EVALUATION OF ENVIRONMENTAL INVESTMENTS PROCEDURES

OVERVIEW MANUAL

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OVERVIEW MANUAL

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Evaluation of Environmental Investments Research Program

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PREFACE

This study was conducted as part of the Evaluation of Environmental Investments Research Program (EEIRP). The EEIRP is sponsored by the Headquarters, U.S. Army Corps of Engineers (HQUSACE). It is jointly assigned to the U.S. Army Water Resources Support Center (WRSC) Institute for Water Resources (IWR) and the U.S. Army Engineer Waterways Experiment Station (WES) Environmental Laboratory (EL). Mr. William J. Hansen of IWR is the Program Manager, and Mr. H. Roger Hamilton is the WES Manager. Program Monitors during this study were Mr. John W. Bellinger and Mr. Brad K. Fowler, HQUSACE. The field review group members who provide complete program direction and the District or Division affiliations are as follows: Mr. David Carney, New Orleans District; Mr. Larry M. Kilgo, Lower Mississippi Valley Division; Mr. Richard Gorton, Omaha District; Mr. Bruce D. Carlson, St. Paul District; Mr. Glendon L. Coffee, Mobile District; Ms. Susan E. Durden, Savannah District; Mr. Scott Miner, San Francisco District; Mr. Robert F. Scott, Fort Worth District; Mr. Clifford J. Kidd, Baltimore District; Mr. Edwin J. Woodruff, North Pacific Division; and Dr. Michael Passmore, formerly of Walla Walla District and now at WES. The work was conducted under the Evaluation Framework Unit of the EEIRP. Ms. Joy Muncy of the Technical Analysis and Research Division (TARD), IWR, and Mr. Jim Henderson of the Natural Resources Division (NRD), WES, were the Principal Investigators.

The work was performed by Planning and Management Consultants, Ltd. (PMCL) under Task Order No. 39, Contract No. DACW72-94-D-0003 managed by Ms. Joy Muncy. Dr. Timothy D. Feather was the Principal Investigator in collaboration with Dr. Keith Harrington.

The report was prepared under the general supervision at IWR of Mr. Michael R. Krouse, Chief, TARD; and Mr. Kyle E. Schilling, Director, IWR. At EL the report was supervised by Dr. Robert M. Engler, Chief, NRD; Dr. John W. Keeley, Director, EL; and Dr. Robert W. Whalin, Director, WES.

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I. INTRODUCTION

For over a decade the U.S. Army Corps of Engineers (Corps) has actively been involved in ecosystem restoration projects. As this new direction for the Corps has evolved, it has become increasingly clear that environmental restoration projects pose different planning challenges than traditional water resources development projects. The Evaluation of Environmental Investments Research Program (EEIRP) was initiated by the Corps to develop planning methodologies that respond to these challenges. Specifically, the EEIRP was intended to address what have become known as the "site" and "portfolio" questions:

(1) How can the Corps determine whether the recommended action from a range of alternatives is the most desirable in terms of the environmental objectives?

(2) How should the Corps allocate limited resources among many "most desirable" environmental investment decisions?

The Corps six-step planning process is based upon the U.S. Water Resources Council's *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (*P&G*), promulgated in 1983. The *P&G* provides a decision-making framework that is equally applicable to traditional water resources projects and environmental restoration projects. However, the differences between these projects, such as restoration's predominance of nonmonetary benefits, require tailoring the planning process for ecosystem restoration. The Corps ongoing adaptations of the planning process include: (1) promulgating the various forms of guidance for environmental planning, (2) documenting field experience with planning environmental projects (i.e., case studies), and (3) developing the process and products provided by the EEIRP. This report, prepared under the EEIRP Evaluation Framework work unit, is part of that effort.

PURPOSE

The purpose of this report is to support Corps planners by identifying EEIRP products that can be used in applying the six-step planning process to environmental projects. Underlying the incorporation of the EEIRP products into the planning process is the need to (1) integrate the tools and techniques identified and developed by the EEIRP and (2) ensure that they collectively help address the site and portfolio questions.

SCOPE

Corps environmental planning encompasses traditional environmental activities, such as mitigation, and new environmental missions, such as ecosystem restoration. Unless otherwise specified, "environmental planning" refers to ecosystem restoration or mitigation activities within this document. Although the motivations for mitigation and restoration projects can be quite different, their planning processes are virtually identical. Similarly, while the products of the EEIRP are focused on ecosystem restoration, they are also applicable to other environmental contexts, such as cultural resources and hazardous, toxic, and radioactive wastes.

This document is intended to serve as a reference guide for Corps environmental planning. It is a procedures manual that synthesizes the many products of the EEIRP and shows how they can support environmental planning. This report does not constitute restoration guidance. It provides an overview of Corps environmental planning and identifies EEIRP products that support specific planning activities. Planners are encouraged to obtain copies of the EEIRP products that pertain to their specific planning challenges. For this reason, an order form for obtaining copies of EEIRP products is included at the end of this report.

Since its inception in 1993, the EEIRP has endeavored to capture the state of the art in environmental planning. There are similar programs ongoing in other Federal agencies. There has been considerable communication between these programs as the Federal government refines its environmental decision-making tools. This cross-fertilization shares successes and setbacks and attempts to avoid duplication of research on environmental evaluation.

REPORT CONTENTS

There are two additional chapters in this document. An overview of the institutional setting for Corps environmental planning is presented in the following chapter (II). This overview introduces pertinent guidance, funding authorities, and typical planning partner relationships among other important parameters. Chapter III identifies analytical tools developed through the EEIRP which can be used to support restoration planning. It is organized using the six steps of the planning process. Chapter III also discusses how the planning challenges of restoration projects are compounded at the portfolio level and identifies ways in which the EEIRP products can help make difficult portfolio decisions.

II. INSTITUTIONAL SETTING FOR CORPS ENVIRONMENTAL PLANNING

INTRODUCTION

This chapter overviews the current institutional setting within which Corps ecosystem restoration planning is conducted, as well as the process and products of the EEIRP. It is organized into four sections that describe (1) the planning process as it has been applied to traditional water resources development projects, (2) the differences between environmental projects and traditional water resources projects, (3) the ecosystem restoration guidance, EC 1105-2-210, and (4) the process and products of the EEIRP.

PLANNING PROCESS: TRADITIONAL WATER RESOURCES PROJECTS

The planning process provides the philosophical and procedural foundations for the development of detailed planning methodologies outlined in other guidance. The six steps of the planning process, illustrated in Figure 1, provide the structure for ecosystem restoration planning.

These steps follow a rational sequence of activities from identification of problems and opportunities to selection of a recommended solution. Underlying the general flow of activities from the first step to the last are analytical iterations: iterations within each step, as well as iterations of the entire process. The following discussions summarize the planning process as applied to traditional water resources projects (e.g., flood control and navigation). This will be followed by discussions of how restoration projects differ from traditional water resources projects, and how these differences can be accommodated within the planning process with the help of the products of the EEIRP.

Specification of Problems and Opportunities

The first step of the planning process is to identify problems and opportunities. During this step, the statement of problems and opportunities is developed. In addition, project scoping activities are initiated in this step, including delineating the planning area, determining the period of analysis, and scoping the project objectives and constraints. At this initial phase of the project, it is particularly important that (1) project partners recognize their responsibilities, (2) stakeholders be identified, and (3) a public involvement program be initiated.

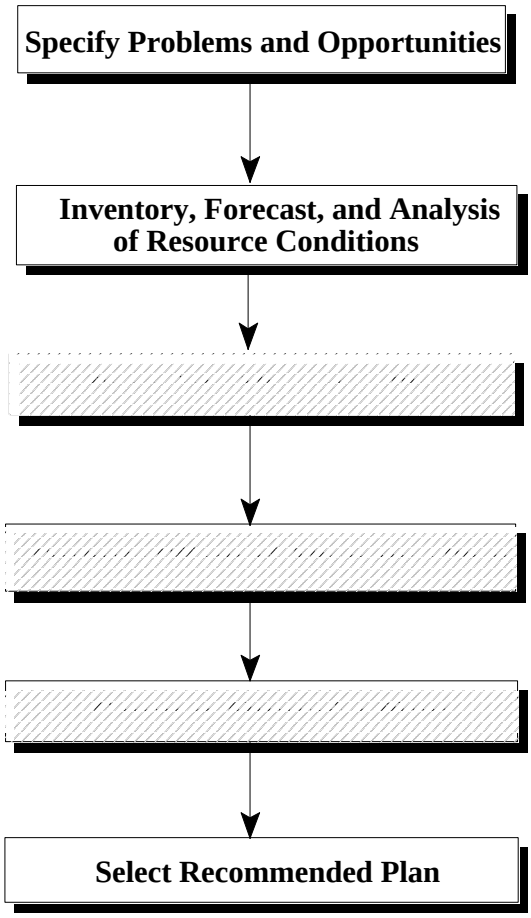

FIGURE 1
PLANNING PROCESS

Inventory, Forecast, and Analysis of Conditions

The second step of the planning process is to anticipate the future conditions of the project area through a defined period of analysis. The emphasis of this effort is on forecasting the without-project condition. These forecasting activities have many challenges, including those of data collection and management. The planning analyses in this step develop a comprehensive picture of the future site conditions if no action is taken, focusing on the future conditions related to problems and opportunities identified in the previous step.

Formulation of Alternative Plans

The third step of the planning process develops alternative plans. The formulation of alternative plans is an iterative process that considers the location, dimensions, materials, and timing of the alternatives. Structural and nonstructural plans are to be considered. In addition, mitigation plans are developed as part of the formulation of alternatives, if necessary.

Evaluation of the Effects of Alternative Plans

In the fourth step, alternative plans are evaluated. This step includes assessment and appraisal of alternative plans. There are assessments of (1) the differences between the with- and without-project futures, (2) the effectiveness of meeting project objectives, and (3) project effects. Assessments identify any differences between the with- and without-project futures to determine project effects. These assessments are followed by appraisals of the significance of project effects to determine if they are beneficial or adverse.

Comparison of Alternative Plans

In the fifth step of the planning process, beneficial and adverse effects of alternative plans are compared. For traditional water resources projects, it is in this step that the plan that maximizes net national economic development (NED) benefits is identified, leading to a single "optimal" solution for the planning objectives.

Selection of a Recommended Plan

In the final step of the planning process, the recommended plan is selected. Among the alternatives considered is the no-action plan. For traditional water resources projects, the NED account comprises the most important decision criterion. As a result, a water resources development plan recommending Federal action must be the NED plan, unless there is an overriding reason to select some other plan.

Portfolio Decisions

After plan selection, portfolio decisions must be made at various regional and national levels to decide which of the best plans will be recommended for further consideration or selected for

funding. There are many parties involved in portfolio decision making, including the Corps hierarchy, the Administration, Congress, and the Office of Management and Budget. To support portfolio decision making, it is desirable that planning investigations employ standardized methodologies and present comparable project information.

CHALLENGES OF ENVIRONMENTAL PROJECTS

Environmental projects have important differences from traditional water resources development projects—differences that challenge the traditional planning process and that are critical determinants of the process and products of the environmental planning effort. They can directly and indirectly influence Corps effectiveness in addressing the environmental problem and Corps efficiency in planning and implementing the project. While each project has unique features, the important differences in environmental projects include the relative importance of (1) ecosystems, (2) nonmonetary benefits, and (3) stakeholders.

Ecosystem Evaluation

In contrast with traditional water resources projects, environmental projects are oriented toward ecosystems rather than national economic development. For example, environmental projects are not usually oriented toward some aspect of human safety or welfare as are traditional water resources development projects, which have some aspect of national economic development as their primary purpose.

The objectives and outputs of restoration projects are also more dependent on the ecosystem's structure and function. The individuality of ecosystems challenges the application of standardized planning procedures to restoration projects. Since they focus on ecosystem structures and functions, the value of restoration activities cannot be directly measured in monetary terms. However, at both the site and the portfolio scales, there is a need to evaluate the potential of a plan to meet the project objectives (i.e., effectiveness) with a limited allocation of resources (i.e., efficiency). These effectiveness and efficiency considerations challenge traditional planning methodologies, which were intended to assess in monetary terms the costs and benefits of alternative plans. In addition, determining the significance of a resource is fundamental to defining the environmental problem and setting planning objectives. These activities can be very difficult if an evaluation standard is absent.

Another distinction of environmental projects is derived from the complexity of the project ecosystem. In some cases, the ability to predict ecosystem responses to different inputs and conditions associated with alternative restoration measures is less evolved than the engineering analyses that typify traditional water resources development projects.

Benefits Measured in Many Metrics

The most important differences between restoration projects and traditional water resources projects are that the benefits of restoration are often measured in many metrics (e.g., habitat units, acres restored, increase in species populations), not simply dollars. While the costs of ecosystem restoration can usually be estimated in dollar values with little difficulty, restoration benefits can be much more challenging. Some indirect restoration benefits, such as improvements in water supply or recreation, may be measurable in monetary terms. However, the outputs of restored ecosystems are typically described in ecological terms, such as habitat units. While there are accepted techniques, for example, the Habitat Evaluation Procedure, to estimate ecosystem outputs, it can be difficult to measure in monetary terms restoration benefits by estimating human valuation of those outputs.

The nonmonetary benefits of restoration projects challenge planning methodologies that were developed to assess and compare the dollar costs and dollar benefits of alternative plans. Environmental decision making is often forced to rely on subjective, rather than objective, measures of efficiency and effectiveness. In addition, there is no longer a single-decision criterion—the maximization of net NED benefits—in the absence of a common metric for costs and benefits. The planning implications of benefits measured in nonmonetary terms have stimulated active research programs in environmental evaluation for several decades, including the EEIRP.

Stakeholders

A stakeholder is someone with something to gain or lose from a recommended course of action. They may be government agencies, private organizations, economic or environmental interest groups, or concerned citizens. While stakeholders can play important roles in planning water resources development projects, they may be more critical to the success of restoration planning. Some stakeholders have extensive experience with restoration projects that can support Corps planning efforts. Others can share their knowledge of the site or the specific ecosystem. In addition, the difficulty of monetary valuation of restoration benefits raises the significance of stakeholders' valuation of restoration alternatives. While stakeholders are typically not needed to identify the NED plans of water resources projects, they can be very helpful in describing the benefits of restoration alternatives.

ECOSYSTEM RESTORATION GUIDANCE

Corps ecosystem planning guidance directs planners toward specific tools and techniques for use in environmental projects. As in the case of traditional water resources planning, these procedures are often standardized to promote effective site planning for particular projects and

consistent methodologies across the Corps portfolio of environmental projects. This guidance includes planning requirements, recommendations, and options. The guidance is transmitted downward through engineering regulations, engineering circulars (ECs), engineering technical letters, engineering pamphlets, various policy guidance letters (PGLs), policy memos, and training programs.

Corps environmental guidance includes a mixture of established information from traditional environmental activities and freshly minted regulations and tools for new ecosystem planning activities. For example, the Corps has a long history with the mitigation of adverse environmental effects of its Civil Works projects. As a result, the guidance for these activities are well developed and well known. In contrast, the ecosystem restoration mission of the Corps is a relatively new mission, and the associated guidance is still under development.

The current ecosystem restoration guidance is *Ecosystem Restoration in the Civil Works Program* (EC 1105-2-210). The purpose of this June 1995 engineering circular is to ensure that restoration projects (1) produce the intended beneficial effects, (2) are cost effective, and (3) are consistent with administration policy.

EC 1105-2-210 clarifies previous guidance on ecosystem restoration. This EC notes that Civil Works budget guidance assigns funding priority to restoration projects (see EC 11-2-163). As in the case of previous restoration guidance, EC 1105-2-210 emphasizes projects that restore environmental degradation to which a Corps project contributed or situations where modification of a Corps project can accomplish the restoration most cost effectively. Emphasis is placed on engineering measures to achieve the restoration objectives. In addition, hydrologic control rather than land acquisition is emphasized. EC 1105-2-210 specifically reasserts previous requirements (PGL No. 24) that the last increment of benefit exceed in value the last increment of cost. While this specification may be difficult to accomplish in many cases, it does identify incremental analysis as an important planning tool.

Ecosystem restoration projects are formulated in the same manner as traditional water resources development projects. EC 1105-2-210 states that "Ecosystem restoration studies differ from traditional projects only in that not all benefits are monetized."

The *P&G* mandates selection of the NED plan except when there are other overriding considerations such as Federal, state, tribal, local, and international concerns. EC 1105-2-210 releases restoration projects from this mandate. It stipulates there is no need to exhibit net NED benefits, but costs should be registered in the NED account. The anticipated value of the outputs of an ecosystem restoration is the principal measure of the plan's worthiness. Since benefits will be expressed in monetary and nonmonetary units, a benefit-cost ratio is not expected. Other than these responses to the challenges of environmental projects, environmental planning should follow the six-step planning process.

EEIRP: THE SEARCH FOR ENVIRONMENTAL PLANNING TOOLS

The ecosystem planning guidance, EC 1105-2-210, describes the Corps restoration philosophy and policy. For some planning activities, such as cost effectiveness analysis, there is clear direction for applying specific tools or techniques. For other activities, such as the incorporation of risk and uncertainty into restoration planning, the direction is less clear. This absence is both an opportunity and a hazard. On one hand, the lack of recommended methodologies is an opportunity that gives Corps planners flexibility in developing and conducting environmental studies. On the other hand, the absence may leave planners without guidance for those activities, and consistency between projects could suffer. Furthermore, interpretation of this guidance among planners and reviewers may differ.

The EEIRP was initiated to help environmental planners draw upon the conceptual foundation of the *P&G* and operationalize the ecosystem restoration guidance. Figure 2 illustrates the elements of Corps environmental planning in the development of planning tools and techniques through the EEIRP.

Technical Work Units

The nine technical work units of the EEIRP were designed to facilitate ecosystem restoration planning by providing planners with analytical tools and techniques. Figure 3 illustrates how the nine EEIRP work units were affiliated with the six steps of the planning process when the EEIRP was initially formulated. In the realities of project planning, the edges between the six steps blur with iterative loops through the process. Similarly, the boundaries of the work units are much less defined than depicted in this figure.

The objectives and activities of each work unit are characterized below. The work unit descriptions are intended to present the structure and goals of the research in order to (1) connect the research process and products to the philosophical and policy base of the guidance and (2) begin to trace how the tools and techniques developed through the program fit into the six steps of the planning process.

Determining and Describing Environmental Significance

The significance work unit developed rational procedures and methods to determine and describe institutional, technical, and public significance. Various ranking and weighting scales for determining, prioritizing, and describing levels of significance were evaluated in this work unit. Degradation of environmental resources may be more difficult for the public and decisionmakers

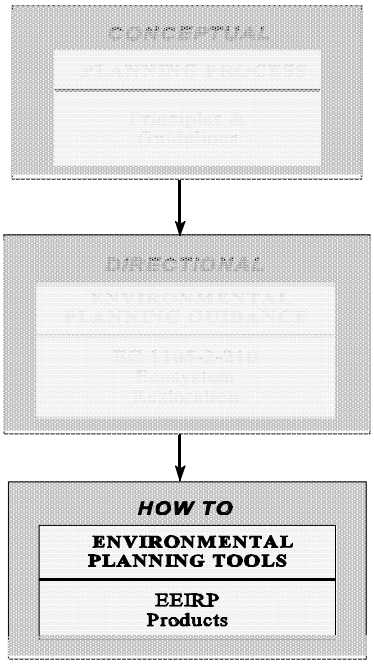

FIGURE 2
ELEMENTS OF CORPS
ENVIRONMENTAL PLANNING

to recognize than traditional water resources problems. Thus, this work unit stressed the importance of identifying significant resources and provided guidelines for communicating significance at the local (project), regional, and national levels. Discussions on resource significance included an assessment of the scarcity of the resources.

Determining Objectives and Measuring Outputs

The objectives and outputs work unit was designed to provide guidance on how to establish clear, realistic objectives for environmental restoration projects and develop improved techniques for clearly measuring outputs that are appropriate for those objectives. The intention was to broaden the scope of restoration planning from univariate concerns, such as the focus on individual species, to a more holistic ecosystem perspective. There were additional considerations that this work unit addressed, including spatial and temporal scales of analyses, adaptive management, and the challenges that arise when the ecosystem extends beyond the restoration site boundaries.

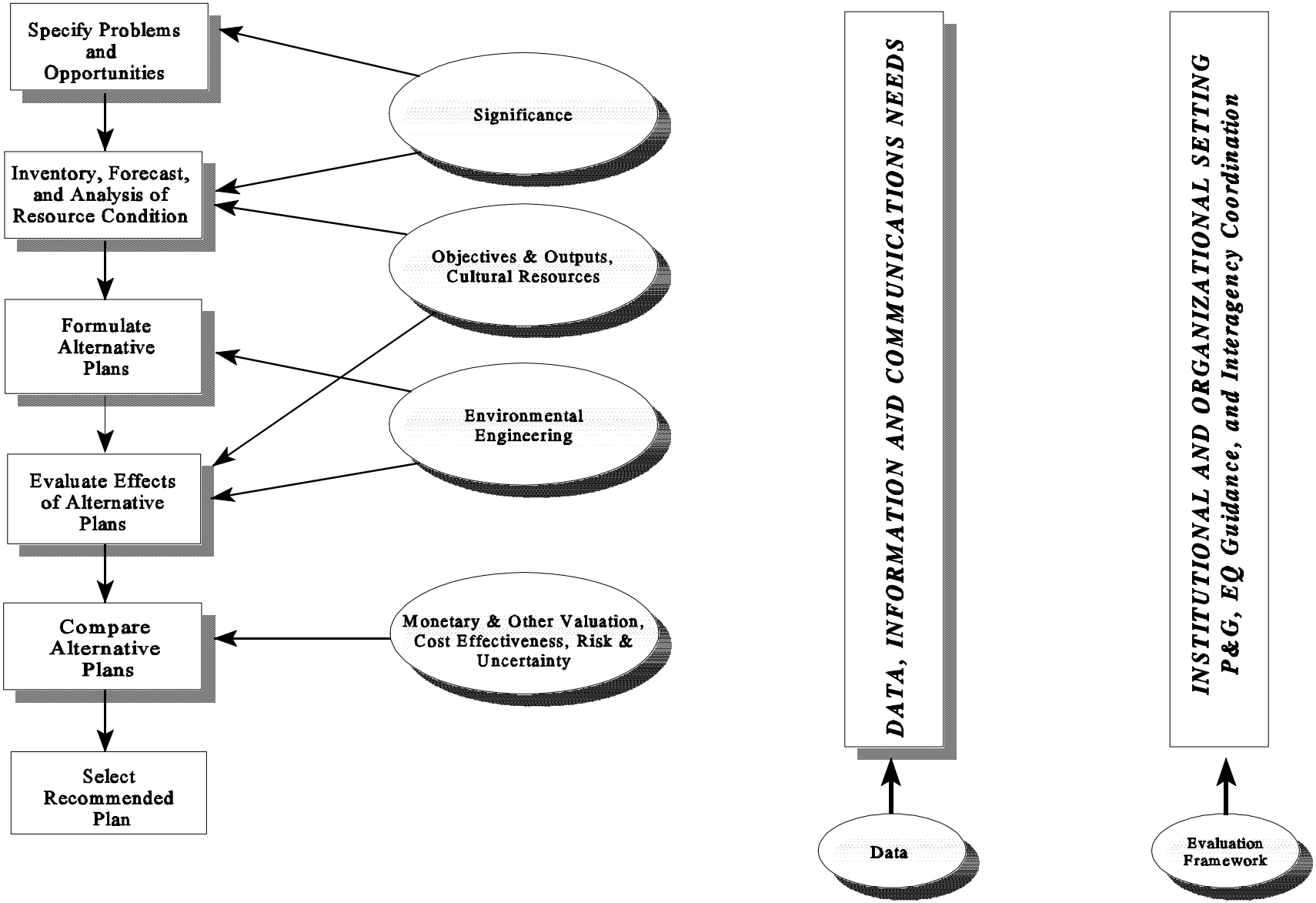

FIGURE 3
EEIRP TECHNICAL WORK UNITS AND THE SIX PLANNING STEPS

Objective Evaluation of Cultural Resources

The cultural resources work unit conducted a review of the literature and practice of cultural resource evaluation. A pilot procedure for employing a quantitative/statistical approach to cultural resource evaluation was developed. This was field-tested with data from a region of northern New Mexico using a combination of research and information management tools.

Engineering Environmental Investments

The engineering work unit identified appropriate techniques for engineering restoration projects. This included development of methods to assess the effectiveness of alternative approaches in producing the intended effects, formulating and estimating costs of project features, and monitoring. Underlying the ultimate formulation of engineering procedures for restoration projects was the intention to focus on standardized procedures, not solutions. Techniques were based on the principles of ecosystem management and the unique requirements of each project.

Cost Effectiveness Analysis Techniques

The cost effectiveness work unit developed analytical techniques for performing cost effectiveness and incremental cost analyses. Recognizing the limitations of traditional benefit-cost analysis for environmental planning, cost effectiveness and incremental cost analyses are valuable decision-making tools for environmental investments. Cost effectiveness ensures that the least-cost solution is identified for each level of environmental output. Subsequent incremental cost analysis reveals changes in costs for increasing levels of outputs. Neither cost effectiveness nor incremental cost analyses will guarantee the identification of an optimal solution. However, they provide information that decisionmakers may use to facilitate and support the selection of a single solution.

Monetary and Other Valuation Techniques

The monetary and other valuation techniques work unit researched methods to identify use and nonuse values associated with outputs from environmental projects. This included clarifying the linkages between environmental outputs and human services and assessing how stakeholders perceive and value environmental restoration projects. In addition, techniques for monetary valuation were researched. This work unit's challenge was to provide decisionmakers with value-inclusive information about project benefits to assist them in determining the relative worth of alternative plans or projects.

Incorporating Risk and Uncertainty into Environmental Evaluation

This work unit focused on identifying generic and specific sources of risk and uncertainty in environmental restoration planning. For example, how well will the restoration project perform? Is there any uncertainty about the accuracy of the data or the models used to predict project outputs? What are the risks of the project not succeeding? Once identified, potential tools and methods were presented to address these risk and uncertainty issues. Approaches for incorporating risk and uncertainty considerations into environmental evaluations were demonstrated through a representative case study.

Environmental Databases and Information Management

The environmental databases and information management work unit developed and implemented concepts for improving communication and dissemination of information to Corps environmental planners. This included two main thrusts. In the first, a prototype decision support system (Integrated Bio-Economic Planning System - IBEPS) was developed which links environmental output models and incremental cost analysis together with spatial data input and handling capability via a geographic information system (GIS). This is a working product directly usable by planners, and it demonstrates the utility of computer-aided decision support systems. In the second, EEIRP products were summarized and made accessible through a World Wide Web site. This enables those with interests in the environmental restoration process to quickly access information specifically relevant to their project.

Evaluation Framework

This report focuses on integrating the products of the other EEIRP work units into the six-step planning process. As part of this effort, this work unit conducted a series of case studies of Corps restoration projects. These case studies were supplemented by research efforts which identified trade-off processes to balance competing interests and examined group processes to elicit the perspectives of project stakeholders.

Alignment of EEIRP Products with the Six Planning Steps

The EEIRP is generating a wide array of products. Some of these products are primarily background materials, including literature reviews, workshop proceedings, and case studies. The

EEIRP has been using this background research, conducted in the early phases of the program, as a foundation for ongoing development of specific tools and procedures for restoration planning.

The products of each EEIRP work unit are presented in Table 1. Since some of the report titles are cumbersome, abbreviated titles for the products are included in this table and will be used throughout the remainder of this text. Annotations of the products of the EEIRP are found in Appendix A. The work units were a vehicle to conduct supporting research and develop practical tools and techniques for environmental planners. From this point onward in this report, the products of the work units will be generalized to be products of the EEIRP.

Table 1 also illustrates the alignments of the EEIRP products with the six steps of the planning process. Connections could be drawn between any of the products and each of the six steps. However, the alignments shown in this table represent direct associations of products with planning steps. Some of the EEIRP products are completed; others are ongoing.

As shown in Table 1, the EEIRP has a balanced coverage of the six planning steps. In general, significance products are critical in the early steps; ecosystem models and environmental engineering are most important in the middle steps; and cost effectiveness and incremental cost analyses are the highest priorities in the final steps. There are other products that are applicable virtually throughout the planning process. Some of these will become resonant themes in this report, including issues of stakeholder participation in the planning process, the different types of trade-off analyses, and the various sources of risk and ways to address them. Others among this group, such as the World Wide Web home page, can be noted as applying to all six steps without extensive discussion.

Alignment of EEIRP Products with Portfolio Allocations

Table 1 also illustrates the alignment of EEIRP products with portfolio decision making. The allocation of resources at the portfolio level may include funding for additional studies or construction. As indicated in the table, the significance reports and cost effectiveness and incremental cost analyses materials are prominent in portfolio allocation applications.

TABLE 1
PRIMARY ALIGNMENT OF EEIRP PRODUCTS
WITH THE SIX PLANNING STEPS AND PORTFOLIO ALLOCATIONS

EEIRP WORK UNIT	**EEIRP PRODUCTS** *(Abbreviated Title)*	**1** Specification of Problems & Opportunities	**2** Inventory & Forecast of Conditions	**3** Formulation of Plans	**4** Evaluation of Effects	**5** Comparison of Plans	**6** Plan Selection	**PA** PORTFOLIO ALLOCATIONS
DETERMINING AND DESCRIBING ENVIRONMENTAL SIGNIFICANCE	*Resource Significance: A New Perspective for Environmental Project Planning (Significance: New Perspectives) IWR Report 95-R-10*	●	●					
	Significance for Environmental Project Planning: Resource Document (Significance: Resource Document) IWR Report 96-R-7	●	●					●
	Significance Protocol Worksheet — Forthcoming *(Significance: Protocols)*	●	●					●

TABLE 1 (Continued)
PRIMARY ALIGNMENT OF EEIRP PRODUCTS
WITH THE SIX PLANNING STEPS AND PORTFOLIO ALLOCATIONS

EEIRP WORK UNIT	EEIRP PRODUCTS *(Abbreviated Title)*	1	2	3	4	5	6	PA
DETERMINING OBJECTIVES AND MEASURING OUTPUTS	*Planning and Evaluating Restoration of Aquatic Habitats from an Ecological Perspective (Ecological Perspectives) IWR Report 96-EL-4*		●	●				
	Use of Predictive Models in Aquatic Habitat Restoration (Predictive Models) IWR Report 96-EL-5		●	●				
OBJECTIVE EVALUATION OF CULTURAL RESOURCES	*Trends and Patterns in Cultural Resource Significance: An Historical Perspective and Annotated Bibliography (Cultural Resource Significance: Trends and Patterns) IWR Report 96-EL-1*	●						
	Evaluating Cultural Resources Significance: New Directions in Theory and Practice, Proceedings of a Corps of Engineers Workshop (Cultural Resource Significance: New Directions) IWR Report 96-EL-3	●						
	Operationalizing Regional Models for Significance Evaluation: An Assessment of the Practice of Significance Evaluation and A GIS Case Study — Forthcoming (Cultural Resource Significance: Regional Models)		●		●			
ENGINEERING ENVIRONMENTAL INVESTMENTS	*Prototype Information Tree for Environmental Restoration Plan Formulation and Cost Estimation (Information Tree) IWR Report 95-R-3*			●				

TABLE 1 (Continued)
PRIMARY ALIGNMENT OF EEIRP PRODUCTS
WITH THE SIX PLANNING STEPS AND PORTFOLIO ALLOCATIONS

EEIRP WORK UNIT	EEIRP PRODUCTS *(Abbreviated Title)*	1	2	3	4	5	6	PA
ENGINEERING ENVIRONMENTAL INVESTMENTS (Continued)	*National Review of Non-Corps Environmental Restoration Projects (Non-Corps Restoration) IWR Report 95-R-12*			●		●		
	National Review of Corps Environmental Restoration Projects (Corps Restoration) IWR Report 96-R-27			●		●		
	Planning Aquatic Ecosystem Restoration Monitoring Programs (Monitoring Programs) IWR Report 96-R-23			●	●			
	Planning Aquatic Ecosystem Restoration Monitoring Programs Training Module (Monitoring Training Module)			●	●			
	Illustrated Handbook of Environmental Engineering Features — Forthcoming (Illustrated Handbook)			●		●		
	Procedures Manual: Engineering for Environmental Restoration — Forthcoming (Engineering Procedures Manual)		●	●	●	●		
COST EFFECTIVENESS ANALYSIS TECHNIQUES	*Interim: Cost Effectiveness and Incremental Cost Analyses Procedures Manual (Interim Cost Effectiveness Manual) IWR Report 95-R-1*			●		●	●	●
	ECO-EASY: Cost Effectiveness and Incremental Cost Analyses — Software Beta Version 2.6 (ECO-EASY)			●		●	●	●

TABLE 1 (Continued)
PRIMARY ALIGNMENT OF EEIRP PRODUCTS
WITH THE SIX PLANNING STEPS AND PORTFOLIO ALLOCATIONS

EEIRP WORK UNIT	EEIRP PRODUCTS *(Abbreviated Title)*	1	2	3	4	5	6	PA
COST EFFECTIVENESS ANALYSIS TECHNIQUES (Continued)	*Cost Effectiveness and Incremental Cost Analyses Training:* **PROSPECT module* **Executive Workshop* **Practitioner's Workshop* *(Cost Effectiveness Training)*			●		●	●	●
	Procedures Manual, Cost Effectiveness and Incremental Cost Analyses: ECO-EASY Beta Version 3.1 — Forthcoming (Final Cost Effectiveness Manual)			●		●	●	●
MONETARY AND OTHER VALUATION TECHNIQUES	*Review of Monetary and Nonmonetary Valuation of Environmental Investments (Valuation Review) IWR Report 95-R-2*				●	●	●	
	Linkages Between Environmental Outputs and Human Services (Linkages) IWR Report 96-R-4		●	●	●			●
	Linkages Between Environmental Outputs and Human Services: Electronic Version — Forthcoming (Linkages Electronic)		●	●	●			●
	Environmental Valuation: The Role of Stakeholder Communication and Collaborative Planning (Stakeholders) IWR Report 96-R-17	●		●	●		●	●

TABLE 1 (Continued)
PRIMARY ALIGNMENT OF EEIRP PRODUCTS
WITH THE SIX PLANNING STEPS AND PORTFOLIO ALLOCATIONS

EEIRP WORK UNIT	EEIRP PRODUCTS *(Abbreviated Title)*	1	2	3	4	5	6	PA
	Monetary Measurement of Environmental Goods and Services: Framework and Summary of Techniques for Corps Planners (Monetary Valuation) IWR Report 96-R-24				●			
MONETARY AND OTHER VALUATION TECHNIQUES (Continued)	*Procedures Manual: Valuation of Environmental Outputs — Forthcoming (Valuation Procedures Manual)*				●	●	●	●
INCORPORATING RISK AND UNCERTAINTY INTO ENVIRONMENTAL EVALUATION	*An Introduction to Risk and Uncertainty in the Evaluation of Environmental Investments (Introduction to Risk and Uncertainty) IWR Report 96-R-8*	●	●		●	●		
	Incorporating Risk and Uncertainty into Environmental Evaluation: An Annotated Bibliography (Risk and Uncertainty Bibliography) IWR Report 96-R-9	●						
	Procedures Manual: Approaches for Incorporating Risk and Uncertainty into Environmental Evaluation — Forthcoming (Procedures Manual: Risk and Uncertainty)	●	●	●	●	●	●	
ENVIRONMENTAL DATABASES AND INFORMATION MANAGEMENT	*Development of the Integrated Bio-Economic Planning System: Conceptual Design (IBEPS Development) IWR Report 96-EL-2*					●		
	Implementation and Demonstration of the Integrated Bio-Economic Planning System — Forthcoming (IBEPS Implementation)					●	●	

TABLE 1 (Continued)
PRIMARY ALIGNMENT OF EEIRP PRODUCTS
WITH THE SIX PLANNING STEPS AND PORTFOLIO ALLOCATIONS

EEIRP WORK UNIT	EEIRP PRODUCTS *(Abbreviated Title)*	1	2	3	4	5	6	PA
	Integrated Bio-Economic Planning System - Version 1.0 and Manual — Forthcoming (IBEPS Software)					●	●	
ENVIRONMENTAL DATABASES AND INFORMATION MANAGEMENT (Continued)	*EEIRP Home Page on World Wide Web (Home Page)*	●	●	●	●	●	●	●
EVALUATION FRAMEWORK	*Compilation and Review of Completed Restoration and Mitigation Studies in Developing an Evaluation Framework for Environmental Resources - Volumes I and II (Case Studies) IWR Reports 95-R-4 and 95-R-5*	●		●	●	●	●	
	Trade-Off Analysis for Environmental Projects: An Annotated Bibliography (Trade-Off Analysis) IWR Report 95-R-8	●		●	●	●	●	
	Identifying Small Group Techniques for Planning Environmental Projects: A General Protocol (Group Process) IWR Report 96-R-29	●		●		●	●	
	Evaluation of Environmental Investments Procedures Interim Overview Manual (EEIRP Interim Overview Manual) IWR Report 96-R-18	●	●	●	●	●	●	●
	Evaluation of Environmental Investments Procedures Overview Manual (EEIRP Overview Manual) IWR Report 96-R-30	●	●	●	●	●	●	●

III. EEIRP SUPPORT FOR RESTORATION PLANNING

In this chapter, the EEIRP's support for Corps environmental planning is explored. The discussions follow the six-step planning process as applied to environmental projects.

STEP 1: SPECIFY PROBLEMS AND OPPORTUNITIES

The first of six steps is the Specify Problems and Opportunities. The outputs of these initial activities provide a critical foundation for subsequent planning steps. Foremost among these outputs is the problem/opportunity statement. Once this statement has been prepared, scoping activities can commence. These will develop planning objectives which address the problem and recognize planning constraints. In addition, scoping activities determine (1) significant issues to be addressed, (2) the geographic extent of the planning area, (3) alternative problems and opportunities realized due to the planned activity, (4) streamlined approaches to the current study based on examination of previous studies, (5) the tentative planning and decision-making schedule, and (6) identification of local project partners and other stakeholders.

For environmental projects, one of the important tasks in this initial planning step is to determine the significance of the site's resources. This determination is critical to both identifying problems and opportunities and to scoping the planning process. Determining the relative significance of an environmental resource can be very challenging due to the complexity of ecosystems and the lack of a standard (monetary) metric for their evaluation.

EEIRP Planning Support: Specification of Problems and Opportunities

Many EEIRP products support the development of the problem/opportunity statement and the planning scope. Those with the most direct support of problem identification include the results of applied research directed toward (1) identifying project stakeholders and including their perceptions and values in the planning process, (2) assessing the risk and uncertainty in problem identification, (3) determining significance of the site's resources.

Stakeholder Participation

A series of Corps restoration projects were analyzed and compared in the *Case Studies* report. This report provided a comprehensive examination of ten restoration projects. Among the findings of this report were the gains in planning efficiency and effectiveness achieved by (1) immediately

identifying the project stakeholders, (2) involving them early in the planning process, and (3) encouraging their participation throughout the process. Stakeholder participation in this first planning step is critical for the Corps to foster working relationships with these interest groups. The active inclusion of project stakeholders should be considered by Corps planners as an opportunity to take advantage of local knowledge about the site and develop support for action to address the environmental problems and opportunities. The *Stakeholders* report can help to identify project stakeholders.

As identified in the *Case Studies* report, stakeholders for environmental projects typically include other Federal agencies, state natural resource agencies, nonprofit organizations, and the general public. The mix of stakeholders and their respective roles in the planning process can be quite variable. For example, active stakeholders in the Homme Lake Habitat Improvement Project, a Section 1135 restoration project, were limited to the North Dakota Department of Game and Fish, the U.S. Fish and Wildlife Service (USFWS), and Ducks Unlimited. In contrast, the Mayfield Creek Restoration Project had a much more extensive list of active project stakeholders, including:

- Kentucky Department of Fish and Wildlife
- USFWS
- Kentucky Division of Water Resources
- U.S. Environmental Protection Agency
- Kentucky Historic Preservation Officer
- Ducks Unlimited
- A land developer
- A timber company
- A real estate development company
- Private landowners.

Stakeholders may be involved with any of the six planning steps. However, the participation of different stakeholders may be more appropriate in some planning activities than in others. The participation of a broad range of stakeholders may be desirable in this first planning step, since their awareness of local conditions or concern for specific project features can greatly inform the Corps planning process.

The input of stakeholders to the planning process will largely depend on their perceptions of the values of the site with and without restoration. The ways in which stakeholder values are formed and expressed are explored in the *Stakeholders* report. Environmental planners must recognize that although the project stakeholders may unanimously support restoration, they may have very different perceptions of project planning, design, tools to be used, and schedule for budget allocation and project completion.

As the *Trade-Off Analysis* report illustrates, small group processes can be very useful in (1) eliciting the values of stakeholders and (2) generating information about the site and the problems and opportunities. Very few water resources or environmental decisions are currently made by one individual or organization. There are simply too many parties and interests involved with these resources. The Corps recognizes this reality and endeavors to improve its cooperation with local

project partners and to solicit the general public's input to the planning process. For environmental projects, an even greater level of coordination with stakeholders may be required for effective and efficient project planning.

The *Trade-Off Analysis* report also explores the ways in which the informational, analytical, or decision-making needs of project planning can be supported by small group processes. In this report, alternative group processes are profiled, and their appropriateness for different planning contexts is characterized. In this report, small group techniques are organized into two primary categories: (1) those that generate (or clarify) ideas and (2) those that evaluate alternatives. To help develop the statement of problems and opportunities and establish a collaborative planning process, the initial meeting of the project stakeholders should focus on idea generation and be designed accordingly.

The selection of a process that is appropriate for particular circumstances must consider all of the variables surrounding the planning effort. Although group process techniques appear relatively simple, their successful application to different groups and subjects can require very high levels of expertise. The *Group Process* report identifies alternative small group techniques and lists criteria for selecting an appropriate technique. This report provides descriptions of the process and products of each technique.

Uncertainty in Developing the Problem/Opportunity Statement

There is uncertainty surrounding virtually all aspects of the planning process. However, the development of the problem/opportunity statement is an especially critical task, and the uncertainty surrounding it is therefore of particular concern. The purpose of the planning process is to develop and evaluate restoration alternatives for specific site resources. However, there may be significant uncertainty about the identity or nature of the problem. In addition, the links between the problem, resource degradation, and the planning objectives may not be well supported. As a result, there could be substantial uncertainty between the restoration action and ecosystem reaction. The potential uncertainty can be limited by a carefully developed problem statement that includes cause-and-effect linkages as well as scientific support for those linkages. Another common source of uncertainty at this step is that problem statements may be either too vague or too specific (i.e., so vague that measuring the projects success is problematic, or so specific that solutions are preordained as an objective).

The process of developing a clearly defined and specified problem/opportunity statement has been one of the focuses of the EEIRP. In *Introduction to Risk and Uncertainty*, sources of uncertainty surrounding the problem identification step, as well as approaches to address them, are discussed in a general sense. In the forthcoming *Procedures Manual: Risk and Uncertainty*, the details of more specific techniques will be further developed. Both of these reports build upon the *Risk and Uncertainty Bibliography*, prepared during early phases of the EEIRP.

Resource Significance

The *P&G* requires evaluation of a project's effects (beneficial or adverse) on the ecological, cultural, and aesthetic attributes of significant natural and cultural resources. The recognition and documentation of the significant resources in a project study will ultimately be what defines Federal interest in a project. Significant environmental quality (EQ) resources and attributes that are institutionally, publicly, or technically recognized as important are to be taken into account in decision making. Focusing on significant issues is also required by Council on Environmental Quality regulations, and makes practical sense; narrowing a large list of resources to only those that are significant allows for a more efficient and meaningful study. While the *P&G* elaborates further on what comprises institutional, technical, or public significance, there is a need for further guidance and procedures to operationalize these factors into the planning process. Procedures are required that will assist in the identification and display of determinations of significance.

A survey of significance programs and models was assembled in *Significance: New Perspectives*. This report was designed to assist planners in identifying the type of information needed to determine resource significance. It was also designed to highlight the importance of resource significance in the planner's eye. Ninety-five Federal, regional, state, and nonpublic organizational programs were identified which address the issue of resource significance and prioritization. These significance programs are organized by parameters such as geographic scale, political scale, ecosystem type, and program type. The scale parameters include international, national, regional, state, and local areas. The ecosystem types encompass wetlands, rivers, riparian areas, lakes, estuaries, watersheds, fish and wildlife habitat, and threatened and endangered (T&E) species.

Significance Protocols

The *Significance: Resource Document* provides additional background information on significance and constitutes an easy reference to laws and regulations pertaining to institutional, technical, and public significance. It is designed to be a guide for determining significance and communicating that information to decisionmakers. In addition, significance protocols are being developed to help planners and local partners identify those resources that are significant institutionally, technically, and/or publicly at the national, regional, state, and local levels. The significance protocols are being designed as a user-friendly guide for identifying and prioritizing significant resources. The protocols were field-tested prior to final publication in the *Significance: Protocols* report.

Cultural Resource Significance

Although restoration planning may focus on natural resources, cultural resources are also an important planning parameter. Cultural resources have conventionally been thought of in terms of Section 106 (National Historic Preservation Act) compliance rather than the comprehensive management and stewardship requirements of Section 110. The concept of significance has been continually redefined and expanded beyond contemporary archeological research to consideration of broader public and social values as explained in the Briuer and Mathers paper in *Cultural Resource Significance: New Directions.* In considering significance of cultural resources in a broader context, the literature provides a number of concepts useful in developing information on significance. In *Cultural Resource Significance: Trends and Patterns*, this literature is synthesized in an interpretive analysis of the following significance concepts:

- Definitional/evaluation criteria
- Representativeness and redundancy
- Cultural resource management research designs
- Proactive management strategies
- Public involvement
- Use and development of new analytical approaches
- Field procedures
- Federal legislation

Results of this Step

The problem identification activities pursued in this initial planning step generate the problem/opportunity statement, planning objectives, and planning scope. The outputs of this planning step will serve as important foundations for the second planning step, Inventory and Forecast of Conditions.

STEP 2: INVENTORY AND FORECAST OF CONDITIONS

The second step of the six-step planning process is to inventory current resources and forecast future conditions at the site without implementing a project. These activities develop a baseline of current conditions and then forecast the without-project conditions through the period of analysis. For environmental projects, it is especially important to discuss the significant resources in the with- and without-project conditions.

In this second planning step, restoration planning typically focuses on (1) identifying key determinants of the ecosystem structure and function and (2) adapting or developing a model of the

ecosystem. The model development is contingent upon the problems/opportunities specified in the first planning step. Once the ecosystem model is developed, it can be applied to forecast the without-project future condition.

EEIRP Planning Support: Inventory and Forecast of Conditions

Many EEIRP products support the inventory and forecast of conditions in the study area. Those with the most direct support of the inventory and forecast of conditions include the results of applied research directed toward: (1) determining the structure and function of the ecosystem, (2) constructing a conceptual ecosystem model, (3) developing a quantitative ecosystem model, and (4) considering risk and uncertainty in each of these activities.

Ecosystem Structure and Function

Developing the without-project future for a site requires understanding the structure and function of the ecosystem. The appropriate level of detail will depend on the planning circumstances, the complexity of the ecosystem, and the restoration objectives. Profiles of different ecosystems and habitats are compiled in *Ecological Perspectives.* This report provides a description of ecological concepts that should be considered for restoration projects. Habitat profiles for aquatic, coastal, estuarine, wetland, riverine, and lacustrine ecosystems are presented using the following parameters:

- Physical condition
- Conceptual models
- Geographic distribution
- Zonation within habitats
- Biological community
- Key ecological processes

The forthcoming *Engineering Procedures Manual* will also be helpful in addressing both ecosystem structure and function. In particular, this report will contain: (1) a general process for ecosystem evaluation, (2) discussions of the relations between structure and function, and (3) specific techniques to determine structure and function of a given ecosystem.

In the first planning step, Specify Problems and Objectives, the outputs of the assessment of resource significance were oriented toward institutional significance. In this second planning step, the technical and public significance is given more prominence in the assessment of resource significance. Technical significance is addressed via the ecosystem profile. Public significance is included in the habitat description, particularly the suitability for a species of public concern or interest. The EEIRP reports *Significance: New Perspectives*, *Significance: Resource Document*, and *Significance: Protocols* are all relevant here.

Conceptual Ecosystem Model

As the structure and function of the site ecosystem is investigated, a conceptual model of the ecosystem can be developed. As indicated in *Predictive Models*, conceptual ecosystem models typically illustrate relationships between target species, restoration performance indicators, and key ecological parameters. Conceptual ecosystem models generally include:

- Key abiotic processes or habitat characteristics
- Food web structure and key resource species
- Foundation, keystone, and engineer species
- Optimal physical characteristics of restoration
- Successional sequences after disturbance
- Spatial and temporal homogeneity
- Natural disturbance regime
- Landscape influences

Quantitative Ecosystem Model

Once the conceptual model of the ecosystem has been developed, the conceptual relationships can be quantified to the extent possible in order to (1) simulate the dynamics of chemical, material, and energy flows in the ecosystem and (2) estimate how inputs to the system, such as a certain quantity or quality of water, translate into the ecosystem outputs of concern (e.g., acres of habitat for a given T&E species). Quantitative does not imply comprehensive. For some ecosystems and planning objectives, a relatively simple model can effectively represent the structure and function of the ecosystem.

In *Predictive Models*, more than 750 annotated and indexed citations relevant to ecological modeling are provided. The ecological models reviewed are differentiated by their treatment of ecosystem functions and geographic scales. Among the different types of models reviewed are habitat models, species population models, energy or material flow models, and models based upon individual species. Most models currently in use for planning purposes are habitat models.

The technical appropriateness and availability of planning resources guide the selection of an ecological model. Among the technical criteria are (1) the objectives for which the model is intended to support, (2) those site resources that are significant, and (3) the emphasis on variables that are subject to management manipulation. These technical criteria reinforce the importance of a clear direction for the planning effort that comes from the first planning step. In *Predictive Models*, the technical appropriateness of alternative models is assessed for different planning contexts.

Data collection and management are critical activities in the development of the without-project future. The data needs of the ecosystem model are paramount. The ecosystem model cannot be used effectively if the required data are unavailable, inaccurate, or inconsistent. In *Predictive*

Models, the variables that Corps restoration projects might affect are identified. The role of models in planning should not be emphasized to the exclusion of other sources of information about alternative future conditions. Information that is nonquantitative or not required by the model can still be relevant to the without-project condition and, ultimately, decision making.

Without-Project Conditions

The report *Ecological Perspectives* also describes the process to develop the without-project conditions. Since ecosystem models cannot include all possible factors that determine ecosystem structure and function, the most important parameters must be identified. This can occur through specific research into the ecosystem structure and function or via the process of ecosystem modeling. There may be a single, readily identifiable key parameter such as a particular hydrologic regime or levels of a specific nutrient. The key parameters could also be a very subtle combination of ecological factors. After the quantitative ecological model has been developed, the critical parameters can be forecasted and input to the model to assess ecological conditions in the absence of restoration action. This assessment is combined with information that is nonquantitative or outside of the model to forecast the without-project future.

The *Linkages* report can be used to develop a baseline of human services/goods that the site would provide without restoration action. The without-project ecosystem outputs can be input to the linkages tables to forecast human services/goods through the planning period. Software versions of the linkages tables are currently being prepared. These will allow easier use of the linkage material, as well as provide automated report generation.

Uncertainty in Forecasting: Without-Project Conditions

The forecasting of the without-project future is a fundamental exercise in uncertainty. However, uncertainty can be unnecessarily exacerbated when specific forecasts are made without acknowledging the inherent uncertainty. Another problem can be created when data collection efforts focus on the quantity, not the relevance, of information. Conversely, there can also be problems associated with too little information. This might be reflected in excessive reliance on professional judgements or extrapolations from existing information. In general, the accuracy of subjective data and professional judgements can be improved by assigning an interval estimate rather than a point estimate to future conditions (e.g., an uncertain quantity is described as between two values rather than stated as a point value). Sensitivity analysis can also be used to calibrate extrapolations, for example, either by varying outcomes — by plus or minus some percentage — to identify ranges of future without-project conditions or by systematically varying critical variables.

In *Introduction to Risk and Uncertainty*, the issues surrounding uncertainties in baseline and future without-project conditions are described, and alternative methods of addressing these

uncertainties are identified. The forthcoming *Procedures Manual: Risk and Uncertainty* presents different risk-based methods of forecasting future without-project conditions in greater detail.

Coordination with Stakeholders: Information Sources

Project stakeholders can support the Inventory and Forecast of Conditions activities. They may be very aware of the ecosystem structure and function. Stakeholders can also help identify sources of data that can serve as inputs to the ecosystem model or otherwise support the planning process. Critical sources of information for this step may be state natural resource agencies.

Significant Cultural Resources

The forecasting of future conditions of significant cultural resources is dependent on availability of data and resources to analyze and project future conditions. *Cultural Resource Significance: Regional Models* demonstrates the use of GIS and development of a regional model to anticipate future impacts on these resources. Although the ability to expend this level of effort is not always possible or appropriate, GIS is becoming increasingly accessible and provides the capability to evaluate large regions and complex inventories of sites.

Results of this Step

There are four principal outputs of this second planning step. The first three outputs are (1) an understanding of the ecosystem structure and function, (2) a conceptual model of the ecosystem that identifies key resources and processes, (3) a quantitative ecological model. The model when combined with forecasts of key ecological parameters generates the fourth output, the without-project conditions. As discussed with the following step, Formulation of Plans, alternative plans can also be formulated using information from the ecosystem model.

STEP 3: FORMULATION OF PLANS

The third step of the six-step planning process is Formulation of Plans. In this step, the planning objectives and resource conditions developed in the two previous steps are used to convert remedial strategies into alternative plans. It is an iterative process that identifies structural and/or nonstructural measures that (alone or in combination) can accomplish the planning objectives. The formulation process seeks to develop alternative plans that are complete, effective, efficient, and acceptable. The alternatives are often differentiated by location, scale, materials, and timing.

Although environmental projects are ecosystem-based, the plan formulation process can involve considerable engineering analysis and design. The plans may entail modification of the operation or structure of existing Corps projects or the construction of new facilities. Alternative plans should be formulated to respond to the objectives. These plans must be sufficiently developed to allow an informed review of their effects in the next planning step.

EEIRP Planning Support: Formulation of Plans

Many EEIRP products support the formulation of alternative plans. Those with the most direct support of formulation of plans include the results of applied research directed toward (1) identifying potential combinations of ecosystem inputs that could achieve the planning objectives, (2) conducting restoration engineering activities, and (3) formulating restoration alternatives.

Combinations of Ecosystem Inputs

The development of the quantitative ecosystem model used to forecast the with- and without-project conditions has been previously outlined. As described in those discussions, the EEIRP supports model development activities with the reports *Predictive Models* and *Ecological Perspectives.*

The details of determining key ecological parameters and ecosystem inputs and outputs are discussed in *Ecological Perspectives*. As outlined in that document, for any given restoration project, there may be different combinations of ecosystem inputs that could achieve the restoration objectives. It may be that a single critical ecosystem input is required in greater quantity or quality, or it may be necessary to modify multiple ecosystem parameters. The alternative input combinations that produce the desired results may be differentiated on the basis of the quantities, qualities, or mix of inputs. The inputs may be water regimes of certain quality or quantity, critical nutrients, or material/energy flows. Using sensitivity analyses in the quantitative ecosystem model can assess how the ecosystem might respond to different combinations of inputs. During plan formulation, a range of outputs are typically considered to identify the optimal restoration level. Those combinations of inputs that are found to be feasible from an ecological perspective are carried forward to the environmental engineering analysis.

Restoration Engineering

The role of environmental engineering in restoration projects is to produce or deliver the ecosystem inputs that could meet the restoration goals. Engineering studies seek to identify those measures that can produce the alternative combinations of ecosystem inputs under consideration. The

EEIRP has been supporting engineering analyses for restoration projects with a variety of technical reports that will culminate in an engineering procedures manual for these projects. The EEIRP's support of environmental engineering is outlined below.

One of the first tasks of the environmental engineering effort of the EEIRP was to conduct a review of Corps and non-Corps environmental restoration programs. The report *Non-Corps Restoration* profiles the restoration experience of other Federal and non-Federal agencies. This profile focuses on the engineering measures utilized to meet the site-specific restoration objectives and the lessons learned from field trials of restoration techniques.

The EEIRP's environmental engineering research has drawn upon Corps and non-Corps restoration experience in the development of new restoration techniques. In the *Corps Restoration* and *Non-Corps Restoration* reports, as well as in *Monitoring Programs* and the *Monitoring Training Module*, this experience is compiled and evaluated. Given the diversity of perspectives on restoration tools and experience and the large number of alternative environmental engineering measures, the management of engineering information assumes a very important role in the Formulation of Alternatives planning step. The *Information Tree* report has begun the process of organizing restoration experience for application to new restoration projects. The report *Ecological Perspectives* provides additional information on environmental restoration projects of the Corps and other agencies using a series of case studies.

As explored in *Ecological Perspectives*, restoration project failures can be as valuable as successes, and descriptions of project experience in this evolving science must include setbacks as well as advances. In that document, descriptions of alternative restoration measures are presented, including objectives met. In addition, the EEIRP is enhancing the translation of restoration experience into prescriptions for restoration action by preparing *Monitoring Programs* and the *Monitoring Training Module*. The success of restoration engineering measures can be only judged through long-term monitoring of restoration projects. Few engineering measures for restoration projects are established practices, and the responses of complex ecosystems to restoration measures are often uncertain.

The capstone product of the EEIRP's environmental engineering research is the *Engineering Procedures Manual*. This document summarizes the role of engineering within the six-step process and provides guidance for engineering analyses. The document identifies linkages between ecosystem structure, function, objectives, management approaches, and specific engineering techniques and features. Monitoring, maintenance, and cost information are also provided. One other product in environmental engineering research will be the *Illustrated Handbook*. This handbook illustrates and describes various engineering features used in environmental projects.

In the *Linkages* report and *Linkages Electronic*, the connections between environmental outputs and human services are traced. The linkage tables contained in this report could be used to identify restoration activities that would achieve desired project outputs with direct inference to specific engineering measures.

Restoration Alternatives

There are three primary approaches to environmental plan formulation: (1) draw upon plans of others, (2) seek the advice of experts, and (3) assemble all possible combinations of management measures. The first approach utilizes the plans of others as a foundation for plan formulation. This might include plans developed by local project partners, other stakeholders, state agencies, or other Federal agencies. The second approach taps the professional judgement and informed personal intuition of "experts" in appropriate disciplines. This process of consulting experts in the development of alternative plans has been common in Corps water resources planning. Examples of technical experts may include in-house Corps personnel, consultants (e.g., firms and academics), or experts in other agencies (Federal, state, or local), and interest groups. The third approach, which assembles all combinations of management measures, begins with a list of individual measures and formulates plans by deriving every possible combination of those measures. The resulting set of combinations is the entire set of alternative plans that can be generated from the measures under consideration. The individual measures might be identified by either of the two previously described approaches to plan formulation.

In the report *Case Studies*, the importance of stakeholder input to the formulation of alternative plans is a recurrent theme. The value of the experience of stakeholders with the project cannot be understated. As described above, some stakeholders have already developed detailed restoration plans before they approach the Corps for assistance. These can serve as a foundation for Corps project planning. The potential contributions of stakeholders to the plan formulation process are described in more detail in the *Stakeholders* report. This latter document reiterates the political reality that stakeholder support of alternative plans is an important measure of their political and institutional feasibility.

As explored in the *Trade-Off Analysis* report, group processes can be used to generate ideas or to make decisions. The formulation of alternative plans is perhaps the best example of utilizing stakeholders potential to generate ideas about alternative means to achieve the restoration objectives. The *Group Process* report identifies multiple meeting designs that can be used for this purpose.

The procedures for cost effectiveness and incremental cost analyses are presented in: *(1) Interim and Final Cost-Effectiveness Manuals, (2) ECO-EASY Software*, and (3) *Cost Effectiveness Training*. These procedures are supplemented with a plan formulation process that formulates the possible combinations of a given set of solutions (management measures or alternative plans). The formulation procedure precedes the cost analyses and begins with a list of solutions and estimates of the environmental output and dollar cost of each solution (and each scale or size of a solution, as applicable). The procedure then elicits information about the combinability and dependencies among the solutions. Finally, the procedure develops every combination of the solutions, screening out combinations that do not meet the defined combinability and dependency conditions.

The *Linkages* report and *Linkages Electronic* can be used to forecast human services/goods that the alternative restoration plans would produce. The with-project ecosystem outputs can be input to the linkages tables to forecast human services/goods associated with alternative plans.

Results of this Step

For restoration projects, the third planning step, Formulation of Plans, identifies alternative means to achieve the restoration goals. These plans result in alternative with-project futures. Once an appropriate range of alternative plans has been formulated, they can be carried forward to the next planning step, Evaluation of Effects.

STEP 4: EVALUATION OF EFFECTS

The fourth step in the six-step planning process is Evaluation of Effects. The objective of this step is to identify how project resources are likely to be affected by alternative restoration plans. Alternative plans formulated in the preceding step should be complete, effective, efficient, and feasible. The feasibility of each alternative is evaluated from the institutional, political, social, technical, financial, economic, and environmental perspectives. The plans must be significantly distinguished to provide decisionmakers an appropriate range of alternatives to consider. In this step, these criteria are used to begin the process of screening alternatives that eventually results in a recommended plan.

The Evaluation of Effects planning step includes two primary activities: assessment and appraisal. Assessment activities objectively identify (1) the differences between the with- and without-project futures, (2) the effectiveness of meeting objectives, and (3) other project effects. Appraisal is a more subjective process of weighing the effects identified by assigning their social values.

EEIRP Planning Support: Evaluation of Effects

Many EEIRP products support the evaluation of effects of alternative plans. Those with the most direct support of problem identification include the results of applied research directed toward the (1) evaluation of restoration benefits, (2) monitoring restoration projects, (3) conduct of trade-off analyses, and (4) consideration of risk and uncertainty in these activities.

Evaluation of Restoration Benefits

The EEIRP has endeavored to better explain linkages between environmental outputs and socially valued services so that available tools to measure restoration benefits in monetary terms can be used effectively. The first EEIRP product associated with this effort was the *Valuation Review*

report. This document provides an overview of the valuation dilemma raised by the loss of the NED decision rule. It presents a detailed discussion of the challenges associated with measuring environmental resources in monetary terms from the disciplinary perspectives of economics, engineering, social psychology, and ecology. It includes a compilation of monetary and nonmonetary valuation techniques in other Federal agencies and an analysis of the Corps institutional setting for adoption of existing methodologies. The concepts and reality of valuation are further described in the *Stakeholders* report, with actual projects used to illustrate selected points.

One of the weaknesses of existing techniques to place monetary values on environmental resources lies in the complex connections between environmental outputs and socially valued services. In the *Linkages* report and *Linkages Electronic*, these connections are strengthened with ecosystem-specific matrices that align ecosystem outputs and socially valued services. As described in Steps 2 and 3, the linkage tables in this report can be used to identify services associated with the with- and without-project futures, respectively. In this fourth planning step, these services can be compared to anticipate incremental increases in human services (i.e., benefits) associated with alternative plans. The forthcoming *Monetary Valuation* report will be a manual to link those outputs, that can be associated with measurable (monetary) human service benefits, with existing tools.

The *Valuation Procedures Manual* will discuss alternative methods of collecting value information tied to ecological outputs resulting from each alternative considered. This report will examine the importance of human values to environmental decision making and provide support in determining these values. First, the use of the *Linkages* report and *Linkages Electronic* to determine the human goods and services which result from a project is discussed. Second, the use of monetary and nonmonetary valuation techniques to elicit value information about these human goods and services is presented.

Monitoring Restoration Projects

Monitoring restoration projects can allow ongoing evaluation of effects to assess the effectiveness of restoration engineering measures and the ecosystem's response. Using *Monitoring Programs* and *Monitoring Training*, the project manager can make decisions and midcourse corrections based on solid monitoring data. The project manager can also determine and demonstrate to others whether the project meets or exceeds performance criteria. In addition, monitoring contributes to the refinement of ecological restoration methods, techniques, and policies.

Trade-Off Analyses

The *Trade-Off Analysis* report summarizes techniques for use in evaluation of alternatives. Multiobjective Analysis (MOA) techniques describe the impact of project alternatives on objectives of the project and show how alternatives differ with respect to different resources and benefits affected by a project. In additional, some of the summaries in the *Case Studies* report identified

difficulties in evaluation and prioritization of projects or alternatives when there was a mix of subjective and quantitative information. MOA techniques can be used to incorporate both types of information in an evaluation.

Uncertainty in Evaluation of Restoration Effects

Evaluations of effects associated with alternative restoration plans have uncertainty that derives from the inability to forecast plan effects with perfect foresight. How well will the project perform? How good are our estimates of project outputs? In *Introduction to Risk and Uncertainty*, a simple example is presented illustrating how risk-based analysis can be used to address some of the uncertainty inherent in the estimation of habitat outputs for alternative plans. In the *Procedures Manual: Risk and Uncertainty*, a more thorough discussion of the advantages and disadvantages of various risk-based methods to estimate with- and without-project outputs is presented.

Cultural Resource Impacts

The evaluation of effects for significant cultural resources is determined by identifying the impacts resulting from the alternative plans. Use of GIS and predictive models can assist in describing the extent of effects on cultural resources. Development of a regional model as described in *Cultural Resource Significance: Regional Models* will allow quantitative assessment of these impacts.

Results of this Step

The Evaluation of Effects planning activities produce assessments of the differences between the with- and without-project conditions for restoration projects. The anticipated effects of alternative plans are then carried forward to the comparison process in the next step.

STEP 5: COMPARISON OF PLANS

In the fifth planning step, Comparison of Plans, the differences between alternative plans are examined and weighed. These activities are based on the positive and negative effects identified in the preceding step. Both quantitative and qualitative plan comparisons are frequently necessary. The points of reference for the comparisons are the planning objectives established in the initial planning step. The comparisons of alternatives must be explicit and objective. The underlying goal of the comparison of plans is to provide information for the plan selection process in Step 6.

Again, environmental projects challenge traditional planning methodologies. These challenges derive from the predominance of nonmonetary benefits that characterize many restoration projects and the high level of dependence of restoration projects on new or evolving ecosystem models. In many cases, cost effectiveness evaluation methodologies are the most appropriate means of comparing alternative restoration plans.

EEIRP Planning Support: Comparison of Plans

Many EEIRP products support the comparison of alternative plans. Those with the most direct support of problem identification include the results of applied research directed toward cost effectiveness analysis and trade-off analyses.

Cost Effectiveness and Incremental Cost Analyses

As highlighted in Chapter II, environmental projects differ from traditional water resources development projects in that their benefits often cannot be measured in monetary terms. This has given impetus to the development of environmental decision-making techniques that can evaluate and compare the efficiency and effectiveness of alternative restoration plans without a traditional benefit-cost analysis.

EC 1105-2-210 requires that restoration proposals include cost effectiveness and incremental cost analyses. Cost effectiveness analysis is conducted to ensure that the least-cost alternative is identified for various levels of ecosystem output. The subsequent incremental cost analysis is intended to evaluate changes in costs for increasing levels of ecosystem output. Cost effectiveness and incremental cost analyses are associated with Steps 3, 5, and 6 of the planning process. The step-by-step procedure for conducting these analyses is described in the *Interim and Final Cost Effectiveness Manuals* and can be conducted by pencil and paper or, in more complicated situations, by using the *ECO-EASY* analytical software.

Cost effectiveness and incremental cost analyses are means to compare the environmental outputs and economic costs of alternative plans. In planning for environmental restoration and mitigation, classic benefit-cost analysis is often difficult, if not impossible, because, although costs of environmental projects can still be measured in dollars, there is no universally accepted method to express environmental benefits in a single metric—dollars or otherwise. Therefore, while it is not possible to use traditional benefit-cost analysis for environmental planning, other tools, such as cost effectiveness and incremental cost analyses, can be used to provide a more informed basis for judging the value of potential restoration and mitigation projects. Many of these ideas are also discussed in the *Valuation Review* report.

Significant costs associated with restoration projects can include land acquisition, materials, construction, monitoring, and maintenance. The *Engineering Procedures Manual* presents summary information on the costs associated with materials, construction, labor, and maintenance for a number of restoration strategies. Costs associated with monitoring efforts are presented in the *Monitoring Programs* report. The *Engineering Procedures Manual* also discusses the potential effectiveness of various restoration techniques. The *Illustrated Handbook* will portray and describe various engineering features for environmental restoration projects.

As cost effectiveness and incremental cost analyses determine the additional cost of each successive level of ecological output, the *Valuation Procedures Manual* will help the planner determine the additional benefit of each successive level of ecological output. In Step 4, value information, both monetary and nonmonetary, was collected for ecological outputs resulting from each alternative considered. During Step 5, Comparison of Plans, this value information is presented to decision makers to help them determine if each additional unit of output is worth the additional cost determined within the cost effectiveness and incremental cost analyses. To support this process, the *Valuation Procedures Manual* will discuss the use of monetary valuation as a means to elicit value information as well as reduce the number of output measures which need to be considered. Also, this manual will provide techniques for incorporating nonmonetary value information into the decision making process. The *Valuation Procedures Manual*, therefore, will complement and support the "Is It Worth It?" process described in the *Interim and Final Cost Effectiveness Manuals*.

Trade-Off Analyses

As explored in the *Case Studies* report, restoration projects often have multiple objectives and multiple stakeholders. The restoration planning process must balance these competing interests and related project outputs. In the *Trade-Off Analysis* report, alternative techniques to trade off competing interests are assessed. They include quantitative approaches such as multiobjective analysis, conflict analysis (a subset of game theory), and small group processes.

As suggested by previous discussions of small group processes for stakeholder involvement, there are opportunities for trade-off analysis throughout the planning process. In the Comparison of Plans step there are opportunities to utilize the trade-off techniques of multiobjective planning and conflict analysis. Multiobjective analysis (MOA) consists of a family of techniques to optimize operation of a system to accomplish multiple goals. The classic example of MOA trade-off techniques is the optimization of multipurpose reservoir operations within a given river basin. MOA would be appropriate for the comparison of alternative restoration plans that have multiple objectives, such as a wetland restoration project that has flood damage reduction, recreation, and restoration objectives. Game theory can also be used to trade off competing interests in planning situations. A quantitative model of conflict between multiple parties can be developed using a game-theoretic structure. The model is based upon each party having a limited number of options available to pursue their interests. Conflict analysis can be used to identify solutions that are satisfactory to all parties—solutions that may be hidden by misunderstandings between parties or because values or options were concealed.

It has been noted throughout this report that there are significant qualitative issues that affect environmental planning. The *Group Process* report provides a protocol for selecting techniques that can be used to compare alternative plans. The information generated through these activities can also be used to support the plan selection process in Step 6.

Uncertainty Issues in Plan Comparison

A comparison requires some criteria upon which it will be based. If the criteria are uncertain (e.g., due to the relative weights different stakeholders give to different outputs) or are not known to decision makers, there is a potential for considerable misunderstanding and error in the decision process. Again, the *Introduction to Risk and Uncertainty* addresses these sources of uncertainty. A systematic approach for addressing these uncertainties will be presented in *Procedures Manual: Risk and Uncertainty*.

Decision Support System

The ability to compare multiple alternatives and to identify differences between plans will be improved through use of the Integrated Bio-Economic Planning System (IBEPS). IBEPS incorporates restoration engineering and management measures with HEP evaluations of the management designs. As described in *IBEPS Development* and *IBEPS Implementation*, *ECO-EASY* software and results of the HEP analyses are used to generate incremental cost evaluations. The *IBEPS Software* enables the planner to incorporate habitat, engineering measures, and cost effectiveness information in a single database. This capability allows and supports "what if" scenarios, readily enabling the reformulation of alternatives to see how HEP and cost effectiveness measurements change in response to changes in the engineering and management measures used in an alternative.

Results of this Step

The Comparison of Plans step identifies and weighs the differences between alternative restoration plans. In the application of cost effectiveness analysis to restoration projects, the Comparison of Plans step develops a graph of incremental costs for a range of restoration alternatives. This incremental graph is carried forward to the final planning step, Plan Selection.

STEP 6: PLAN SELECTION

The final step in the six-step planning process is Plan Selection. In this step, a recommended plan is selected from among feasible alternatives. By this point in the planning process, all nonfeasible alternatives should have been eliminated. The selection of a recommended plan is based upon the comparisons of quantitative and qualitative information generated by the previous planning activities.

The comparisons of plans in the preceding step do not automatically lead to an obvious decision about a recommended restoration plan. The analyst's role is to provide information and advice on a recommended plan. The results of the planning process are typically presented to other parties who collectively generate a recommendation. These other parties include Corps higher authorities, other Federal agencies, non-Federal project partners, project stakeholders, and the general public.

EEIRP Planning Support: Selection of Plans

Many EEIRP products support plan selection. Those providing the most direct support include the results of applied research directed toward: (1) cost effectiveness and incremental cost analyses, (2) stakeholder participation, (3) decision support systems, and (4) internal coordination with Corps higher authority.

Cost Effectiveness and Incremental Cost Analyses

The *Interim and Final Cost Effectiveness Manuals* and *ECO-EASY Software* contain guidelines that can help in interpreting the analyses' results for plan selection. In place of the traditional plan selection rule—to select the "NED plan"—making selection decisions among environmental alternatives is guided by the question "Is it worth it?" The results of cost effectiveness and incremental cost analyses—displayed as graphs of outputs against costs—permit decisionmakers to progressively compare increasing levels of environmental outputs and ask if each successive level is "worth it"—that is, is the additional environmental output in the next level worth its additional monetary cost? The procedure suggests several decision-making guidelines that may be helpful, including output targets, minimum and maximum output thresholds, maximum cost thresholds, breakpoints, data uncertainty, and unintended effects. Although neither cost effectiveness nor incremental cost analysis will usually result in the identification of a single best alternative, they will result in more informed decision making for environmental restoration and mitigation.

Stakeholder Participation in Plan Selection

The selection of the recommended plan is a joint decision between the Corps and the local project partners, often with substantial input from project stakeholders and the general public. While this is generally true for traditional water resources development projects, the absence of a unique, optimal restoration plan, such as the NED alternative, can place significantly greater emphasis on stakeholder coordination in restoration planning.

The EEIRP has devoted considerable attention to stakeholder input to the planning process through small group processes. As explored in the *Stakeholders* report, small group techniques that are used for decision making are particularly relevant for plan selection. In the *Valuation Review* report, the absence of monetary benefits led to recognition that close coordination with project stakeholders is needed to select a restoration plan and that small group techniques can lead to agreement on plan selection. Both the *Group Process* and *Trade-Off Analysis* reports describe alternative group techniques that can be used to make decisions. Depending on the makeup of the group and the issues involved, there are many small group techniques that can aid decision making.

Decision Support System

In support of documenting the plan selection process, the *IBEPS Software* produces GIS maps and analyses as well as tables and other summary data showing the HEP and cost effectiveness information for the alternatives under consideration. *IBEPS Implementation* provides an example of the evaluative information that can be produced by the system.

Internal Coordination with Higher Authority

The evolving nature of the Corps restoration mission and the absence of monetary benefits add significant subjectivity in the plan selection process. As discussed in the *Case Studies* report, this subjectivity has resulted in different perspectives within and between the different hierarchical elements of the Corps. This internal uncertainty can create inefficiency and ineffectiveness not only on the part of the planning team, which may be unsure of the requirements of higher authorities, but for the organization as a whole with respect to communication within the hierarchy. The *Stakeholders* report further examines issues of internal coordination within the Corps and provides suggestions for enhancing communication between the Corps hierarchy.

Results of this Step

The result of this step is a recommended plan, including possibly No-Action, for consideration by higher authority and/or Congress for implementation. The planning process might still be far from complete. The process is iterative. Depending on the type of project authority, there may yet be multiple iterations through the sequence of six steps of the planning process.

PORTFOLIO-SCALE RESOURCE ALLOCATION

From the beginning of the EEIRP, the objectives of the program have been to address the site and portfolio questions. Regarding the site question, the program has endeavored to retain flexibility in planning to creatively select the "best" restoration plan in terms of the environmental objectives and constraints. Regarding the portfolio question, the EEIRP has promoted the use of consistent and effective methodologies for all Corps restoration planning.

Many of the site and portfolio considerations for restoration planning are longstanding issues for traditional water resources planning. For water resources development and restoration projects, an appropriate balance of these considerations would be most desirable. Specifically, the goal would be to retain creativity and flexibility at the site level with some measure of consistency supporting portfolio decisionmaking without excessive losses in planning efficiency and effectiveness.

For restoration projects, these common decisionmaking factors are compounded by the difficulty in evaluating their nonmonetary benefits. One of the resonant themes of this report has been how the absence of a common metric for evaluating the benefits of alternative plans complicates the selection of the "best" plan. This challenge is magnified at the portfolio scale of analysis, when comparisons between projects with completely different nonmonetary benefits must be made.

The portfolio challenges of restoration projects are not insurmountable. Several products of the EEIRP are particularly pertinent to portfolio decisionmaking. First, the reports *Significance: Resource Document* and *Significance: Protocols* can be used to determine and communicate institutional, technical, and public significance of the resources affected by alternative "best" projects for portfolio analysis. This can be used to help determine the level of Federal interest and guide the project's priority of Federal action. The *Cultural Resource Significance: Trends and Patterns* and *Cultural Resource Significance: New Directions* reports can provide similar information for cultural resources. Second, the cost effectiveness and incremental cost analyses products can be used to apply the "Is it worth it?" question to alternative plans and aid in portfolio decisionmaking. Third, the *Linkages* report and *Linkages Electronic* can be used to identify and compare socially valued goods and services (i.e., benefits) associated with the different "best" plans from around the country. Finally, portfolio decisionmaking can be supported by comparing the combinations of the above quantitative information with other project information, such as stakeholder input. The *Stakeholders* report may be particularly helpful in synthesizing quantitative and qualitative information.

APPENDIX A

ANNOTATED BIBLIOGRAPHY

ANNOTATED BIBLIOGRAPHY OF EEIRP PRODUCTS

(Note: The order of presentation is consistent with Table 1 in the main text.)

Resource Significance: A New Perspective for Environmental Project Planning

Resource significance is one metric that can be used in the selection and prioritization of environmental projects for implementation. This report provides a brief discussion of the concept of resource significance in terms of scientific or technical, institutional, and public criteria. It provides a summary of a review of 95 existing programs that have been developed for purposes of ranking projects, with more detailed summaries of selected programs that assist in determining environmental significance. Included in the review are examples of Federal, regional, state, and nonprofit programs and programs for historical properties.

Significance for Environmental Project Planning: Resource Document

This report provides guidance for identifying and describing resource significance in environmental project planning within the Corps of Engineers Civil Works Program. The concept of resource significance is taking on a new meaning. In flood control and navigation projects, the environmental concerns were to avoid negative impacts on significant resources. If and when negative impacts did occur, they had to be mitigated. As a result, often the minimum was offered as mitigation for detrimental impacts. In today's planning environment, with environmental resources becoming the project purpose, the emphasis is shifting towards identifying all of the significant environmental resources in the study area and planning to enhance or restore those resources to some self-sustainable state. Given that some resources are more significant than others, and that there will never be adequate funding to address all environmental resource problems and opportunities, we are faced with developing a selection process for identifying the most significant environmental resources so that those can be addressed with available funding.

Use of Predictive Models in Aquatic Habitat Restoration

This report provides information on use of models in ecosystem restoration. For ecosystem restoration planning, quantitative models are used to predict habitat, species populations, water quality parameters, and other outputs so that future conditions can be described with and without restoration efforts. The report is based on a review of over 750 models and other information related to use of models in restoration planning. Guidance is provided on use of appropriate technical criteria for selection of quantitative models. Major chapters discuss important examples of different classes of hydrologic models (catchment simulations and river/stream channel models) and biological models (species community models, avian models, and ecosystem models).

Planning and Evaluating Restoration of Aquatic Habitats from an Ecological Perspective

Planning for ecosystem restoration requires an understanding of the structure and function of aquatic ecosystems. This report provides profiles of aquatic ecosystems to be used in developing an understanding of ecological processes. The information can be used to identify those ecological processes that are important to ecosystem structure and function and that should be part of restoration of the affected ecosystem. Profiles are included for open coastline and near coastal waters, subtidal estuarine habitats, coastal wetlands, freshwater wetlands, streams and rivers, and lakes and reservoirs. For each ecosystem the habitat profiles include information on physical condition, conceptual models, geographic distribution, zonation within habitats, biological community, and key ecological processes.

Trends and Patterns in Cultural Resource Significance: An Historical Perspective and Annotated Bibliography

This report offers a broad, analytical review of the literature concerned with the challenging subject of evaluating cultural resource significance. The review of significance includes two main sections: (a) an Annotated Bibliography (consisting mostly of peer-reviewed literature) and (b) an Analysis Section (devoted to tracing historical trends in archaeological method and theory). The literature summarized is extensive and is not widely accessible to the archeological and cultural resource management (CRM) communities. After analyzing a wide range of publications, 21 major themes or concepts were established to characterize the breadth of archaeological views and ideas about significance. A review of each theme was undertaken, including both a discussion and a graphical presentation of trends through time. Systematic indexing and cross-referencing of publications, authors, and significance themes have also been carried out to assist users in locating references of special interest. The concluding section offers some suggestions and insights into the future direction of significance evaluation with respect to the work unit and within CRM generally. Particular emphasis is placed on the opportunities to develop more holistic management strategies, to make greater use of new approaches and technologies, and to use more explicit evaluation methods.

Evaluating Cultural Resources Significance: New Directions in Theory and Practice, Proceedings of a Corps of Engineers Workshop

This report is composed of six papers presented at an EEIRP workshop that focused on evaluation of the significance of cultural resources. The papers are authored by Corps and Forest Service cultural resource managers. The papers discuss various aspects of evaluation of cultural resources significance in light of field experience in Corps and Forest Service planning and regulatory

contexts. The subjects covered in the papers include existing challenges; current, state-of-the-art, and holistic approaches; and future directions in significance evaluation.

Operationalizing Regional Models for Significance Evaluation: An Assessment of the Practice of Significance Evaluation and a GIS Case Study (Forthcoming)

Evaluating regional impacts to, and planning for, regional management of cultural resources requires data on hydrology, land use, vegetation, and threatened and endangered species in addition to cultural resources data. Geographic Information Systems (GIS) provide an excellent tool for managing cultural resources on a regional basis. This report documents the development of a regional model for cultural resources for Rio Arriba County, New Mexico.

Prototype Information Tree for Environmental Restoration Plan Formulation and Cost Estimation

This is the first of a series of reports that investigates the possibility of developing an informational tool for organizing and providing the type of data and information necessary for identifying and costing environmental restoration measures and techniques. It describes the conceptual development of an information tree to assist in the design of environmental restoration projects. The report focuses on three specific objectives: 1) develop a prototype information tree structure to provide and organize data and information useful for environmental restoration plan formulation and cost estimation; 2) describe the content of the tree branches and their linkages; and 3) begin the process of building the tree database, and identify additional data sources and data deficiencies with respect to its more complete implementation. This report: 1) identifies the environmental variables that need to be manipulated to promote project goals (i.e. target variables); 2) links target variables with broad management approaches that could be used to manipulate them; 3) links broad management approaches with more specific management measures and techniques for their implementation; 4) identifies the major engineering features or components associated with alternative management techniques; and 5) provides information that will help project planners to estimate the costs of management techniques and to identify their potential effectiveness and ancillary ecological and other effects.

National Review of Non-Corps Environmental Restoration Projects

This report has compiled and compared management measures, engineering features, monitoring techniques, and detailed costs for a representative sample of non-Corps environmental projects or engineering projects (39) with environmental features. This report is part of the series of reports that will help build into the ***Prototype Information Tree for Environmental Restoration***

Plan Formulation and Cost Estimation report. The projects are categorized into 16 types, based on the projects' primary features. These types are: 1) bottomland hardwood forest restoration, 2) enhancement of fish and wildlife habitat, 3) estuarine wetland creation, 4) estuarine wetland enhancement, 5) estuarine wetland restoration, 6) estuarine wetland restoration and wildlife enhancement, 7) mitigation bank establishment, 8) stream enhancement, 9) stream restoration, 10) water quality remediation, 11) wetland creation, 12) wetland creation and enhancement, 13) wetland enhancement, 14) wetland mitigation, 15) wetland restoration, and 16) wetland restoration and enhancement.

National Review of Corps Environmental Restoration Projects

This report provides descriptive information from 52 Corps environmental restoration studies. For each project, information is provided concerning: its general location, the resource problems being addressed, objective(s), management measures, outputs, and estimated total costs. Also included in the report are unit price tables for various engineering features from many of the Corps projects described in the report. The projects selected represent a cross-section in terms of geographic location, legislative authority, and types of engineering features recommended. This report is not a critique or an analysis of these 52 Corps environmental restoration studies; its primary purpose is to provide descriptions of environmental management measures and/or engineering features and their costs. For example, the resource problems, objectives and outputs/benefits are provided only to assist the reader in better understanding the setting under which the management measures were being considered. This information was directly extracted or summarized from the study reports without critique or evaluation.

Planning Aquatic Ecosystem Restoration Monitoring Programs

The purpose of this report is to provide a unified approach to planning, implementing, and interpreting monitoring of restoration projects. The report is directed at Corps planners to help them determine what factors to consider in a monitoring program, and how to design and implement an efficient, cost-effective program. The report guides the planner on how a monitoring program proceeds from identification of goals through selecting monitoring methods, and finally to interpretation and dissemination of results. The report reviews how to use monitoring results to implement corrective actions to assure that performance goals are met. This report brings together a number of previously published—but somewhat unrelated—reports that have attempted to develop monitoring approaches. This report is not a "how to" manual of the specifics of sampling, sample processing, statistical analysis of data, etc., but rather a guide to fundamental elements of a monitoring program for aquatic restoration.

Illustrated Handbook of Environmental Engineering Features (Forthcoming)

This forthcoming handbook will be a compilation of various environmental engineering features with an illustration accompanying each feature. These various features are obtained from various projects, case studies, other handbooks, and technical articles. Features covered include various types of bank protection, beneficial use of dredge material, different types of small-scaled dams, coastal features, wetland features, and other structural and nonstructural options.

Procedures Manual: Engineering for Environmental Restoration (Forthcoming)

This forthcoming manual will be a summary of the findings found in the *Information Tree*, *Non-Corps Restoration*, *Corps Restoration*, and the *Monitoring Programs* reports. This manual will attempt to format these findings in a similar way, as presented in the *Information Tree*, but expanded.

Evaluation of Environmental Procedures Manual Interim: Cost Effectiveness and Incremental Cost Analyses (includes ECO-EASY: Cost Effectiveness and Incremental Cost Analyses - Software Beta Version 2.6)

The cost effectiveness procedures manual was developed to serve as a practical guide for applying and interpreting cost effectiveness and incremental cost analyses for comparing the effects of alternative environmental restoration and mitigation plans. It describes the analyses' data requirements, step-by-step instructions for conducting the analyses, examples of the analyses' application in different planning settings, decision making using the analyses' results, case studies, exercises, and instruction in the use of the program, ***ECO-EASY: Cost Effectiveness and Incremental Cost Analyses Software***. The ***ECO-EASY*** software was developed to perform the routine, and often time-consuming, "number crunching" required by the analyses; freeing planners to focus on the identification of solutions, the estimation of their environmental and economic effects, and the communication of information to support decision making. Both the manual and the ***ECO-EASY*** software include a module to assist with plan formulation, where individual management measures and their inter-relationships are identified and then combined into all alternative combinations of measures, and guidelines that assist in interpreting and using the results to make decisions.

Cost Effectiveness and Incremental Cost Analyses Training:

**** PROSPECT Module***
**** Executive Workshop***
**** Practitioner's Workshop***

Workshops and training for the ECO-EASY Software Beta Version 2.6.

Procedures Manual, Cost Effectiveness and Incremental Cost Analyses: ECO-EASY Beta Version 3.1 (Forthcoming)

An expanded version of Beta Version 2.6 with improved graphics and reporting capabilities.

Review of Monetary and Non-Monetary Valuation of Environmental Investments

Placing value on the environment, whether through monetary-based methods or through other evaluation techniques, has been and will continue to be a widely debated topic. The conceptual foundation and institutional setting for pursuing further study are developed in this report. Specific objectives are to: 1) describe services provided by environmental resources and systems and methods for their measurement or valuation; 2) review existing research programs and products; and 3) evaluate the resource constraints on potential Corps' field applications. Independent expert views from an economist, engineer, ecologist, and psychologist as to environmental outputs and valuation techniques are included as appendices.

Linkages Between Environmental Outputs and Human Services

This report identifies relevant socioeconomic use and nonuse values associated with environmental projects and also improves the linkages between environmental output measures and necessary inputs for socioeconomic evaluation. It answers the question: What are the possible changes in the ecosystem that may result from USACE environmental mitigation and restoration projects, and what outputs and services do these changes provide society? The report includes a suite of tables which link USACE management options, to ecological inputs, to ecological outputs, and then finally to human services. Also, indirect effects of management options are identified.

Linkages Between Environmental Outputs and Human Services: Electronic Version

Forthcoming electronic version of the above report.

Environmental Valuation: The Role of Stakeholder Communication and Collaborative Planning

This report describes how understanding the perspectives of stakeholders in USACE environmental projects might improve the identification and communication of project benefits. Valuation of project features is a central component of the Corps decision-making framework. This report is based, in part, on three case studies of current USACE environmental projects as well as interviews with USACE Headquarters personnel involved in policy making for or review of environmental projects. The goal of the interviews and meetings was to better understand project priorities from individual stakeholders and to observe interchange on selected issues among the stakeholders.

Monetary Measurement of Environmental Goods and Services: Framework and Summary of Techniques for Corps Planners

This report provides information on the potential applicability and use of monetary measurement techniques (also referred to herein as economic benefits estimation or valuation techniques) for environmental project planning studies within the Corps of Engineers' Civil Works Program. In some cases it may be possible and desirable to estimate the monetary benefits associated with certain environmental outputs provided by ecosystem restoration projects. The purpose of this report is to help project planners better understand what tools are available for estimating the monetary benefits of environmental outputs, when they may be technically appropriate to use, and their potential resource requirements in the ecosystem restoration context.

A variety of economic techniques are available for estimating the monetary benefits provided by nonmarketed, environmental goods and services. Most of these tools are described in very broad terms in economic textbooks and in very technical terms in economic journals, leaving an information gap which often makes it difficult for potential practitioners to evaluate their potential applicability and use in different contexts. Additionally, very little summary information has been complied concerning the data requirements of these techniques, the time it takes to perform such analyses, and the technical expertise required to use techniques effectively.

This report attempts to address these information gaps by providing Corps planners with a summary of selected economic valuation techniques and their resource requirements, and a framework for evaluating their potential applicability and use in ecosystem restoration project planning.

Procedures Manual: Valuation of Environmental Outputs (Forthcoming)

This procedures manual is a reference for the Corps planner interested in ecosystem restoration planning. It serves the planner in three ways. First, it provides a review of the economic concepts that are central to understanding the role of valuation in project planning. Second, it provides the reader with a review of the foundations of the National Economic Development (NED) analysis and Cost Effectiveness/Incremental Cost analyses, including their advantages and limitations. Third, it demonstrates to the planner how components from NED analysis and cost effectiveness/incremental cost analyses can be integrated, as appropriate, into a valuation framework.

The combined valuation framework consists of four interrelated steps. These are:

- Linking ecosystem outputs to human services;
- Monetary valuation of select human services;
- Cost-effectiveness and incremental cost analyses;
- Compilation of value information to support plan selection.

An Introduction to Risk and Uncertainty in the Evaluation of Environmental Investments

Incorporating risk and uncertainty into environmental restoration planning studies can be a means of improving the quality of the decision-making process. This report introduced Corps personnel involved in the planning of environmental restoration projects to the basics of risk and uncertainty analysis. The taxonomy of terms described in this report provides the new risk analyst with a way to think about the knowledge, model, and quantity uncertainty that is present in environmental planning. Selected tools and broad concepts are introduced as a means of addressing these uncertainties. In addition to generic, "big picture" sources of uncertainty related to the Corps six-step planning process, uncertainties specific to environmental planning are identified. Common potential sources of uncertainty include delineation of the study area, identification of target species, the structure of habitat suitability index models, habitat variable measurements, calculation of existing and future habitat units, and modeling project performance using habitat evaluation procedures. An example introducing risk-based analysis to the estimation of habitat unit changes is offered to demonstrate the feasibility of some of the methods presented in the report.

Incorporating Risk and Uncertainty into Environmental Evaluation: An Annotated Bibliography

This report introduces Corps personnel involved in the planning of environmental/ecosystem restoration projects to some of the relevant literature for assessment of risk and uncertainty issues in the evaluation of environmental investments. The literature review serves two audiences: both as a primer on the general risk and uncertainty literature that will help planners find the tools they need to do risk analysis; and as a gateway to the more detailed and specific applications of risk analysis to environmental issues for Corps risk analysts, planners, managers, modelers, and environmental experts. Fifty-two books, reports, papers, and articles are reviewed at length. The report also provides suggestions to the reader for sources of information worth monitoring for future developments in the literature, as well as an extended traditional bibliography of books and articles (not reviewed or annotated) of potential interest.

Procedures Manual: Approaches for Incorporating Risk and Uncertainty into Environmental Evaluation (Forthcoming)

This forthcoming *Procedures Manual* uses an actual Section 1135 restoration case study as an example to document: the important sources of risk and uncertainty in a representative environmental restoration project; suggested risk-based tools and methods for addressing those sources of uncertainty; and how these methods can improve environmental planning in the analysis of without- and with-project conditions and decision-making in comparing and selecting plans. The report also contains a generic outline suggesting an approach to the identification, assessment, and treatment of risk and uncertainty in a typical Corps environmental restoration project. The outline thus serves as a template that can be applied to the conduct of a risk and uncertainty analysis for other environmental activities.

Development of an Integrated Bio-Economic Planning System for Corps of Engineers' Planning Projects: Conceptual Design

In the environmental planning realm, U.S. Army Corps of Engineers planners are frequently asked to assist in the design of restoration projects, as well as assess potential impacts of projects/programs, and suggest cost-effective and biologically productive compensation/mitigation solutions for impacted areas of concern. To accomplish these tasks, planners must have direct access to the necessary data (spatial inputs/outputs, and costs for the potential development management measures) to aid in the selection of cost-effective solutions during the plan formulation process of project design. The Walla Walla District Corps of Engineers has developed a conceptual design for an Environmental Decision Support System (EDSS) that would give planners the ability to design multiple management scenarios and assess the biological outputs associated with each scenario in a

"user-friendly" environment. The EDSS would also allow comparisons of multiple scenarios and combinations of scenarios using a cost-effective and incremental cost strategy. Four major components would be combined to produce the EDSS: 1) spatial information and analyses, 2) environmental benefit and cost evaluations, 3) incremental cost and cost-effective analyses, and 4) multiple management design analyses.

Implementation and Demonstration of the Integrated Bio-Economic Planning System (Forthcoming)

This report is an application of the Integrated Bio-Economic Planning System to an on-going ecosystem restoration project.

Integrated Bio-Economic Planning System - Version 1.0 and Manual - Draft (IBEPS Software) (Forthcoming)

This product is the software and user's documentation of the IBEPS conceptual design.

EEIRP Home Page on the World Wide Web

An EEIRP Home Page on the World Wide Web will soon provide information about the products of the EEIRP. The EEIRP Home Page is expected to be installed by May 1997. Information can be accessed according to planning step and resource type. The address of the EEIRP Home Page will be www.wes.army.mil/el/ecubed (note: lower case letters).

Compilation and Review of Completed Restoration and Mitigation Studies in Developing an Evaluation Framework for Environmental Resources, Volumes I and II

Corps Districts are being faced with servicing the present environmental needs of their constituencies. This is being met with varying degrees of success from the perspectives of the Corps planner and local interests. Monitoring the recent past and real time environmental endeavors of the Corps reveals that, although there is cumbersomeness in the planning arena, some successful techniques are emerging. This two-volume set describes important environmental restoration and mitigation planning issues currently facing Corps planners. Findings are based on ten (10) Corps field case studies, including interviews of both Corps and non-Corps study team members, and a focus session conducted with Washington level reviewers. Volume I includes a description of the research

approach and findings and recommendations for future research. Detailed summaries of the focus session and the individual case study interviews are in Volume II.

Trade-Off Analysis for Environmental Projects: An Annotated Bibliography

Trade-off analysis is composed of many tools for identifying optimal solutions to complex problems. Tools must be appropriate to the specific context. In some circumstances, a single evaluation technique may be appropriate; in others, combinations may be most effective. This study explores the literature for analytical techniques that can support the complex decision-making process associated with Corps environmental projects. The literature review focuses on opportunities for using trade-off methodologies and group processes in environmental plan formulation and evaluation. An annotated bibliography is included.

Identifying Small Group Techniques for Planning Environmental Projects: A General Protocol

This report provides planners with a protocol for small group techniques to support the planning of ecosystem restoration projects. It examines techniques that are structured to improve the efficiency and effectiveness of generating ideas, making decisions, and discussing information. The protocol will help planners consider alternative small group techniques for use with stakeholders to: 1) gather and share information, 2) generate alternatives, and 3) evaluate alternatives. These techniques are designed to address the needs of small groups. Task forces, planning teams, advisory boards, and steering committees are some examples of typical small group meetings. They do not readily lend themselves to large public meeting formats. Although the organization of these techniques has been developed for ecosystem restoration planning, there are broad applications to other planning, operations, and regulatory settings where small groups of people are brought together. A case study is included in the report.

Evaluation of Environmental Investments Procedures Interim Overview Manual

This Interim report supports planners by identifying EEIRP products that can be used to apply the P&G planning process to environmental projects. Underlying the incorporation of the EEIRP products in the planning process is the need to 1) integrate the tools and techniques identified and developed by the EEIRP and 2) ensure that they collectively address the site and portfolio questions. This report is intended to serve as a reference guide for Corps environmental planning. It is a procedures manual that synthesizes the many products of the EEIRP and shows how they can support environmental planning, which is conducted in accordance with the six-step planning process. It provides an overview of Corps environmental planning and identifies EEIRP products that support

specific planning activities. Planners are encouraged to obtain copies of the EEIRP products that pertain to their specific planning challenges.

Evaluation of Environmental Investments Procedures Overview Manual

This report is a revision of the *Interim Overview Manual* described above. This revision will include the EEIRP products and reports that were not completed when the Interim report was published.