

U.S. Army Corps of Engineers
Institute for Water Resources

IWR Planning Suite
User's Guide

November 2006

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IWR Planning Suite User's Guide

by

Cory Rogers and Michael Robinson

CDM

1050 North Reed Station Road, Suite D
Carbondale, IL 62902
(618) 351-4530

and

L. Leigh Skaggs and Shana Heisey

U.S. Army Corps of Engineers
Institute for Water Resources
Casey Building
7701 Telegraph Road
Alexandria, VA 22315-3868

(703) 428-9068

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Acknowledgements

Executive Summary

The US Army Corps of Engineers Institute for Water Resources has developed IWR Planning Suite Decision Support Software to assist with the formulation and comparison of alternative plans. While IWR Planning Suite was initially developed to assist with environmental restoration and watershed planning studies, the program can be useful in planning studies addressing a wide variety of problems. IWR Planning Suite can assist with plan formulation by combining solutions to planning problems and calculating the additive effects of each combination, or “plan.” IWR Planning Suite can assist with plan comparison by conducting cost effectiveness and incremental cost analyses (CE/ICA), identifying the plans which are the best financial investments, and displaying the effects of each on a range of decision variables. The software is available for download via the IWR Planning Suite website (<http://www.pmcl.com/iwrplan/>).

IWR Planning Suite builds upon previous MS Access-based versions of IWR-Plan, and upon the basic plan formulation and comparison framework of the DOS program *ECO-EASY: Cost Effectiveness and Incremental Cost Analyses for Environmental Planning*, developed within the Corps Evaluation of Environmental Investments Research Program. IWR-Plan transformed ECO-EASY to a Windows operating environment, while IWR Planning Suite adds new functionality, flexibility, and reporting tools. Development of IWR Planning Suite has been carried out within the Corps Decision Methodologies Research Program, conducted at IWR. The Corps and the Social Sciences Institute of the NRCS cosponsor IWR Planning Suite development.

Section 1

Introduction

Audience

Today's environmental decision makers are faced with a complex dilemma. Many of our nation's valued watersheds, ecosystems and habitats are degraded or threatened. At the same time, dwindling budgets at all levels of government are forcing some hard choices about how tax dollars can best be invested. When it comes to making decisions about how to invest limited dollars in solving increasingly critical problems, decision makers must answer some very tough questions: How much can we afford to invest in an environmental project? Is it worth potentially doubling a project's cost, for example, to get a small increase in environmental benefits? What level of environmental benefits is worth it?

Traditional benefit cost analysis is not enough, or even useful, in answering many of these kinds of questions. While the costs of environmental investments can still be measured in dollars, there is no universally-acceptable method to measure environmental benefits using a single metric, dollars or otherwise. However, other tools, such as cost effectiveness and incremental cost analyses, can be used to give decision makers better information in making such choices.

Purpose of Manual

This manual was developed to serve as a practical guide for applying and interpreting cost effectiveness and incremental cost analyses in environmental planning. 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, a case study, and instructions in the use of the program, *IWR Planning Suite*. The *IWR Planning Suite* software was developed to perform the routine, and often time-consuming, number crunching required by the analyses; thereby 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.

While economists may be most comfortable with the procedures of cost effectiveness and incremental cost analyses, biologists, ecologists, and other environmental scientists will typically determine the environmental variables to be analyzed and the methods by which changes in those variables will be measured and communicated as environmental outputs. Staff from plan formulation, engineering, environmental, and other areas will formulate alternative plans to effect changes in those variables. Similarly, cost engineers, real estate specialists, economists and others must combine their expertise to estimate the financial and economic costs of those alternative plans. It is important that all members of a study team, regardless of their discipline, understand how their respective inputs are used in the analyses, and provide decision makers with their unique insights in interpreting the analyses' results.

Just as the manual is intended for readers from varied backgrounds, it is also intended for readers with varied interests. Environmental restoration and mitigation planning studies will typically involve non-Corps parties. This manual may provide an understanding of the rationale for, and application of, cost effectiveness and incremental cost analyses in planning to interested representatives of other groups and agencies as well as to local cost-sharing partners.

It should be noted by non-economist readers, that a learning curve lies ahead in gaining an understanding about cost effectiveness and incremental cost analyses and their uses in planning. The analyses require some of us to think about some new things, and to think about some familiar things in different ways. We have tried to help you through this learning curve with the explanations and examples provided throughout the manual. For some readers, the best way to really become familiar with the analyses may be to do a simple example application that can be worked out with a calculator, pencil and paper. For others, the IWR Planning Suite software can be a valuable educational tool for working through example applications at the computer. In either case, you may wish to use the example exercise included in this manual to work through a test problem and develop your skills in doing the analyses.

What Are Cost Effectiveness and Incremental Cost Analysis?

The cost effectiveness and incremental cost procedures presented in this manual are based upon the planning framework established in Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (U.S. Water Resources Council 1983), referred to as the P&G. The P&G provides the instructions and rules for Federal water resource planning. The P&G require that, in developing alternative plans, Federal planners should include only increments that provide net NED [National Economic Development] benefits [for flood damage reduction, navigation, and other traditional benefit categories]... Increments that do not provide net NED benefits may be included...if they are cost effective.

For environmental planning, where traditional benefit-cost analysis is not possible because costs and benefits are expressed in different units, cost effectiveness and incremental cost analyses offer plan evaluation approaches that are consistent with the P&G paradigm. *Cost effectiveness analysis* is conducted to ensure that the least cost plan alternative is identified for each possible level of environmental output; and that for any level of investment, the maximum level of output is identified. Subsequent *incremental cost analysis* of the cost effective plans is conducted to reveal changes in costs as output levels are increased.

In the absence of a common measurement unit for comparing the non-monetary benefits with the monetary costs of environmental plans, cost effectiveness and incremental cost analyses are valuable tools to assist in decision making. The results of the analyses, which can be displayed as graphs of outputs against costs, permit decision makers to progressively compare alternative levels of environmental outputs and ask if the next level is worth it. In other words, is the additional environmental output in the next attainable level worth the additional cost? Typical examples of cost-effectiveness and incremental cost graphs are included in Figure 1.

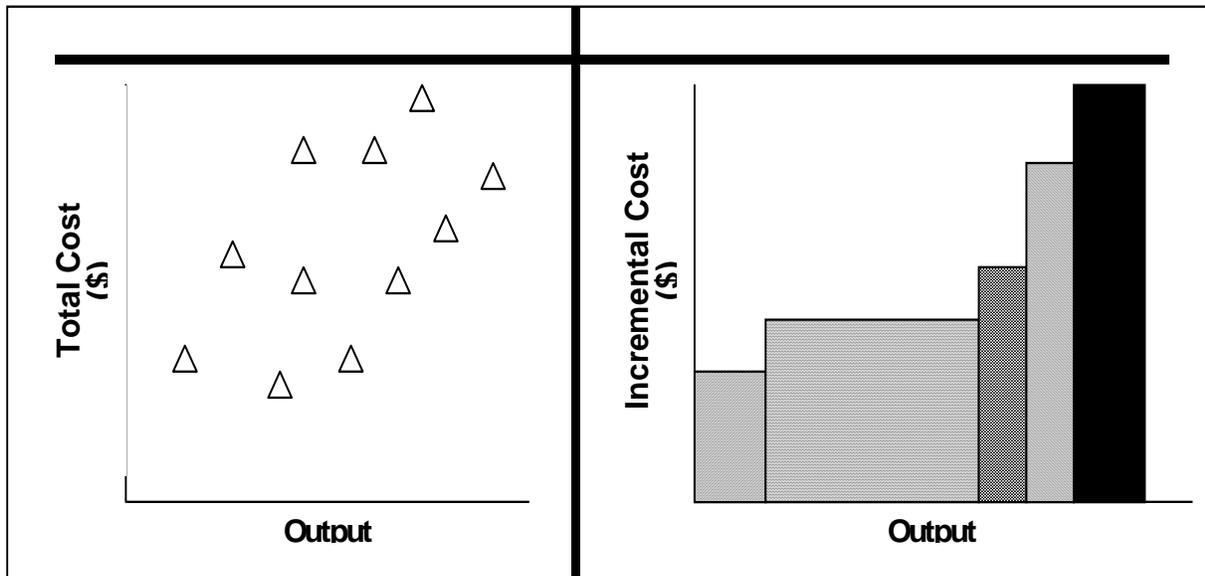


Figure 1

Cost-Effectiveness Analysis

Incremental Cost Analysis

Incremental Cost Analysis

Why Conduct Cost Effectiveness and Incremental Cost Analyses?

The planning paradigm in the P&G provides a rational and deliberate approach to solving problems and making decisions. Such decision-making requires information; for example, information about future environmental conditions with, and without, the implementation of each alternative plan under consideration. The cost effectiveness and incremental cost analyses procedures in this manual are intended to organize and communicate the types of information needed to support the decision making process.

Figure 2 shows some tools of economic analysis that can be used to provide varying levels of information to support decision-making. This decision-support continuum ranges from cost oblivious decision making (ignore all information about costs) to benefit-cost analysis (a mathematical comparison of benefits and costs). Between these two extremes, the economic tools of cost effectiveness analysis and incremental cost analysis can provide information to support decision making (Yoe 1992).

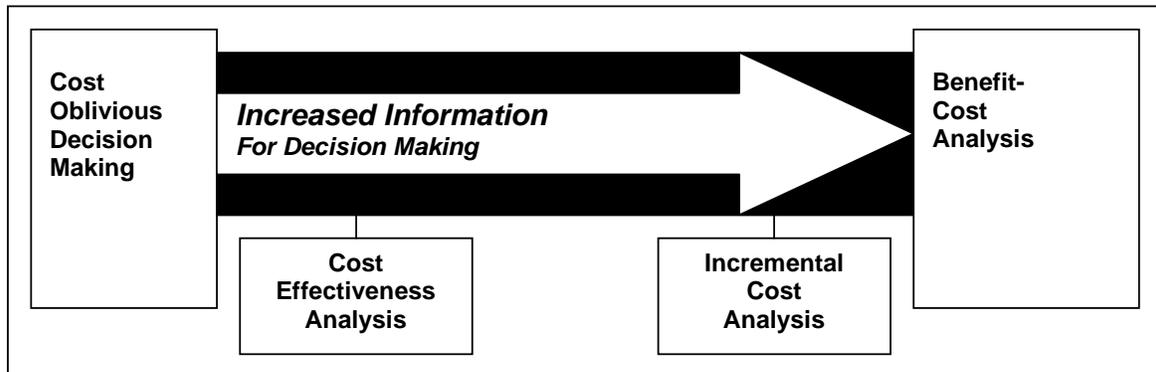


Figure 2
Economic Analysis Decision-Making Tools

Benefit-cost analysis is generally considered the best-case scenario for Federal water resources decision-making. In benefit-cost analysis, the monetary cost of a plan is subtracted from the monetary value of the benefits to be provided by that plan to compute net dollar benefits. When there is a range of alternative plans, the plan that provides the most net benefits is considered optimal, and is typically the recommended plan.

When project benefits are not measured in dollars, cost effectiveness and incremental cost analyses offer next-best approaches. While the cost effectiveness and incremental cost analyses of alternative plans may not identify a unique or optimal solution, they can lead to more-informed choices from among alternatives by elevating the decision making process above cost oblivious decision making (Yoe 1992).

The value of this approach to environmental planning is recognized in the National Research Council's National Strategy for the Restoration of Aquatic Ecosystems. The Council's strategy states that, in lieu of benefit-cost analysis, the evaluation and ranking of restoration alternatives should be based upon a framework of incremental cost analysis. Continually questioning the value of restoration by asking whether an action is worth its cost is the most practical way to decide how much restoration is enough (NRC 1992). As an example, the National Research Council cites the Corps approach where a justifiable level [of output] is chosen in recognition of the incremental costs of increasing [output] levels and as part of a negotiation process with effected interests and other federal agencies (NRC 1992).

Although cost effectiveness and incremental cost analyses will not, like benefit-cost analysis, usually lead us to a single solution, they will, at the very least, help us make *more informed* decisions. And, with some care and thought in interpreting and communicating the results, they may help us make *better-informed* decisions. In the long term, we hope that this will bring about *better decisions* about today's actions that will effect the environment of future generations.

Applicability

The plan formulation and cost effectiveness and incremental cost analyses procedures in this manual were developed for both restoration and mitigation planning. They are useful for a wide range of problem and project sizes, and can be used for scoping solutions even at the

earliest stages of planning. In addition, although these procedures were developed to meet Corps needs in restoration and mitigation planning, focusing on fish and wildlife habitat and watershed or ecosystem-related studies, they should be equally useful in addressing many other planning applications both within and outside the Corps. For example, the procedures may be useful to address problems of dredged material disposal, natural resource management, and mitigation banking. Environmental planning and management applications outside the Corps might include studies addressing water and air pollution, hazardous waste, cultural resources, or mitigation planning in transportation alternatives analysis. Ultimately, applicability is limited only by analysts' ability to define and measure the output and cost of solutions to planning problems.

How Do the Analyses Fit in the Planning Process?

Federal water resources planning is a formal choice process that integrates many perspectives. Engineering, economic, environmental, social, and political concerns are brought to the table and traded off as a number of alternative plans are formulated and evaluated. The P&G planning process consists of a series of steps that provide an orderly and systematic approach to selecting a recommended plan. The P&G planning process consists of the following major steps:

1. Identify problems and opportunities;
2. Inventory and forecast without-project conditions;
3. Formulate alternative plans;
4. Evaluate effects of alternative plans;
5. Compare alternative plans; and
6. Select a plan.

Though the numbering of the planning steps indicates the basic order in which they are conducted, planning is a dynamic process, the steps of which may be repeated, (or iterated) one or more times as steps of the process uncover new information, new alternatives are developed, or as objectives are reevaluated. The cost effectiveness and incremental cost analyses procedures in this manual can contribute to a planning study in a number of ways, both early on and later in the planning process.

Cost effectiveness and incremental cost analyses can be useful tools during even the earliest iterations of the planning process. As experience will show, the analyses can help you quickly formulate a very wide range and number of alternatives during reconnaissance or other early phases of work.

Cost effectiveness and incremental cost analyses are *comparisons* of the effects of alternative plans; more specifically, they involve comparisons between the outputs and costs of different solutions. As such, you must first develop at least preliminary information about alternative plans (planning step 3) and their effects (planning step 4) in order to conduct the cost effectiveness and incremental cost comparisons (planning step 5). In this sense, cost

effectiveness and incremental cost analyses may be thought of as being “late” in the six-step planning process.

Cost Effectiveness and Incremental Cost Analyses...What They Are Not

Prior to elaboration of what cost effectiveness and incremental cost analyses are, consider some things that the analyses are *not*. For example, cost effectiveness and incremental cost analyses are:

Not the planning process...

...but you have to understand the planning process to understand the role of the analyses;

Not a technique to measure or forecast environmental outputs...

...the analyses do not measure or forecast the environmental effects of plans; but that information, provided through other techniques, is required to conduct the analyses;

Not a technique for monetizing environmental outputs...

...the analyses will not place monetary values on measurements of environmental outputs; but rather the analyses will compare monetary costs against non-monetary outputs across solutions;

Not a way to reduce or eliminate environmental requirements...

...rather, the analyses can show how to meet requirements and keep costs down - or how to maximize output for a given expenditure level; and

Not a method that identifies a single right or optimal solution...

...unlike benefit-cost analysis, no single plan, like a National Economic Development (NED) plan, will emerge as the optimal selection; however, the analyses provide the types of information that will support the selection of a single plan.

And a final disclaimer: There is no single right way to conduct cost effectiveness and incremental cost analyses for every application. Planners and analysts need to look at each planning problem and determine the best way to proceed. The procedures in this manual provide a basic framework for plan formulation and evaluation. This framework is flexible enough to handle necessary modifications for its application to a wide variety of planning situations. The following chapters provide a number of examples, using the same analytical concepts in a variety of different planning applications. Again, once the learning curve has been overcome, and with some practice, the insights required to determine the best way to proceed will come with greater ease.

The development of the IWR Planning Suite software may lead some to think of the analysis as a black box, where data is input and then, without requiring any knowledge of the analytical

procedures being conducted, an answer is provided. Planners must recognize that uninformed dependence on the software's analysis results is inappropriate and misguided.

The capability to perform reality checks on the software's output, the insight required to use the software to handle different planning scenarios, and the ability to interpret results are important aspects of effectively utilizing IWR Planning Suite. But they may all be applied for naught without a critical understanding of the procedures behind the software. Such an understanding will also provide valuable opportunities to consider new and different solutions that deliver more for less.

Herein you will find detailed, step-by-step, instructions in the procedures encoded into the software program. Understanding the procedures and the examples presented in the following chapters will assist analysts in achieving a comfort level with applying the analyses.

History and Background

Benefit-cost analysis, incremental cost analysis and cost effectiveness analysis have long been integral to Federal water resources planning. Requirements for these types of economics-based analyses can be traced from the first Federal guidance in the Green Book (1950, 1958), through Senate Document 97 (1962), to the Principles and Standards (1973, 1980). Traditionally, these requirements have focused on projects' monetary costs and monetary benefits. Cost effectiveness analysis has been used to identify the least costly means to achieve a range of project benefits; subsequent incremental cost analysis has been used to scale project size by judging whether increasing economic benefits are worth their additional costs.

The evolution of economic analyses in Federal water resources planning was paralleled by the development of requirements and technologies for environmental evaluation. As the nation's first comprehensive environmental legislation, the National Environmental Policy Act of 1969 mandated, in Section 102 (2)(B):

All agencies of the Federal Government shall...identify and develop methods and procedures, in consultation with the Council on Environmental Quality established by Title II of the Act, which will ensure that presently unquantified environmental amenities and values may be given appropriate consideration in decision-making along with economic and technical considerations.

In 1983, the U.S. Water Resources Council replaced the Principles and Standards with the Principles and Guidelines (P&G), providing the instructions and rules for Federal water resources planning. The P&G requires that:

In general, in the formulation of alternative plans, an effort is made to include only increments that provide net National Economic Development (NED) benefits after accounting for appropriate mitigation costs. Increments that do not provide net NED benefits may be included, except in the NED plan, if they are cost effective measures for addressing specific concerns. (paragraph 1.6.2 (b))

While the P&G places emphasis on plans to achieve NED benefits, it does leave the door open for *cost-effective* plans to achieve other benefits, such as environmental benefits.

In the mid-1980's, the Corps adopted the principles of cost effectiveness and incremental cost analyses for use in planning and justifying mitigation for fish and wildlife habitat losses caused by projects for flood control, navigation, and other developmental purposes. Costs for mitigation are essentially the same types of financial costs that are incurred for other project purposes, including costs for: preconstruction engineering and design; real estate; construction; ongoing operation, maintenance, repair and rehabilitation; and monitoring.

Benefits for mitigation are more problematic since, unlike flood control, navigation and other developmental purposes, mitigation benefits are not measured monetarily. The analytical difficulty that this presents to justifying environmental projects is so pervasive that the Water Resources Development Act of 1986 sought to legislate a solution. Section 907 of that Act directs that:

In the evaluation by the Secretary [of the Army] of benefits and costs of a water resources project, the benefits attributable to measures included in a project for the purpose of environmental quality...shall be deemed to be at least equal to the costs of such measures.

Notwithstanding the intent of the Act, there remains no universally acceptable method to express environmental benefits in exclusively monetary or economic terms. Mitigation of environmental damage can, however, be expressed in other metrics, ranging from simple numbers of acres of a given habitat to more sophisticated indicators like habitat units. Therefore, although a traditional benefit-cost analysis cannot be conducted without monetary benefits, the costs of mitigation plans can be compared with their non-monetary effects. Such comparison is at the heart of cost effectiveness and incremental cost analyses, and is the basis for their application in environmental planning.

Initial Corps guidance on the application of incremental cost analysis in environmental planning, presented in engineering circular number 1105-2-185 (U.S. Army Corps of Engineers 1988), included:

Incremental cost analysis is an investigation and characterization of how the costs of extra units of output increase as the level of output increases. In mitigation planning, such analyses will result in an array of implementable mitigation plan increments, ranked from most to least cost effective.

This guidance was subsequently incorporated into the Corps engineering regulation number 1105-2-100, Guidance for Conducting Civil Works Planning Studies (U.S. Army Corps of Engineers 1990). This regulation, referred to as the Planning Guidance Notebook and revised in 2000, requires that:

An incremental cost analysis shall be performed for all recommended mitigation plans. The purpose of incremental cost analysis is to discover and display variation in costs, and to identify and describe the least cost plan.

The requirement of incremental cost analysis for the mitigation of adverse project impacts was extended to the *restoration* of fish and wildlife resources through Policy Guidance Letter #24, (U.S. Army Corps of Engineers, 1991).

In June 1995, the Corps released engineering circular number 1105-2-210, Ecosystem Restoration in the Civil Works Program. This guidance underscores the importance of cost effectiveness and incremental cost analysis in ecosystem restoration planning. The circular states that:

Cost effectiveness analysis and incremental cost analysis are fundamental concepts in project formulation and evaluation. These analyses provide ways of thinking about outputs resulting from the various levels of expenditures. Ecosystem restoration studies differ from traditional studies only in that not all benefits are monetized.

A cost effectiveness analysis is conducted to ensure that least cost alternatives are identified for various levels of environmental output. After the cost effectiveness of the alternatives has been established, subsequent incremental cost analysis is conducted to reveal and evaluate changes in cost for increasing levels of environmental output.

Although incremental cost analysis does not provide a discrete decision criterion (such as the maximizing of net benefits in NED analysis), it provides for the explicit comparison of the relevant changes in costs and outputs on which such decisions should be made.

The Planning Guidance Notebook, ER 1105-2-100, was revised in 2000 and contains the Corps' current policy regarding the requirement to conduct cost effectiveness and incremental cost analyses for ecosystem restoration projects. Paragraph E-36 states:

Cost effectiveness and incremental cost analyses are two distinct analyses that must be conducted to evaluate the effects of alternative plans. First, it must be shown through cost effectiveness analysis that an alternative restoration plan's output cannot be produced more cost effectively by another alternative. "Cost effective" means that, for a given level of non-monetary output, no other plan costs less, and no other plans yields more output for less money. Subsequently, through incremental cost analysis, a variety of implementable alternatives and various- sized alternatives are evaluated to arrive at a "best" level of output within the limits of both the sponsor's and the Corps' capabilities. The subset of cost effective plans are examined sequentially (by increasing scale and increment of output) to ascertain which plans are most efficient in the production of environmental benefits. Those most efficient plans are called "Best Buys." They provide the greatest increase in output for the least increases in cost. They have the lowest incremental costs per unit of output. In most analyses, there will be a series of Best Buy plans, in which the relationship between the quantity of outputs and the unit cost is evident. As the scale of Best Buy plans increases (in terms of output produced), average costs per unit of output and incremental costs per unit of output will increase as well. Usually, the incremental analysis by itself will not point to the selection of any single plan. The results of incremental analysis must be synthesized with other decision-making criteria (for example, significance of outputs, acceptability, completeness, effectiveness, risk and uncertainty, reasonableness of costs) to help the planning team select and recommend a particular plan.

Early Corps field applications of cost effectiveness and incremental cost analyses to environmental planning problems frequently consisted of an intuitive calculation and display of

the average cost per unit of environmental output (benefit) for a set of alternative plans. In a 1989 survey of Corps planning staff titled *Effectiveness of Incremental Analysis for Mitigation Planning*, many respondents reported that incremental cost analysis was perceived as a hindrance to plan formulation and selection. The most common criticisms pointed to the analyses' time-intensive nature and to a lack of clear procedural guidance for their implementation (Reese 1989).

To address these criticisms, Corps Headquarters tasked the Institute for Water Resources to better define how cost effectiveness and incremental cost analyses could be accomplished. This resulted in an overview, entitled Economic and Environmental Considerations for Incremental Cost Analysis in Mitigation Planning (Greeley-Polhemus Group 1991), and a draft manual titled Incremental Cost Analysis Primer for Environmental Resources Planning (Yoe 1992). These studies provided background research that evolved into Cost Effectiveness Analysis for Environmental Planning: Nine EASY Steps (Orth 1994). Concurrent with this work, IWR supported a field demonstration to test the applicability of the *Nine EASY Steps* procedures and the resultant report, Bussey Lake: Demonstration Study of Incremental Cost Analysis in Environmental Planning (Carlson 1993) was produced. In May 1995, Evaluation of Environmental Investments Procedures Manual; Interim: Cost Effectiveness and Incremental Cost Analyses (Robinson, et al. 1995) was released for review and comment. Accompanying the manual was the software, ECO-EASY, the predecessor to IWR-Plan and IWR Planning Suite. In 2002 IWR also published Lessons Learned from Cost Effectiveness and Incremental Cost Analyses (Brandreth and Skaggs 2002) to document how well the procedures were being applied to Corps ecosystem restoration planning efforts and lessons learned that might improve their application.

The conversion of the approach to a Windows[®] operating system platform, and the addition of many new features, was carried out through the development of IWR-Plan, starting in July of 1996. As IWR-Plan became a standard tool for performing this type of analysis within USACE, a wealth of additional features were considered for incorporation within IWR-Plan. The underlying approaches identified by these explorations were kept in mind by the IWR Planning Suite development and maintenance team for incorporation into the current design where appropriate.

Beginning in November of 2003, a complete redesign to incorporate desired features and new technologies was initiated, culminating in the current IWR Planning Suite. This newly redesigned IWR Planning Suite encapsulates the following fundamental design concepts. One concept is to consider plan descriptions as discrete entities, as opposed to the concept of a plan alternative solely as a derived aspect of a set of solution combinations. The *planning set editor* and *plan descriptions database* represent this concept. Yet another fundamental modification of the tool structure is a move from a single application to a modular approach consisting of an integrated suite of component modules. Such modules include a plan editor, plan generator, reporting tools, and analysis modules. These concepts are further explained in Section 5 of this User's Guide in "Software terms and Procedures."

Section 2

Plan Formulation

Let us assume that a planning investigation has been initiated concerning, for example, the degradation of a particular floodplain's ecosystem. Various problems and potential opportunities have been characterized and identified during the initial stages of the investigation. The objectives of the investigation and the constraints that are imposed upon it have been derived from the characterized problems and opportunities.

Further, during the investigation's information gathering process, the historic, existing, and future conditions of the site have been evaluated. Through this process, the problems and opportunities have become more fully and accurately described, as have the costs of various alternatives, protected resources, and other items deemed relevant to the investigation. At a relatively early stage, it will be possible to formulate plans and perform analyses, which can then be fed back into another, more detailed iteration of the planning cycle.

The specifics of the information needed to initially proceed with plan formulation and evaluation vary with each investigation, but will always include at least three kinds of data needed to formulate and evaluate plans. These types of information are:

1. Solutions,
2. The output of each solution, and
3. The cost of each solution.

This chapter provides an overview of solutions, outputs, and costs; and discusses how output and cost data can be manipulated to extract the types of information needed to support decision-making.

What's a Solution?

A *solution* is a way to achieve, in whole or in part, one or more planning objectives. Every solution will provide some level of output at some cost. Cost effectiveness and incremental cost analyses examine the different cost and output levels provided by different *solutions*.

Solution is an umbrella term for three more familiar terms: management measure, alternative plan, and program. Throughout the remainder of this text, whenever we use the term "solution" it implies that the discussion applies to measures, plans and programs.

A *management measure* (or simply "measure") is either a feature or an activity, or some combination of the two that can be implemented at a specific geographic site to achieve desired effects. A *feature* is generally a "structural" element that requires site construction; for example, a levee. On the other hand, an *activity* is generally a "nonstructural" action; for example, vegetative planting. An activity might be a one-time occurrence, like planting; or it may be ongoing (continuing or periodic), such as harvesting aquatic vegetation. A *site* is a place on land or water (at, above or below the surface) in which there is a legal interest, through outright

ownership or a right to use or act on it (flowage easement, grazing rights, etc.), for implementation of features or activities. Examples of management measures that may be used for restoration and mitigation are listed in Table 1.

aerators	detention basins	revetments
algaecide application	dredging	rock piles
bank overhangs	fencing	rock shoals
bank stabilization	fish ladders	rootwads
boulder deflectors	fish screens	rototilling
breakwaters	fish stocking	sedimentation basins
brush bundles	gabion baskets	stake beds
brush mattresses	gravel traps	stormwater treatment areas
brush piles	harvesting	substrate improvement
bulkheads	jetties	tree layering
chemical injection	log deflectors	water control structures
chemical precipitation	mowing	water dilution
concrete block piles	new channels	water pumps
contouring	planting	weirs
cribs	reservoirs	wing walls
dams	retention ponds	wood reefs

Management measures are the building blocks of alternative plans. An *alternative plan* (or simply “plan”) is one or more management measures. A management measure may or may not be able to stand alone as a plan; it depends on the characteristics of the measure. Most alternative plans are made up of more than one measure. And, just as management measures can be combined to form plans, so too can plans be combined to form programs. As we use it in this manual, a *program* is a set of one or more plans (or “projects”), usually located over a large geographic area. Some of the Corps current environmental programs are listed in Table 2.

TABLE 2	
EXAMPLES OF CURRENT CORPS ENVIRONMENTAL PROGRAMS	
<u>National Programs:</u>	
<ul style="list-style-type: none"> ● Section 1135 Program - Project Modifications for Improvement of the Environment ● Coastal America Program ● North American Waterfowl Management Plan 	
<u>Regional Programs:</u>	
<ul style="list-style-type: none"> ● Upper Mississippi River System Environmental Management Program ● Coastal Wetlands Planning, Protection, and Restoration Act Program (Breaux Bill ; currently implemented in coastal Louisiana) ● Comprehensive Everglades Restoration Plan (CERP) 	

Scales of Solutions

Scales are different and mutually exclusive properties of a solution. Scales are most typically thought of as different “sizes”, but they also apply to other dimensions. A management measure may be scaled by several different properties, such as:

- *Physical properties*, including different sizes, amounts, counts, etc. For example, size of a site (30 acres, 40 acres, 50 acres, etc.); number of plantings per acre; percent canopy cover of vegetation; water depth; discharge capacity of a pump.
- *Composition*, including different materials and methods that would accomplish the same purpose. For example, a fence may be constructed as a chain-link fence, or a barbed-wire fence, or a wooden slat fence. For the purpose of developing alternative plans, the different materials may be thought of as different scales of a fence.
- *Locations*, including different sites for the same solution.
- *Timing and duration*, including different start and stop times, and durations for the same solution. For example, low flow releases could be scheduled to last 6, 8, or 12 hours.

An alternative plan may be scaled in terms of the measures that make up the plan - which measures are included in the plan, and in what order would they be implemented? A program may be similarly scaled in terms of the alternative plans (or projects) that make up the program.

Scales are mutually exclusive; for example, we must decide upon one channel depth. Therefore, a plan may contain only one scale of a given characteristic of a measure, and a program may contain only one scale of each component plan.

Many of the variables used in habitat-based evaluation procedures (see below) can be used to define scales of management measures. For example, if “percent herbaceous canopy cover” is a variable for a target species, and if planting herbaceous vegetation is being considered as a measure, then the measure could be sized in increments of the variable, such as: 30 percent herbaceous canopy cover, 40 percent herbaceous canopy cover, 50 percent herbaceous canopy cover, and so forth.

How Many Scales?

The number of possible solutions—and consequently the number of output and cost estimates—will rapidly increase as we consider increasing numbers of scales of measures. Therefore, the numbers of measures and their scales should be kept to a reasonable number to minimize study cost and time. There are no universal rules for determining the proper number of scales that should be considered in every case—the number that should be defined is a matter of judgment. In reaching that judgment, it is helpful to think about scales that are:

- *Meaningful.* For example, scales of a fenced-in area in increments of 0.01 of an acre, or in increments of 10,000 acres, are probably not correctly sized and would result in too many or too few solutions for most analyses. Also, there is no reason, beyond ease of comparisons and symmetry, that increments must be identical in size. For example, a scale of 10, 25, 50 and 100 units may be used in the same analysis if it makes sense to do so.
- *Practical.* Some solutions may be implementable over very few scales. Some measures may be “either-or” measures that are not possible, or reasonable, to size, and there is only one scale to consider. For example, although different sized areas may be considered, natural revegetation may be a single-scale measure (either it does or it doesn’t naturally revegetate). Administrative actions, such as requiring a permit or a license, may also be single-scale measures (for example, either a license is required or it isn’t). Equipment is often available in only a single size or relatively few sizes (for example: water pumps with fixed pumping capacities).

Minimum and maximum sizes could be a basis to bound a range of scales. For example, a bird may require a deciduous shrub cover between 1.0 foot and 3.0 feet in height. Planting schemes that would provide lesser or greater cover heights would not meet the requirement and need not be considered. Where a large number of scales is possible, the analyses could be initially limited to analyzing only the largest and smallest sizes (“high-low” analysis), or high-middle-low sizes, to bound and scope the range of costs and outputs; subsequent iterations could then be conducted for the more promising scales.

- *Revealing.* The number of scales should be adequate to reveal significant changes in outputs and costs. A cost effectiveness curve or an incremental cost graph reflecting only two points is usually not revealing, and therefore not helpful, for decision making.
- *Reasonable.* The number of scales should strike a reasonable balance between the needs and constraints of the analysis and the burdens (cost, time, and understanding) imposed by large numbers of scales that are not sufficiently differentiated to make a difference in decision-making. In many cases, only a few will be reasonable. Additional scales should not be artificially created simply for the sake of analysis.

The most important consideration in defining scales is that *changes in scale should result in changes in output, or cost, or both.*

Interrelationships of Solutions: Combinability and Dependency

The ability to make plans from measures, and programs from plans, is governed by two types of relationships: combinability and dependency. In a typical Corps study, management measures may or may not be mutually exclusive, and it is the property of *combinability* that allows you to mix and match measures into different plans. Conversely, some measures may preclude others, and this will limit your ability to mix and match them. In thinking about combinability, you should consider whether two measures might be mutually exclusive because of:

- *Location*, where two different measures cannot occupy the same space at the same time. For example, at a particular stream site, you could create a calm slackwater area by either excavating the channel or by constructing a dam across the channel; you can do one or the other at the same site.
- *Function*, where two different measures may work against one another. For example, at Site A, it probably would not make sense to both build a retaining dike to hold water at the site and install drains to speed the removal of water from the site.
- “*Nested*” measures, where one measure is actually a smaller scale or a subset of another measure. For example, you could not combine a 4-acre wetland with a 5-acre wetland to produce a 9-acre wetland if the two wetlands are not physically separate and any part of the 4 acres is physically included—or “nested”—in the 5 acres.

While measures may or may not be combinable, alternative plans are mutually exclusive within a single planning study, and decision makers must ultimately select one plan. Within a single study, selection of a plan will preclude the selection of any other plan. However, at the program level, alternative plans (or “projects”) may or may not be mutually exclusive. Again, it is the property of combinability that, at the program level, allows us to develop different total programs based on different mixes of plans (or “projects”).

In addition to being combinable, many measures may be dependent on other measures in order to be implemented. *Dependency* relationships between two measures may exist for several reasons, including:

- *Necessary to function*. For example, the survival of willow tree plantings may be dependent upon an irrigation system; without irrigation the plantings will die. In this case, irrigation is necessary for the willows to function.
- *Reduce risk or uncertainty*. For example, we may wish to establish 50 willow trees per stream mile. However, because previous planting programs in the area have shown that about one-third of willow plants will not survive the first critical growing year, we elect to plant 75 trees per stream mile to account for the survival risk. The 50 trees per mile that we expect to survive are actually dependent on the additional 25 trees per mile that experience has shown are not likely to survive.

- *Improve performance.* For example, we may also elect to improve the growth rate of willow plantings by fertilizing them. The fertilizer is not necessary for the plants to function, nor will it reduce any risks or uncertainties of survival. However, it will improve the willows' performance by producing more mature trees faster.

Dependencies can occur in at least two different ways. *Mutual dependency* exists where two or more measures must be implemented in combination or not at all. For example, consider the following two measures:

- *Management Measure [A] = Vegetative Planting;*
- *Management Measure [B] = Irrigation System.*

If [A] will not work without [B], then [A] cannot stand alone and cannot be a plan. Similarly, if [B] is only included because of the existence of [A], then [B] cannot stand alone as a plan. Here only the combination [A+B] is a viable plan. In cases where we have mutual dependency, it is best to group the two measures together and think of them as a single measure for the purposes of analysis. For example, in this case we could group management measures A and B together as a new measure C such that:

Management Measure [C] = Planting & Irrigating

A different type of dependency is where some measure(s) are dependent upon other measure(s) but the relationship is not reciprocal. We will refer to this type of dependency as *path dependency*. Understanding path dependency relationships can help to assure that time and resources are not wasted evaluating plans that could not be implemented because they fail to meet a dependency path requirement. For example, consider a case where we have five management measures: A, B, C, D, and E. In this example, we must implement A before implementing B; if A and B are both present, we can then add C. Also, D must be present before we can add E.

Recognizing dependency relationships among management measures can assist in screening out plans that are not feasible because they fail to meet dependency requirements when using the "all combinations of management measures approach" to plan formulation. In our example, there are 32 possible combinations of the management measures A-E. However, many of these possible combinations are not functionally feasible because they violate the dependency requirements. Table 3 includes all combinations with shading over those plans that are not feasible because they do not meet dependency path requirements. Out of the initial 32 possible plans, only 12 meet dependency path requirements and are functionally feasible.

Situations may arise where we are faced with *either...or* dependencies. *Either...or* dependencies occur when a common measure may be added to more than one dependency path. For example, consider that on a common plot of land we have two measures: G –to plant one type of vegetation and T –to plant a second type of vegetation. Assume that we could plant either alone, or both in combination. If we were to add to either G or T (or both) planting measures a new measure: F–to fertilize; we would then put the same measure in two dependency paths.

Now, we can add measure F (fertilize) if *either G or T* is present. Similarly, F could be added if *both G and T* are present. In this case, we might only incur the cost of fertilizing once, but the effect of fertilizing on the planting may vary depending upon whether one or two types of planting are being affected. In such cases, the potential for improper estimates (either of cost, output, or both) is high. In situations where “*either...or*” dependencies occur between management measures, it is important to check the validity of the cost and output estimates of all combinations that include those measures to assure that costs or benefits are not being double-counted.

Where Do Solutions Come From?

The process of building alternative plans from management measures (and programs from plans) is called *plan formulation*. Plan formulation occurs in three very general phases: identification of management measures, formulation of alternatives, and reformulation. In every study, these phases will overlap and be repeated (or “*iterated*”) again and again. For additional discussions about the plan formulation process, see the Planning Manual (IWR Report 96-R-21).

There are many plan formulation approaches, such as “ask an expert,” considering “plans of others,” and using brainstorming, HEP models, and checklists (see the Planning Manual). While any of these approaches may be used to develop solutions, a formulation approach known as “*all possible combinations*” is a viable approach frequently used during planning investigations. This approach begins with a list of individual management measures, defines combinability and dependency relationships among the measures, and finally derives every possible combination of the measures given the defined relationships. The resulting set of combinations is the entire set of alternative plans that can be generated from the measures under consideration—every plan possible will have been formulated. Once this set of all possible plans

TABLE 3 ALL COMBINATIONS OF MANAGEMENT MEASURES (with shading over plans which do not meet dependency path requirements)			
NO COMBINATION	AD	ABC	BDE
A	AE	ABD	CDE
B	BC	ABE	ABCD
C	BD	ACD	ABCE
D	BE	ACE	ABDE
E	CD	ADE	ACDE
AB	CE	BCD	BCDE
AC	DE	BCE	ABCDE

has been identified, they can be evaluated using the cost effectiveness and incremental cost analyses procedures.

The results of plan formulation–management measures, alternative plans, and programs–must be both “output-friendly” (you can estimate what outcomes or outputs you get from it) and “cost-friendly” (you can also estimate its costs).

What’s an Output?

As we use it in this manual, the term output means an *intended, beneficial, nonmonetary effect*. Cost effectiveness and incremental cost analyses examine how *output levels*, and their respective costs, vary across different solutions.

An output is the means by which we measure how well we achieve a planning objective. Usually, we identify one type of output for each objective. For example, you may decide to measure progress in restoring a wetland in terms of changes in its habitat quality and quantity.

In some cases, it may be important to look at more than one aspect of an objective, and, therefore, you may use multiple outputs for a single objective (for example, habitat quality and the presence of a keystone species). In addition, if your study is addressing more than one planning objective, then you may use a different type of output for each objective. Using multiple outputs will complicate, but not necessarily overwhelm, your analysis. See Chapter Five for a discussion about how you can handle the “apples and oranges” problem of multiple outputs (called “commensuration”).

Outputs are the intended results of implementing solutions. In this sense, they are the analytical equivalent of traditional economic “benefits.” Outputs, like traditional dollar benefits, are a special type of what many of us refer to as “environmental impacts.” The difference is that “outputs” are the desired and intended effects of solutions (we’re trying to create them), while “impacts” usually refer to the full range of effects, both undesirable and desirable, and unintended and intended. Note that, although our primary concern here is with environmental outputs, the full range of effects, including other environmental and social impacts, must be assessed for environmental restoration and mitigation solutions. For example, the impacts of a wetland restoration project on lost upland habitat, displaced upland wildlife, relocated structures and utilities, and other impacts should also be assessed.

Although we have focused our discussions on fish and wildlife and ecosystem-related outputs, the procedures described in this manual can be applied to a wide range of other outputs. The basic questions posed in these procedures, culminating in the “Is it worth it?” analysis, are equally valid for problems related to water and air quality, hazardous and toxic wastes, aesthetic resources, cultural resources, and any other type of resource. So long as the basic measurement requirements are met, any non-monetary output should be amenable to the essential analyses of these procedures.

Measuring Outputs

Every output is measured using a technique that measures changes in terms of a metric, or “measurement unit”. There is no single, universal, all-purpose unit of environmental output,

nor is there a single, universal, all-purpose measurement technique. Traditional metrics for measuring environmental outputs have included:

- *Physical dimensions*, such as acres, miles, days, etc.
- *Population counts* of a species or guild (number of wading birds, for example).
- *“Habitat units”* are a product of the “Habitat Evaluation Procedures” (U.S. Fish and Wildlife Service 1980; also referred to as “HEP”), as well as several other habitat-based evaluation methodologies similar to HEP. While the original HEP applications focused on single species, recent HEP-like procedures focus on communities and may measure “community units” or similar metrics.

Other less commonly used metrics include measurements of biodiversity, productivity and risk. Again, there is no one way to measure environmental outputs that will apply in all cases. Each study must determine the best way to measure outputs to meet its unique decision making needs.

Current Corps guidance provides flexibility in the measurement of outputs, but states that outputs that measure ecosystem value and productivity are preferred. According to ER 1105-2-100, paragraph 3-5, c (1):

Ecosystem restoration outputs must be clearly identified and quantified in appropriate units. Although it is possible to evaluate various physical, chemical, and/or biological parameters that can be modified by management measures that would result in an increase in ecosystem quantity and quality in the project area, the use of units that measure an increase in “ecosystem” value and productivity are preferred. Some examples of possible metrics which may be used include habitat units, acres of increased spawning habitat for anadromous fish, stream miles restored to provide fish habitat, increases in numbers of breeding birds, increases in target species and diversity indices. Alternate measures of ecosystem value and productivity may be used upon approval by CECW-P. Monetary gains (e.g., incidental recreation or flood damage reduction) and losses (e.g., flood damage reduction or hydropower) associated with the project shall also be identified.

Ideally, we should first define the output to be measured (based on a planning objective); then define the unit in which we will measure change in the output; and finally select the measurement technique that will provide values in terms of the selected unit. Selecting the technique first will, by definition, select the measurement unit, which may or may not be the best indicator for the output. Analysts should recognize linkages among outputs, units and techniques in developing measurement frameworks for their studies. Appendix C of Corps engineering circular 1105-2-210 (June 1, 1995) provides a good summary of current ecological measurement methods.

What's a Cost?

Cost is a sacrifice that must be made in order to do or acquire something. Cost is frequently characterized as a monetary value for the purposes of planning investigations. The costs of environmental planning solutions have three components: *implementation costs*, *opportunity costs*, and *incidental benefits*. While all three components are discussed below, only implementation costs are to be included in the cost calculations for CE/ICA, per Corps policy. Opportunity costs and incidental benefits, if applicable, may be displayed in the comparison of alternative plans for trade-off analysis purposes, but are not to be included in CE/ICA procedures.

Implementation costs are what economists might refer to as explicit costs; they are the out-of-pocket, cash outlays for producing environmental outputs. Examples of implementation costs include outlays for preconstruction engineering and design, real estate, construction, OMRR&R (operation, maintenance, repair, relocation and rehabilitation), and monitoring. Implementation costs include what are typically thought of as the cost estimate and the real estate appraisal.

The level of detail appropriate for cost estimates and real estate appraisals will vary through different phases of planning. For the purposes of these analyses, a Corps M-CACES (Microcomputer-Aided Cost Estimating System) cost estimate, and a real estate appraisal, may not be needed, especially during early phases of planning. Professional judgment is needed in determining a level of detail that is appropriate for the phase of planning, project scale, and the level of detail in output measurements. Moreover, communication is required to inform staff from cost engineering and real estate about what types of decisions their estimates will support (for example, preliminary scoping of measures) so they can be comfortable with the appropriate level of detail.

Opportunity costs of foregone benefits are what economists might refer to as implicit costs; they don't cost us money we already have in pocket, but rather they cost us the opportunity to have done something else. For example, restoration of a riparian corridor may require removal of a levee, which would reduce flood damage reduction benefits provided by the levee. In Federal water resources planning, opportunity costs typically refer to foregone National Economic Development (NED) benefits. The P&G specifies the following goods and services as NED benefits:

- Municipal and industrial water supply;
- Agricultural floodwater, erosion and sedimentation reduction;
- Agricultural drainage;
- Agricultural irrigation;
- Urban flood damage reduction;
- Hydropower;
- Inland navigation;

- Deep draft navigation;
- Recreation;
- Commercial fishing; and
- Other categories of benefits.

See ER 1105-2-100 for a discussion of procedures for estimating these NED benefits. Additional Corps guidance for estimating many of these benefits can be found in the Corps National Economic Development Procedures Manual Series (see references).

Incidental benefits are monetary benefits that occur as unintended consequences of an environmental planning solution and incur no additional implementation costs. In some ways, they can be thought of as the opposite of opportunity costs. Incidental NED benefits are incidental benefits in the same eleven categories listed above. For example, restoration of a wetland, upstream from an urban center, may provide incidental flood damage reduction benefits to the urban area.

Although incidental benefits are not costs to be included in cost effectiveness and incremental cost analyses, they may nonetheless represent pertinent information for decision-making. If a solution provides significant incidental benefits, these benefits should be displayed in the comparison of alternative plans. A particular restoration alternative's incidental benefits may play an important role in plan selection.

Total Cost

Summing all implementation costs produces the total cost of a solution to be used as the cost element in CE/ICA procedures. The formula for this calculation is shown in Figure 3.

Total Cost = Implementation Costs

Figure 3
Computing the Total Cost of a Plan Alternative

Section 3

Plan Analysis

Before You Start

Cost effectiveness and incremental cost analyses are tools for comparing alternative solutions to planning problems. The analyses should not require any additional data than what would otherwise be generated in a typical planning study. They examine how costs vary at different levels of output.

In cost effectiveness and incremental cost analyses, output values are added, subtracted, and divided. Therefore, ordinal units of measurement (1st, 2nd, 3rd...) cannot be used in these analyses. However, cardinal units of output measurement, such as population counts and habitat units, can be used.

Since the analyses are tools for making comparisons across alternative solutions, it is important to convert all data to comparable values. Specifically, all costs must be discounted to reflect the time value of money; and if costs are converted to average annual equivalent costs, outputs should also be computed on an average annual basis.

The remainder of this chapter will discuss calculations that are made in cost effectiveness and incremental cost analyses to extract information from the cost and output data. Perhaps the simplest such calculation is that of total cost.

Average Cost

Average cost is calculated by dividing total cost by total output. The formula for this computation is shown in Figure 4. Average cost is altogether different than the concept of average annual cost. The average cost for a particular level of output is the cost per unit of output for that level. If a solution provides 100 units of output at a total cost of \$1000, the average cost is \$10 per unit for that alternative. Average costs can facilitate the comparison of production efficiencies across alternatives by placing each alternative plan in a common metric: dollars per unit of output. For example, a solution, which produces output at \$10 per unit, would be considered more efficient in production than a solution producing the same type of output at \$20 per unit.

$$\text{Average Cost} = \frac{[\text{Total Cost of Solution A}]}{[\text{Total Output of Solution A}]} = [\text{Cost per Unit Output of Solution A}]$$

Figure 4
Computing Average Cost

What's an Increment?

If you've been involved in planning studies, you've probably heard people talk about "increments". Unfortunately, like many other words in our business, the term increment has several different meanings, each of which are correct when used in the right context.

In general, "increment" is used in two different ways in Corps planning. First, and perhaps most commonly, increment is used in a design-sense to mean the size of a management measure or the composition or size of an alternative plan. For example, a levee's height may be sized in one-foot increments (4-feet high, 5-feet high, 6-feet high, etc.). Increments of a plan usually refer to additions of new measures to the plan (a levee plan; a levee and channel plan; a levee, channel and drop structure plan; etc); or different sizes of a particular measure included in a plan (a levee and 2,000-foot channel plan; a levee and 2,500-foot channel plan; a levee and 3,000-foot channel plan; etc.). A "last-added increment" is the final size or measure included in a plan. In this manual, we use the term "scale" to mean this design-sense of increment.

Incremental Cost and Incremental Output

When we use the term increment or incremental in discussing incremental cost analysis, we are using the term in its economic-sense to mean a *difference, or change*, between two solutions. The types of changes we are interested in are differences in cost and differences in output between solutions; these differences are referred to as incremental cost and incremental output.

Incremental Cost is the difference in total cost between two solutions, expressed in dollars. For example, if a 40-acre pond costs \$100,000, and a 50-acre pond costs \$175,000, the increment of cost (or change in cost) between the two ponds is \$75,000. This incremental cost information simply tells us that the 50-acre pond costs \$75,000 more than the 40-acre pond. Figure 5 contains the formula for incremental cost.

$$\text{Incremental Cost of Solution B} = [\text{Total Cost of Solution B}] - [\text{Total Cost of Solution A}]$$

Figure 5
Computing Incremental Cost

Incremental Output is the difference in output between two solutions, expressed in the output's unit of measurement. Continuing with the pond example, if the 40-acre pond would produce 20 habitat units, and the 50-acre pond would produce 30 habitat units, the increment of output between the two ponds is 10 habitat units. In other words, the 50-acre pond provides 10 more habitat units than the 40-acre pond. Figure 6 contains the formula for incremental output.

$$\text{Incremental Output of Solution B} = [\text{Total Output of Solution B}] - [\text{Total Output of Solution A}]$$

Figure 6
Computing Incremental Output

Incremental Cost Per Unit

Incremental cost analysis is an examination of the changes in both cost and output across alternative solutions. We can make this two-dimensional variation more apparent, helping us to make comparisons across solutions, by combining the concepts of incremental cost and average cost to compute *incremental cost per unit*; one number that reflects both types of change. Figure 7 contains the formula for incremental cost per unit.

$$\text{Incremental Cost per Unit of Solution B} = \frac{[\text{Incremental Cost of Solution B}]}{[\text{Incremental Output of Solution B}]}$$

Figure 7
Computing Incremental Cost Per Unit

Note: Figures 5, 6, and 7 refer to the incremental cost, incremental output, and incremental cost per unit, respectively, of *Solution B*. While saying these incremental values correspond to one solution simplifies the discussion, the incremental values in these formulas actually apply to *the decision to implement Solution B over Solution A*.

Examining the changes in incremental cost per unit across solutions is, in other words, examining how the cost per unit (or average cost) of incremental output changes as the level of output changes. Returning again to the pond example, the incremental cost per unit of the 50-acre ponds is \$7,500 per habitat unit, based on the following calculation:

$$\begin{aligned} (\$175,000_{\text{ cost of 50 acre pond}} - \$100,000_{\text{ cost of 40 acre pond}}) &= \$75,000 \\ &= \$7,500/\text{HU} \\ (30 \text{ HU}_{\text{ output of 50 acre pond}} - 20 \text{ HU}_{\text{ output of 40 acre pond}}) &= 10 \text{ HU} \end{aligned}$$

This tells us that the 10 extra habitat units that the 50-acre pond can provide (over the 20 units provided by the 40-acre pond) cost \$7,500 each. Using the average cost equation in Figure 4, we find that the 20 habitat units provided by the 40-acre pond cost \$5,000 each. This information tells us that we can get the first 20 habitat units for \$5,000 each; if we want more we can get 10 additional units, but those will cost \$7,500 each. Now we have our cost and output data in a format that facilitates answering the “is it worth it?” question. Specifically, are 20-habitat units worth \$5,000 each?; if so, are 10 more worth \$7,500 each?

The concepts of incremental cost, incremental output and incremental cost per unit are not difficult; but may be new, especially to non-economists. And, because they are unfamiliar, they are sometimes confused with average cost. Both types of cost measurements - incremental and average-play a role in our analyses, but they are different and cannot be used interchangeably.

Section 4

Case Study

Introduction

In order to demonstrate how cost effectiveness and incremental cost analyses can be performed using IWR Planning Suite software, the following case study is presented. Although the case study is based on an actual Corps ecosystem restoration feasibility study, the actual solutions, costs, and environmental outputs have been modified in this manual for illustration purposes. None of the cost and output figures used in this example represent real data from the feasibility study.

Study Area Setting

The City of Phoenix and the Corps are studying means of restoring degraded riparian and riverine ecosystems in a seven-mile segment of the Salt River floodplain in the Phoenix metropolitan area. The Salt River channel downstream and south of the city is dry during most of the year, but the river and surrounding floodplain are subject to infrequent flood flows resulting from periodic flash flood events. The primary objective of the potential ecosystem restoration project is to restore the degraded ecological resources of the Salt River and associated floodplain. Incidental recreation benefits are expected. A planning constraint is that the proposed restoration measures should not increase flood damages to nearby residences and farms; if possible, the measures should contribute to the reduction of flood damages.

There are several manifestations of the degraded environment in this part of the Salt River floodplain. Riparian vegetation, including cottonwood-willow and mesquite vegetative covers, both native to the riparian zones of the study area, has been greatly reduced in aerial extent during the last 50 years. This is due primarily to the reduction of surface water flow volumes in the Salt River channel. Upstream water diversions and consumption are primarily responsible for the reduction in surface water flows in the study area. Reduced flow volumes have negatively impacted the availability of surface and groundwater to support the cottonwood-willow and mesquite vegetative cover types. As a result, approximately 1,000 acres of the previously mentioned cover types have been lost in the study area in the last 50 years. Both cottonwood-willow and mesquite riparian woodlands provide valuable habitat for many native Sonoran Desert bird and mammal species, including the Yuma clapper rail (a state-listed sensitive species) and the cactus wren. The former and existing riparian corridors also provide important resting and feeding sites for several Neo-tropical migratory species of birds.

Another sign of the degraded ecosystem is the virtual disappearance of riverine wetlands and open water areas within the study area. Again, due to reduced surface water flows, the open water sections of the channel have been reduced to a few seasonal pools (a loss of approximately 600 acres), while approximately 400 acres of former riverine and fringe wetlands in the floodplain have dried up. Much of the former river channel and riverine wetlands have been replaced by exposed rock, cobble, and sand. The loss of these ecosystems has resulted in the loss of habitat for such aquatic and wetland species as the snail darter, leopard frog, and blue heron.

Yet another manifestation of the degraded ecological conditions in the study area is the rampant growth of an exotic tree species called salt cedar. Salt cedar, a salt- and drought-tolerant invasive species, has thrived in dry Salt River riverbed, out-competing, and in many areas, replacing native vegetation. The leaves of salt cedar trees exude a noxious compound that, upon decomposition in the soil, increases the salinity of the soil, thereby inhibiting the growth of other plant species. Stands of salt cedar therefore tend to be dense and monotypic, providing very low habitat values for native birds and mammals. In addition to their negative impacts on habitat quality, the density and roughness of salt cedar “forests” in the Salt River riverbed also contribute to flooding problems during episodic flash flood events (the trees retard passage of flood flows and contribute to increased sediment deposition). An estimated 1,000 acres of salt cedar now cover the floodplain in the study area.

An illustration of our sample study area is shown in Figure 8. (Note that this figure shows proposed solutions for the study area. A figure of the study area itself would not actually show proposed features, only existing conditions.)

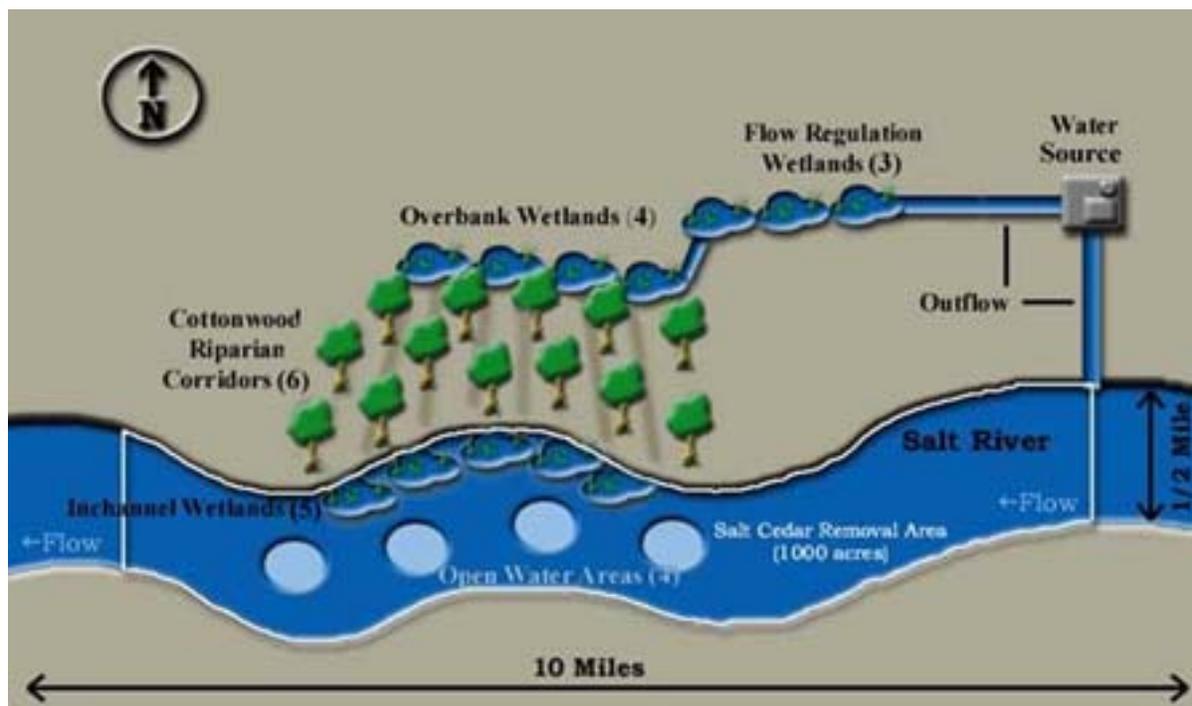


Figure 8
Sample Study Area

Solutions

In cooperation with the local sponsor, state resource agencies, other Federal agencies, and local stakeholders, the Corps District office developed several solutions (various management measures at various sites) to the problem of degraded riparian and riverine ecosystems in the Salt River floodplain. Since lack of surface water in the Salt River channel was considered fundamental to all associated environmental problems, finding a source of water was a critical prerequisite to all proposed solutions. Fortunately, an underutilized source of water was available and acceptable to all the concerned parties: outflow from a nearby municipal wastewater treatment plant. Effluent from the plant is treated with secondary treatment processes, meeting all state water quality and EPA discharge criteria. All the proposed ecosystem restoration solutions make use of the wastewater treatment plant outflow. The individual sites and management measures (explained below) can be employed individually or in combination with each other to contribute to ecosystem restoration.

Solution 1: Diurnal Flow Regulation Wetlands

Diurnal flow regulation wetlands would be created on the north bank of the Salt River and just west and downstream from the treatment plant outfall. They would be constructed at bank level above the 100-year floodplain. A pump would be required to move water from the wastewater treatment plant outflow discharge to the wetlands site. The wetlands would help to control and attenuate the diurnal pulses of water released from the plant, evening out the flows to more closely emulate a natural system. The wetlands would help to “polish” the effluent, thereby further improving water quality, as well as creating valuable habitat for the Yuma clapper rail, blue heron, and other bird species. It was estimated that a minimum of 50 acres would be required to handle and regulate the flow from the treatment plant. Therefore, 50 acres was considered the minimum scale for this solution. However, land is available to accommodate larger areas of diurnal flow regulation wetlands; these could be built linearly and further west of the initial 50-acre site. Larger wetland acreages of 100 and 150 acres would therefore be considered (corresponding to scales 2 and 3) of this first solution.

Solution 2: Overbank Wetlands

Overbank wetlands would be created further west and downstream of the regulation wetlands and located, not in the Salt River channel itself, but at bank level. These wetlands would be supplied with water from the regulation wetlands. Their purpose is to provide similar habitat to what had historically existed for various aquatic, bird, amphibian, reptilian, and mammalian species. The overbank wetlands would also provide source water for downstream (and downhill or “downbank”) cottonwood and willow riparian corridors. Various scales and configurations of overbank wetlands are possible, but their general shape would be roughly linear along the top of the river bank, between approximately 100 to 200 yards wide, and covering areas of 25 to 150 acres (25 acres corresponding to scale 1; 75 acres to scale 2; 100 acres to scale 3; and 150 acres to scale 4). Because the overbank wetlands (solution 2) are supplied water through the diurnal flow regulation wetlands (solution 1), solution 2 is dependent on solution 1.

Solution 3: Remove Salt Cedars from River Channel

This solution would entail removing all 1,000 acres of invasive salt cedar trees from the Salt River riverbed and the area between the overbank wetlands and the riverbed. The trees would be bulldozed, uprooted, and removed. Removing invasive salt cedar is a prerequisite to enabling native plant species to re-vegetate the area and would also improve the channel's capability to handle and pass flood flows. It was determined that removing all 1,000 acres would be required to effect any significant improvement in the local ecosystem. Complete removal would prevent the rapid re-population of salt cedar stands, which is able to out-compete native species due to its tolerance for high salt concentrations in the soil. Therefore only 1 scale would be considered for this solution. This solution is required before any of the other solutions involving re-vegetation of native species can be considered (i.e., solutions 4, 5, and 6 are dependent on solution 3.) No specific outputs are associated with the removal of salt cedar *per se*. Rather, this solution is a pre-requisite to the implementation of solutions 4-6 and the associated riparian, open water, and wetland habitats they would provide.

Solution 4: Cottonwood-Willow Riparian Corridors

These 500- to 1,000-yard long corridors of planted cottonwood and willow trees would extend southwesterly from outflow points along the overbank wetlands, extending down the river bank toward the river channel itself. Water from the wetlands would feed excavated, shallow ditches, descending in elevation toward the river, with the banks along both sides of the ditches planted with cottonwood and willow trees and native bushes. Surface water and groundwater flow through the trench corridors would provide the required quantity of soil moisture to support tree growth. The cottonwood-willow riparian vegetative cover provides very high habitat values to a variety of bird and mammalian species. Enough water discharging from the overbank wetlands would be available to support up to six riparian corridors of approximately 50- to 100-yard widths and 500- to 1,000-yard lengths. These riparian corridors would correspond to scales 1 - 6 for this solution category (scale 1 = construct 1 riparian corridor, scale 2 = construct 2 riparian corridors, scale 3 = construct 3 riparian corridors, and so on). Because the cottonwood willow corridors (solution 4) are dependent on water flows from the overbank wetlands (solution 2), solution 4 is dependent on solution 2. Likewise, the establishment of cottonwoods and willows is dependent on the removal of salt cedar, so solution 4 is also dependent on solution 3.

Solution 5: Create Open Water Areas in River Channel

This solution would consist of excavating and grading depressions or pits in the riverbed that would serve as deep water pools and open water areas to capture water from flood flows and some of the wastewater treatment plant outflow. The open water areas would provide habitat for various aquatic species, as well as provide food and water sources for various bird and terrestrial species. Various sizes and configurations of open water areas could be constructed. Four scales would be considered: 100, 200, 300, and 400 acres. Before this solution can be implemented, the existing stands of salt cedar must be removed, so solution 5 is dependent on solution 3. Creation of open water areas will also inhibit the re-establishment of salt cedar in the area.

Solution 6: Create Riverine and Fringe Wetlands Within River Channel

This solution would entail excavation and grading of sand and cobble areas to appropriate elevations within the river channel adjacent to open water areas and along the edge of the river channel to create riverine and fringe wetland areas. Water would be supplied from nearby open water areas and residual flow from riparian corridors. Wetland plants would be planted. These wetland areas would provide habitat for various aquatic, bird, amphibian, reptilian, and mammalian species. One to 5 wetland areas of 120 acres each would correspond to scales of 120, 240, 360, 480, and 600 acres. Before this solution can be implemented, the existing stands of salt cedar must be removed, so solution 6 is dependent on solution 3. Creation of wetlands within the river channel area will also inhibit the re-establishment of salt cedar.

Costs and Outputs

The important variables that must be considered in any cost effectiveness and incremental cost analyses (CE/ICA) are the costs and outputs of the proposed solutions. In this study, the implementation and operation and maintenance costs in dollars of each proposed solution and scale were calculated by cost estimators and converted to an average annual equivalent amount by economists (presented in \$1000 in Table 4 below).

Solution Number	Solution Description	Scale Number	Scale (Acres)	Costs (\$1,000)
1	Flow Regulation Wetlands	1	50	661
1	Flow Regulation Wetlands	2	100	783
1	Flow Regulation Wetlands	3	150	849
2	Overbank Wetlands	1	25	415
2	Overbank Wetlands	2	75	620
2	Overbank Wetlands	3	100	815
2	Overbank Wetlands	4	150	1,010
3	Remove Salt Cedar	1	1,000	3,480
4	Riparian Corridors	1	15	144
4	Riparian Corridors	2	27	251
4	Riparian Corridors	3	47	370
4	Riparian Corridors	4	75	489
4	Riparian Corridors	5	101	560
4	Riparian Corridors	6	125	664
5	Open Water	1	100	2,150
5	Open Water	2	200	3,780
5	Open Water	3	300	5,777
5	Open Water	4	400	7,220
6	In-channel Wetlands	1	120	1,667
6	In-channel Wetlands	2	240	3,156
6	In-channel Wetlands	3	360	4,200
6	In-channel Wetlands	4	480	5,913
6	In-channel Wetlands	5	600	6,656

Note: Costs are expressed on an average annual equivalent basis.

In this study, the outputs of the proposed solutions are the changes in ecosystem values derived from the habitats produced by each solution. Some of the solutions use treated wastewater as a water source to produce wetlands and riparian habitats. Other solutions yield open water and wetlands habitats in the river channel, while another involves removal of a low-quality habitat associated with monotypic stands of an exotic species, which allows it to be replaced with higher-value native species. These wetlands, riparian, and open water areas provide habitat for a variety of aquatic, wetland, terrestrial, and bird species. Rather than attempting to measure ecosystem outputs on a species-by-species basis, the interdisciplinary study team in this case decided to quantify outputs in terms of the acres and quality of those acres for each cover type or habitat produced by each solution. The output categories were therefore defined as wetland habitat, cottonwood-willow riparian habitat, and open water habitat. The quality of these habitat types was estimated by the biologists on the study team using available ecological models and best professional judgment. Quality Index values of 0.0 to 1.0, similar to Habitat Suitability Index (HSI) values, were estimated for each parcel of cover type to describe its overall quality for a variety of species' habitats under without project and with project conditions. Table 5 displays the acreage of various cover types produced by each of the solutions and scales, as well as the difference in Quality Index values between without project and with project conditions (i.e., the Quality Index value shown is the improvement or "lift" in habitat quality effected by implementation of a given solution). These quality index values were then multiplied by the acreage of each cover type restored or created to provide a quantity and quality measurement of the ecological output of each solution and scale (see Table 6 below). These "net" outputs are the output quantities to use for CE/ICA. The outputs displayed were calculated on an average annual basis over the 50-year project life.

The cost information from Table 4 and the output information from Table 6 for the various solutions and scales will be used in the IWR Planning Suite software example in the following sections.

**TABLE 5
OUTPUTS (ACRES AND QUALITY INDEX VALUES) OF SOLUTIONS AND
SCALES**

Solution Number	Solution Description	Scale Number	Scale (Ac)	Wetlands		C-W Riparian		Open Water	
				Ac	QI	Ac	QI	Ac	QI
1	Flow regulation wetlands	1	50	50	0.8				
1	Flow regulation wetlands	2	100	100	0.8				
1	Flow regulation wetlands	3	150	150	0.8				
2	Overbank Wetlands	1	25	25	0.85				
2	Overbank Wetlands	2	75	75	0.85				
2	Overbank Wetlands	3	100	100	0.85				
2	Overbank Wetlands	4	150	150	0.85				
3	Remove Salt Cedar	1	1,000	1,000	0				
4	Riparian Corridors	1	15			15	1.00		
4	Riparian Corridors	2	27			27	1.00		
4	Riparian Corridors	3	47			47	1.00		
4	Riparian Corridors	4	75			75	1.00		
4	Riparian Corridors	5	101			101	1.00		
4	Riparian Corridors	6	125			125	1.00		
5	Open Water	1	100					100	0.65
5	Open Water	2	200					200	0.65
5	Open Water	3	300					300	0.65
5	Open Water	4	400					400	0.65
6	In-Channel Wetlands	1	120	120	0.90				
6	In-Channel Wetlands	2	240	240	0.90				
6	In-Channel Wetlands	3	360	360	0.90				
6	In-Channel Wetlands	4	480	480	0.90				
6	In-Channel Wetlands	5	600	600	0.90				

Note: Ac – Acres; QI – Quality Index. Quality Index values shown are the difference (improvement) in QI between with project and without project conditions.

**TABLE 6
COMPOSITE OUTPUTS (ACRES X QUALITY INDEX VALUES)**

Solution Number	Solution Description	Scale Number	Output
1	Flow Regulation Wetlands	1	40
1	Flow Regulation Wetlands	2	80
1	Flow Regulation Wetlands	3	120
2	Overbank Wetlands	1	21.25
2	Overbank Wetlands	2	63.75
2	Overbank Wetlands	3	85
2	Overbank Wetlands	4	127.5
3	Remove Salt Cedar	1	0
4	Riparian Corridors	1	15
4	Riparian Corridors	2	27
4	Riparian Corridors	3	47
4	Riparian Corridors	4	75
4	Riparian Corridors	5	101
4	Riparian Corridors	6	125
5	Open Water	1	65
5	Open Water	2	130
5	Open Water	3	195
5	Open Water	4	260
6	In-Channel Wetlands	1	108
6	In-Channel Wetlands	2	216
6	In-Channel Wetlands	3	324
6	In-Channel Wetlands	4	432
6	In-Channel Wetlands	5	540

Section 5

Software Terms and Procedures

The following sections describe terminology and procedures for using the IWR Planning Suite software.

Software Terminology

IWR Planning Suite uses terms that have specific meanings within the context of the application to refer to various aspects of the planning process, and to refer to different entities associated with the planning investigation. Commonly used terms you will need to know in order to easily work through the example follow. These include such concepts as:

- Plan Alternatives
- Planning Sets
- Plan Studies
- Variables and Attributes
- Application Suite
- Plan Editor
- Plan Generator

There is also a glossary at the end of this guide which may be used as a quick reference for many common terms.

Plan Alternative

A Plan Alternative, which may just be referred to as a “plan” or an “alternative”, is a set of one or more solutions (activities) of particular scales. Plan alternatives are created to address planning objectives. Each plan has a cost and one or more resulting outputs. Within IWR Planning Suite, a plan consists of a plan name, a set of variables, and a set of attributes.

Plan alternatives are discrete entities, and need not necessarily be derived from a fixed set of solution and scale combinations. With such a configuration, the planner gains a great deal of leverage in the ability to define their own plan alternatives and scenario sets and to edit, combine or remove plans from both planning sets produced by the Plan Generator Module, and those that they enter themselves.

The same plan alternative can be a member of and shared by more than one planning set in a plan study simultaneously. This capability gives planners complete control over the planning sets used for analysis and removes any restrictions that would be imposed by a planning set generator that is tied directly to a plan scenario analysis. Prior to analysis, the plan alternatives

can be described in exactly the format and subset most appropriate for the analysis that is to be undertaken.

Planning Set

A planning set or “plan set” is a grouping of individual plan alternatives. There are different kinds of planning sets in IWR Planning Suite, all having their own special use and purpose. There are generated planning sets, user-defined planning sets, constrained planning sets, and analysis planning sets. A description of each follows. The user may think of planning sets as similar to the term “scenario” as used under the IWR-PLAN version 3.33 nomenclature.

Generated Planning Set: A set of plan alternatives created with a plan generator from solutions (management measures) and scales.

User-Defined Planning Set: A set of plan alternatives entered by a user through the Plan Editor. Planners gain a great deal of leverage in the ability to define their own plan alternatives and scenario sets and to edit, combine or remove plans from both planning sets produced by IWR Planning Suite’s plan generation capabilities and those produced by other means.

Constrained Planning Set: A set of plan alternatives created by applying limiting criteria to an existing planning set. Constraints may be defined within the plan editor to filter the planning set to only those plan alternatives that meet a set of predefined criteria. The criteria are minimum and maximum acceptable values for a particular variable. Derived variables (explained below) are not available for use by a constraint group. To define a constrained planning set, the planning set name is entered, along with one or more variables to constrain it by a minimum and maximum acceptable value for each variable. The application of a constraint to a planning set will generate a new planning set containing only the plan alternatives that meet the constraining criteria.

Analysis Planning Set: A set of plan alternatives created by performing an analysis on an existing planning set.

Active Planning Set: The planning set that is currently selected and visible in the Plan Editor. The active planning set is the one that component modules act upon. The user can easily change the active planning set to another planning set at any time, allowing a variety of planning sets to be operated on simultaneously.

Plan Study

A “Plan Study” or “Planning Study” refers to a single database or data file in IWR Planning Suite. It is a related group of planning sets derived from a common set of plan alternatives. It contains all of the plan alternatives and analysis results used to evaluate candidate plans for a specific planning task. In some cases, it may be considered to represent the plan formulation and analysis portion of the planning investigation. In other cases it may represent one portion or one iteration of these parts of a particular planning investigation.

Plan Alternative Variable

A Plan Alternative Variable is a category used for comparative purposes in analyses. A “variable” describes some characteristic of the alternatives, or management measures comprising those alternatives, in a planning study. Some examples of variables are cost, output, habitat units, and other effects. Variables are the constituent components of “derived variables.” A Derived Variable is a variable, the value of which has been derived via a user-defined mathematical formula from the values of other variables in the plan alternative. Derived variables are described by formulae applied to component variables. Mathematical functions such as the additive, multiplicative, or exponential functions may be applied to these component variables, along with many other standard mathematical operations. They are thus added to the planning study and described in terms of a variable name, description, measurement units, and a calculation formula.

Plan Alternative Attributes

The plan alternative representation is enhanced by the ability to internally associate data items other than solutions, scales, costs and outputs with plan alternatives. This new kind of plan alternative association is called a plan “attribute.”

An Attribute is a value or hierarchical structure of values associated with a plan alternative. It is distinguished from a variable in that it identifies a characteristic of the entire plan alternative, rather than being an intrinsic part of the plan alternative. An attribute is connected to a plan alternative associated with a particular planning set. In other words, two attributes of the same name connected to the same plan alternative may have two different values in two different planning sets.

In IWR Planning Suite, an attribute is a named label with a textual or numeric value associated with it. Some examples of attributes are Cost Effective, Plan of Interest, and Rank.

Attributes applicable to the analysis may be defined, such as a *plan of interest* attribute, to be used by reporting and visualization modules. Then, once the rows of the planning set are created, individual *plans of interest* may be chosen. To do so, the *plan of interest* attribute of the row is marked in the planning set editor. At this time, if the planning set was generated by the Plan Generator Module, a more appropriate name for the plan (say, for example, than A1B0C4D2), may be entered and associated with a specific plan alternative.

For example, for a proposed Civil Works project, there may exist a *locally preferred plan*, which is a plan that is preferred by a non-Federal sponsor of a Civil Works project. In such a case, it would be desirable during analysis to take particular note of this plan and its relationship to various plan alternatives during analysis. This would be a case where designating the locally preferred plan as a *plan of interest* would be useful.

Distinguishing between a variable and an attribute

Here are some useful tips to help you to remember what a variable is used for as opposed to the use of an attribute. As previously stated, a variable is an intrinsic characteristic of a plan alternative, while an attribute identifies a characteristic that may change for a given alternative between different planning sets.

The result of this distinction is that variable values are the same for a particular plan alternative in any planning set in a plan study. For example, in the planning study “My Plan Study”, in all planning sets that use “Plan A”, the “Cost” variable of Plan A will have the same value.

However, attribute values may be different for a particular plan alternative in any planning set in a plan study. For example, Plan A’s “Cost Effective” attribute may be “Yes” in one planning set, and “No” in another, because different analysis parameters may have been used to generate the two planning sets.

Application Suite

IWR Planning Suite is an Application Suite of software Components. It is composed of the base Plan Editor component, to which other components can be readily added or removed. The modular “plug-and-play” ability to add or remove new components without re-installing IWR Planning Suite lends itself to a more flexible architecture where you can pick and choose the modules that suit your needs. Current modules include a Plan Editor Component, which includes CE/ICA analysis and reporting, and a Plan Generator Component. A Multi Criteria Decision Matrix (MCDM) module is being developed along with new reporting and graphing capabilities. New modules are easy to add to IWR Planning Suite as needed. All of the functionality of all modules is dynamically integrated into and available from within the Plan Editor multi-document interface (MDI) window.

Plan Editor

The Plan Editor is a Windows-based MDI (Multiple Document Interface) application. It is the “Frame” for other components. Other modules, such as the Plan Generator, can be “Plugged Into” it, and enabled or disabled at will by the user.

The plan editor allows you to create sets of plan alternatives individually without the need to invoke the Plan Generator. However, it is also able to accept generated planning sets from the Generator module. Planning Sets are grouped into a Planning Study within the Plan editor.

A diagram of the various toolbar components of the Plan Editor and their use is shown below (Figure 9). You may use it as a quick reference while going through the example scenario below.

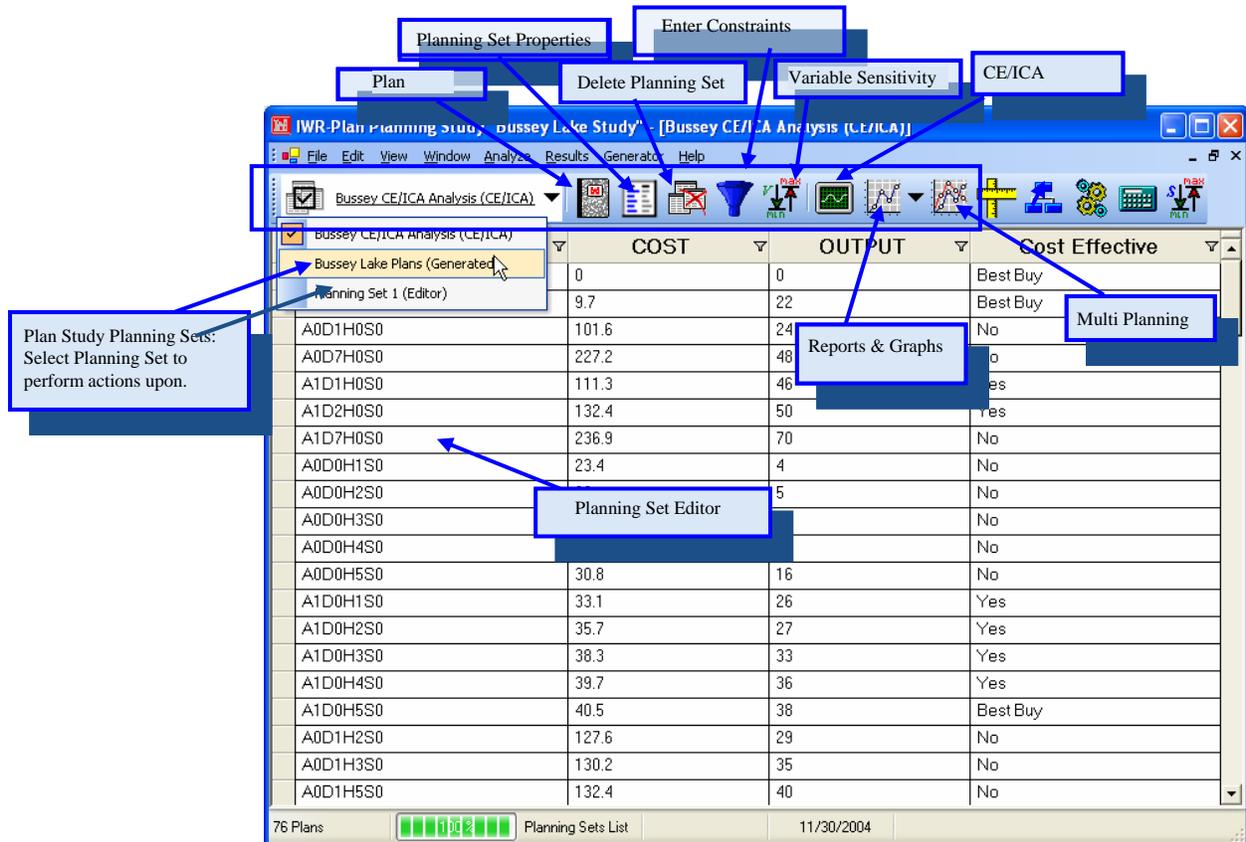


Figure 9
Plan Editor Toolbar Components

The Plan Editor is the primary user interface for IWR Planning Suite because planning sets are the principal “documents” that IWR Planning Suite works with. The plan editor module has the intrinsic ability to edit, import and export sets of planning alternatives or “planning sets”. The plan editor module allows the active planning set to be edited. The individual values in a plan alternative may be edited. Individual row cells, representing variable or attribute values, may be selected and modified to change the individual values of a specific plan alternative in the planning set. In other words, values may be typed directly in each cell of the new row to enter the values for the plan attribute. Individual plan alternatives may also be inserted into or removed from the active planning set.

Plan Generator

The Plan Generator is a wholly separate module which runs fully integrated within the IWR Planning Suite Editor. It uses the previously described Solutions and Scales approach to plan generation to generate planning sets which may then be subjected to analysis. A diagram of the various toolbar components of the Plan Generator and their use is shown below (Figure 10). You may use it as a quick reference while going through the example scenario below.

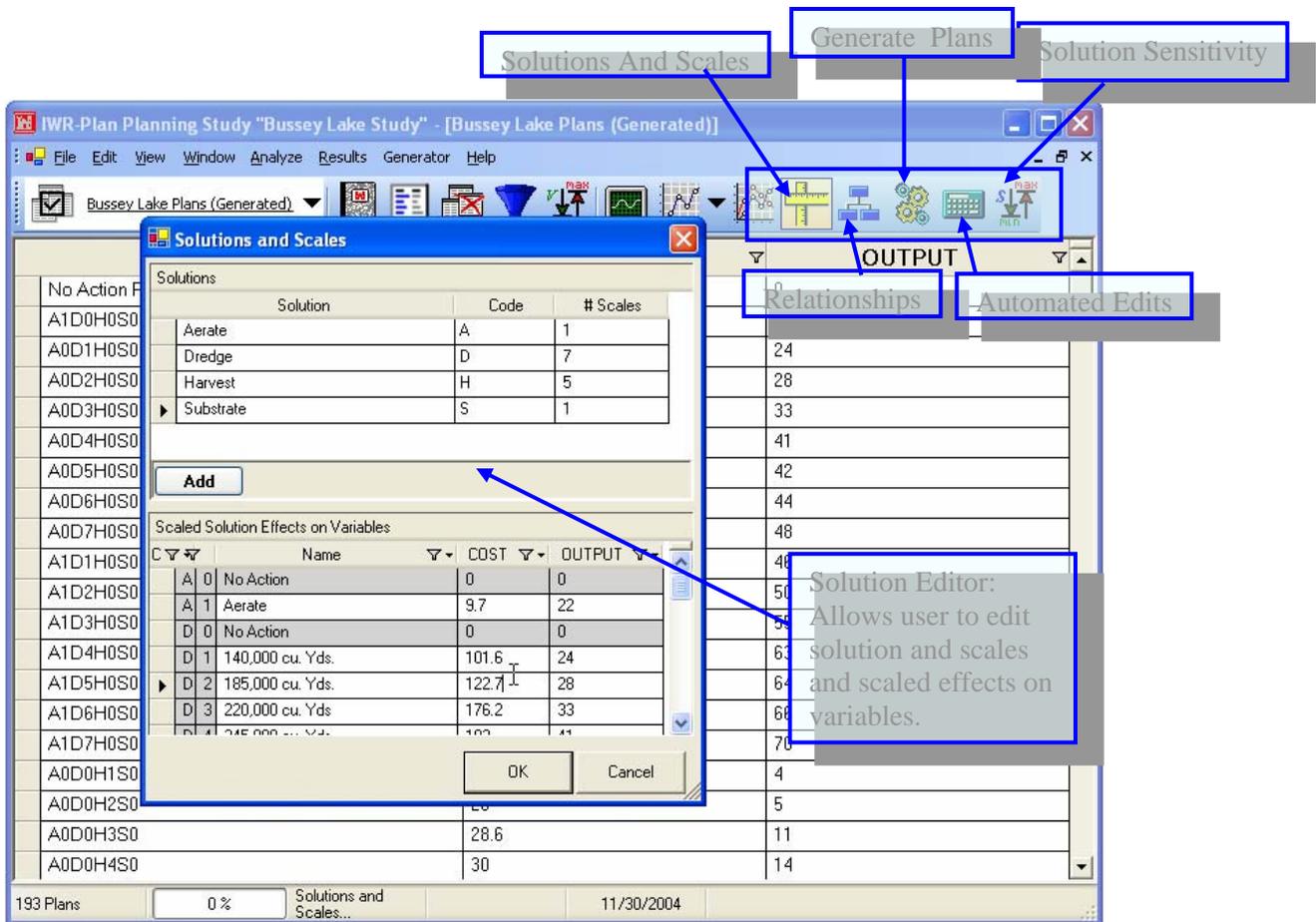


Figure 10
Plan Generator Toolbar Components Use

Software Procedures

Opening the Plan Editor

You will be working within the IWR Planning Suite Plan Editor throughout the example scenario. The Plan Editor maintains a Plan Study containing planning sets, and all IWR Planning Suite functions are performed within Plan Studies. To open the plan editor, click on the Windows Start button to open up the Start Menu with your name listed at the top of the menu (see Figure 11).

The Plan Editor module allows the active planning set to be edited. The individual values in a plan alternative may be edited. Individual plan alternatives may also be inserted into or removed from the active planning set. The same plan alternative can be a member of and shared by more than one planning set in a plan study simultaneously.

This capability gives the planner complete control over the planning sets used for analysis and removes any restrictions that would be imposed by a planning set generator that is tied directly to a plan scenario analysis. Within this open environment, where planning sets may be created manually or may be imported from an export file, planning sets are not limited to a fixed set of solution and scale combinations as they were in IWR-PLAN version 3.33. Generated planning sets are now “open” such that plan alternatives can be added to or deleted from them or edited in the planning set manually.

Creating a New Plan Study

To follow along with the case study described in the previous chapter, simply create a new file and follow the procedures below. To create a new file, select New from the File menu and provide a name for the file as shown in Figures 13 and 14. Alternatively, you may use the default Plan Study that IWR Planning Suite automatically creates the first time you start it.

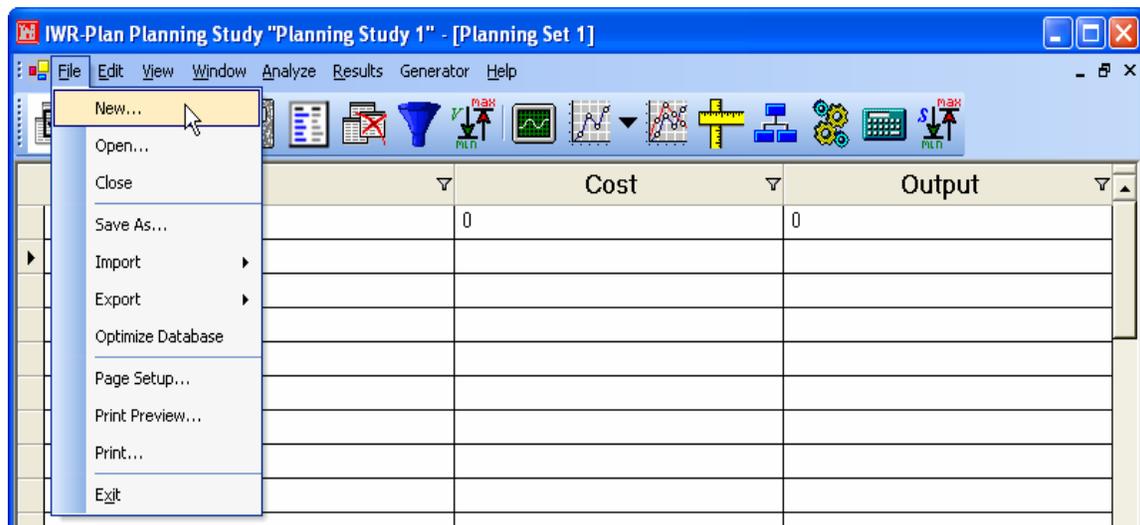


Figure 13
Creating A New Study Plan

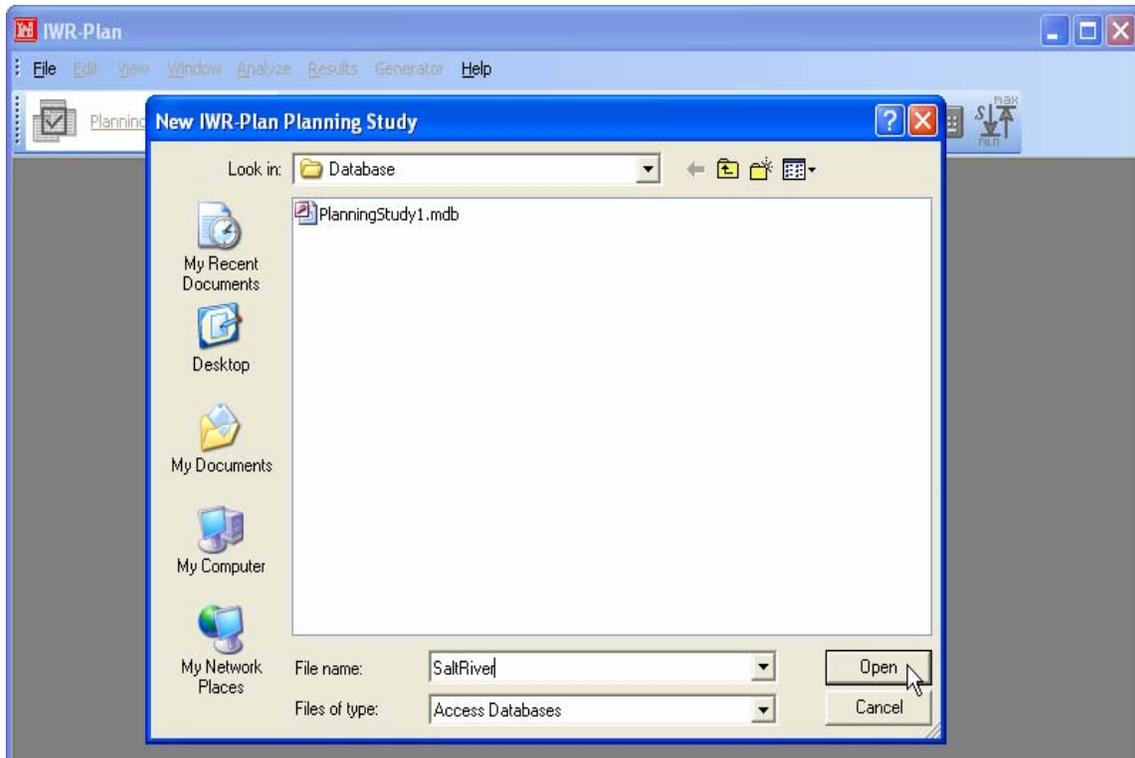


Figure 14
New File Name "SaltRiver"

In this case study, the name "SaltRiver" is used as the file name

Working with Planning Sets

A default planning set that may be edited through the Plan Editor is created for each new Plan Study. Other planning sets of a plan study may be created through several methods, including importing, constraints, plan generation, and plan analysis. Planning set properties (see Figure 15 for the icon on the toolbar), as shown in the planning set properties dialog (see Figure 16), include the title of the parent planning set from which they are derived.



Figure 15
Planning Set Properties Option

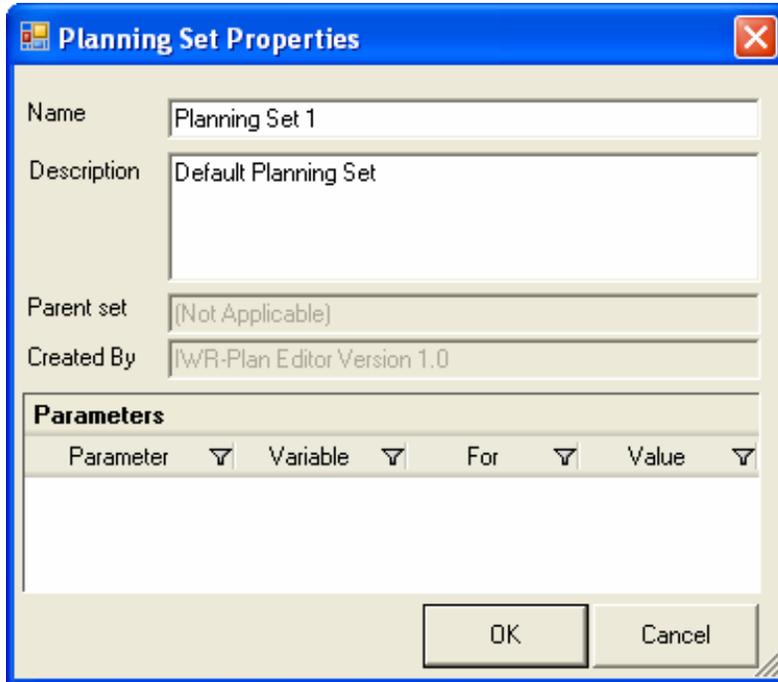


Figure 16
Planning Set Properties Dialog

In the case of an imported planning set file, an example would be “Imported Planning Set myplanningset.xls.” If the planning set were generated from the active planning set, by an analysis module or by a constraint group, the parent planning set would be the name of the active planning set.

For example, if a constraint is defined and performed on the planning set “base plans,” the new planning set generated (for example, “constrained plan 1”), would have a “parent set” value of “base plans.” You will be able to determine the contextual meaning of a planning set from this information,

whether it is an initially generated plan, a scenario variation on that plan or the results of an analysis.

Removing Planning Sets

Planning sets other than the default Plan Editor planning set may be deleted, or removed from the plan study by clicking the *Delete Planning Set...* icon of the toolbar (see Figure 17), or as an item under the main menu View menu.

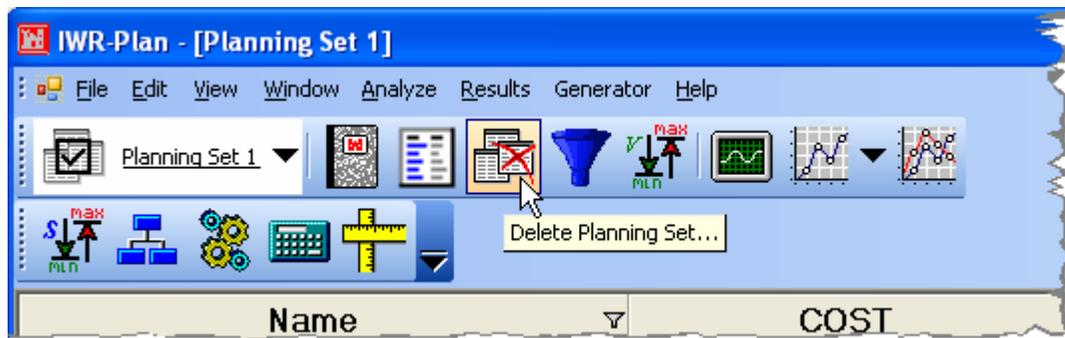


Figure 17
Delete Planning Set Icon

This will cause the Delete Planning Set dialog to appear (Figure 18).

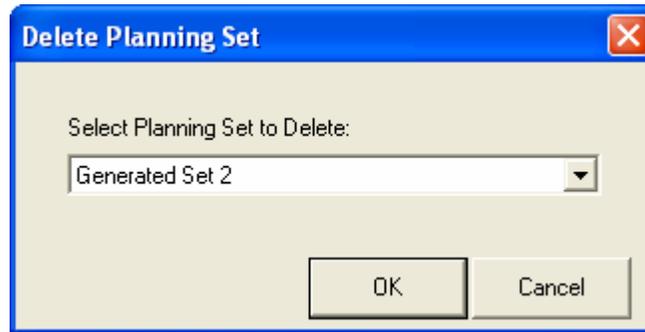


Figure 18
Delete Planning Set Dialog

You may select the planning set you wish to delete from the list of available plan sets, and press OK to remove it from the planning study permanently. Please be aware that the operation cannot be undone once OK is pressed, and the planning set selected will be deleted and will not be recoverable by any means. Press Cancel to exit the form without removing any planning sets from the planning study.

If no planning sets exist other than the default plan editor planning set, which cannot be deleted, the following dialog (Figure 19) will appear indicating that no planning sets are available to be removed in the current planning study:



Figure 19
Planning Set Removal Dialog

Planning Set removal may become necessary if a planning set analysis is performed with the incorrect cost and output variables, for example, or if a planning set is generated with an incorrect set of parameters. It may also be helpful to delete planning sets when the planning study has become "cluttered" with too many that are no longer current or no longer applicable.

Costs and Outputs

The first step in performing incremental cost analyses for our sample ecosystem restoration study is to determine and define the costs and outputs to be used. Within the IWR Planning Suite, we use the term *variables* to denote these costs and outputs. Variables are the categories upon which the effects of alternative plans will be compared and upon which cost effective and incremental cost analyses will be performed. A minimum of two variables must be defined for

cost effectiveness and incremental cost analyses: a cost variable and an output variable. Examples of output variables might include: habitat units, acres of wetlands, stream miles restored, number of salmon, diversity indices, etc. Due to processing time considerations, it is recommended that no more than ten variables be defined in an IWR Planning Suite data file. The IWR Planning Suite also allows for the definition of *derived variables*, which are included in the recommended count of ten or fewer variables. Derived variables will be discussed in more detail later in this chapter.

Plan variables may be created or removed from all the planning sets in a plan study through a planning study structure editor in the Planning Study Properties dialog, which displays the available variables and attributes of the planning sets in the study. Once new attributes or variables have been added and defined via the planning study dialog, the new variable and attribute values may be edited to insert values manually through the planning set editor.

To begin the process, variables and derived variables for an analysis are defined within the plan study properties dialog. The costs and outputs associated with the study are determined and defined. These variables are the categories used for comparative purposes during analysis. For example, if a given planning set was to be used as input data for subsequent CE/ICA analyses, then a cost and an output variable would need to be defined for that planning set. Variables are defined with a variable name, description, and unit of measure. Additional types of variables would be needed for other kinds of analyses, such as multi-variable efficiency analysis.

To define these variables, navigate to the Variables form by selecting the Planning Study icon as shown in Figure 20.

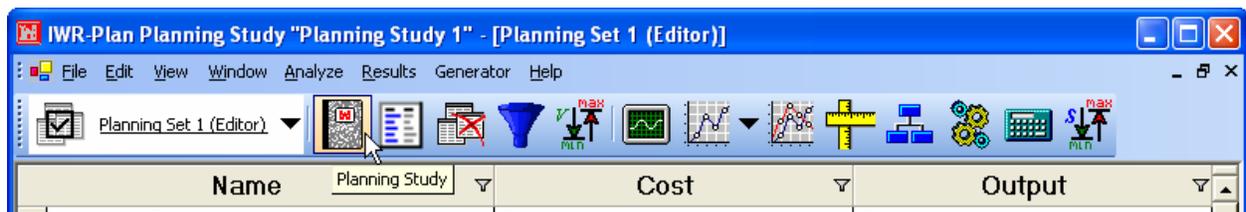


Figure 20
Planning Study Icon

This will open the Planning Study form (Figure 21), which contains a Variables data entry table to allow for the addition, modification, and deletion of variables. Initially, this form displays default "Cost" and "Output" variables for your use. These default variables can be removed or renamed at your discretion to suit the needs of a particular Planning Study. As variables are defined, they will be added to the collection of variables, and will be available for review or modification.

New variables may be defined by clicking the Add button under the Variables table on the Planning Study form (Figure 21). Doing so will create a new row in the table where you may enter properties in six fields that define the variable. These properties are the variable's name, units of measurement, description, whether it is a derived variable, the derived variable formula, and whether the field is to be hidden when displaying planning sets in the Plan Editor.

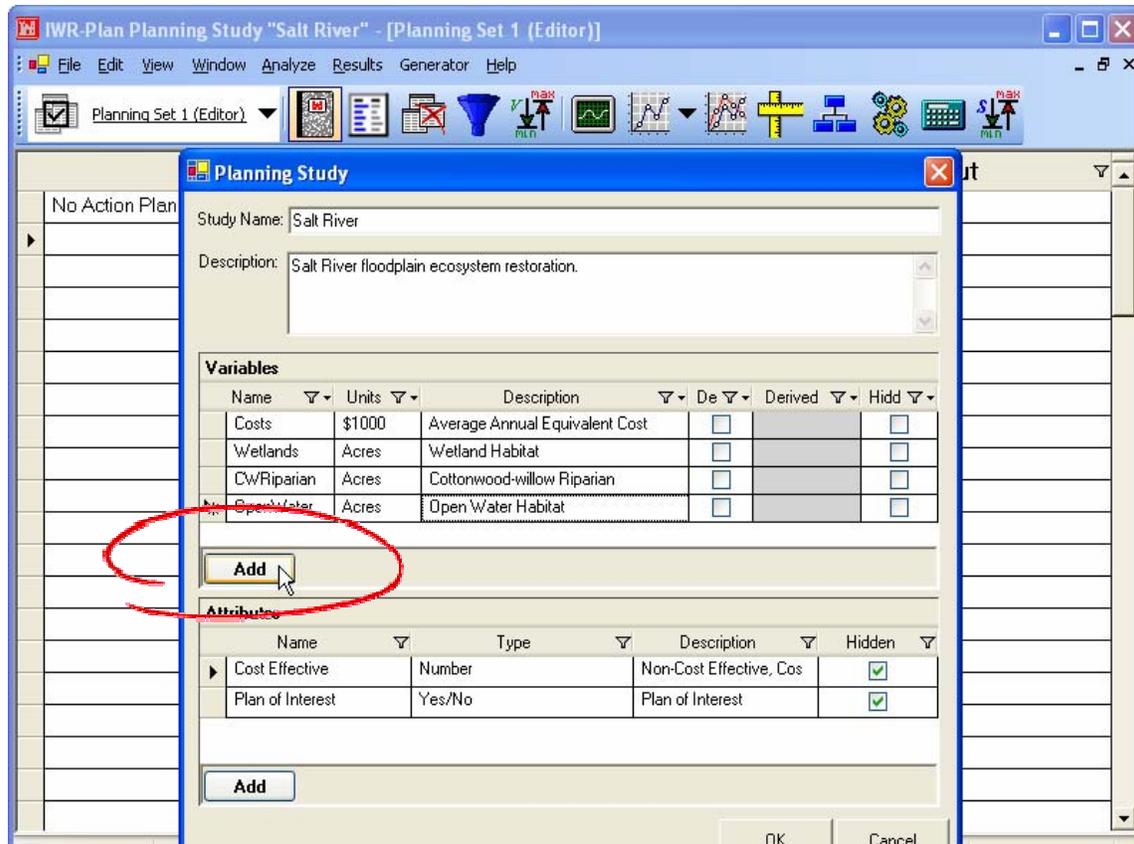


Figure 21
Planning Study Form

The variable name gives a name to the variable that the IWR Planning Suite can use in analysis and reporting. This property is required to be entered and can be made up of any combination of alphanumeric or punctuation characters up to 15 characters in length. Enter “Costs” in the space provided for the variable’s name now.

The description field describes the variable throughout the IWR Planning Suite, specifically in reporting. This field can be up to 50 characters in length. Enter “Average Annual Equivalent Cost” in the space provided for the description now. The units field, or units of measure, is a quantitative representation of the unit used for each variable and can be up to 15 characters in length. Enter “\$1000” in the space provided for units.

The derived checkbox will determine if this variable is a derived variable or not . A Derived Variable is a formulaic combination of two or more other variables already entered into the database. Derived Variables will be discussed later in this section. You may leave the “Hidden” checkbox unmarked for all of the variables you will be entering.

It is highly recommended that the optional fields (“units” and “description”) be defined, as they will be used throughout the IWR Planning Suite in reports and graphs. To add more variables,

simply click the Add button and repeat the procedure above. The table below describes the four variables used in this case study.

Variable (Name)	Description	Units
Costs	Average Annual Equivalent Cost	\$1000
Wetlands	Wetland Habitat	AAHU's
CWRiparian	Cottonwood-willow Riparian Habitat	AAHU's
OpenWater	Open Water Habitat	AAHU's

The first variable that has just been defined is the cost variable for this study. The three remaining variables will be used as the output measures. Enter the three output variables defined in Table 7 now by following the above procedure.

Existing variables may be modified or deleted by clicking on the variable's row in the grid to select it. When a specific variable is selected, it may either be modified or deleted. To modify the current variable, simply tab to and change the appropriate fields. Pressing the Delete or Del key on your keyboard will delete the current existing variable (Figure 22).

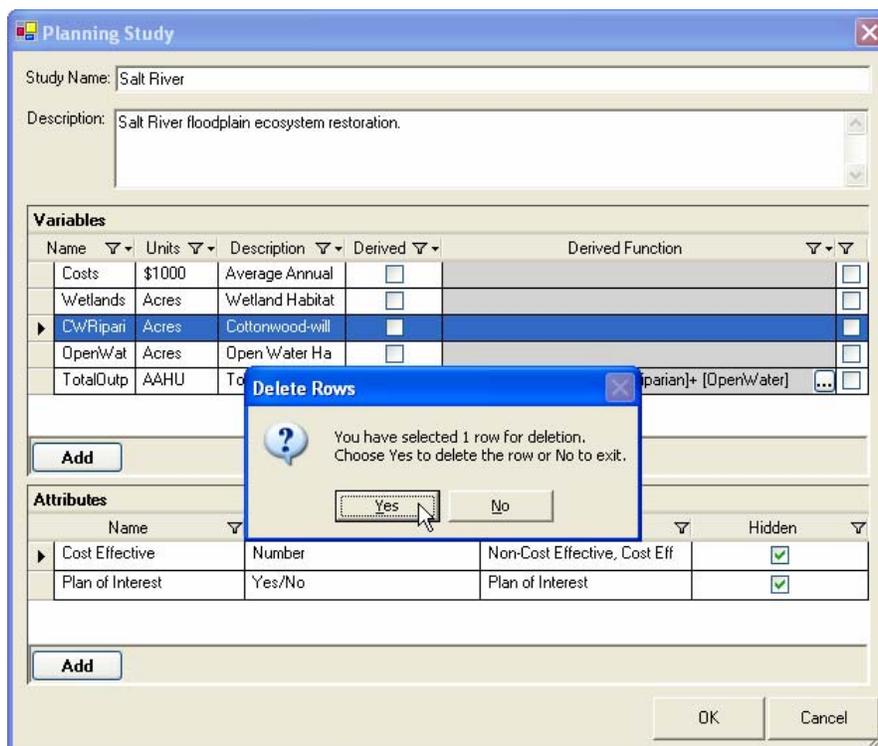


Figure 22
Delete Confirmation

Clicking the OK button will save your changes and close the Plan Study form, while clicking the Cancel button will close the form without saving any changes (Figure 21).

Derived Variables

Next we will define a derived variable. A derived variable is a formulaic combination of two or more other variables already entered into the database. Within a derived variable formula, other variables may be added, subtracted, multiplied, divided, or raised to a power. Square roots, natural logs, and absolute values may also be performed. Derived variables are also added to the planning study through the plan study properties dialog and described in terms of a variable name, description, measurement units, and a calculation formula.

To indicate that a variable is a derived variable, if the planning study properties dialog has been closed, re-open the plan study properties dialog by clicking the planning study properties toolbar icon. Clicking on the Derived checkbox on a variable's row (Figure 23, Step 1) will mark the checkbox and enable the ellipses ("...") button in the Derived Function field. Clicking on the ellipses button will cause the Formula Editor to appear with which to define the formula for computing a derived variable. (Figure 23, Step 3).

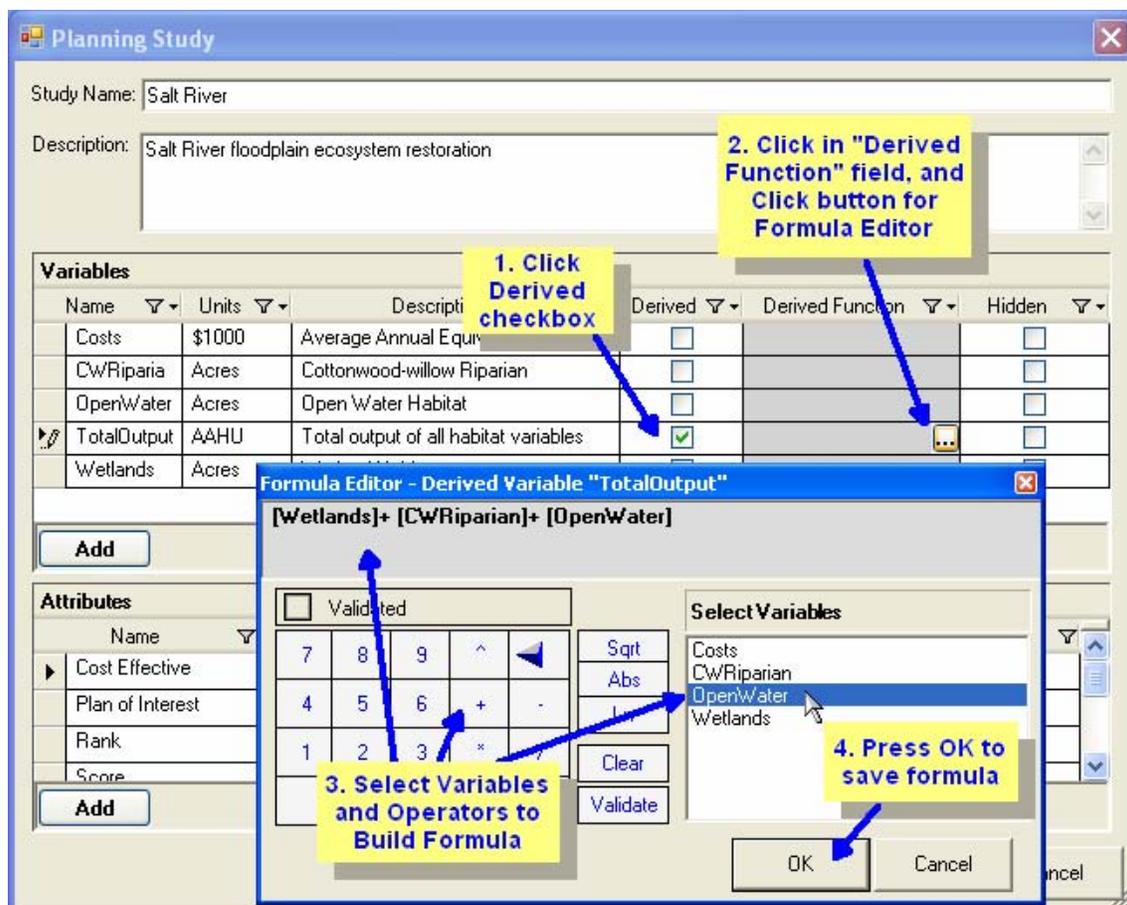


Figure 23
Adding Derived Variables

The Formula Editor contains a blank field in which the user defines the derived variable (Figure 23, Step 3). The user cannot type information manually into the field; rather, the user must select (by clicking) numbers, operators, functions, and variables in sequence to define the derived variable formulation (Figure 23, Step 3). Add a new variable by pressing the Variables table Add button. For the Name, enter "TotalOutput". Enter "AAHU" and "Total output of all habitat variables" as the unit and description. Now proceed to click on the derived checkbox for the variable, and click in the following field with the header "Derived" in order to enable the ellipses button. Click on this button (step 2). Enter the variable formula for "TotalOutput" now by using the sub-form. At this point, the user can click on the Validate button to confirm that the formula is logically valid (from a mathematical perspective, not a scientific one). Alternatively, when the user clicks OK on the Formula Editor dialog, the IWR Planning Suite will automatically check (validate) the derived variable for logical consistency.

Note that since the values of derived variables are not entered by the user, but rather are calculated directly by the IWR Planning Suite, derived variables do not appear in the "Effects on Variables" columns on the Solutions and Scales form. Derived variables are automatically calculated by the program and can be selected as either Cost or Output Parameters to conduct cost effectiveness and incremental cost analyses. To see the calculated values of derived variables for a planning set, select the Planning Set in the Planning Sets combo box in the Plan Editor. Derived variables are labeled as such and their values are displayed.

Solutions and Scaled Effects

The next step in performing incremental cost analyses is to define *solutions* and their effects on each variable. Solutions and their scaled effects are defined through a "Solutions and Scales" dialog (see Figure 24 for the icon on the toolbar). A solution is a management measure or activity and there usually are many levels or sizes for a given solution. These different solution sizes are the scales at which the solution can be implemented. A solution description, solution code, and a number of action scales for the solution are entered to define each solution and scale.



Figure 24
Solutions and Scales Dialog

Solutions and scales may be added, edited, or deleted through the solutions and scales editor. Any solution and scale to be excluded from the set of generated plans may be removed through this editor. The editor automatically generates a "No Action" scale for each solution in the same fashion that solutions and scales were generated for the IWR PLAN version 3.33 functionality.

To define solutions, navigate to the Solutions and Scales dialog (Figure 24).

Once the Solutions and Scales form is loaded (Figure 25), solutions can be defined by pressing the Add button and entering the information. The solution description is a description of what action or measure is to be taken. Enter "Flow Regulation Wetlands" in the space provided for the solution description now (Figure 25, Step 1). The solution code is a multi-letter code of up to ten characters that represents this solution. This code will be used in place of the description when a plan is generated. Now, enter "F" in the space provided for the code for the solution "Flow Regulation Wetlands" (Figure 25, Step 2). The last field on this form represents the number of action scales this solution has. By default, a zero scale is added to each solution and represents no action taken. For example, Flow Regulation Wetlands has three action scales. This means that there are three possible scales at which Flow Regulation Wetlands can be implemented. Enter "3" in the space provided for the number of action scales now (Figure 25, Step 3). This scale will also be used in the plan code (automatically generated by the Plan Generator module) to represent which scale of action is being administered. Take the plan "F2O4R0S1W2I4" for example; the "F" represents the Flow Regulation Wetlands solutions.

The screenshot shows the 'Solutions and Scales' dialog box. It features a table with the following data:

Solution	Code	# Scales
Flow Regulation Wetlands	F	3
Overbank Wetlands	O	4

Below the table is an 'Add' button. At the bottom of the dialog is a table titled 'Scaled Solution Effects on Variables' with the following data:

Cod	Name	Costs	CWRiparian	OpenWater	Wetlands
F 0	No Action	0	0	0	0
F 1	Flow Regulat	0	0	0	0
F 2	Flow Regulat	0	0	0	0
F 3	Flow Regulat	0	0	0	0
O 0	No Action	0	0	0	0
O 1	Overbank W	0	0	0	0
O 2	Overbank W	0	0	0	0
O 3	Overbank W	0	0	0	0
O 4	Overbank W	0	0	0	0

At the bottom right of the dialog are 'OK' and 'Cancel' buttons.

Figure 25
Solutions And Scales Form

Considering the example plan above, the “F2” portion indicates that the second action scale for Flow Regulation Wetlands is being used for this alternative plan. Once a solution or set of solutions are entered, clicking the OK button will validate and save the new solutions (Figure 25, Step 5). If the OK button is not clicked, the solutions are not saved. The Cancel button will close the form (Figure 25).

Table 8 below represents the solutions that are used in this case study. The first solution has just been defined for “Flow Regulation Wetlands”. Enter the five remaining solutions now. Note that up to 52 solutions can be defined per data file. Up to 20 scales (including No Action) can be defined per solution.

TABLE 8 SOLUTIONS		
Solution Description	Code	Number of Action Scales
Flow Regulation Wetlands	F	3
Overbank Wetlands	O	4
Riparian Corridors	R	6
Remove Salt Cedar	S	1
Open Water	W	4
In-channel Wetlands	I	5

For reporting purposes, solutions are displayed in the Solutions and Scales form in the order they will be used to generate plan alternatives. By default, each new solution is given the next consecutive position for its order. Solutions may be dragged and dropped to change the solution order. To create a new solution, simply click the Add button which will add a new row into which the solution information may be entered. Clicking the Delete key on the keyboard after selecting a solution will permanently remove the current existing solution (Figure 25). The OK or Cancel button (Figure 25, Step 5) will allow this form to be closed.

The Solutions and Scales dialog will also allow the entry of quantitative effects on each variable for every solution and scale through the “Scaled Solution Effects on Variables” data entry table (Figure 26). The first two columns of the data entry matrix make up the solution code. The first column is the designator code for the respective solution (provided by the user); the second column is the scale counter. These code columns in the “Scaled Solution Effects on Variables” table are generated by the program and are not editable. The third column is for entering a description for each solution-scale. This default description is editable. The entry of a description is not required, but is recommended. The description may be included in reports and is particularly useful for differentiating different scales of a given solution. Descriptions can be made up of any combination of alphanumeric or punctuation characters and can be up to 30 characters in length. For example “F1” is described as Flow Regulation Wetlands on 50 acres. Therefore, 50 acres will be the description for “F1.” Enter “50 Acres” in the space provided for the description of “F1” now (Figure 26, Step 1). This particular action will cost \$661,000 and result in 40 habitat units of wetlands habitat being generated. These values are entered as follows: the “Costs” field has a value of 661 since the Costs variable is measured in \$1000. Enter “661” in the space provided for the Costs of “F1” now (Figure 26, Step 2). The “Wetlands” field has a value of 40 for this solution and scale. Enter “40” in the space provided for Wetlands now (Figure 26, Step 3). In this case, the solution “F1” does not have any output for CW Riparian (Figure 26, Step 4) or Open Water (Figure 26, Step 5), so these fields may remain “0”. This is how the effects that each solution and scale have on each variable are entered into IWR Planning Suite.

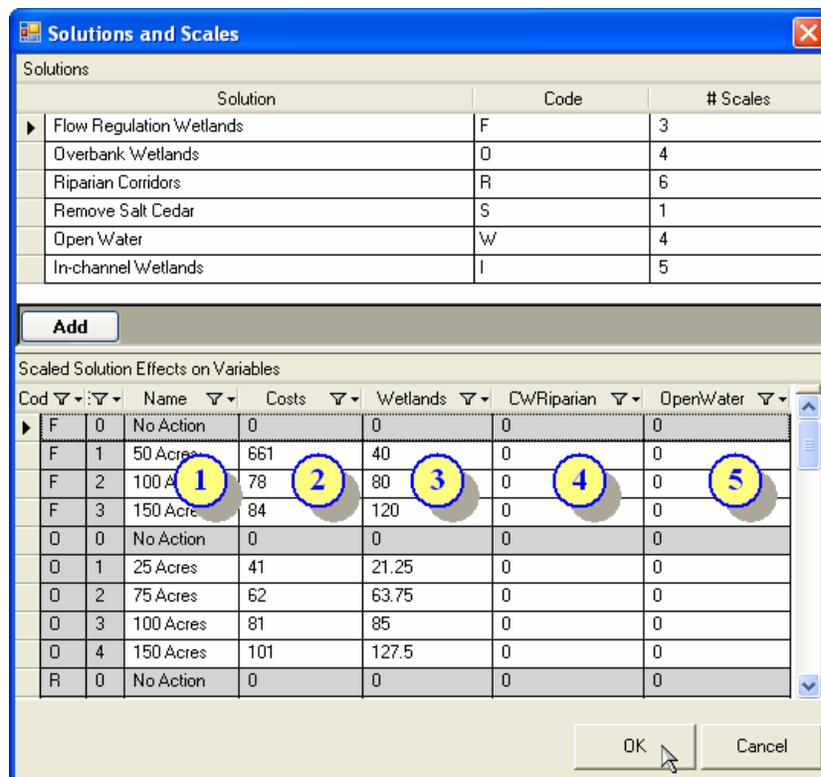


Figure 26
Scaled Solution Effects on Variables Data Entry Table

Table 9 below defines the solutions and scales that are used in this case study. Repeat the procedure above for the 28 remaining solution-scales now.

TABLE 9 SOLUTIONS AND EFFECTS						
Code	Scale	Description	Costs (\$1000)	Wetlands (AAHU's)	CW Riparian (AAHU's)	Open Water (AAHU's)
F	0	No Action	0	0	0	0
F	1	50 Acres	661	40	0	0
F	2	100 Acres	78	80	0	0
F	3	150 Acres	84	120	0	0
O	0	No Action	0	0	0	0
O	1	25 Acres	41	21.25	0	0
O	2	75 Acres	62	63.75	0	0
O	3	100 Acres	81	85	0	0
O	4	150 Acres	1,01	127.5	0	0
S	0	No Action	0	0	0	0
S	1	1000 Acres	348	0	0	0
R	0	No Action	0	0	0	0
R	1	15 Acres	14	0	15	0
R	2	27 Acres	25	0	27	0
R	3	47 Acres	37	0	47	0
R	4	75 Acres	48	0	75	0
R	5	101 Acres	56	0	101	0
R	6	125 Acres	66	0	125	0
W	0	No Action	0	0	0	0
W	1	100 Acres	215	0	0	65
W	2	200 Acres	378	0	0	130
W	3	300 Acres	577	0	0	195
W	4	400 Acres	722	0	0	260
I	0	No Action	0	0	0	0
I	1	120 Acres	166	108	0	0
I	2	240 Acres	315	216	0	0
I	3	360 Acres	420	324	0	0
I	4	480 Acres	591	432	0	0
I	5	600 Acres	665	540	0	0

Note that specific solutions may be filtered for ease of data entry. To select which solutions will appear in the data entry/editing matrix, (Figure 27) click on the Funnel-shaped Filter Icon

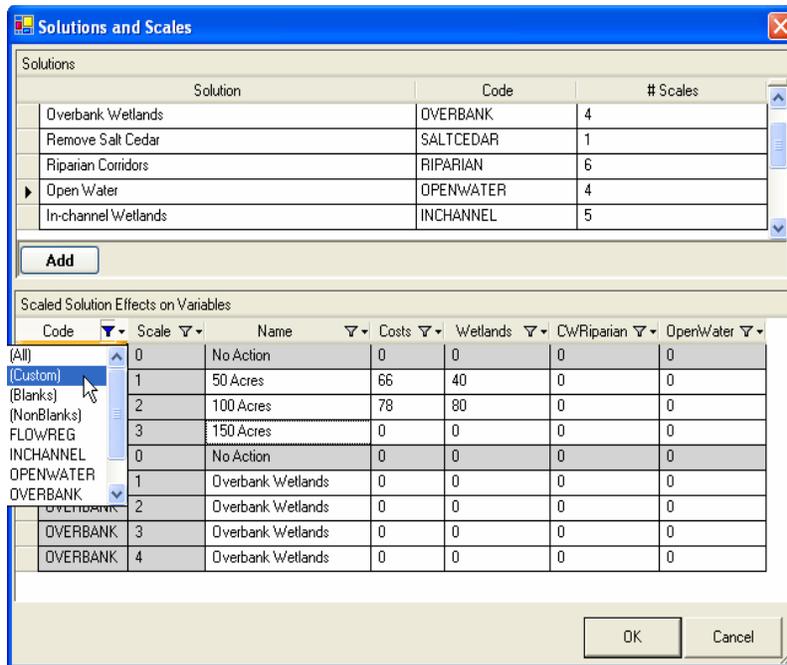


Figure 27
Data Entry/Edit Matrix

above the Code Header and select the solutions you would like to display (Figure 28). After all desired Solutions have been selected, click on the OK Button and the selected solutions will populate the data entry/editing matrix.

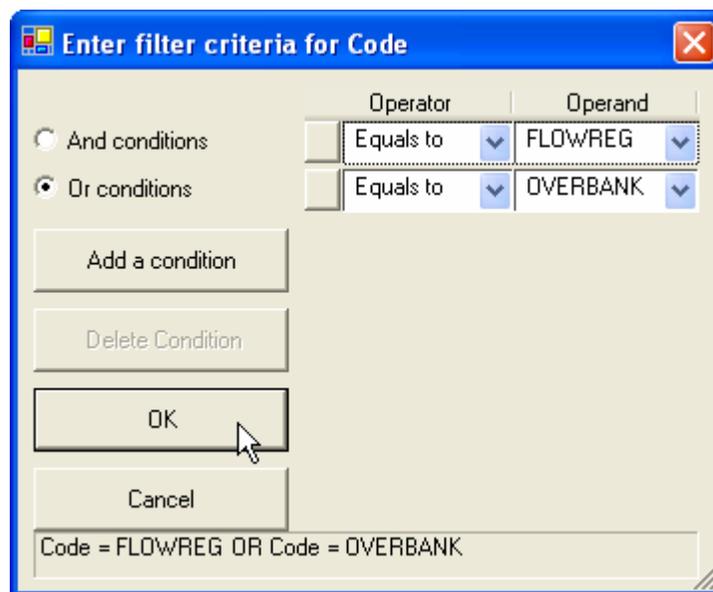


Figure 28
Filter Criteria For Code

This does not delete any Solution or any associated effects data from the database; it simply will not appear in the data entry/editing matrix on the Solutions and Effects form until the filter is turned off by selecting "(All)" from the filter icon combo box.

At this point, solutions may be added or deleted by clicking the Add button on the Solutions and Scales form (Figure 25) or selecting a solution and pressing the Delete key on your keyboard. Deleting will display a confirmation dialog as shown in Figure 29. Clicking Yes will delete the solution, and clicking No will cancel the action.

Scales may be added to or removed from a solution by entering a new number in the # Scales column of the Solutions table of the Solutions and Scales dialog (Figure 30).

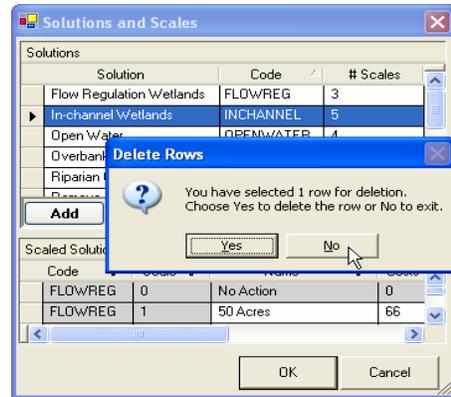


Figure 29
Confirmation Dialog

Solutions			
	Solution	Code	# Scales
	Flow Regulation Wetlands	FLOWREG	3
	In-channel Wetlands	INCHANNEL	5
▶	Open Water	OPENWATER	15
	Overbank Wetlands	OVERBANK	4
	Riparian Corridors	RIPARIAN	6
	Remove Salt Codes	SALTCEPAR	1

Add

Figure 30
Solutions Table

If the Delete action was selected, deleted scale(s) will no longer appear on the Solutions and Scales form.

Solution Relationships

The set of rules regarding which solution and scale combinations are dependent upon one another, also known as "dependency relationships", may be defined as appropriate before plan generation. These relationships occur between solutions when the implementation of one solution is dependent on the implementation of one or more other solutions. Dependencies are entered by stating the dependent solution and the set of solutions upon which it depends.

The rules for defining combinability relationships between solutions may also be defined, as appropriate. Such relationships occur between solutions when the implementation of one solution cannot be combined with the implementation of other solutions. Combinability is declared by selecting the solution and selecting those solutions with which it is not combinable.

Dependency and combinability relationships may be defined at this time by clicking the Relationships Icon on the Plan Editor Toolbar (Figure 31). This will open the Dependency and Combinability Relationships form (Figure 32)

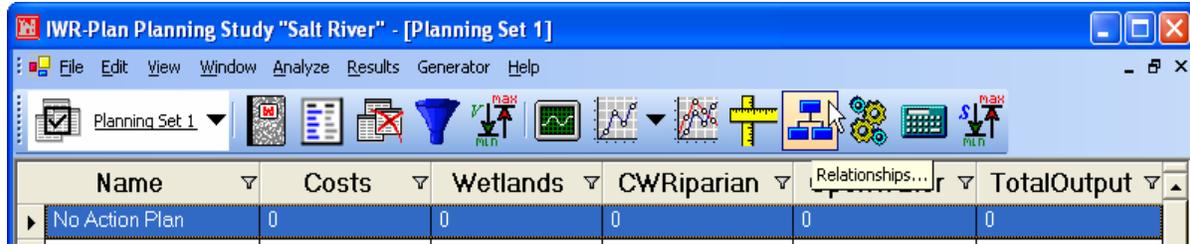


Figure 31
Plan Editor Toolbar

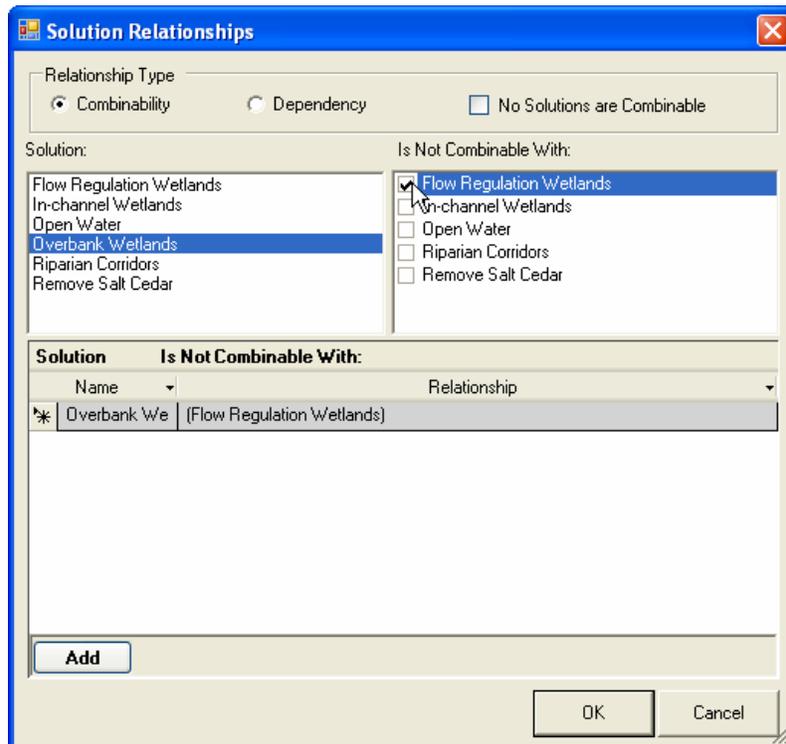


Figure 32
Relationship Form

Dependencies

First we will define dependency relationships. Dependency relationships occur between solutions when the implementation of one solution is dependent on the implementation of one or more other solutions. Click the Dependency radio button under the Relationship Type group

box in order to specify dependency relationships for the solution currently displayed on the form (Figure 33, Step 1). “And...” relationships (for example, A is dependent on B AND C) are entered across rows in the table, “either...or”

relationships are entered using multiple rows. While a default dependency row is provided for your first row, subsequent rows are defined by pressing the “Add” (Figure 33, Step 2). For example, to define the dependency relationship for “Overbank Wetlands,” click on the Overbank Wetlands solution in the Solution list box (Figure 33, Step 3). Next, select the Flow Regulation Wetlands checkbox (Figure 33, Step 4). The solution “Overbank Wetlands” is now dependent on “Flow Regulation Wetlands.” Note, if there were multiple solutions required, they would all be checked and would appear across the first row of the “Solution Is Dependent Upon:” table.

You will notice that when a dependency is defined by pressing the Add button, a new row appears below the current row. This will allow the “either...or” dependency relationships to be defined.

Table 10 below defines the dependency relationships that are used in this case study. Repeat the procedure above for the 3 remaining dependency relationships now.

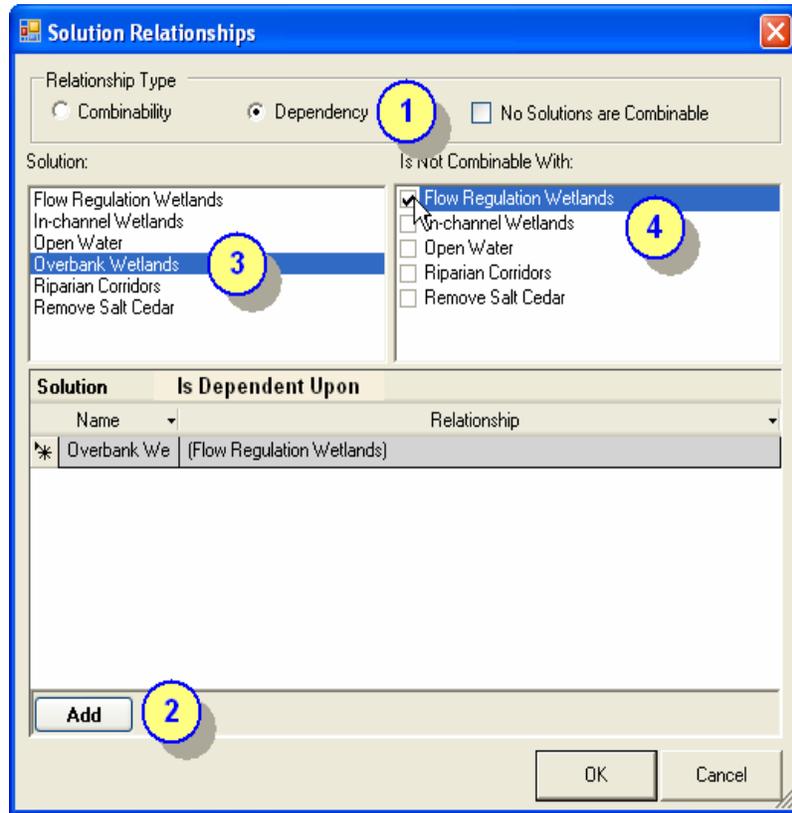


Figure 33
Solution Relationships

TABLE 10 DEPENDENCY RELATIONSHIPS	
Solution	Dependent On
Overbank Wetlands (O)	Flow Regulation Wetlands (F)
Riparian Corridors (R)	Flow Regulation Wetlands (F), AND Overbank Wetlands (O), AND Remove Salt Cedar (S)
Open Water (W)	Remove Salt Cedar (S)
In-channel Wetlands (I)	Remove Salt Cedar (S)

Combinability Relationships

Next we will define the combinability relationships. Combinability relationships occur between solutions when the implementation of one solution cannot be combined with the implementation of one or more other solutions. Click the Combinability relationship type radio button in order to specify non-combinable relationships for the solution currently displayed on the form (Figure 34, Step 1). “And...” relationships (for example, A is not combinable with B and C together) are entered across rows in the sub-form, “either...or” relationships are entered using multiple rows. The “Add” button is pressed to add new rows (Figure 34, Step 2).

However, if no solutions are combinable with each other (for example, each solution represents a fully formulated, discrete alternative plan), a shortcut to specifying individual non-combinability relationships between Solutions is to click on the checkbox in the upper-right-hand corner of the Solution Relationships form marked “No Solutions Are Combinable” (Figure 34, Step 1). When this box is checked, the IWR Planning Suite will automatically prevent any solution from being combined with another. As with dependency relationships, click the solution you want to define a non-combinability relationship for (Figure 34, step 3), check the solutions it is not combinable with (Figure 34, step 4), and, when done, press the OK button (Figure 34, step 5).

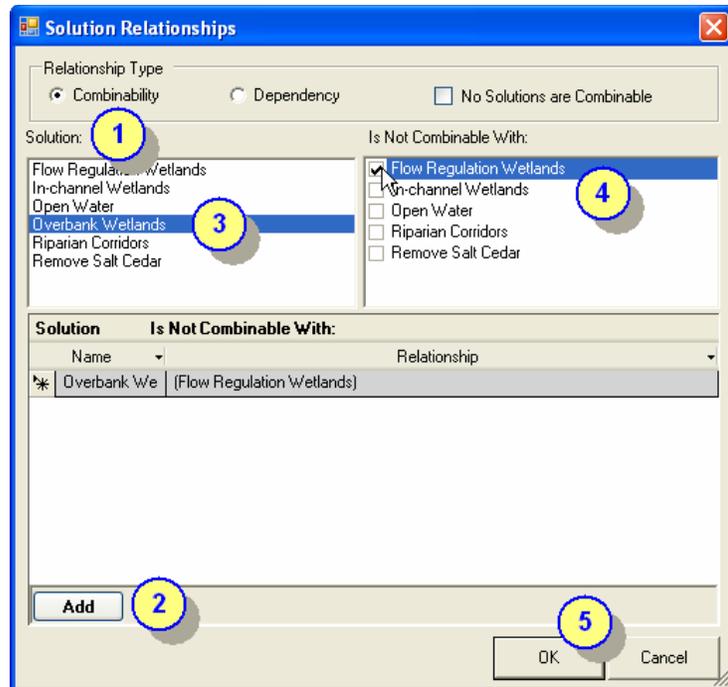


Figure 34
Combinability Relationships

No combinability relationships will be entered at this point in the tutorial.

When finished defining relationships, click the OK button to save the defined relationships.

Automated Editing

Automated editing is a feature which allows the planner to automatically account for the fact that a group of plan effects to be generated may not be a matter of simple addition of solution effects. A mathematical function is entered to describe complex additive effects for a set of solution combinations. To define an automated edit, an edit group name, applicable variable, additive function and logical condition for application of the edit are entered in an automated

edit group entry form. During plan generation, the automated edit entries are used in place of simple addition for applicable solution and scale combinations.

Next we will define automated edits. Clicking the Automated Edits Icon on the Main Menu Toolbar (Figure 35) will open the Automated Editing form (Figure 36).

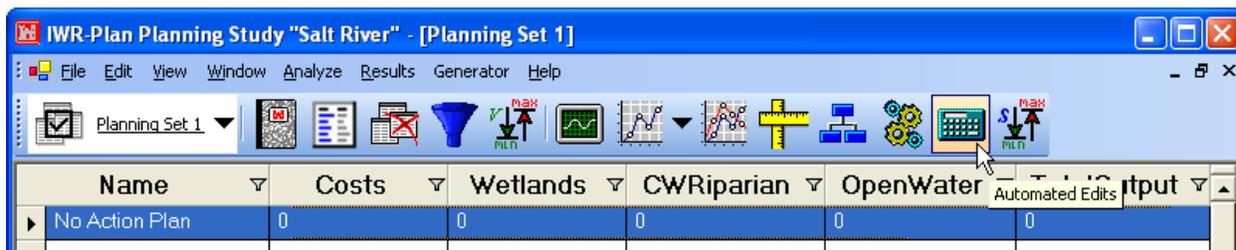


Figure 35
Automated Edits Icon

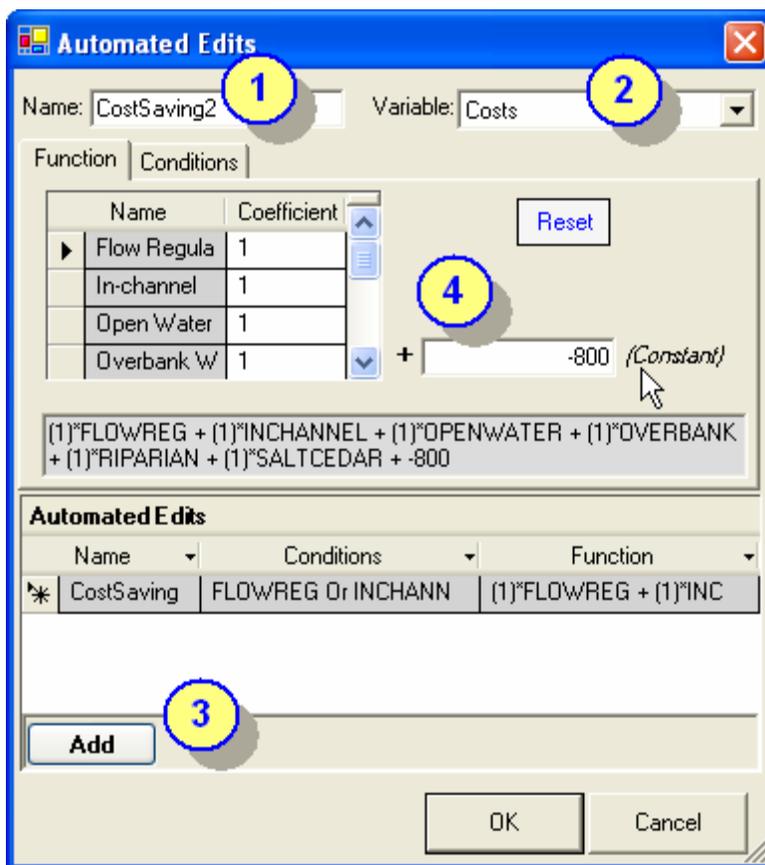


Figure 36
Automated Editing

The automated editing feature allows users to automatically account for the fact that all plan effects may not be additive (IWR Planning Suite's default assumption) when individual

solutions are combined. Alternatively, the user has the ability to edit the effects of plan combinations manually on a plan by plan basis directly within the Plan Editor planning set table.

Automated editing can make the editing process more efficient and time-saving by enabling the user to specify multiple non-additive effects when the edit can be described by some logical statement such as, "When solution A and solution B are combined, reduce the sum of the cost of (A+B) by \$1000." These edits to account for non-additive effects will take place as plan combinations are being built.

To perform an automated edit, (See Figure 36, Steps 1-4, and Figure 37, Steps 5-6), the user must complete the following information on the Automated Editing form:

Figure 37
Defining Automated Editing Functions

1. Edit Group Name (Required) - The user must provide a unique edit group name (up to 15 characters in length) for each individual automated edit he/she wishes to perform. Enter "CostSaving2" as the edit group name now.
2. Variable (Required) - The user must specify the variable on which the automated editing will be performed by clicking to select from the pull-down list next to the variable field. Select "cost" from the pull-down list.

3. Add a new edit – Press this button to add a new automated edit.
4. Function (Required) - In this field the user specifies the editing function to be performed on the variable. The default function that first appears in the Function field displays IWR Planning Suite’s additive assumption, i.e., each solution’s value for that variable is added together to yield that combination of solutions’ value for that variable. (In the default case, the “1’s” indicate that a coefficient of 1 will be multiplied by each of the solution’s values, and the constant of “0” indicates that no additional constant will be added to the solutions’ values; thereby adhering to the program’s additive assumption.)

To edit the default function, the user can change the coefficients as appropriate by clicking in the Coefficient column and typing in a new value; and can change the constant as appropriate by clicking in the Constant field and typing in a new value. Solution values are multiplied by coefficients; to divide a solution value, a decimal coefficient (<1) must be used in the Coefficient column. Similarly, constants are added to solution values; to subtract a constant, a negative value must be typed in the Constant field.

For this edit group, all the solution coefficients remain as 1, however we will add a constant of – 800. As described above, this will actually subtract 800 from the combination of solutions’ values.

5. Conditions (Not required, but usually necessary) - In this field the user specifies under what conditions (i.e., where) the editing function is to be performed on the variable to be edited. The default function that first appears in the Where: field is “under all conditions” or for all action plan combinations. Unless you want the automated edit function to be applied to all plan combinations, you will need to change the statement in this field.

To change the Where: conditions, first click on the “Clear” button to delete the default statement in the Where: field. Then double-click on the appropriate solution code in the “Solution/Description” box to insert that solution code into the Where: condition field. Next, choose a Boolean operator (AND or OR; NOT may be used in conjunction with AND or OR) by clicking on the appropriate button to place that operator after the first solution code in the Where: condition statement. Next, select another solution code by double clicking on the appropriate code to place it in the Where: field statement. Repeat this process of selecting solution codes and Boolean operators until the desired conditions appropriate to the automated edit function are specified in the Where: field. Use the parentheses buttons () as appropriate. In defining Where: condition statements, those specified within parentheses are performed first. Operations are performed in the following order of precedence: NOT statements first, followed by AND statements, then OR statements. If you make a mistake, use the backspace button (<-) to delete the preceding term or use the “Clear” button to start over. Click on the “Validate” button to validate the logical consistency of the Where: condition statement. The IWR Planning Suite will automatically verify the validity of the Where: condition statement when the user presses OK to close the Automated Edits form.

For this edit group, the where condition is “INCHANNEL And OPENWATER.” Enter this now by pressing the Clear button, then entering the where: conditions.

Table 11 below defines the other automated editing function that is used in this case study. Repeat the procedure above for the remaining automated editing function now.

TABLE 11 AUTOMATED EDITING FUNCTION		
Group Name	Function	Where Condition
Modoutput	$(1) * F + (0.5) * I + (1) * O + (2) * R + (1) * S + (1) * W + (0)$	F OR I OR O OR R OR S OR W (Default)

Notice that the new edit group name is “Modoutput” and that the automated editing function being applied is a reduction of In-channel wetlands AAHU’s by 50 percent and a doubling of Riparian Corridors AAHU’s. These output modifications will occur under all conditions, so the where: condition statement does not need to be modified from the default condition.

You may add or delete groups at this time by clicking the Add button or selecting an automated edit and pressing the Delete key on the keyboard respectively. Clicking the OK button will save the automated edits you have defined.

Plan Generation

Once a planning study comprised of variables, derived variables, and attributes has been defined by the user with the plan editor, the plan generation module is used to populate a new planning set with plan alternatives. The plan generation module is used only to define those items that relate to solutions and scales, rather than to variables and attributes. Items like cost and value variables and plans of interest, are defined through the plan editor rather than through the plan generation component because they apply to variables and attributes, not to individual solutions and scales. Of course, both modules can be used simultaneously on the plan study’s active planning set through the common user interface of the plan editor infrastructure, so that the user’s current workflow is retained.

The plan generation module will automatically generate a Planning Set from a set of solutions and scales using the same mechanisms available in the current The IWR Planning Suite application. It generates a planning set directly to the IWR Planning Suite database and, like all the default IWR Planning Suite modules, this active planning set in the database is associated with the current plan study. A plan study may contain many planning sets derived from the generated planning set by various mechanisms such as an analysis applied to a planning set, but it may contain only one planning set that has been created by the plan generator.

The solutions, scales, combinability and dependency relationships which together determine the full set of plan alternatives which may be generated are defined by the user. Additionally, automated edits, constraint groups, and solution sensitivities are defined. The complete process, which corresponds closely to the existing IWR Planning Suite interface workflow follows.

Generated planning sets will be displayed with some information that will assist planners in managing them and keeping them in context. For example, planning sets will include the name

of the planning study to which they belong. They will also include the name and version of the component and function that created them. Examples of the “created by” attribute of a planning set might be “IWR Planning Suite Planning Set Generator Component 1.0,” “Plan Editor 1.0 Manual Entry” or “Plan Editor 1.0 Constraint Group.”

To generate plans, click on the Generate Plans Icon in the toolbar (Figure 38).



Figure 38
Generate Plans Icon

This will bring up the “Generate Planning Set” dialog.

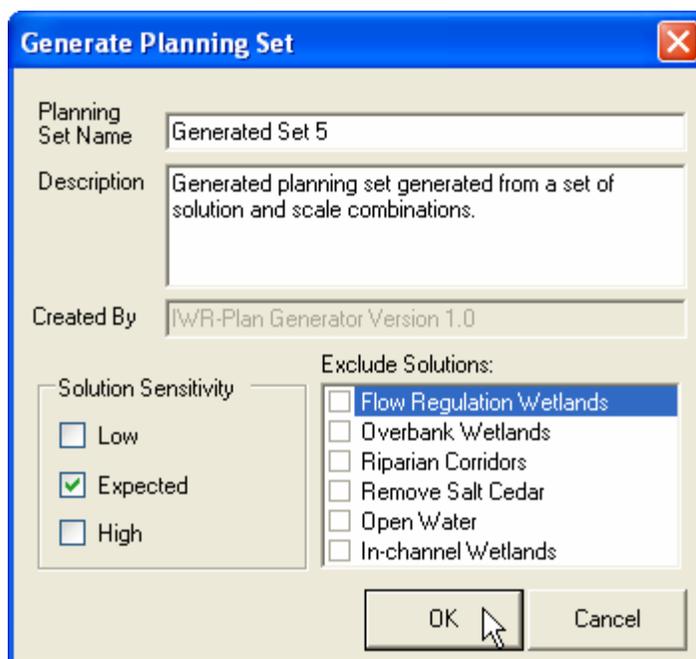


Figure 39
Generate Plan Dialog

You may take the default settings of this dialog and just press OK, and plans will be generated. You may, if you wish, define the planning set’s name, description, solution sensitivities to be generated, and any solutions you wish to exclude.

When you press OK, the planning set is generated. If there are many solutions and scales defined, this may take from several minutes to many hours. A progress bar at the bottom of the IWR Planning Suite window will display the percentage of plans that have been generated.

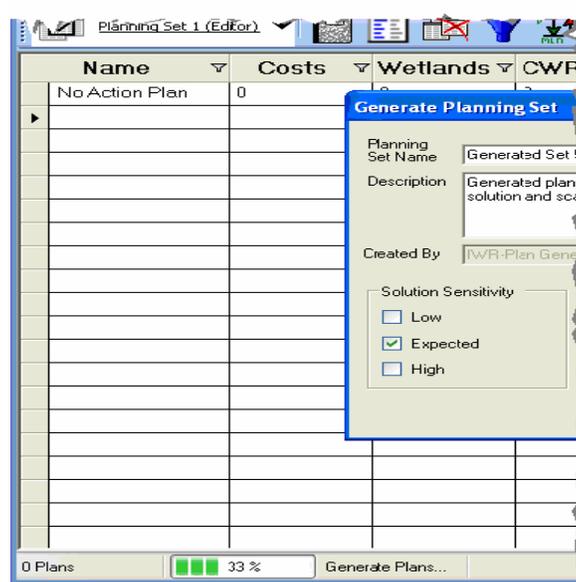


Figure 40
Generate Plan Progress Bar

Inefficient Plan Removal

Inefficient Plan Removal, the filtering of all plans except cost-effective plan alternatives, may be applied as an option when generating the planning set. To enable inefficient plan removal, select the Options... Menu item from the Generator Dialog on the main menu, check the box to "Remove inefficient plans..." and press OK as shown in the examples below (see Figures 41 and 42) .

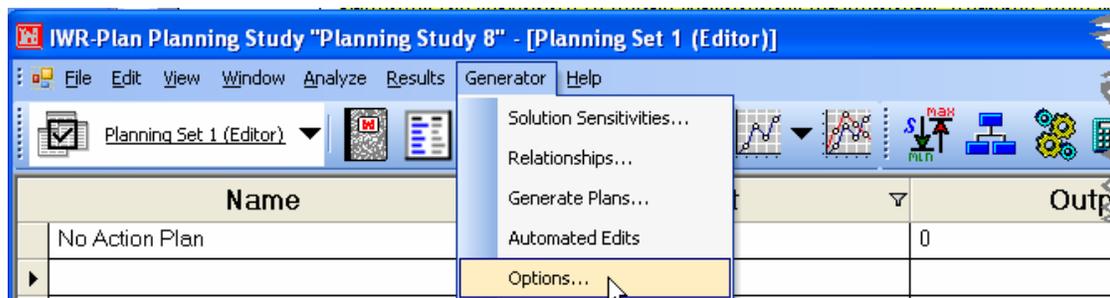


Figure 41
Generator Menu Dialog

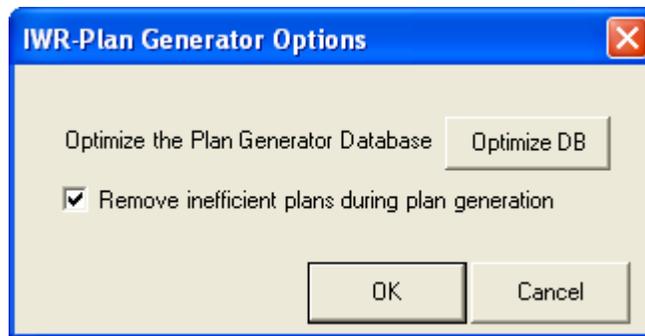


Figure 42
Plan Generator Options

This option is of value in cases where numerous solutions and scales have been defined, which would result in an extremely large set of solution combinations, which may exceed the limits of the database. When this option is selected, plan generation only saves cost-effective plans to the database. Further detail on what constitutes a cost-effective plan definition may be found in the description of the CE/ICA component.

Constraints

Constraints may be defined within the plan editor to filter a planning set to only those plan alternatives that meet a set of predefined criteria. The criteria are minimum and maximum acceptable values for a particular variable. Note that, as in previous versions of IWR-Plan, constraints may not be applied to derived variables.

To constrain a planning set, a planning set name is entered, along with one or more variables to be constrained and a minimum and maximum acceptable value for each variable. The application of constraints to a planning set will generate a new planning set containing only the plan alternatives that meet the constraining criteria.

Constraints can be defined to limit the a planning set's alternatives to only those plan alternatives from a parent planning set that meet the criteria defined by the constraints. In defining a constrained planning set, the user can select any non-derived variables for inclusion in the group from the pull down pick list. The user then can enter in minimum and maximum acceptable values for each variable.

Note that IWR Planning Suite automatically provides a minimum value for each variable of 0, and a maximum value for each variable of 9,999,999,999. The user must edit these values as appropriate.

To define a constrained planning set, navigate to the Constraints dialog (Figure 43) by clicking constraints on the toolbar (Figure 44).

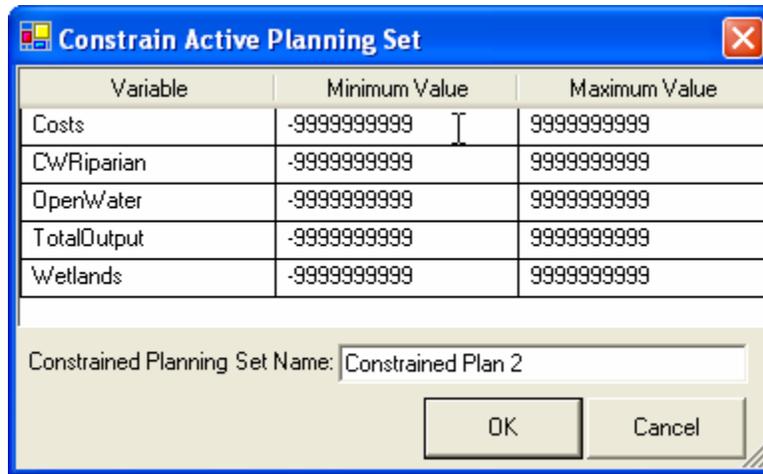


Figure 43
Constraints Dialog

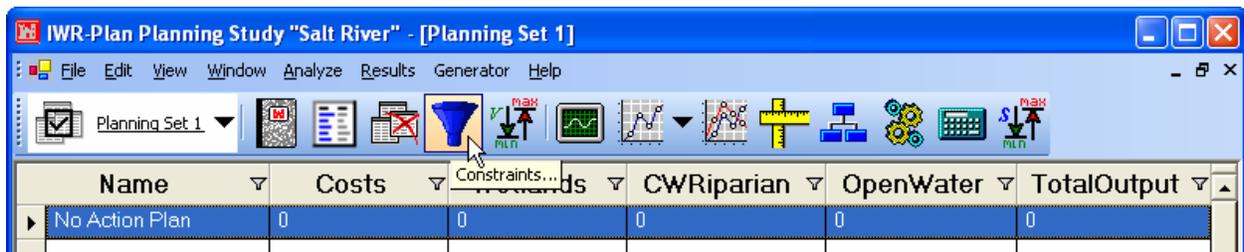


Figure 44
Constraints Icon

When defining constraints, you must first specify a name to be used for the constrained planning set (Figure 45). The name can be comprised of any combination of alphanumeric or punctuation characters and can be up to 15 characters in length. Next, you would select the variable to be constrained. After the variable has been selected, a minimum and maximum value must be entered. To have multiple variables constrained, simply keep performing these steps for the other variables.

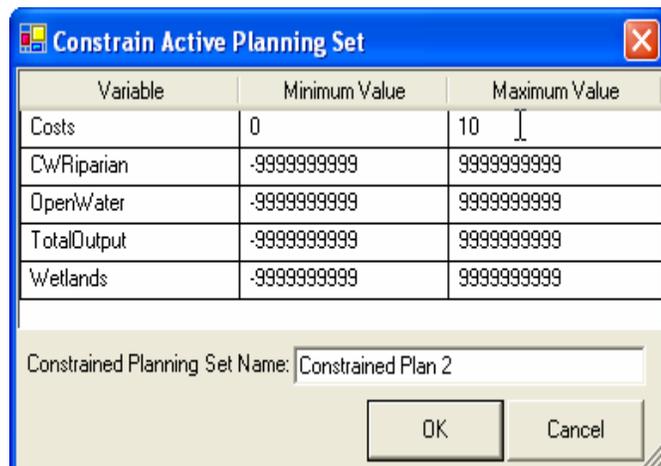


Figure 45
Constrained Planning Set

Plans of Interest

Plans of interest are defined as plans that are deemed interesting, and therefore the user desires to keep track of them, for some purpose.

Certain different types of variables or attributes must be associated with a planning alternative and given values, either during the manual creation of the planning set, or by the planning set generator, before the set may be subjected to subsequent analysis. For example, in order to be processed by the CE/ICA module, each plan alternative must have variables, which represent the cost and output measures of the plan. The CE/ICA analysis will allow the user to specify which variables of the planning set represent the cost and output measures for analysis purposes.

In the planning study editor, attributes applicable to the analysis may be defined, such as a *plan of interest* attribute, to be used by reporting and visualization modules. Then, once the rows of the planning set are created, individual *plans of interest* may be chosen. To do so, the *plan of interest* attribute of the row is marked in the planning set editor. At this time, if the planning set was generated, a more appropriate name for the plan of interest may be entered and associated with a specific plan alternative.

Plans of interest are defined by marking the Plan of Interest checkbox in the plan editor for each plan deemed to be interesting. Each Plan alternative has a Plan of Interest attribute, but this attribute is hidden by default. It may be displayed by bringing up the Plan Study dialog, and clicking the “Hidden” property of the Plan of Interest Attribute (thereby un-checking it) in the Plan Study Attributes table (Figure 46).

The Plans of Interest checkbox allows the user to specify particular plans as plans of interest. Initially when the plan editor displays a planning set, the Plan of Interest column will appear blank since no plans of interest have yet been defined.

To enter a plan as a plan of interest, click the Plan of Interest Checkbox on the plan alternative deemed to be of interest (see Figure 47).

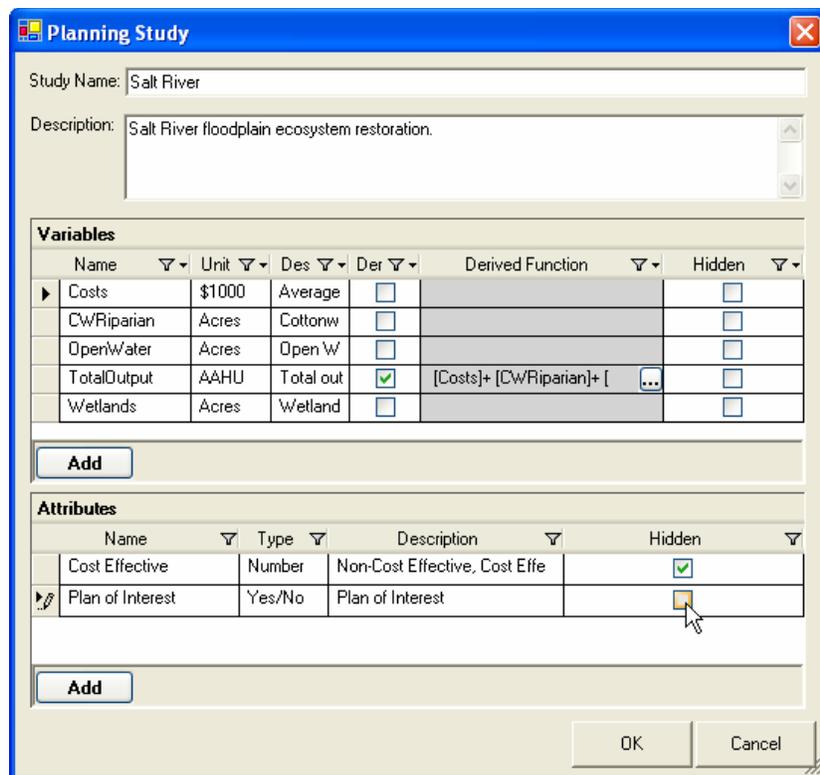


Figure 46
Plan Study Attributes

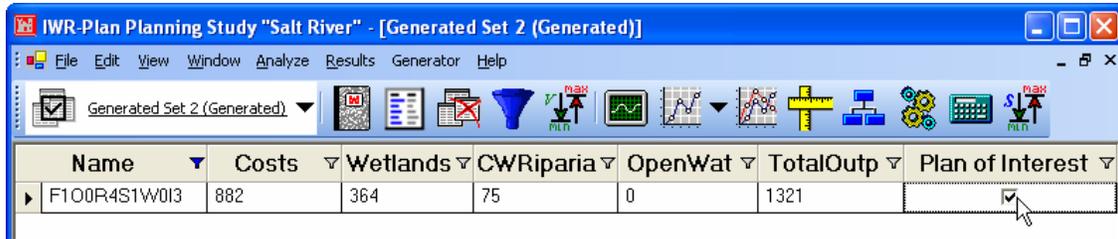


Figure 47
Plan of Interest Checkbox

To find a particular plan to mark as of interest in a large planning set, select the “(Custom)” filter by clicking on the filter icon of the plan name in the plan editor table, and enter the name of the plan to find and press OK (see Figure 48).

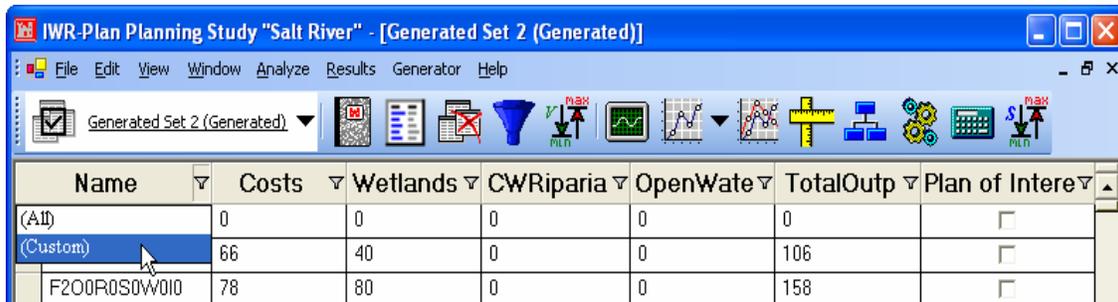


Figure 48
Custom Filter

Sensitivity

Sensitivity values can be entered at one of two levels – variable sensitivity and solution sensitivity. Variable sensitivity allows the user to enter uniform coefficients for computing all high and low values for a given variable (for example, evaluate all cost estimates by +/- 20%). Variable sensitivity is a function of the Plan Editor module and can be changed by clicking on the Variable Sensitivity icon on the tool bar (see Figure 49).



Figure 49
Variable Sensitivity Icon

Solution sensitivity allows the user to enter uniform coefficients for computing all high and low values for a given variable and solution combination (for example, evaluate all cost estimates

for the solution “dredging” at +/- 20% but all cost estimates for the solution “aquatic plant harvesting” at +/- 40%). Solution sensitivity is a function of the Plan Generator module and can be changed by clicking on the Solution Sensitivity icon on the tool bar (see Figure 50).

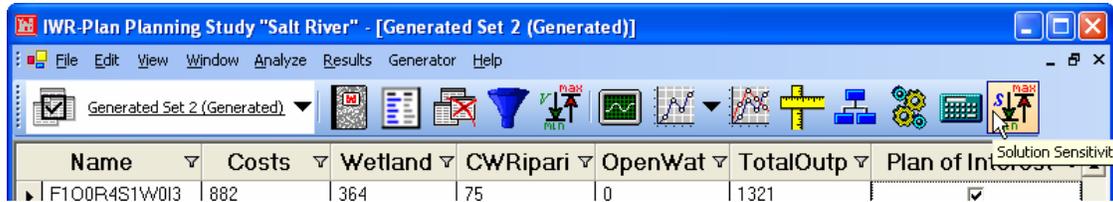


Figure 50
Solution Sensitivity Icon

Variable Sensitivity

For variable sensitivity, the high and low variable values entered are uniform coefficients used for computing the high and low values for the selected variable. This creates a value range result for that variable.

If Variable Sensitivities is selected, the Variable Sensitivities form will be opened (Figure 51). Next you will enter uniform coefficients for computing all high and low values for the corresponding variable. Note that low coefficients must always be a real number less than or equal to one including negative numbers and high coefficients must be a real number greater than or equal to 1. Once the coefficients have been defined, simply click the OK button to save the coefficients (Figure 51). Clicking the Cancel button will simply discard any changes and close the form.

The screenshot shows the "Variable Sensitivities" dialog box. It has a title bar with the text "Variable Sensitivities" and a close button (X). The main area contains a table with three columns: "Variable", "Low Coefficient", and "High Coefficient". The table lists four variables: "Costs", "CWRiparian", "OpenWater", and "Wetlands", each with a "Low Coefficient" of 1 and a "High Coefficient" of 1. At the bottom right of the dialog, there are two buttons: "OK" and "Cancel".

Variable	Low Coefficient	High Coefficient
Costs	1	1
CWRiparian	1	1
OpenWater	1	1
Wetlands	1	1

Figure 51
Variable Sensitivities Form

Variable Sensitivity causes two hidden derived variables – a high value and low value -- to be added to the planning study for each variable. In the resulting planning set, these new variables

are filled with the respective high and low values indicating the sensitivity range for the variable. In addition to this ability to set all the plan alternative variable sensitivities in a study at one time by using high and low coefficients, the capability exists through the plan study variables editor to make the low and high values of any individual plan alternative visible. They can then be edited, so that every plan alternative could potentially have custom sensitivity values.

Solution Sensitivity

Similar to variable sensitivity, the high and low values entered for solution sensitivity are uniform coefficients used for computing the high and low values for the selected solution combination. This creates a value range result for that solution. When a planning set is then generated to the plan study, hidden high and low value variables are added for each variable of each plan alternative in the generated planning set.

When the Solution Sensitivity icon is clicked, the Solution Sensitivity dialog will be opened (Figure 52).

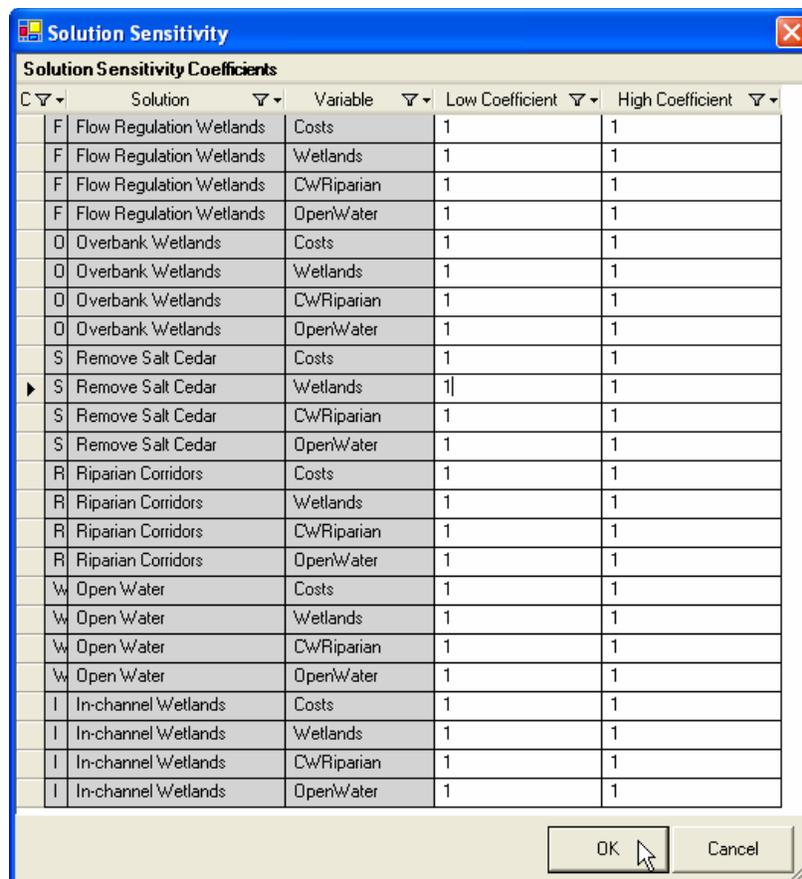


Figure 52
Solution Sensitivity Coefficients

Through this dialog, you may enter uniform coefficients for computing all high and low values for any and every given variable and solution combination. As with variable coefficients, low coefficients must always be a real number less than or equal to one including negative numbers and high coefficients must be a real number greater than or equal to 1. Once the coefficients have been defined, click the OK button will save the coefficients (Figure 52). Clicking the Cancel button will discard any changes and close the form.

For this case study two variable and solution combinations have sensitivity that need to be defined. Enter the coefficients from Table 12 below now by the methods described above.

TABLE 12			
VARIABLE AND SOLUTION COMBINATION SENSITIVITY			
Solution Code	Variable	Low Coefficient	High Coefficient
F	Cost	1	2
S	Cost	0.5	1

Save Plan Study

Now that we have fully defined variables and solutions, we are ready to save a basic plan study. The Save As form allows the user to save a plan study. To save a plan study, navigate to and click on the Save As... form on the File menu of the main menu bar (Figure 53). If any plan studies currently exist, clicking Open... under the File menu loads the Plan Study.

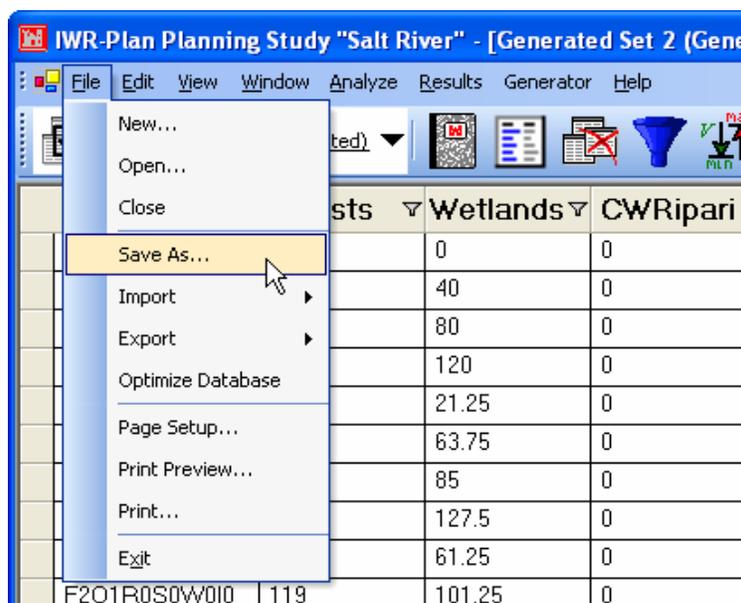


Figure 53
File Menu

The Save Plan Study As... dialog (Figure 53) will allow a Plan Study to be saved in two steps. The first step is to give the plan study a name. The Plan Study name is required and can be made up of any combination of alphanumeric characters up to 15 characters in length (spaces

are not allowed in the name, however). Since IWR Planning Suite will use plan study names in the titles of various reports and graphics, as well as to differentiate and keep track of different plan studies, it is useful to define plan studies with meaningful names. Enter “CombinedOutput” in the space provided for the plan study name now. The final step in saving a plan study is confirming the new name by clicking the Save button. Click the Save button to confirm this name now (Figure 54). Note, if the Cancel button is clicked, no new plan study will be added.

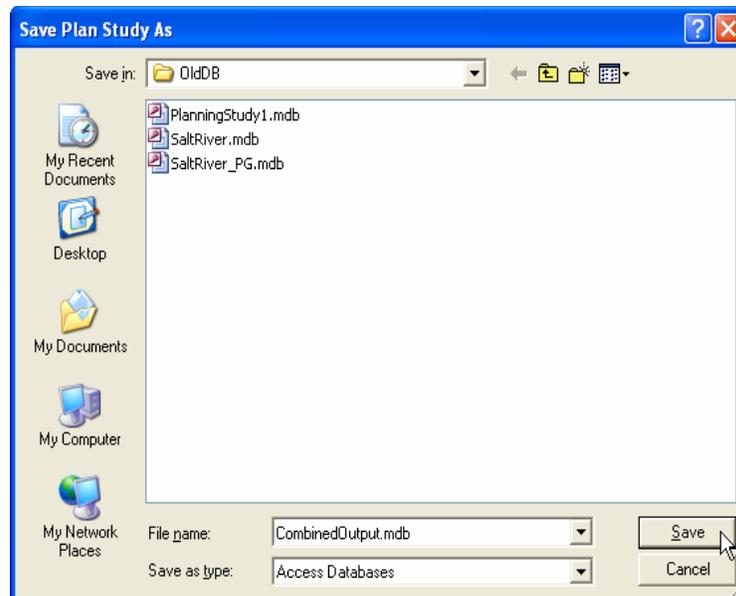


Figure 54
Save Plan Study As

Once a new plan study has been added using the Save As, the new plan study will be displayed in the Plan Study properties form.

CE/ICA Analysis

Cost Effectiveness and Incremental Cost Analysis is described in detail in Section III, “Plan Analysis”. Here is an overview of how it is applied within the IWR Planning Suite application.

Cost Effectiveness is a method of identifying least-cost solutions for different levels of outputs or benefits. It is utilized in planning situations where dollar values are not used to measure outputs. In the absence of economic valuation of effects, then, it can lead to more informed and supportable decisions than might cost-oblivious decision making.

In a planning set comprised of many plan alternatives, cost effectiveness can support decision-making by filtering out and eliminating many plan alternatives that are ineffective and inefficient. Plan alternatives that cost the same amount or more compared to plan alternatives that produce the same or more outputs can be reasonably discarded, thereby significantly

reducing the number of plan alternative options to a more manageable subset from which the most viable plan alternative may be chosen.

Incremental Cost Analysis is performed by determining the incremental cost per unit between successively larger (i.e., more output) plan alternatives, and identifying best buy plans as those plans for which the incremental cost per unit is lowest for a particular output level. Incremental cost per unit is defined as the plan alternative's incremental cost divided by its incremental output.

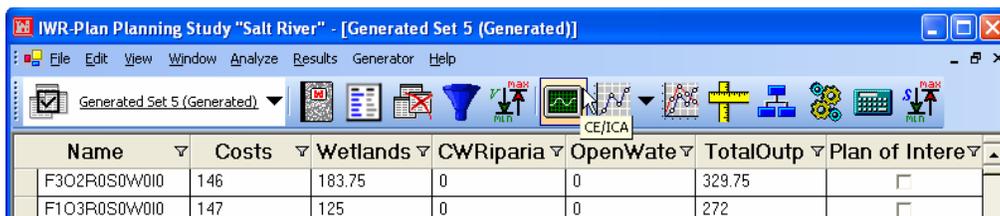
Incremental Cost is the difference in cost between the costs of two plan alternatives. It is determined by subtracting the cost of the less expensive plan alternative from the cost of the more expensive plan alternative. Incremental output is the difference between the outputs of two plan alternatives. It is determined by subtracting the output of the smaller output plan alternative from the output of the larger plan alternative.

The CE/ICA module performs CE/ICA on an active plan set. The existing planning set data will be evaluated to generate results, which may be filtered down to a preferred set of plans.

The CE/ICA analysis module is capable of processing plans from any of the planning sets in the current plan study in the IWR Planning Suite database. Results may be generated as a planning set directly to the IWR Planning Suite database, from which they may be edited, reported on or graphed, printed, used as input to additional analyses, or exported to a file.

The CE/ICA analysis dialog will accept active planning sets in the IWR Planning Suite database, those generated by the plan generator or plan editor, or by any other means such as export, and will allow the user to perform subsequent analysis of the planning set. The analysis results will be output as an active planning set to the IWR Planning Suite database, from which it may be exported if desired. The default "Cost Effective" attribute is made visible in the resulting planning set to indicate the cost-effectiveness or "best buy" status of each of the plan alternatives from the analyzed planning set.

Open the CE/ICA Analysis form now (Figure 55) to generate a new analysis planning set from the current generated planning set. The same steps may be followed to perform an analysis on a planning set manually entered through the plan editor, or imported from a file.



Name	Costs	Wetlands	CWRiparia	OpenWate	TotalOutp	Plan of Intere
F302R0S0W0I0	146	183.75	0	0	329.75	<input type="checkbox"/>
F103R0S0W0I0	147	125	0	0	272	<input type="checkbox"/>

Figure 55
CE/ICA Generated Planning Set

The description field is an optional field that allows the user to give a better description of the Plan Study. Note that the description can be up to 50 characters in length. Enter "CE/ICA run

on Combined Output of All Cover Types” in the space provided for the Plan Study description now (Figure 56). The cost parameter field is a drop-down list populated with the defined variables. IWR Planning Suite will use the selected cost variable as the Y-axis variable for all analyses. The cost parameter is what is used in all cost effectiveness and incremental cost calculations. Select “Cost” as the cost parameter now. As with the cost parameter, the output parameter field is a drop-down list populated with the defined variables. IWR Planning Suite will use the selected variable as the X-axis variable for all analyses. The output parameter is also used in all cost effectiveness and incremental cost (incremental cost per unit of output) calculations. Select “TotalOutput” as the output parameter now (Figure 56).

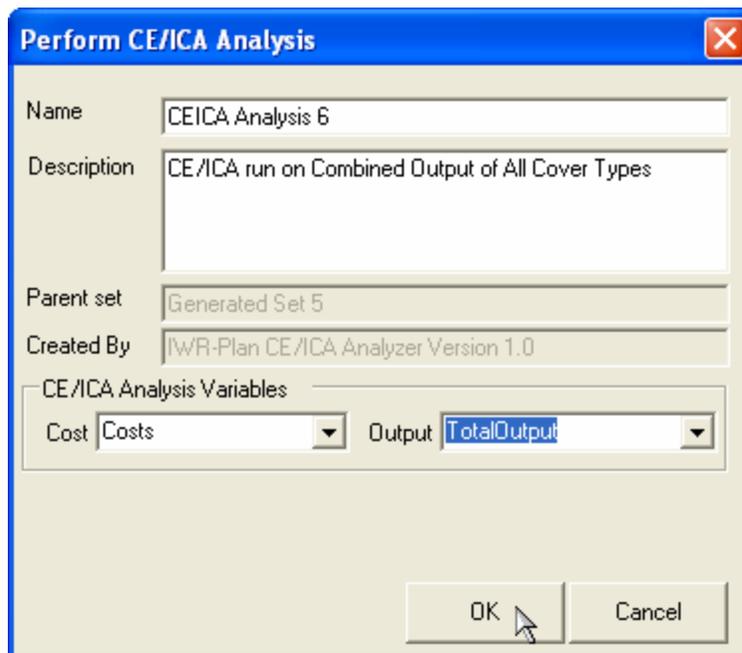


Figure 56
CE/ICA Analysis Output Parameter

As soon as an analysis planning set has been built, it will become the active planning set. The active planning set is indicated in the planning sets selection dropdown on the plan editor toolbar. For all previously analyzed planning sets, IWR Planning Suite only retains the data related to each analysis planning set’s cost effective and best-buy plans.

A particular analysis module will usually require certain variables or attributes, such as cost and value attributes, which are prerequisite components of every plan alternative in the planning set. A default “Cost” and “Output” variable are automatically created for new plan studies to support the intrinsic CE/ICA analysis module.

Analysis Results

The Analysis Results function of IWR Planning Suite provides a variety of graphical and textual reports for the planner to assist in the evaluation of plan alternatives. Reports can be generated

from the IWR Planning Suite database of the active planning set, or selected from the entire set of analysis results for multi-planning set reports.

The reporting and graphing capabilities are intended to be performed on the results of a CE/ICA analysis. However, these reports are more broadly applicable to any analytic technique that associates appropriate output variables and attributes to the plan alternatives. When a report or graph is chosen for display, the user will be asked to select the appropriate parameters, such as filtering by cost effective plans, needed to generate the report or graph.

Available reports include an average cost report, an incremental cost analysis report, an “Is it worth it?” report, and an “All Variables” report.

Graph types include graphs of All Plans, cost effective plans and best buy plans. All plans and cost effective plans may also be graphed in a differentiated format (i.e., differentiated between non-cost effective, cost effective, and best buy plans). The best buy plans graph is viewable as a Cartesian (x,y) coordinates graph, as a box graph, and other formats including three dimensional visualization graphs.

Single Planning Set Results

Once at least one planning set has been analyzed, you may view the analysis results. Such results are called “Single Planning Set Results.” Navigate to the Single Planning Set result dialogs by clicking the Single Planning Set toolbar Icon and selecting the “Report...” option to generate reports of analysis results, or the “Graph...” option to graph analysis results (Figure 57).

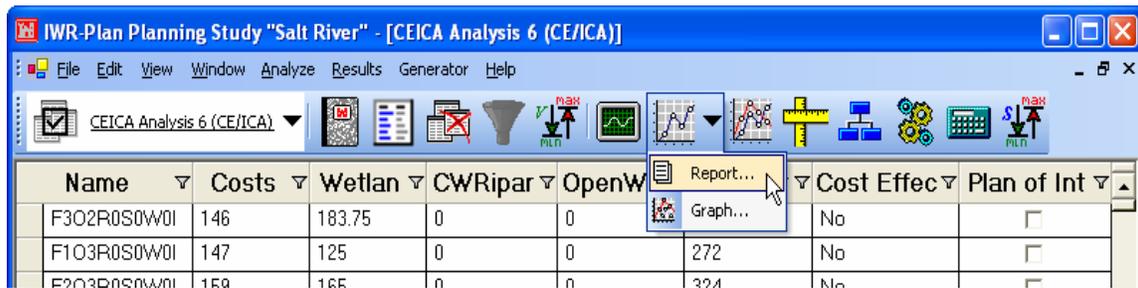


Figure 57
Single Planning Set Report

The Single Planning Set Reports form allows the user to select an analysis planning set (formerly known as a “scenario” in IWR-Plan version 3.33) and how to view the results of that analysis Planning Set. The drop down list (Figure 58) contains all the CE/ICA analyses that have been performed. Select the way in which report data is to be sorted from the “Sort by:” dropdown list, for example, sorting the reported plans in order of their Cost or Output.

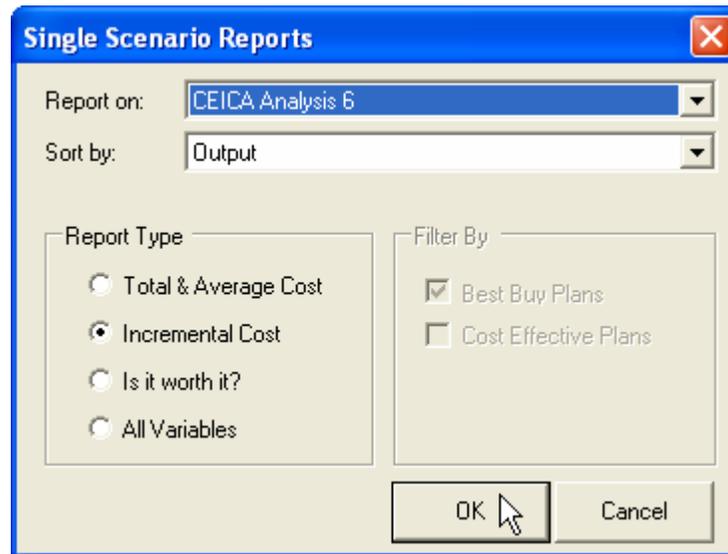


Figure 58
Selecting Report Type

The first step in selecting a report to view is to specify which of the planning set analyses to report on. To do this, simply select the name of the analysis planning set from the Report on: dropdown list. Next, Reports may be sorted in different ways. Simply select the desired sort in the “Sort by:” dropdown list to sort the results on the desired field.

Next, specify which type of report to view by clicking the corresponding Report Type. Some reports have the option of displaying multiple sets or subsets of data. The “Filter By” checkboxes will allow selection of the possible sets of data that the selected report type may display. For example, the Average Cost report by default displays All Plans, but checking the appropriate “Filter By” checkbox can allow you to report only on Cost Effective Plans or Best Buy Plans. Once all of the desired options have been set, clicking the OK button will display the report.

Graph Single Planning Set Results

Navigate to the Single Planning Set graphing dialog by clicking the Single Planning Set toolbar Icon and selecting the “Graph...” option to graph analysis results (Figure 59).

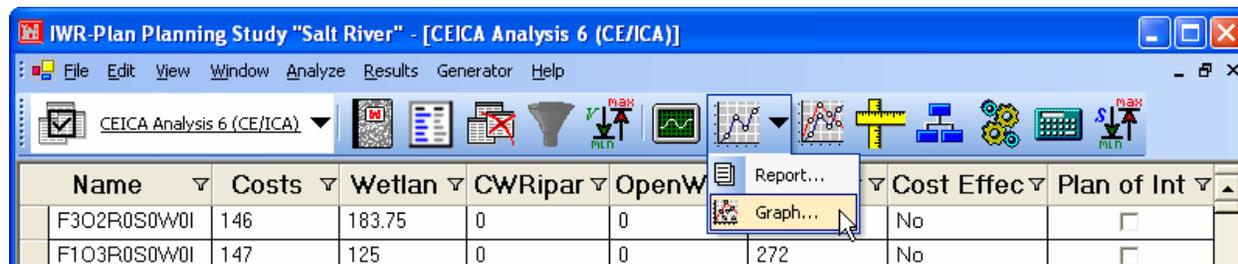


Figure 59
Selecting Graph Option

The first step in selecting a graph to view is to specify which analysis planning set to graph. To do this, select the desired planning set from the “Report on:” dropdown list (Figure 60). Next, the user must specify which type of graph to view by clicking the corresponding Graph Type. For some reports, the user may also select a subset of analysis results to graph by clicking appropriate options in the “Plan Alternatives to Graph” group. For some reports, the Differentiated checkbox may also be checked, indicating that non-cost effective, cost effective, and best buy plans will be indicated on the graph by different symbols and colors. Once the analysis set, graph type, and the other desired options have been selected, clicking the OK button will display the graph.

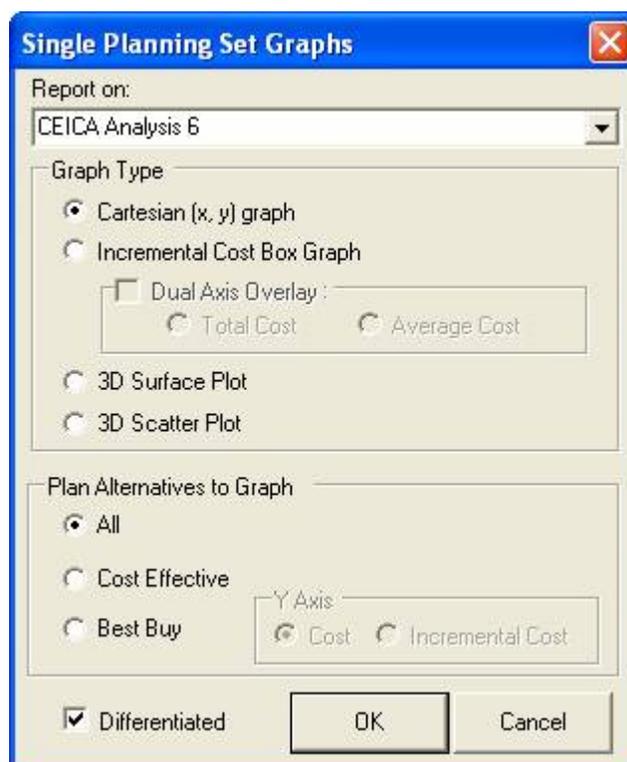


Figure 60
Selecting Graph Type

An example of a Cartesian (x, y) All Plans Differentiated graph for a CE/ICA analysis planning set is shown below (Figure 62). In this example, all plans are graphed by Cost and Output, with the cost effectiveness status of each plan alternative differentiated by different colors and symbols. The graphing tool allows the user many ways to customize the way in which the data is displayed. The user may zoom in by holding the left mouse button down and dragging the rectangle to the area of interest. Likewise, the user may click on a point on the graph to see the data pertaining to that point (Figure 61). The graph tool also allows the user to pick many different styles of viewing by right clicking on the graph. The user may experiment with these options at his or her convenience.

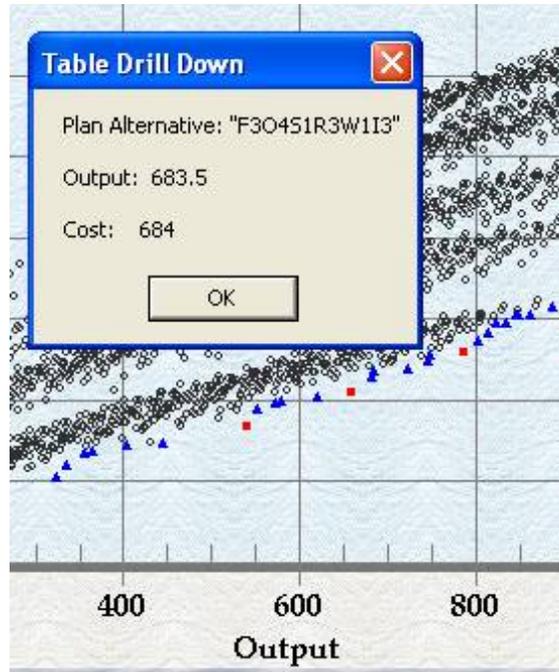


Figure 61
Graph Point Data

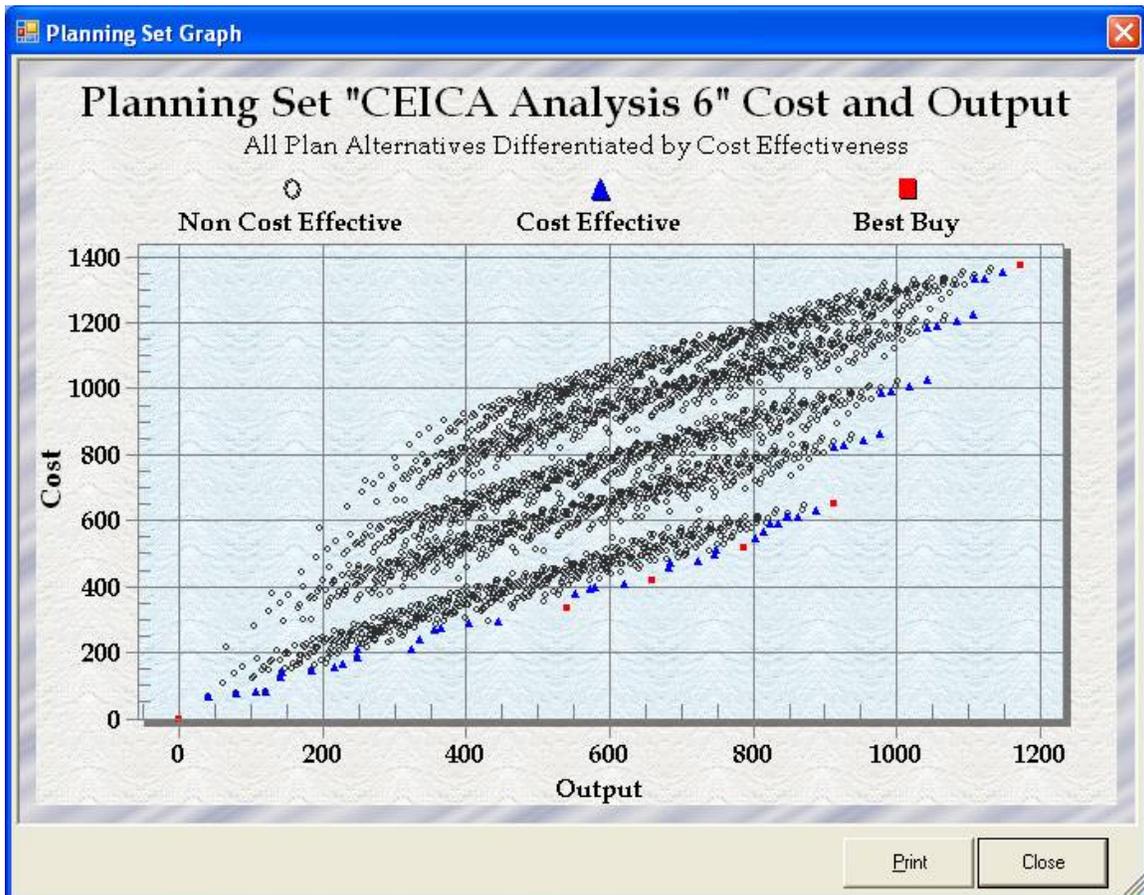


Figure 62
Cost Effective Plans Graph

The Incremental Cost Box Graph option allows the user to display the Best Buy plans (see Figure 63) resulting from incremental cost analyses.

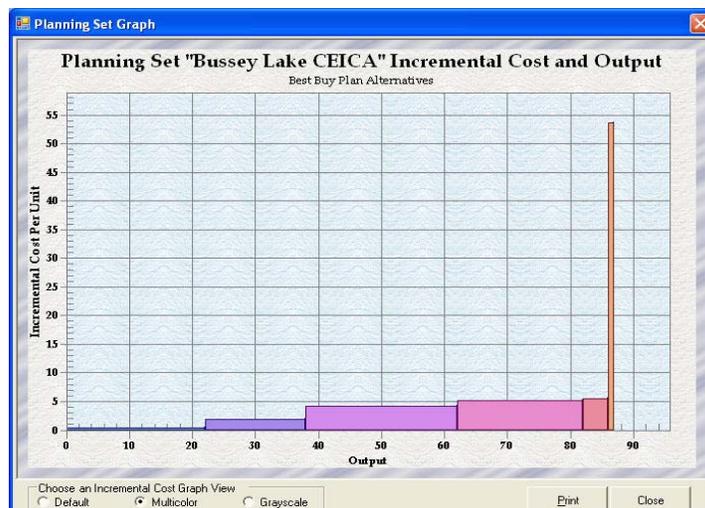


Figure 63
Best Buy Box Graph

Multiple Planning Set Results

Reporting may be performed across multiple planning sets. An intersection report will display all plans that are cost effective or best buy plans in common to the various planning sets selected. A union report shows all plans that are cost effective or best buy in any one of the selected planning sets.

Intersection and union graphs will also be available for viewing, similar in graphical representation to the text reports just described.

When at least two CE/ICA analysis planning sets have been processed, you may view the results for a combination of analysis planning sets. Such results are called "Multiple Planning Set Results." Navigate to the Multiple Planning Set Results form by clicking the Multiple Planning Set icon on the Plan Editor Toolbar (Figure 64).

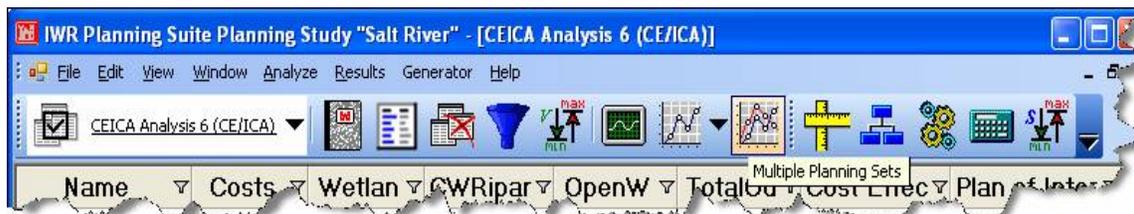


Figure 64
Plan Editor Toolbar

The Multi Planning Set Results dialog displays all of the CE/ICA Planning Sets in the Planning Sets list box (Figure 65). Desired planning sets can be selected using the <Shift>-Click to select sets contiguous to one another in the list, and <Control>-Click to select non-contiguous sets (separated in the list from one another by one or more intervening sets).

Next, select the Display Type (Figure 65) to view either Graphs or Reports.

Selecting the various result Options is the next step in viewing multiple analysis results. In the Options group box dropdown list, two types of **Reports** can be selected: **Intersection** or **Union**.

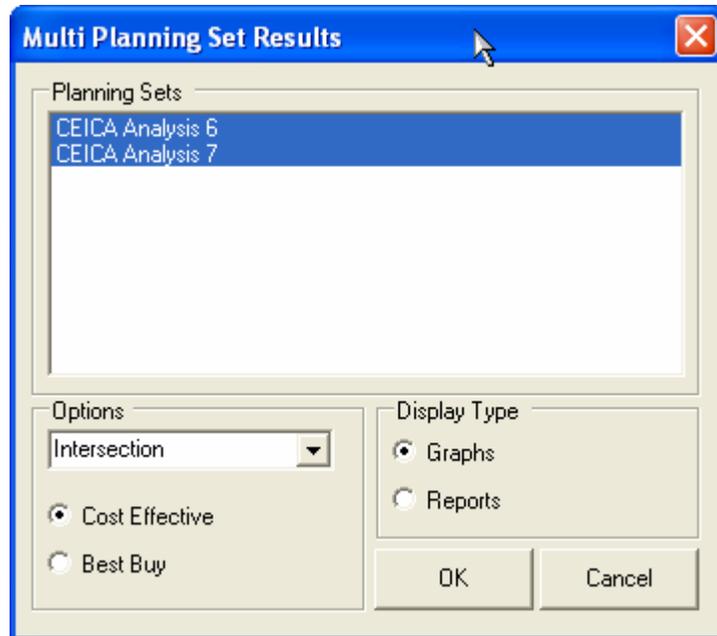


Figure 65
Display Appropriate Graph or Report

- The **Intersection** report displays all plans that are consistently cost effective or Best Buy plans in each of the planning sets selected. For either cost effective or Best Buy plans (user selects), the report shows, the plan combination code, the total output, total cost, and average cost by planning set for each plan.
- The **Union** report shows all plans that are cost effective or Best Buy plans in any of the selected planning sets. For either cost effective or Best Buy plans (user selects), the report shows for each planning set the plan combination code, total output, total cost, and average cost by plan.

For **Graphs**, either of two types of results can be selected: **Intersection** and **Union**.

- The **Intersection** graph displays the cost effective or Best Buy plans in common to each of the planning sets selected. Since the selected planning sets may use different cost and output parameters, the axes are merely labeled "y-axis variable" for the specified cost parameters and "x-axis variable" for the specified output parameters. Each plan is plotted by its total cost and total output.
- The **Union** graph shows all plans that are cost effective or Best Buy plans in any of the selected planning sets. Since the selected planning sets may use different cost and output parameters, the axes are merely labeled "y-axis variable" for the specified cost parameters and "x-axis variable" for the specified output parameters. Each plan is plotted by its total cost and total output.

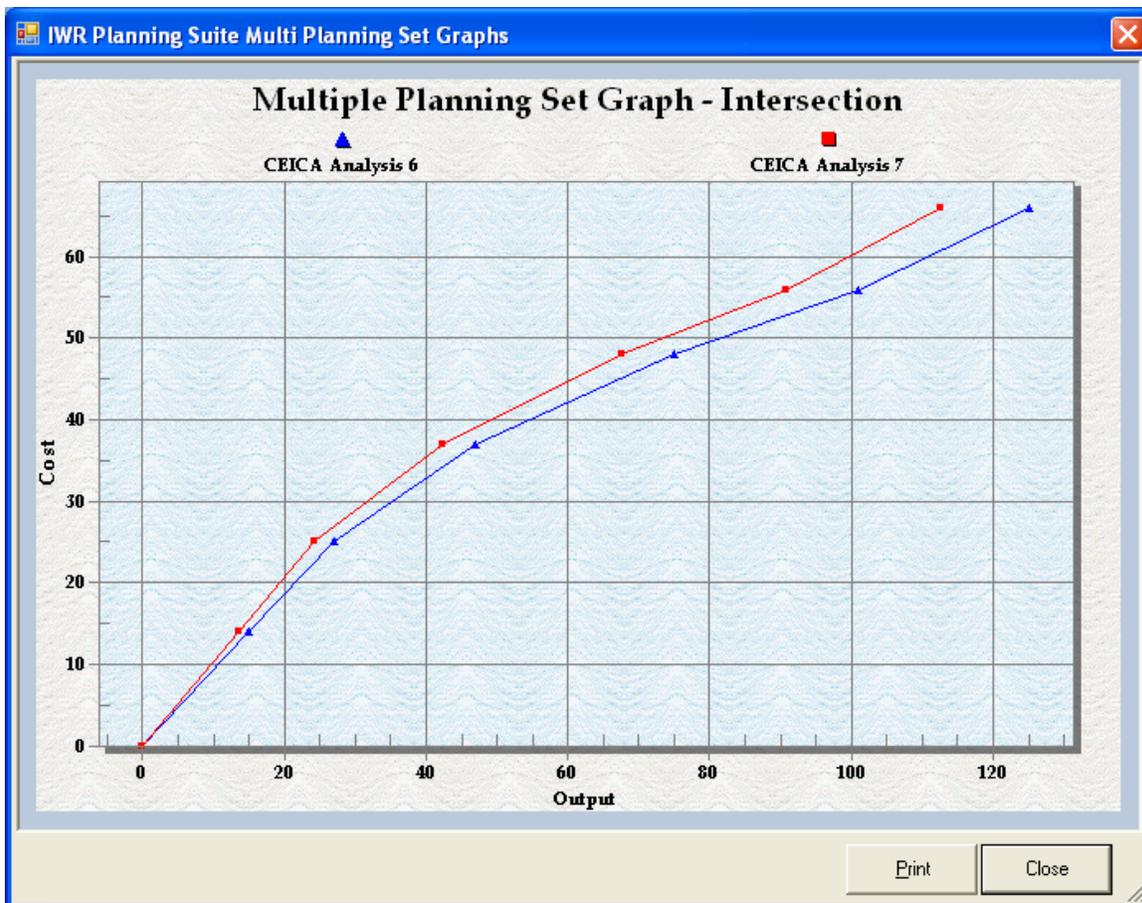


Figure 66
Multi-scenario Graph

The other option in the Options group box the user must specify is the selection of either the Cost Effective or Best Buy subset as the result set to view. Finally, clicking the OK button will display the appropriate multi planning set graph or report. An example multi planning set graph is shown.

File Menu Extras

IWR Planning Suite provides many additional features that can be found under the File menu (Figure 67).

New

Use “File New...” (Figure 67) to create a new IWR Planning Suite database and planning study. The current study will be saved and closed, and a new, empty default database will be created for you to begin working in. You may choose to start entering

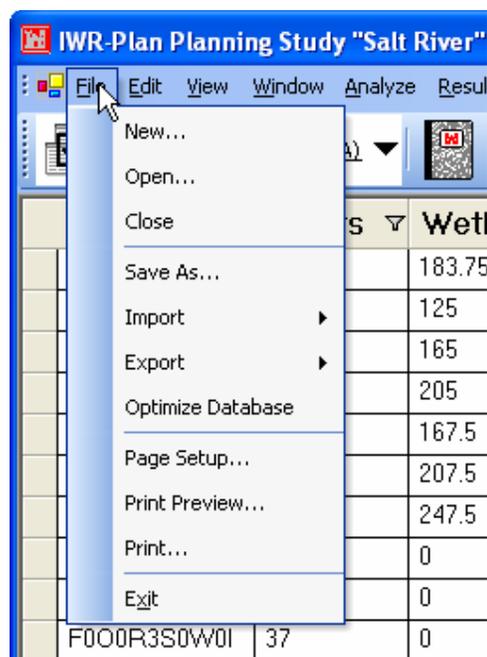


Figure 67
File Menu Extras

data manually through the plan editor, or import data from another source.

Open

Use “File Open...” (Figure 67) to open an existing IWR Planning Suite database and planning study. Any currently open plan study and database will be saved and closed, and the existing database will be opened in IWR Planning Suite, ready for editing or analysis.

Close

The “File Close” menu item (Figure 67), when selected, will close the current planning study and database. Many menu items will become unavailable when the plan study is closed, because there is no open plan study for them to act upon. The “New” and “Open” items will remain available so that another planning study may be created or opened for editing and analysis.

Save As

Select “File Save As...” to give a new name to any existing database file. The currently open database file is the file to be renamed. The “Save Plan Study As” dialog will appear, then type in a new name in the File name form. Click on “Save” to rename the database.

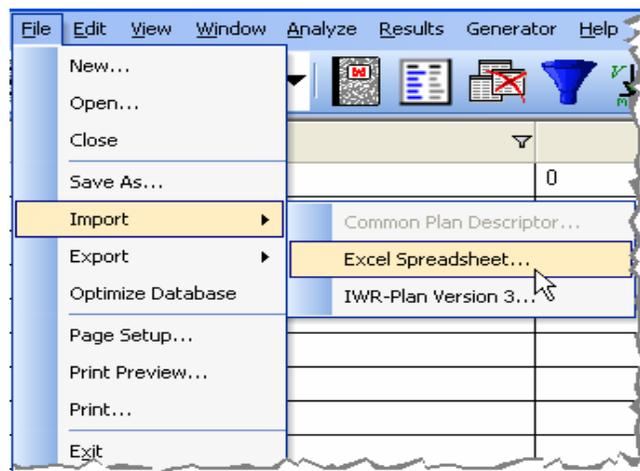


Figure 68
Import Data

Import

Use “File Import” (Figure 68) to import a data file from an existing Excel spreadsheet file or an existing IWR Planning Suite Version 3.33 database file.

Import Excel Spreadsheet

The import utility will automatically populate variable names, solution and scale codes, and Solutions and Effects data within an IWR Planning Suite data file from the source spreadsheet file. The advantage of this option is that the user will in most cases already have developed data that is to be processed in IWR Planning Suite. If the data can be transferred to an Excel

spreadsheet file having the proper format, the user can avoid having to re-type the same information within IWR Planning Suite.

First, the user must select the spreadsheet file to import from by pressing the ellipses (...) button next to the Excel Spreadsheet entry field (Figure 69). This will bring up the standard Windows file navigation dialog entitled “Select Excel Datafile to Import From” (Figure 70). Navigate to the appropriate Excel file and press the Open button to select the spreadsheet file to import from.

Once the spreadsheet file has been selected, please enter a name for the planning set to be imported in the entry field labeled “Planning Set Name”

After entering the new planning set name, the import format of the Excel spreadsheet to be imported should be selected. IWR Planning Suite accepts three different format variations for imported Excel files: two formats for importing management measure solutions and variables, and one format for importing fully-formulated plan alternatives and variables. These are:

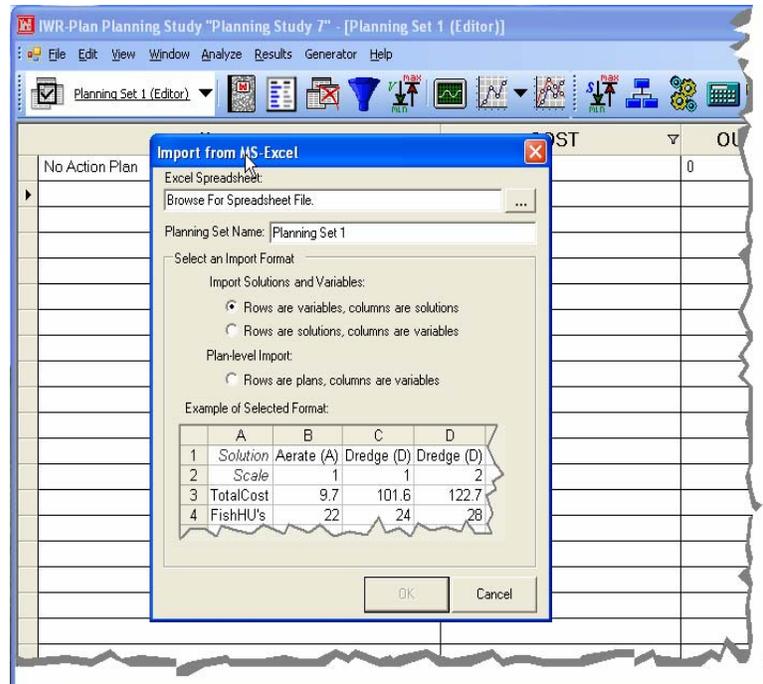


Figure 69
Plan Editor Toolbar Components

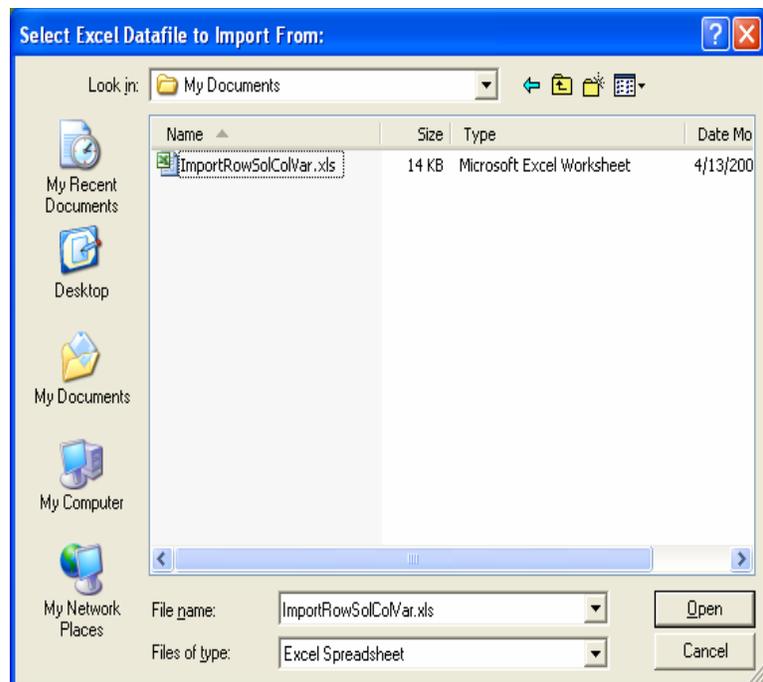


Figure 70
Select Datafile to Import

Import Solutions and Variables:

- Rows are variables, columns are solutions. An example of an Excel spreadsheet in this format would look like this (Figure 71):

The screenshot shows a Microsoft Excel window titled "ImportRowVarColSol.xls". The spreadsheet has columns A through E and rows 1 through 6. The data is as follows:

	A	B	C	D	E
1		Aerate	Dredge	Dredge	
2	Scale	1	1	2	
3	TotalCost	9.7	101.6	122.7	
4	FishHU's	22	24	28	
5					
6					

Figure 71
Row Variables

- Rows are solutions, columns are variables. An example of an Excel spreadsheet in this format would look like this (Figure 72):

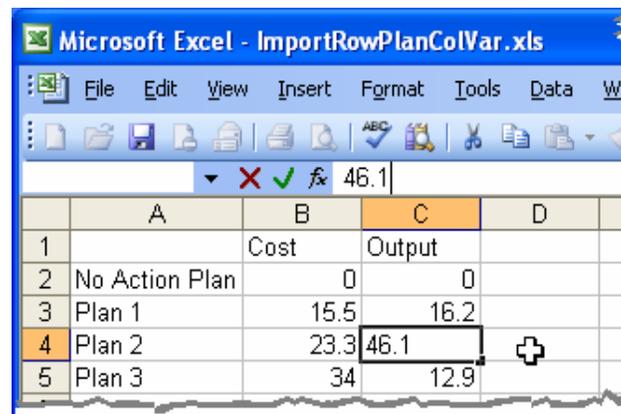
The screenshot shows a Microsoft Excel window titled "ImportRowSolColVar.xls". The spreadsheet has columns A through E and rows 1 through 5. The data is as follows:

	A	B	C	D	E
1		Scale	Cost	FishHU's	BirdHU's
2	Aerate	1	9.7	22	0
3	Dredge	1	102	24	5
4	Harvest	1	37.2	0	15.2
5					

Figure 72
Row Solutions

Plan-level Import:

- Rows are complete fully-formulated plans, columns are variables. An example of an Excel spreadsheet in this format would look like this (Figure 73):



	A	B	C	D
1		Cost	Output	
2	No Action Plan	0	0	
3	Plan 1	15.5	16.2	
4	Plan 2	23.3	46.1	
5	Plan 3	34	12.9	

Figure 73
Row Plans

Choose the format appropriate to your Excel spreadsheet, and select one of the options from the dialog “Select an Import Format” section by clicking the appropriate radio button:

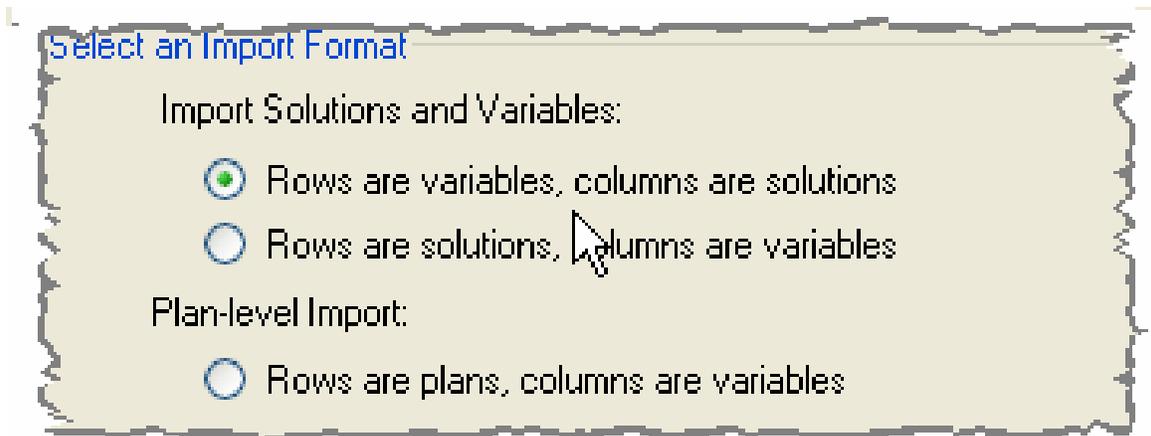


Figure 74
Select Import Format Dialog

Once the Import Format is selected, Press the OK button to initiate the importation of data from the Excel spreadsheet into the IWR Planning Suite planning study (Figure 75). Clicking the Cancel button will close this dialog without importing solutions, plans, or variables into IWR Planning Suite.

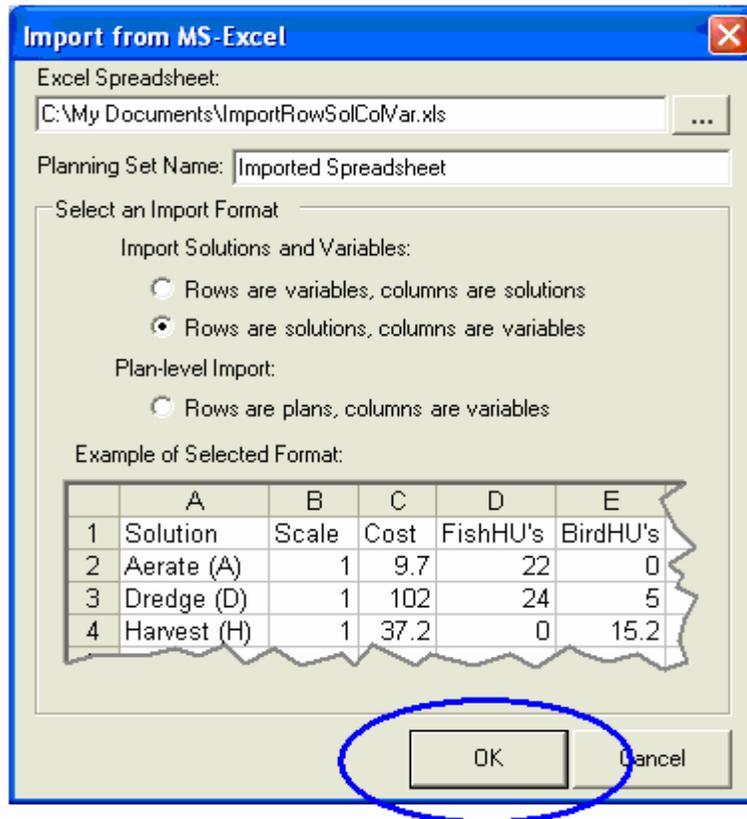


Figure 75
Initiate Importation

Please note that the import procedure will overwrite any existing data in the currently open IWR Planning Suite file (see warning message in Figure 76).

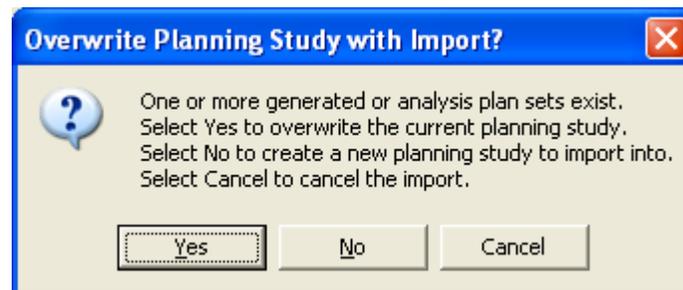


Figure 76
Overwrite Option

To avoid overwriting existing data, first open a new IWR Planning Suite data file from the main menu before beginning the Import procedure.

If analysis plan sets exist, you will be prompted by the dialog above asking whether you want to overwrite the current plan study. Click Yes to overwrite it, click No to create a new planning study, or Cancel to stop the import and avoid overwriting the current IWR Planning Suite data file.

Import from IWR Planning Suite Version 3.33

To import previously saved IWR Planning Suite data files (created with the previous version of IWR Planning Suite, Version 3) in Version 4 of IWR Planning Suite, go to File on the main menu bar, and Select Import > IWR Planning Suite Version 3... (Figure 77).

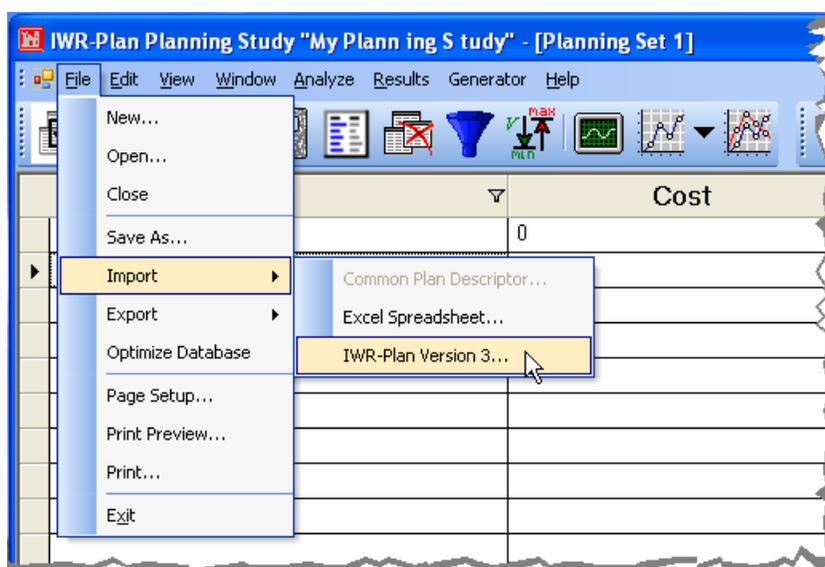


Figure 77
Import from IWR Plan Version 3

Select the folder in which the old data files are located, then click on Open. Select the appropriate file to convert, and then click on Open again. IWR Planning Suite will import variables, solutions, and scaled effects from the old IWR Planning Suite database.

The dialog "Select IWR Planning Suite Version 3.33 Database for Import" will display. Navigate to the appropriate database and press the Open button to import data from that database into IWR Planning Suite version 4.

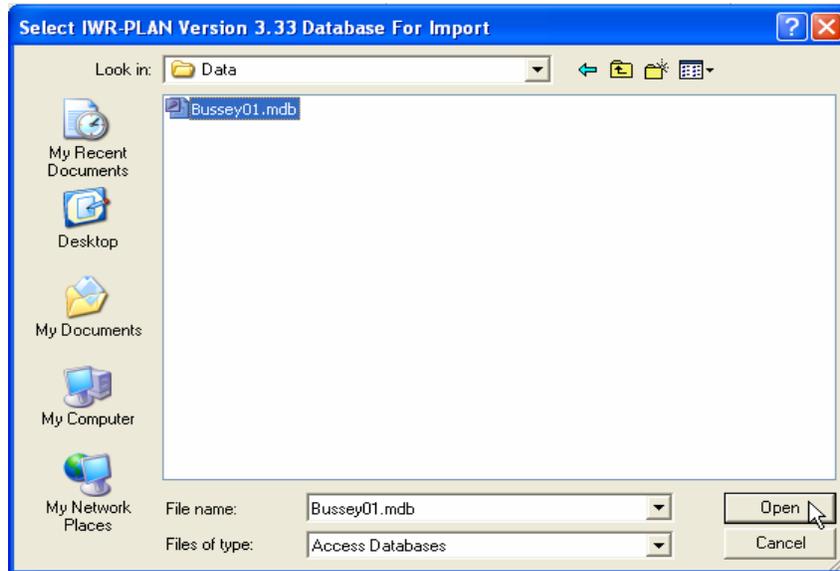


Figure 78
IWR Plan Version 3.33 Dialog

When the importation process is complete, an informational message box displays indicating success.

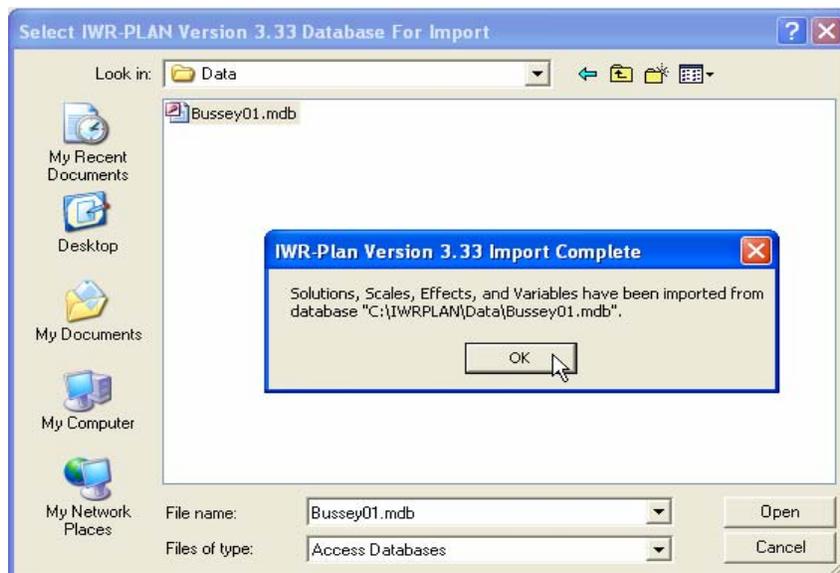


Figure 79
Import Complete Message Box

Export Planning Set

To export IWR Planning Suite data to other programs and file formats, navigate to the Export popup menu from the main menu File popup menu (see Figure 80).

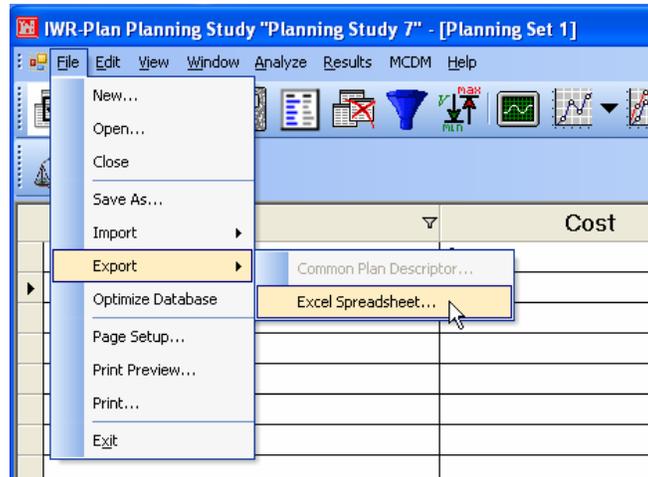


Figure 80
Export to Excel

Then select the format in which you wish to export (currently only Excel file formats are supported from the "Export" function). An Export dialog will appear (see Figure 81).

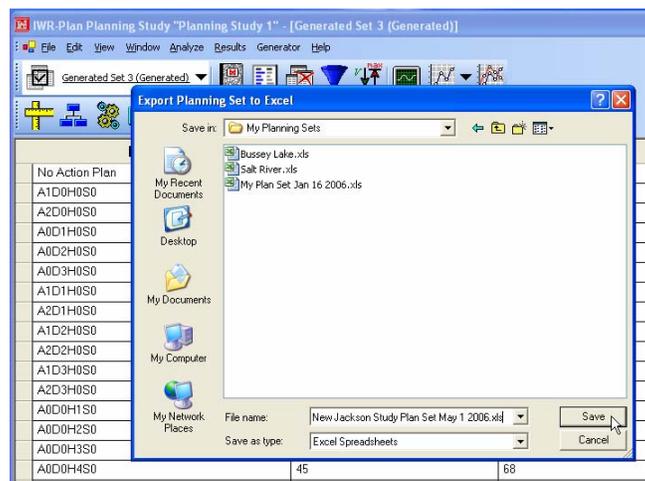


Figure 81
Excel Export Dialog

Select the directory you wish to save the exported planning set to in the "Save In" dropdown list. In the File Name: entry field, enter the name of the new file to which you wish to export the current planning set. The file will be created and the current planning set will be exported as a sheet in an Excel spreadsheet file. You can then open up the exported planning set in Microsoft Excel (see Figure 82).

	A	B	C
	Name	Cost	Output
1	No Action Plan	0.00	0.00
2	A1D0H0S0	3.00	56.00
3	A2D0H0S0	7.00	60.00
4	A0D1H0S0	23.00	13.00
5	A0D2H0S0	34.00	16.00
6	A0D3H0S0	45.00	21.00
7	A1D1H0S0	26.00	69.00
8	A2D1H0S0	30.00	73.00
9	A1D2H0S0	37.00	72.00
10	A2D2H0S0	41.00	76.00
11			

Figure 82
Excel Planning Set

Note that graphs are exportable separately from the graphics export option available by right clicking the mouse on a desired graph.

Use Export to export a planning set to an Excel spreadsheet file. Select Export > Excel Spreadsheet (Figure 80) to display the Excel export dialog (Figure 81).

Enter the name you would like the spreadsheet file to have and press OK. The entire active planning set will be exported to the spreadsheet file.

Optimize Database

Choose “File Optimize Database” (see Figure 83) from the main menu to de-fragment , repair, and compact existing database files. This is an optional operation. However, periodic compacting/repairing of data files is recommended to speed processing times and reduce file sizes.

When selected, the database is closed and optimized, and the following dialog is shown when optimization is completed (see Figure 84):

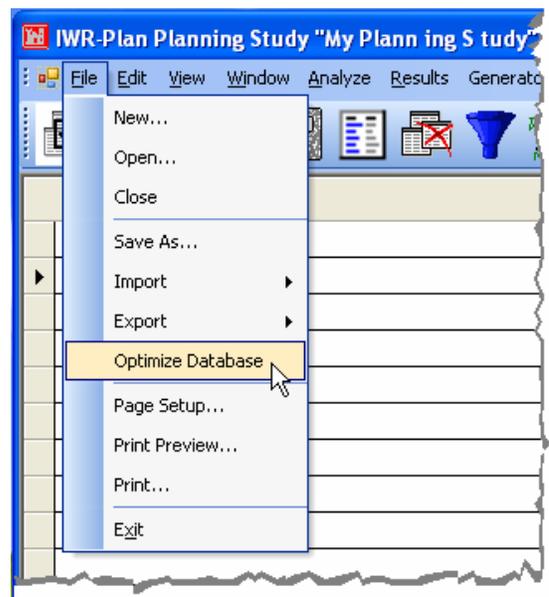


Figure 83
Optimize Database



Figure 84
Database Optimized

The database is then automatically re-opened so that you can continue working in it.

Page Setup...

When “File Page Setup...” option is selected from the main menu (see Figure 85), a standard Windows page setup dialog similar to ones used in Microsoft Office products is displayed (see Figure 86).

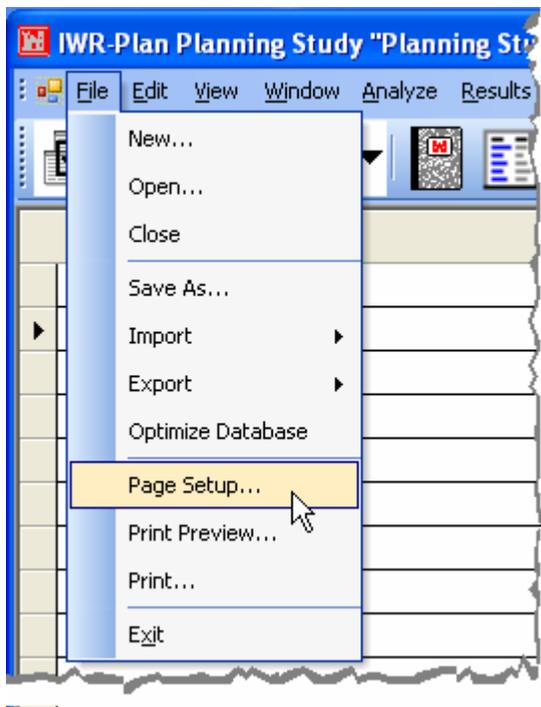


Figure 85
Page Setup Option

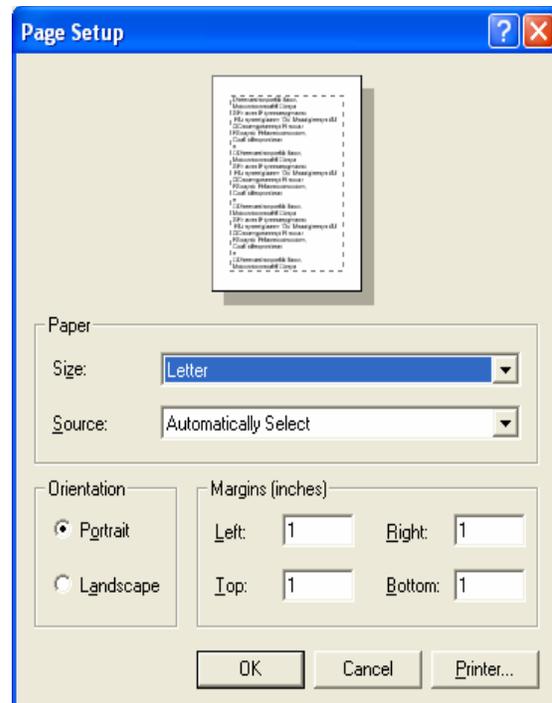


Figure 86
Page Setup Dialog

The Page Setup option allows the user to specify the printing configuration for documents to be printed through IWR Planning Suite.

The paper size, printer paper source, landscape or portrait mode, and print margins may all be defined through this dialog. Press OK to accept any modifications made. Press Cancel to leave the dialog without applying any page setup changes.

Pressing the Printer... button on the Page Setup dialog will allow you to select the printer that you wish to print to, if you do not wish to print to the default printer setup in your Windows configuration.

To do so, select the desired printer from the drop-down printer Name list (see Figure 87), and press the OK button. Pressing the Cancel button exits the Printer Page Setup dialog without changing the currently selected printer.

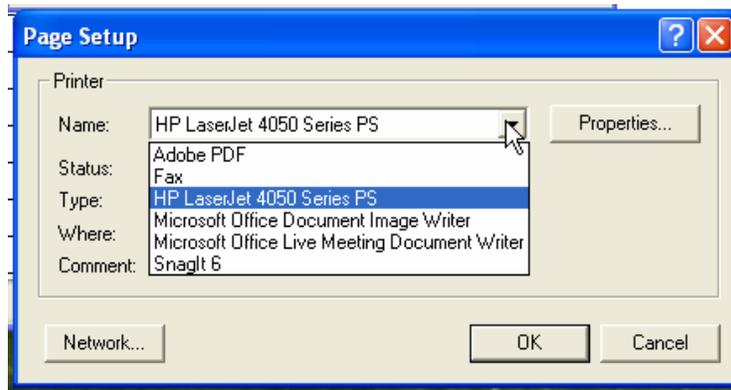


Figure 87
Page Setup Printer Selection

Print Preview...

The "File Print Preview" option (see Figure 88) displays a preview of how the current planning set will appear when it is printed out to the selected printer.

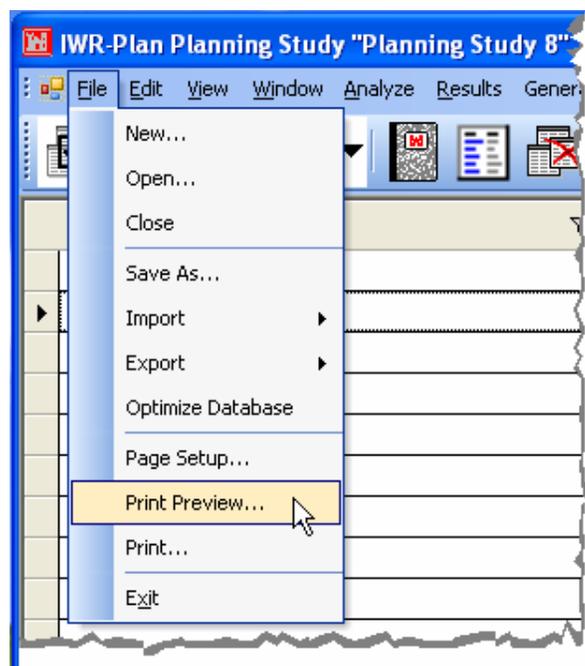


Figure 88
Print Preview

The Print preview dialog (see Figure 89) allows the user to then print the planning set to the printer, to zoom in on the print image, or to select several different single or multi-page views of the printed planning set. Pressing the Close button will close the preview dialog without printing the planning set.

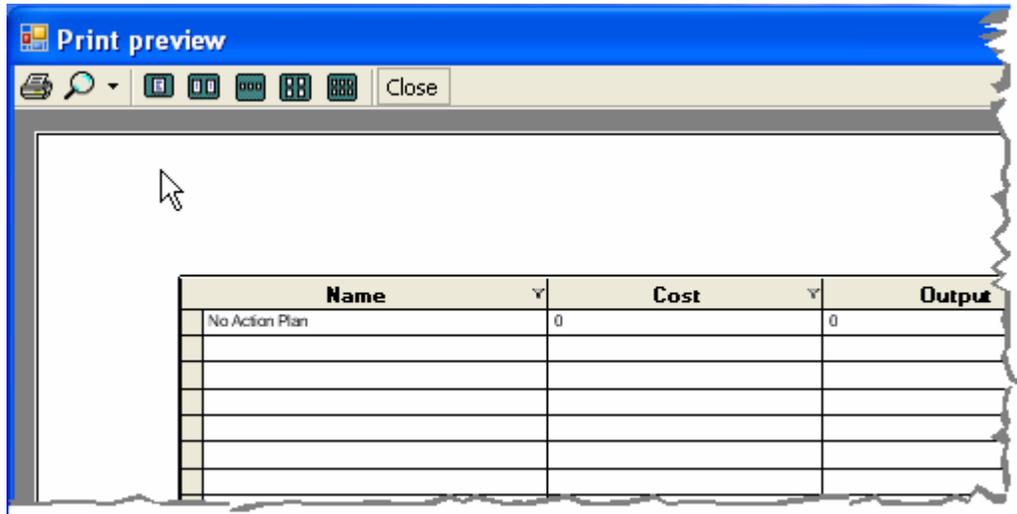


Figure 89
Print Preview Dialog

Print

Selecting "File Print" will print the current planning set to the default printer, or to the printer that has been defined through the "File Page Setup..." dialog.

During the printing process, the page being printed will be displayed in a dialog with the option to cancel the printing process (see Figure 90).



Figure 90
Print Dialog

Exit

To quit the IWR Planning Suite application, select the “File Exit” option from the File menu as shown in Figure 91.

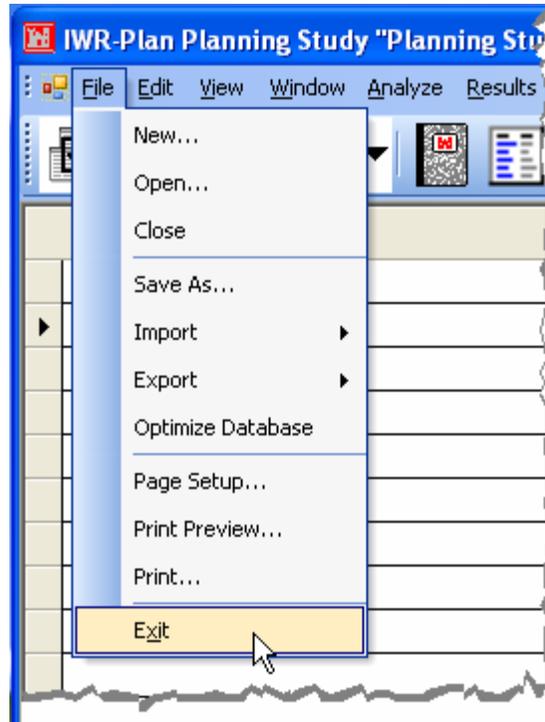


Figure 91
Exit

Edit Menu

The Edit Menu is used to modify values in a planning set. A value is selected in a planning set, and a menu item is selected from the Edit menu to perform an edit operation on that selected value (see Figure 92).

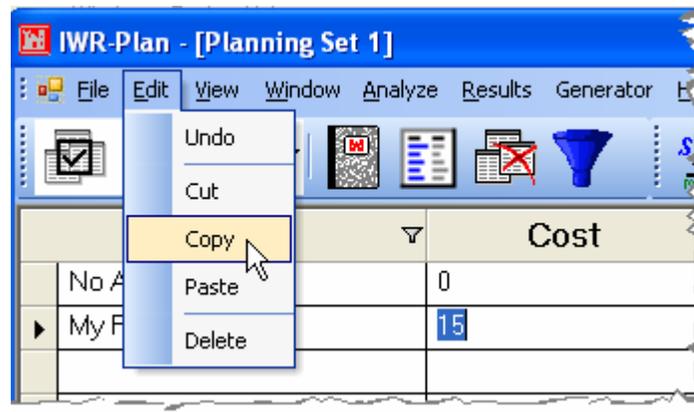


Figure 92
Edit Menu

“Edit Cut” will remove the value and place it in the Windows Clipboard from which it can then be pasted into another location in the planning set. The “shortcut” key for Cut is <CTRL>X (i.e., pressing the Control key on the keyboard and the letter X at the same time).

“Edit Copy” will copy the value into the Windows Clipboard from which it can be pasted into another location in the planning set. The “shortcut” key for Copy is <CTRL>C.

“Edit Paste” will paste any value in the Windows Clipboard into the current planning set location selected. This would include pasting values from an Excel spreadsheet into the planning set. The “shortcut” key for Paste is <CTRL>V.

“Edit Delete” will remove the selected value from the planning set. You may also press the Delete key on your keyboard to perform this operation.

“Edit Undo” will undo only the last edit operation performed on the current cell, either Cut, Copy, Paste, or Delete. The “shortcut” key for Undo is <CTRL>Z.

An advanced feature of the Windows clipboard edit capability of IWR Planning Suite can be attained by using the shortcut keys described above. Using these shortcut keys, it is possible to select an entire range of values (a grid of values) to copy or cut from the active planning set, and you may also paste an entire range of values from the Windows clipboard into the active planning set.

Windows Menu

The IWR Planning Suite Windows menu provides the standard set of windows arrangement functions familiar across all standard Microsoft Windows Applications. These include the ability to Arrange Icons, Cascade windows, Close All Windows, Tile Windows Horizontally or Vertically, or minimize all windows, as well as including a list of windows that can be selected from (Figure 93).

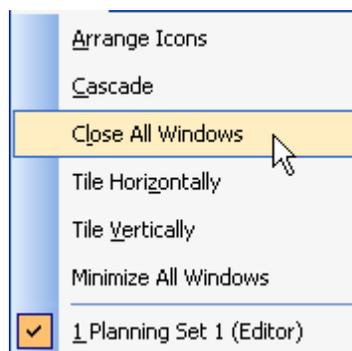


Figure 93
IWR Planning Suite Windows Menu
Items

Help Menu

Elements of the IWR Planning Suite Help System can be chosen by clicking on the Main Help menu entry and selecting the appropriate item (Figure 94).

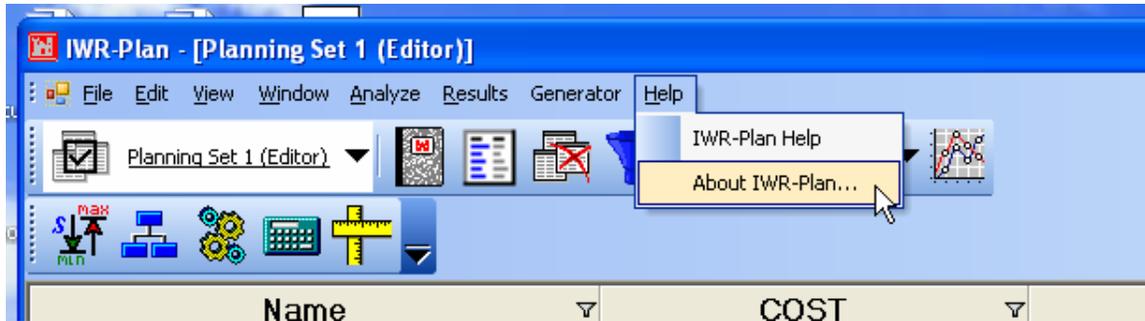


Figure 94
The IWR Planning Suite Help System Menu

The Help system is a full-featured Windows format Help System including much of the information available in this User's Manual, arranged in an electronic Help System Format which is fully indexed and completely searchable (see Figure 95). The IWR Planning Suite Help System can be accessed at any time by selecting "IWR Planning Suite Help" from the Help menu or pressing the F1 function key on your keyboard.

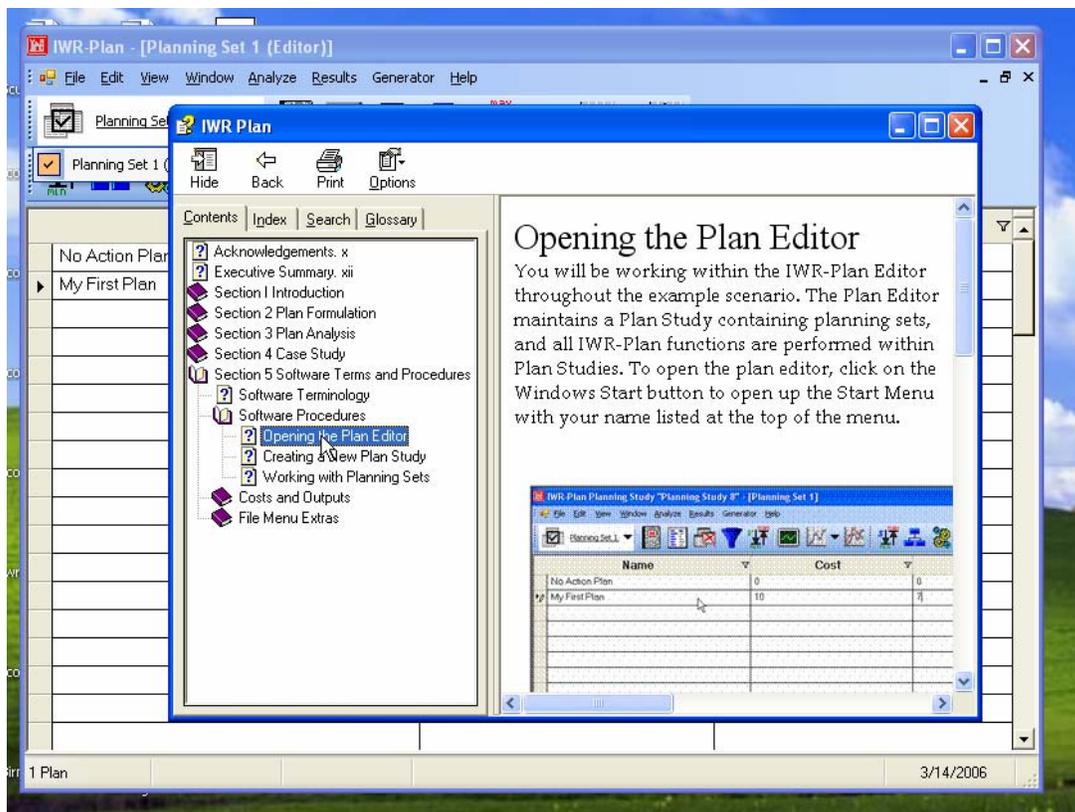


Figure 95
IWR Plan Help

IWR Planning Suite Help System

The Help menu also includes a Help About dialog providing version, release and system information that can be accessed by selecting “About IWR Planning Suite...” from the Help Menu (Figure 96).

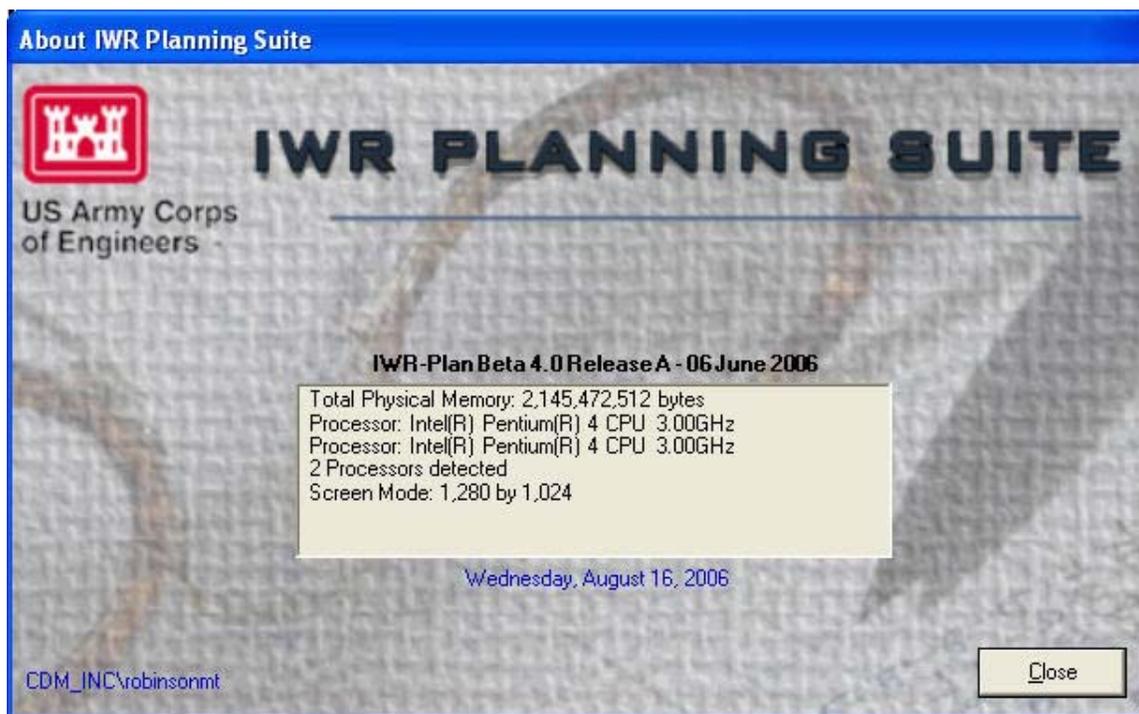


Figure 96
The Help About Dialog

Appendix

Glossary

Glossary

Attribute	A value or hierarchical structure of values associated with a plan alternative which identifies a characteristic of the entire alternative. In IWR Planning Suite, a text label with a textual or numeric value associated with it.
Derived Variable	A variable associated with a plan alternative, and described by formulae applied to component variables. Mathematical functions are applied to component variables to define a derived variable.
Plan alternative	A set of one or more management measures (activities) of particular scales. Comprised to address planning objectives.
Planning set	Any group of plan alternatives.
Plan study schema	A named set of variable and attribute definitions held in common by a planning study. Within IWR Planning Suite, describes a particular planning study.
Planning study	The plan alternatives and analysis results, maintained in planning sets, used to evaluate candidate plans for a specific planning task. A related group of planning sets derived from a common set of plan alternatives.
Scale	A discrete feature magnitude or level of activity applied to a solution.
Scenario	A specific analysis to be performed upon a planning set, or the results of that analysis.
Sensitivity	A basic method of indicating the analytic uncertainty of a plan alternative variable through the mechanism of assigning low and high values to describe the variable's value as a range.
Solution	A feature or activity that can be implemented to address one or more planning objectives. A planning task management measure.
Variable	One of the constituent components of a plan alternative. A category used for comparative purposes during analysis. A representation of the combined measures of a study, such as cost and output. The constituent components of a derived variable.