and accessible open spaces and recreation</td>
<td>Provide energy-efficient transportation</td>
<td>Promote wetland and native species</td>
<td>Other</td>
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<tr>
<td>Comply with state and federal water and air quality laws</td>
<td>Provide development with transit-supported congestion</td>
<td>Preserve native and rare species</td>
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<td>Preserve or create multitudinal diversity</td>
<td>Provide urban environment for those with special needs</td>
<td>Preserve rare and threatened species</td>
<td>Other</td>
</tr>
<tr>
<td>Preserve historic sites</td>
<td>Provide sound management of solid and hazardous waste</td>
<td>Preserve sensitive environments</td>
<td>Other</td>
</tr>
<tr>
<td>Provide choice of affordable residential locations</td>
<td>Protect natural ecosystems</td>
<td>Maintain natural processes</td>
<td>Other</td>
</tr>
<tr>
<td>Provide urban environment for those with special needs</td>
<td>Protect wetland diversity</td>
<td>Maintain natural ecosystems</td>
<td>Other</td>
</tr>
<tr>
<td>Provide a range of services accessible to all</td>
<td>Restore natural ecosystems</td>
<td>Other</td>
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</tbody>
</table>

### Location:

TABLE E-19

**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 Areas Impact Study. This study provided a detailed analysis on possible locations and roadway types (such as front street, 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 (Simulated 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) that gives the size of the study area.

An assessment of existing downtowns would also be useful to determine the vacancy rate and the effect 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

[Ar00030126]
# TABLE E-16

**STUDY AREA DIRECTIONS AND GOALS CHECKLIST**

(Inv. where applicable)

**Project Name:** Grand Rapids South Shilin  
**Location:** Grand Rapids, MI  
**Analyst:** J. Perry  
**Date:** 3/14/96

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<td>Both Inside and Outside MSA</td>
<td>Grand Rapids</td>
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**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 mode/interruption characteristics; i.e., factors relevant to subsequent indirect effects analysis).

- Identify existing 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 out in study area
- Map and describe existing vacant areas and demand
- Map and describe major concentrations of existing and planned development
- Describe modal interrelationships (including competing and complementary characteristics)

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<td>Slow Growth</td>
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<td>Rapid Growth (&gt;15%)</td>
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<td>Rapid Growth (&gt;15%)</td>
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4. **Planning Context**

- Yes
- No
- Other

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<td></td>
<td>Municipal Master Plan</td>
<td></td>
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<tr>
<td></td>
<td>Growth Management Plan</td>
<td></td>
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<tr>
<td></td>
<td>Water Quality Management Plan</td>
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</tr>
<tr>
<td>Other Natural Resources Management Plan</td>
<td></td>
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</tr>
</tbody>
</table>

5. For each plan identified in No. 4, summarize key goals, elements and linkages to other plans (specifically, to particular elements related to economic development, land use development, the transportation system, and natural resource protection).

6. **Public Involvement:**

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

8. **Is the activity center dependent on transportation system improvement?**

   Yes  No

9. **Is the transportation needed linked to economic growth and land development?**

   Yes  No

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

   Yes  No

Reviewed by:

<table>
<thead>
<tr>
<th></th>
<th>Name</th>
<th>Affiliation</th>
<th>Date</th>
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</thead>
</table>

AR00303127
TABLE E-17

NOTABLE FEATURES CHECKLIST

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional habitats of conservation-dependent areas</td>
<td>Specified, beach areas, coastal, threatened species and associated habitats</td>
</tr>
<tr>
<td>Rare, threatened or endangered species and associated habitats</td>
<td></td>
</tr>
<tr>
<td>Species requiring high survival rates</td>
<td></td>
</tr>
<tr>
<td>Rare, threatened species of marine fishery species</td>
<td></td>
</tr>
<tr>
<td>Communities with vulnerable human populations or associated habitats</td>
<td></td>
</tr>
</tbody>
</table>

Industrial properties and the amount of vacant developable land should be compiled. In addition, the use of the Delphi technique to analyze the effect could also be useful in 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 FWS.

Product: A 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

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.
<table>
<thead>
<tr>
<th>Modification of Habitat</th>
<th>Yes</th>
<th>No</th>
<th>If Yes, Describe Generally (Breadth, Duration, Location and Time)</th>
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<tbody>
<tr>
<td>Exotic Flora Introduction</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Modification of Habitat</td>
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<td></td>
</tr>
<tr>
<td>Alteration of Ground Cover</td>
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<td>Alteration of Groundwater Hydrology</td>
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<td>Alteration of Drainage</td>
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<td>River Control and Flow Modification</td>
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<td>Channelization</td>
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<tr>
<td>Noise and Vibration</td>
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<table>
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<tr>
<th>Land Transportation and Construction</th>
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<th>No</th>
<th>If Yes, Describe Generally (Breadth, Duration, Location and Time)</th>
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<td>Service or Support Sites and Buildings</td>
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<td>New or Expanded Service or Freeway Roads</td>
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<tr>
<td>Utility Transmission Lines, Pipelines and Corridors</td>
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<tr>
<td>Barriers, Including Fencing</td>
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<tr>
<td>Channel Dredging and Straightening</td>
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<td>Channel Movements</td>
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<td>Buildings or Seawalls</td>
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<td>Cut and Fill</td>
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<table>
<thead>
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<td>Surface Occurrence</td>
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<td>Subsurface Occurrence</td>
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<tr>
<td>Dredging</td>
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<table>
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<td>Wetland or Open Water Fill and Drainage</td>
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<td>Harbor Dredging</td>
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<td>Waste Recycling</td>
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<tr>
<td>Site Remediation</td>
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<table>
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<th>Changes in Traffic (Including adjoining facilities)</th>
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<td>Railroad</td>
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<tr>
<td>Transit (Bus)</td>
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<tr>
<td>Transit (Fixed Guideway)</td>
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<td>Automobile</td>
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<td>Trucking</td>
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<td>Aircraft</td>
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<td>River and Canal Traffic</td>
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<td>Pleasure Boating</td>
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<td>Communications</td>
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<td>Operational or Service Charge</td>
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<th>Waste Enrichment and Treatment</th>
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<td>Landfill</td>
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<td>Emplacement of Spoil and Overburden</td>
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<td>Underground Storage</td>
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<td>Sanitary Waste Discharge</td>
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<td>Septic Tanks</td>
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<tr>
<td>Stack and Exhaust Emission</td>
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<table>
<thead>
<tr>
<th>Chemical Treatment</th>
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<td>Fertilization</td>
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<td>Chemical Delaying</td>
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<td>Chemical Soil Substitution</td>
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<td>Weed Control</td>
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<tr>
<td>Pest Control</td>
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<table>
<thead>
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<th>Access Attractions</th>
<th>Yes</th>
<th>No</th>
<th>If Yes, Describe Generally (Breadth, Duration, Location and Time)</th>
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<tbody>
<tr>
<td>New or Expanded Access to Activity Center</td>
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<td>New or Expanded Access to Undeveloped Land</td>
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</tr>
<tr>
<td>Alter Travel Circulation Patterns</td>
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<tr>
<td>Alter Travel Times between Major Trip Productions and Attractions</td>
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<td></td>
<td></td>
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<tr>
<td>Alter Travel Costs between Major Trip Productions and Attractions</td>
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<table>
<thead>
<tr>
<th>Others</th>
<th>Yes</th>
<th>No</th>
<th>If Yes, Describe Generally (Breadth, Duration, Location and Time)</th>
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<tbody>
<tr>
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</table>

Reviewed by: [Name] [Affiliation] [Date]
### TABLE E-20

**CHECKLIST FOR ASSESSING STUDY AREA'S POTENTIAL FOR INDUCED GROWTH**

<table>
<thead>
<tr>
<th>Project Name: Grand Rapids South Beltline</th>
<th>Location: Grand Rapids, MI</th>
<th>Analyst: J. Perry</th>
<th>Date: 3/14/96</th>
</tr>
</thead>
</table>

**Regional Study Area Conditions**

A yes answer indicates conditions 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 retaining Federal/State 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? 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 in the 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 higher 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, <3.5% slopes)? 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

**Effects Related to Induced Growth**

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/or utility systems? Y
19. Is the local study area served 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

---

### 5.0 REFERENCES

**Table E-21**

**EVALUATION MATRIX FOR PROJECT INDIRECT EFFECTS OF CONCERN**

<table>
<thead>
<tr>
<th>Indirect Effect Type</th>
<th>Direct Effects from Impact-Causing Activities</th>
<th>Indirect Effects from Direct Effects (LIF)</th>
<th>Potential Manifestation of Indirect Effects (LIF)</th>
<th>Link between Indirect Effect and Goal or Notable Feature that Meets Assessment Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enrichment-Alteration</td>
<td>Eco-System-related</td>
<td>Wetlands</td>
<td></td>
<td>Yes (Go to Step 3)</td>
</tr>
<tr>
<td>Induced Growth (Activity-Alteration)</td>
<td>Socioeconomic-related</td>
<td></td>
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<td>Yes (Assessment Complete)</td>
</tr>
<tr>
<td>Encroachment-Alteration</td>
<td></td>
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</tr>
</tbody>
</table>

Assessment criteria = (1) Confidence that the effect is likely to occur; (2) Knowledge about indirect effect to make consideration useful; and (3) Need to know about the impact now.

Reviewed by:

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Date</th>
</tr>
</thead>
</table>

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### 6.5 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 U.S. 190, 191-1981, 1984/80, 1988, 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-81/64/380 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 LVII 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 LVII 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: 1-6). 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 26% by 1998 and 54% over the next 25 years (FEIS, 1992: 1-12).

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 LVII 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 LVII. 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 the plan (FEIS, 1992: 3).

1.3 Affected Environment and Alternatives Considered

The LVII 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 LVII 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 reflec
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.

2.6 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 sensitivity-making, the FHWA and PennDOT have directed that secondary impacts be incorporated into the highway development process for the LVIII.

One of the key points of the LVIII 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 LVIII 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 LVIII. 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 economic 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 LVIII 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 LVIII 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 LVIII. 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 LVIII 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 LVIII, 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,Als/ geology, mine hazards cultural resources, water supply, waste water management, storm water 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 LVIII Lackawanna County Soil Survey, and field reconnais-
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 each different level. 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 habitat 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 habitats 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 habitats 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. Aceh'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 will be based on data acquired during the LVBIH 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 of 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 unstable soils. Where there are large deposits of calm 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 reclamation, 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 hydraulic 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, aerial 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 LVBIH, 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 proposed minimum and maximum development and the no build scenario at the county, municipal, and school district level. After the following land use: 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 folklore 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 interpretively using cooperative strategies (Plan, 1994:9).

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-
ing economic export activities, attracting a work force, and
encouraging redevelopment of older areas for new purposes.
Ecosystem protection goals include protecting ecosystems,
providing habitat for sensitive areas, 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 Lack-
awanna River Citizens Master Plan provide direction 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, inter-
views 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,
riparian vegetation, and other areas), and species of special
concern (snowshoe hare) in the Valley. In addition, there are
diverse socioeconomic features such as noncompliance 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 com-
mercial establishments.

Reviewing the product of the study

Product: List of notable features for the indirect effects
assessment, with an accompanying map illustrating the loca-
tion and the extent of the feature, where appropriate. Com-
pletion 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 pro-
mote economic development including new residential,
commercial, and industrial areas. 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 doing business.

In addition to inducing development, the LVITH could cre-
ate several other impact causing activities. The construc-
tion 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 alterations including: erosion control, stormwater man-
agement, and associated soil spoil

TABLE E-22 ORGANIZATION AND TABULATION OF GOALS CHART
(Click where applicable)

| Project Name: LVITH, Location: Scranton, PA | Analyst: J. Perry | Date: 3/14/96 |
| 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 maintained diversity | | |
| Preserve heritage | | |
| Provide choice of affordable residential | | |
| locations | | |
| Protect urban environments for which those | | |
| with special needs | | |
| Promote land use patterns with sense of | | |
| community | | |
| Provide a range of services accessible to all | | |
| Preserve a healthy and safe environment | | |
| Provide area management of solid and | | |
| hazardous waste | | |
| Other | | |
| Economic Opportunities Goals | | |
| Support activities to new changing economic | | |
| conditions | | |
| Provide developments with transit supported | | |
| opportunities | | |
| Target economic activities | | |
| Accept and maintain workforce | | |
| Promote uplift of small, passed-over sites | | |
| Encourage redevelopment of older areas for | | |
| new purposes | | |
| Other | | |
| Ecosystem Protection Goals | | |
| Protect ecosystems | | |
| Maintain fragmented ecosystems | | |
| Protect native species | | |
| Protect rare and keystone species | | |
| Protect sensitive environments | | |
| Maintain natural processes | | |
| Maintain natural structural diversity | | |
| Maintain genetic diversity | | |
| Restore modified ecosystems | | |
| Other | | |

Reviewed by: | | |

Additions | Date |

TABLE E-23 STUDY AREA AREAS AND GOALS CHECKLIST
(Check where applicable)

| Project Name: LVITH, Location: Scranton, PA | Analyst: J. Perry | Date: 3/14/96 |
| 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 maintained diversity | | |
| Preserve heritage | | |
| Provide choice of affordable residential | | |
| locations | | |
| Protect urban environments for which those | | |
| with special needs | | |
| Promote land use patterns with sense of | | |
| community | | |
| Provide a range of services accessible to all | | |
| Preserve a healthy and safe environment | | |
| Provide area management of solid and | | |
| hazardous waste | | |
| Other | | |
| Economic Opportunities Goals | | |
| Support activities to new changing economic | | |
| conditions | | |
| Provide developments with transit supported | | |
| opportunities | | |
| Target economic activities | | |
| Accept and maintain workforce | | |
| Promote uplift of small, passed-over sites | | |
| Encourage redevelopment of older areas for | | |
| new purposes | | |
| Other | | |
| Ecosystem Protection Goals | | |
| Protect ecosystems | | |
| Maintain fragmented ecosystems | | |
| Protect native species | | |
| Protect rare and keystone species | | |
| Protect sensitive environments | | |
| Maintain natural processes | | |
| Maintain natural structural diversity | | |
| Maintain genetic diversity | | |
| Restore modified ecosystems | | |
| Other | | |

Reviewed by: | | |

Additions | Date |

AR00030135
TABLE E-24
NOTABLE FEATURES CHECKLIST
(Check where applicable)

<table>
<thead>
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<th>Location: Safield</th>
<th>Analyst: Parer Dale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location: Safield</td>
<td>Analyst: Parer Dale</td>
</tr>
<tr>
<td>Location: Safield</td>
<td>Analyst: Parer Dale</td>
</tr>
<tr>
<td>Location: Safield</td>
<td>Analyst: Parer Dale</td>
</tr>
</tbody>
</table>

**Notable Features**

- Regional habitats of concern/critical areas
- Rare, threatened, or endangered species and associated habitat
- Species whose intrinsic rates of increase fluctuate greatly
- Communities with vulnerable keystone predators or materials

**Socioeconomic Features**

- Poor access to amenities
- Economically disinvested areas
- High proportion of low-income residents
- Low proportion of low-income residents
- Inadequate affordable housing
- Lack of institutional land use controls

**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.

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**Step 4: Identify Indirect Effects for Analysis**

The indirect effects from this project with a high need-to-know factor is the possible hazardous 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 project 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...
# PROJECT IMPACT-CAUSING ACTIVITIES CHECKLIST

**Project Name:** LVH  **Location:** Scranton, PA  **Analyst:** J. Parry  **Date:** 3/14/96

### Modification of Habitat
- Exotic Flora Introduction
- Modification of Habitat
- Alternation of Ground Cover
- Alternation of Groundwater Hydrology
- Alternation of Drainage
- River Control and Flow Modification
- Chemicalization
- Noise and Vibration

### Land Transportation and Construction
- New or Expanded Transportation Facility
- Service or Support Sites and Buildings
- New or Expanded Service or Passage Roads
- Auxiliary Transmission Lines, Pipeline 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

### Process
- Product Storage

### Land Alteration
- Drainage Control and Terminating
- Mine Boating and Drain Control
- Landscaping
- Wetland or Open Water Fill and Drainage
- Harbor Dredging

### Resource Renewal
- Reclamation
- Groundwater Recharge
- Water Recycling
- Site Remediation

### Changes in Traffic (including adjacent facilities)
- Railroad
- Transit (Bus)
- Transit (Fixed Guideway)
- Automobiles
- Trucking
- Aerial
- River and Canal Traffic
- Pleasure Boating
- Commercial
- Operational or Service Charge

### Waste Generation and Treatment
- Landfill
- Replacement of Spill and Overburden
- Underground Storage
- Sanitary Waste Discharge
- Septic Tanks
- Sulfur and Exhaust Emission

### Chemical Treatment
- Fertilization
- Chemical Delineation
- Chemical Soil Stabilization
- Wood 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

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**Reviewed by:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Date</th>
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</table>

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AR00030137
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 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 LVII. 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 gainer and losers in the construction and operation of the LVII. 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

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### TABLE E-27

**CHECKLIST FOR ASSESSING STUDY AREA’S POTENTIAL FOR INDUCED GROWTH**

**Project Name:** LVII. **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.]
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is the regional population increasing rapidly (generally &gt;5% per 10 years)?</td>
</tr>
<tr>
<td>2. Is the region considered favorable for receiving FHA/VA loans?</td>
</tr>
<tr>
<td>3. Are there any major growth generators (e.g., industries, defense installations, highways, tourist attractions) in the region?</td>
</tr>
<tr>
<td>4. Is the regional office/commercial market characterized by low (generally, &lt;10%) vacancy rates in any class of space?</td>
</tr>
<tr>
<td>5. Is the region’s business and civic leadership committed to rapid development?</td>
</tr>
<tr>
<td>6. Is the region an exporter of natural resources?</td>
</tr>
</tbody>
</table>

#### 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 study area has not experienced conversion, the more yes answers, the higher the certainty that land use conversion will be induced by the project to its immediate vicinity.]
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Is the regional push to development in the direction of the local study area?</td>
</tr>
<tr>
<td>8. Is the project within 5 miles of a growing community (generally, &gt;5% per 10 years)?</td>
</tr>
<tr>
<td>9. Is the local study area characterized by rapid and/or high income levels?</td>
</tr>
<tr>
<td>10. Is the local study area free of memoriam to development (e.g., sewer installations, growth restrictions)?</td>
</tr>
<tr>
<td>11. Is the local study area within a 30-minute drive of a major employment center?</td>
</tr>
<tr>
<td>12. Does the local study area have relatively high land availability/low land prices (generally &lt;one-third of larger parcels developed)?</td>
</tr>
<tr>
<td>13. Is the vacant land characterized by relatively large parcels?</td>
</tr>
<tr>
<td>14. Is the local study area characterized predominantly by level land (generally, &lt;5% slope)?</td>
</tr>
<tr>
<td>15. Is the project’s Potential Impact Area characterized by sites suitable for development?</td>
</tr>
<tr>
<td>16. Is the project’s Potential Impact Area predominantly free of flooding or wetlands?</td>
</tr>
</tbody>
</table>

### TABLE E-28

**EVALUATION MATRIX FOR PROJECT INDIRECT EFFECTS OF CONCERN**

**Project Name:** LVII. **Location:** Scranton, PA. **Analyst:** J. Parry. **Date:** 3/14/96.

<table>
<thead>
<tr>
<th>Indirect Effect Type</th>
<th>Direct Effects from Impact-Causing Activities</th>
<th>Indirect Effects from Direct Effects (List)</th>
<th>Potential Manifestation of Indirect Effects (List)</th>
<th>Link between Indirect Effect and Cause or Notable Feature that Meets Assessment Criteria1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enrichment-Alteration</td>
<td>Ecosystem-related</td>
<td>Forest development enhancement</td>
<td>Development of wetlands, interchanges, wetland loss, reclamation, fragmentation</td>
<td>N/Yes</td>
</tr>
<tr>
<td>Induced Growth (Assessment-Attraction)</td>
<td>Socioeconomic-related</td>
<td>Stimulates community development</td>
<td>Development at interchanges, wetland loss, reclamation, fragmentation</td>
<td>Y</td>
</tr>
<tr>
<td>Effects Related to Induced Growth</td>
<td>Ecosystem-related</td>
<td>Socioeconomic-related</td>
<td>Society-related</td>
<td>Socioeconomic-related</td>
</tr>
</tbody>
</table>

Assessment criteria = (1) If the effect is likely to occur; (2) If enough enough about indirect effects to make considerations useful; and (2) Need to know about the impact now.

Reviewed by: Name: Affiliation: Date:

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*AR00030138*
municipalities outside of the study area who will lose the new transportation development when it locates adjacent to the LV1H. 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 oversight 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 at the request of the agencies that a study be undertaken to analyze the secondary impacts of the construction of the LV1H 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, new laws 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 sized 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.

- **Zoning Plan.** The planning divided the Valley into two regions: low growth and growth. Low growth areas included most of the sides of the Valley east of LV1H 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 hillside character 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 uses 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 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 LV1H 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 areas 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 2,000 to 2,800 housing units above the present inventory, and a net increase of about 7,800 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 LV1H 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 locations for new residential development which incorporate flexible 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 LV1H 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 proposed which the municipalities can adapt to their own municipality. Also, the county planning department will provide assistance when the municipalities change their zoning, subdivisions, 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 PEIS for this project provided a very detailed analysis of secondary impacts which was probably 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 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.*


**Plan for the Lackawanna Heritage Valley, The Lackawanna Valley Team, 1991.**

**Lackawanna Valley Corridor Plan, Lackawanna County Regional Planning Commission, no date.**

6.0 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 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, warehousing, and office use.

The prime economic development goal of this project is to increase the level of regional business activity to provide 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-
According to the FEIS for the Stewart International Airport Properties project, the purpose of the proposed project is to:

"Develop 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 ratabilities through payments in lieu of taxes to local municipalities and school districts by providing non-aviation, commercial space on land adjacent to Stewart Airport to generate approximately 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.

The proposed project is to develop seven million square feet (MSF) of office, light industry, warehousing and flex-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 ease 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 to socio-economic 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
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 not under a 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 development analysis, the indirect effects of the project on the local population were quantified in terms of new residents using modeling techniques. For the study of the physical environment, for example, wetlands and floodplains, the identification of indirect effects related primarily on professional judgment and academic literature and was evaluated quantitatively. 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 associated with the initial development; (2) the indirect impact—impact generated by the indirect effect or chain of transactions that results from 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 p-17]."

For an environmental use of the definition, impacts to vegetation resources were described as:

Direct impacts are those that result from actions taken to mitigate a site condition or 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 stream that is downstream 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, in a manner where the land can no longer support all elements of the forest community) [FEIS p-168].

Impacts to wildlife were defined as:

The direct impacts to wildlife will result from habitat destruction. Indirect impacts are associated with the alternation of migration and movement corridors within and between habitats, habitat isolation, physical encroachment, landscape fragmentation and water quality degradation [FEIS p-149].

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 the businesses that locate in the city in terms of new jobs, income, 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 use space 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.

• Fiscal impacts. The induced growth in population as a result of the project was estimated by multiplying the total employment forecast from the above analysis of 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 sub-basin while decreasing the rate of stormwater runoff to another. This would also affect the hydrology of the wetlands on-site.

• Floodplain. The floodplain analysis revealed that the direct effect of Alternative Five, which encompasses 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 regulations 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.

WATER RESOURCES

• Surface Water Hydrology. The indirect impact to surface water hydrology will be the change in drainage pattern within the eight major sub-basins as a result of regrading of the site topography. This impact will create increases in the rate of stormwater runoff to one sub-basin while decreasing the rate of stormwater runoff to another. This would also affect the hydrology of the wetlands on-site.

• Floodplain. The floodplain analysis revealed that the direct effect of Alternative Five, which encompasses 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 regulations 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
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, nesting and/or nesting activities.

The analysis did address and define cumulative impacts as "the loss of reproductive potential for animals displaced by construction, the inability to breed, population loss among both breeding and wintering animals caused by increased mortality of displaced animals and by dispersal of some of the displaced 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 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 evaluated qualitatively through professional judgement.

Co-located, the Indirect effects identified in the FEIS showed effects to areas greater than five miles away from the project site and were evaluated qualitatively through professional judgement.

Goals

The previous goal assessment would assist the completion of Goals (Tables E-29 and E-30) and possibly technical memorandum for more complex situations.

- A-Ctitag.

Social Health and Well-Being Goals

- Achieve adequate, appropriate and accessible open space and recreation
- Conserve clean and vital water and air quality laws
- Preserve or create multicultural diversity
- Preserve heritage
- Provide choice of affordable residential locations
- Provide urban environments for those with special needs
- Provide land use patterns with sense of community
- Provide a range of services accessible to all
- Promote health and safe environments
- Provide sound management of solid and hazardous waste

Economic Opportunity Goals

- Support activities to meet changing economic conditions
- Provide energy-efficient transportation
- Provide developments with transit-supported capabilities
- Target economic export activities
- Assist and maintain workforce
- Promote skill of smaller, passed-over size
- Encourage redevelopments of older areas for new purposes
- Other Provide development with transportation-supported capabilities

Environmental Protection Goals

- Protect ecosystems
- Minimize fragmentation
- Protect rare and unique species
- Promote endangered environments
- Maintain natural processes
- Maintain natural structural diversity
- Protect genetic diversity
- Restore modified ecosystems
- Other

Frame: Completion of Goals checklist (Tables E-29 and E-30) and possibly technical memorandum for more complex situations.

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 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 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 extent of the feature, where appropriate (see Table E-1 and E-32).

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 Tables 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 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 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 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 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>
<thead>
<tr>
<th>TABLE E-30</th>
<th>STUDY AREA DIRECTIONS AND GOALS CHECKLIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Check where applicable)</td>
<td></td>
</tr>
<tr>
<td><strong>Project Name:</strong> <strong>Stewart Properties</strong></td>
<td><strong>Location:</strong> <strong>Orange County, NY</strong></td>
</tr>
<tr>
<td>1. Generalized Setting</td>
<td></td>
</tr>
<tr>
<td>Within Metropolitan Statistical Area (Identify MSA)</td>
<td></td>
</tr>
<tr>
<td>Outside of MSA</td>
<td></td>
</tr>
<tr>
<td>Both Inside and Outside MSA</td>
<td>Indicate Distance to Nearest Metropolitan Center</td>
</tr>
<tr>
<td>5 miles, city of Newburgh, New York</td>
<td></td>
</tr>
<tr>
<td>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 interrelationships characteristics, i.e., factors relevant to subsequent indirect effects analysis).</td>
<td></td>
</tr>
<tr>
<td>- Identify existing links in transportation system</td>
<td></td>
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<tr>
<td>- Map and describe existing level of service on minor and principal arterials and their access characteristics</td>
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</tr>
<tr>
<td>- Indicate distance to nearest interstate highway if not in study area</td>
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<tr>
<td>- Map and describe existing transit routes and demand</td>
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<tr>
<td>- Map and describe major concentrations of existing and planned development</td>
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<tr>
<td>- Describe modal interrelationships including competing and complementary characteristics</td>
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<tr>
<td>3. Population Trends</td>
<td></td>
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<tr>
<td>Declining</td>
<td></td>
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<tr>
<td>Stable (±1%/10 years)</td>
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<tr>
<td>Slow Growth</td>
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<tr>
<td>Rapid Growth (&gt; 1%/10 years)</td>
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<tr>
<td>Employment Trends</td>
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<tr>
<td>Declining</td>
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<tr>
<td>Stable (±1%/10 years)</td>
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<tr>
<td>Slow Growth</td>
<td></td>
</tr>
<tr>
<td>Rapid Growth (&gt; 1%/10 years)</td>
<td></td>
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<tr>
<td>4. Planning Context</td>
<td></td>
</tr>
<tr>
<td>Zoning</td>
<td>Yes</td>
</tr>
<tr>
<td>State Master Plan</td>
<td></td>
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<tr>
<td>County/Regional Master Plan</td>
<td></td>
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<tr>
<td>Municipal Master Plan</td>
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<tr>
<td>Growth Management Plan</td>
<td></td>
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<tr>
<td>Water Quality Management Plan</td>
<td></td>
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<tr>
<td>Other Natural Resources Management Plan</td>
<td></td>
</tr>
<tr>
<td>5. For each plan identified in No. 4, enumerate 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 over pages, focus development on existing towns and villages, support cities, reduce sprawl</td>
<td></td>
</tr>
<tr>
<td>6. Describe any efforts to elicit local needs and goals from residents and/or agencies (source and result).</td>
<td></td>
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<tr>
<td>7. Describe known plans for major new or expanded activity centers including public facilities.</td>
<td></td>
</tr>
<tr>
<td>8. Is the activity center dependent on transportation system improvement?</td>
<td>Yes</td>
</tr>
<tr>
<td>9. Is the transportation need linked to economic growth and land development?</td>
<td>Yes</td>
</tr>
<tr>
<td>If yes, is the nature of the linkage to:</td>
<td></td>
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<tr>
<td>Serve the needs of planned growth</td>
<td></td>
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<tr>
<td>Channel growth</td>
<td></td>
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<tr>
<td>Stimulate growth</td>
<td></td>
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<tr>
<td>Based on information obtained, are there any apparent conflicts between transportation and other needs that could result in controversy? (Describe)</td>
<td></td>
</tr>
<tr>
<td>Reviewed by:</td>
<td>Name</td>
</tr>
</tbody>
</table>
TABLE E-31
NOTABLE FEATURES CHECKLIST
(Check where applicable)

<table>
<thead>
<tr>
<th>Ecosystem Features</th>
<th>Special sensitive wildlife to forested areas of Stewart Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional habitats of concern/critical areas</td>
<td>Sensitive species requiring high survival rates</td>
</tr>
<tr>
<td>Rare, threatened or endangered species and associated habitat</td>
<td>Species requiring special conservation efforts</td>
</tr>
<tr>
<td>Species requiring high survival rates</td>
<td>Species whose intrinsic rates of increase would greatly benefit from conservation efforts</td>
</tr>
<tr>
<td>Communities with vulnerable keyswae predators or materialists</td>
<td>Communities with vulnerable keyswae predators or materialists</td>
</tr>
<tr>
<td>Other</td>
<td>Large habitat sensitive</td>
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<tr>
<td>Subeconomic Features</td>
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<tr>
<td>Low proportion of low-income residents</td>
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<tr>
<td>Low proportion of long-term residents</td>
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<tr>
<td>Lack of institutional land use controls</td>
<td></td>
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<tr>
<td>High proportion of property zoned for:</td>
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<tr>
<td>Residential</td>
<td></td>
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<tr>
<td>Commercial</td>
<td></td>
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<tr>
<td>Industrial</td>
<td></td>
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<tr>
<td>Other</td>
<td></td>
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<tr>
<td>Non-compliance with state and federal environmental laws</td>
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<tr>
<td>High concentration of uncontrolled solid and hazardous waste sites</td>
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<tr>
<td>Inadequate affordable housing</td>
<td></td>
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<tr>
<td>Inadequate access to essential services</td>
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<tr>
<td>Environmental disturbance area</td>
<td></td>
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<tr>
<td>Lack of institutional land use controls</td>
<td></td>
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<tr>
<td>High proportion of property zoned for:</td>
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<tr>
<td>Residential</td>
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<td>Commercial</td>
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<tr>
<td>Industrial</td>
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<td>Other</td>
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Reviewed by: 

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Date</th>
</tr>
</thead>
</table>

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 professionals to evaluate possible socioeconomic and real estate changes to the study area as a result of the project would assist in identifying impacts. Cletographic 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. Economic analysis suggests 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 promote the relocation of existing commercial and industrial tenants in the county from existing office and industrial parks into new, subsidized space in Stewart Properties? How can this effect be prevented?
### Project Impact-Causing Activities Checklist

**Project Name:** Stewart Properties  
**Location:** Orange County, NY  
**Analyst:** A. Cheng  
**Date:** 1/2/96

<table>
<thead>
<tr>
<th>Modification of Real Estate</th>
<th>Yes</th>
<th>No</th>
<th>If Yes, Describe Generally (Threat, Duration, Location and Type)</th>
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<tr>
<td>Exotic Flora Introduction</td>
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<tr>
<td>Modification of Habitat</td>
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<td>Channelization</td>
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<td>Noise and Vibration</td>
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<table>
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<td>New or Expanded Transportation Facility</td>
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<tr>
<td>Service or Support Sites and Buildings</td>
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<td>New or Expanded Service or Franchise Roads</td>
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<td>Auxiliary Transmission Lines, Pipelines and Corridors</td>
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<tr>
<td>Barriers, Including Fencing</td>
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<td>Channel Dredging and Straightening</td>
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<td>Buildings or Seawalls</td>
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<td>Dredging</td>
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<td>Mine Sealing and Waste Control</td>
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<td>Landscaping</td>
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<td>Wetland or Open Water Fill and Drainage</td>
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<td>Harbor Dredging</td>
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<td>Waste Recycling</td>
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<td>Site Remediation</td>
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<td>Trucking</td>
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<td>Operational or Service Charge</td>
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<td>New or Expanded Access to Undeveloped Land</td>
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</table>

<table>
<thead>
<tr>
<th>Others</th>
<th>Yes</th>
<th>No</th>
<th>If Yes, Describe Generally (Threat, Duration, Location and Type)</th>
</tr>
</thead>
</table>

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 indirectly 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 6. Evaluate Analysis Results

The objective of this step is to prepare 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 causes 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

### CHECKLIST FOR ASSESSING STUDY AREA'S POTENTIAL FOR INDUCED GROWTH

<table>
<thead>
<tr>
<th>Project Name: Stewart Properties</th>
<th>Location: Orange County, NY</th>
<th>Analyst: A. Chen</th>
<th>Date: 1/1/96</th>
</tr>
</thead>
</table>

#### 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 PIAA/NA 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? 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 in 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
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 lead prices (generally one-third or larger parcels developed)? DK
13. Is the vacant lead 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 largely free of flooding or wetlands? N

**Indicators of Condition Inverse to Conversion to Higher Density Development**

17. Does the local study area have relatively low land availability/high lead prices (generally >two-thirds of larger parent developed)? DK
18. Is the local study area served by existing principal utilities and wastewater systems? DK
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:

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Date</th>
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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 Master Plan, Chalmers & Wakefield Inc. (undated).

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

![Image of Hudson River Waterfront]

### TABLE E-35
**EVALUATION MATRIX FOR PROJECT INDIRECT EFFECTS OF CONCERN**

<table>
<thead>
<tr>
<th>Indirect Effect Type</th>
<th>Direct Effects from Impact-Inducing Activities</th>
<th>Indirect Effects from Direct Effects (List)</th>
<th>Potential Manifestations of Indirect Effects (List)</th>
<th>List between Indirect Effect and Goal or Notable Feature that Must Be Documented</th>
<th>Yes (Go to Step 2)</th>
<th>No (Assessment Completed)</th>
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<tbody>
<tr>
<td>Enroachment-Alteration</td>
<td>Ecosystem-related</td>
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<td></td>
<td>Socioeconomic-related</td>
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<tr>
<td>Induced Growth (Access-Alteration)</td>
<td>Serves specific development</td>
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<td></td>
<td>Stimulates complementary development</td>
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<td>Influences location decisions</td>
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<tr>
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<td></td>
<td>Socioeconomic-related</td>
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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]

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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 travel 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
• maximize mobility for area residents and workers;
• support the economic redevelopment of the Hudson River Waterfront;
• conserve 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 needs 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 1864, 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 1835, 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 1899, the Hudson and Manhattan Railroad began operations through its newly completed tunnel from Jersey City to its massive Hudson Terminal in southern Manhattan. In 1901, the Pullman Car Manufacturing Company opened its new plant on the west bank of the Hudson River, near the site of the Transportation Dockage 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 outdated, 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 distinct 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 25 million square feet of additional office space, 42,000 new housing units, and four million square feet of retail space would lose the Waterfront if all developers’ plans were completed. This development would create a north-south fissure 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 Sip 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 approach 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 2000. 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 to Bayonne’s east side for a system 14.4 miles in length.

Alternative V: Core LRT and Weehawken Tunnel Transitway—Includes a 9.8-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 5.6-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.
2.3 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 material 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 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 routing, 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 issues.

The transformation of the Waterfront represents an intriguing interplay between transit investment (as proposed) and real estate development. One can assert with confidence that a unified transit system would have a positive effect first roughly quantified and its achievement 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 sewage capacity, and favorable local land use zoning ordinances and tax policies.

"As presented, the Waterfront's most productive sites are the ones most easily accessible to the PATH system and the NIT
TABLE E-37
STUDY AREA DIRECTIONS AND GOALS CHECKLIST
(Check where applicable)

| Project Name: Hudson-Bergen Light Rail | Location: NJ | Analyst: L. Perelkis | Date: 

1. Generalized Setting
   - Within Metropolitan Statistical Area (identity 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 in-depth analyses)
   - 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 complimentary characteristics

3. Population Trends
   - Declining
   - Stable (± 1% /10 years)
   - Slow Growth
   - Rapid Growth (> 10% /10 years)

<table>
<thead>
<tr>
<th></th>
<th>Trend</th>
<th>Projection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declining</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slow Growth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rapid Growth</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Planning Context
   - Zoning
   - State Master Plan
   - County/Regional Master Plan
   - Municipal Master Plan
   - Growth Management Plan
   - Water Quality Management Plan
   - Other Natural Resources Management Plan

<table>
<thead>
<tr>
<th>Planning Context</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zoning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>State Master Plan</td>
<td></td>
<td></td>
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<tr>
<td>County/Regional Master Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Municipal Master Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth Management Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Quality Management Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Natural Resources Management Plan</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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. Liberty State Park Master Plan, Jersey City Medical Center Renovation
   - Port Imperial Mixed Use

8. Is the activity center dependent on transportation system improvements?
   - Yes
   - No

9. Is the transportation need linked to economic growth and land development?
   - Yes
   - No

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

Reviewed by:

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Date</th>
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</table>

AR003039150
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 magnitude of the 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 foster interaction and opportunity through increased accessibility, particularly in the lower income communities of the corridor. How the effects of the neighboring corridor would benefit from the proximity of new transit services from the high-density, or more fully developed communities to 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 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 habitats in an area through increased noise, vegetation destruction, and habitat fragmentation.

Impacts on Water Quality (p. 5-35)—The lower automotive use within 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 urban orientation. Municipalities in the corridor are intensely interested in new economic development primarily to increase tax revenues and plan the municipalities in improved local positions. Indeed, as reflected by official plans and policies, state and local officials understand the need for new infrastructure to foster the area’s fullest realization. The State Development and Redevelopment Guide Plan notates the corridor as one where infrastructure investments shall be directed. The state feels that infrastructure investment in such urban core areas is not only necessary to counteract the negative externalities of urban sprawl but also to attract new businesses to the corridor.

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, 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 variously correlates with low income in the corridor. The dominant race in the corridor is white, but sizable concentrations of African-American 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 deficit and high tax default 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-39
**Notable Features Addressed by Federal Statutes**

<table>
<thead>
<tr>
<th>Resource Type or Area</th>
<th>Statute/Order</th>
<th>Source of Information and Map Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 4(f) Resources</td>
<td>Department of Transportation Act</td>
<td>Local Parks or Recreation Officials, State Historic Preservation Office or local historic preservation organizations</td>
</tr>
<tr>
<td>Public Parks and Recreational Lands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wildlife and Waterfowl Refuges</td>
<td></td>
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<tr>
<td>Historic Sites</td>
<td></td>
<td></td>
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<tr>
<td>Historic Districts</td>
<td></td>
<td></td>
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<tr>
<td>Archaeological Remains</td>
<td></td>
<td></td>
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<tr>
<td>Historic Structure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coastal Zone</td>
<td>Coastal Zone Management Act</td>
<td>State Coastal Zone Management Office</td>
</tr>
<tr>
<td>Waters of the United States</td>
<td>Clean Water Act; E.O. 1990</td>
<td>State Fish and Game Commission, U.S. Fish and Wildlife Service</td>
</tr>
<tr>
<td>Sole Source Aquifer</td>
<td>Safe Drinking Water Act</td>
<td>State Natural Resources Agency, U.S. Environmental Protection Agency</td>
</tr>
<tr>
<td>Areas of Known Contamination</td>
<td>Comprehensive Envr. Response Compensation Liability Act</td>
<td>State environmental protection agency; U.S. Environmental Protection Agency</td>
</tr>
<tr>
<td>Floodplain</td>
<td>E.O. 11988</td>
<td>Federal Emergency Management Agency</td>
</tr>
<tr>
<td>Range or Habitat of Threatened or Endangered Species</td>
<td>Endangered Species Act</td>
<td>State Fish and Game Commission, U.S. Fish and Wildlife Service</td>
</tr>
<tr>
<td>Wild, Scenic or Recreational River</td>
<td>Wild and Scenic Rivers Act</td>
<td>U.S. National Park Service</td>
</tr>
<tr>
<td>Plateau or Unique Foreland</td>
<td>Partland Protection Act</td>
<td>U.S. Soil Conservation Service</td>
</tr>
<tr>
<td>Sensitive Recipient</td>
<td>Clean Air Act; Noise Control Act</td>
<td>State environmental protection agency</td>
</tr>
<tr>
<td>Nonattainment or Maintenance Areas</td>
<td>Clean Air Act</td>
<td>State and local air and transportation agencies; metropolitan planning organization; state implementation plan; conformity determinations of transportation plans, programs and projects.</td>
</tr>
<tr>
<td>Residential or Commercial Establishments</td>
<td>Uniform Relocation Act; E.O. 12318</td>
<td>Local governments</td>
</tr>
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</table>

**Reviewed by:**

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<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Date</th>
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</thead>
</table>

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### Table E-40
**Project Impact-Causing Activities Checklist**

**Project Name:**  *Hudson-Bergen Light Rail*  
**Location:**  *NJ*  
**Analyst:**  *L. Peskey*  
**Date:**

<table>
<thead>
<tr>
<th>Modification of Baseline</th>
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<th>No</th>
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<tr>
<td>Exotic Flora Introduction</td>
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<tr>
<td>Modification of Habitat</td>
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<tr>
<td>Alteration of Ground Cover</td>
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<td>Alteration of Groundwater Hydrology</td>
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<td>Alteration of Drainage</td>
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<tr>
<td>River Control and Flow Modification</td>
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<tr>
<td>Channelization</td>
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<tr>
<td>Noise and Vibration</td>
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<table>
<thead>
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<th>Land Transportation and Construction</th>
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<td>Service or Support Sites and Buildings</td>
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<tr>
<td>New or Expanded Service or Frontage Roads</td>
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<tr>
<td>Auxiliary Transmission Lines, Pipelines and Corridors</td>
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<tr>
<td>Barriers, Including Fencing</td>
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<tr>
<td>Channel Dredging and Straightening</td>
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<td>Channel Replacements</td>
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<td>Cemeteries</td>
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<td>Cut and Fill</td>
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<td>Subsurface Excavation</td>
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<td>Dredging</td>
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<table>
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<th>Land Alteration</th>
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<tbody>
<tr>
<td>Erosion Control and Terracing</td>
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<tr>
<td>Mine Sealing and Waste Control</td>
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<td>Landscaping</td>
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<tr>
<td>Water or Open Water Fill and Drainage</td>
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<tr>
<td>Harbor Dredging</td>
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<tr>
<th>Resource Renewal</th>
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<tr>
<td>Reclamation</td>
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<tr>
<td>Groundwater Recharge</td>
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<tr>
<td>Waste Recycling</td>
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<td></td>
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<tr>
<td>Site Remediation</td>
<td></td>
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</tr>
</tbody>
</table>
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. Spatial analysis could be applied to correlate development areas with important viewsheds and areas of historic architectural significance.

Step No. 5. 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. 6. 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

<table>
<thead>
<tr>
<th>Regional Study Area Conditions</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the regional population increasing rapidly (generally, &gt;5% per 10 years)?</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Is the region considered favorable for receiving FHA/VA loans?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Are there any major growth generators in e.g., universities, military installations, industries, major attractions in the region?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Is the regional economic/commercial market characterized by low (generally, &lt;10%) vacancy rates in any class of space?</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Is the region's business and civic leadership committed to rapid development?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Is the region an exporter of natural resources?</td>
<td>N</td>
<td>Y</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Local Study Area Conditions</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the regional path of development in the direction of the local study area?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Is the project within 5 miles of a growing community (generally, &gt;5% per 10 years)?</td>
<td>Yes, downtown Jersey City</td>
<td>No</td>
</tr>
<tr>
<td>Is the local study area characterized by middle and/or high income levels?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Is the local study area free of environmental development (i.e., sewer utilities, growth restrictions)? Generally, yes</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Indicators of conditions favorable to conversion to lower density development</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Is the local study area within a 30-minute drive of a major employment center?</td>
<td>Within</td>
<td>Outside</td>
</tr>
<tr>
<td>Does the local study area have relatively high land availability/low land prices (generally &lt;one-third of larger parcels developed)?</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Is the vacant land characterized by relatively large parcels? Generally, no</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Is the local study area characterized predominantly by level land (generally, &lt;5% slope)? Waterfront, yes</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Is the project's Potential Impact Area characterized by soils suitable for development?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Is the project's Potential Impact Area predominantly free of flooding or wetlands?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Indicators of conditions favorable to conversion to higher density development</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Does the local study area have relatively low land availability/high land prices (generally &gt;two-thirds of larger parcels developed)?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Is the local study area served by existing principal arterials and water/sewer systems?</td>
<td>Principal arterials, no Water/sewer, yes</td>
<td>No arterials, no Water/sewer, yes</td>
</tr>
<tr>
<td>Is the local study area covered by relatively few governmental jurisdictions?</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Is the local study area characterized by poorly enforced zoning regulations?</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Does the local study area lack recent (generally, &lt;10 years old) assessed plans?</td>
<td>N</td>
<td>Y</td>
</tr>
</tbody>
</table>

Reviewed by: [Name] [Affiliation] [Date]

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).

5.3 REFERENCES

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
NCTR 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
U.S.DOT United States Department of Transportation
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