# NATIONAL ECONOMIC DEVELOPMENT PROCEDURES MANUAL -

# OVERVIEW MANUAL FOR CONDUCTING NATIONAL ECONOMIC DEVELOPMENT ANALYSIS


by

The Greeley-Polhemus Group, Inc.
West Chester, PA


for


U.S. Army Corps of Engineers
Water Resources Support Center
Institute for Water Resources
Fort Belvoir, VA 22060-5586

October 1991

IWR Report 91-R-11

## PREFACE

This manual would not be complete without an acknowledgement of the Corps personnel responsible for its preparation and the process by which they guided its formation.

From the outset, the content of this manual has been the invention of the Institute for Water Resources and the Field Review Group charged with its oversight. Dr. Mark Dunning, the technical monitor for this manual, identified a Field Review Group (FRG) consisting of ten Corps personnel. The Greeley Polhemus Group, Inc., the contractor for this manual, conducted interviews of the FRG members to ascertain the range of National Economic Development (NED) economic issues of concern to them. Each FRG member was asked to identify other Corps personnel knowledgeable in the area of NED economic issues. The contractor interviewed a dozen of these people.

The results of the interviews were compiled to identify those issues that were both economic in nature, rather than formulation issues, for instance, and enjoyed some degree of consensus among the Corps personnel. The FRG members were provided with a draft manual outline and the contractor's suggestions for examples to be included in the manual.

On November 7, 1990 the Institute for Water Resources convened a meeting between the FRG and the contractor. At that time, the FRG prepared a detailed outline for the draft manual that was used by the contractor to prepare the draft of the manual before you now.

The draft manual was circulated to the FRG in January for initial comments. These comments were addressed by the contractor in a revised draft that was the subject of a second meeting of the FRG on March 13 and 14, 1991. At that meeting this manual was approved in the form in which it now appears.

The contractor would like to acknowledge and thank, without implicating, the following members of the FRG.

Dr. Mark Dunning CEWRSC-IWR
Mr. Mike Arabatzis CENAD-PL-F
Mr. Charles Armstrong CESWD-PL-P
Mr. Ken Boire CENPD-PL-EC
Mr. Roger Burke CESAM-PD-F
Mr. Steven Cone CECW-PD
Mr. William T. Hunt CECW-PD
Mr. Russell Iwamura CEPOD-ED-PJ
Mr. Larry Kilgo CELMVD-PD-E
Mr. Harvey Kurzon CEWRC-WLRC
Mr. Ron Roberts CEMRD-PD-E
Mr. Dave Swenson CEPOD-ED-PJ
Mr. Gary Wickboldt CENCD-PD-EC

This manual was prepared as part of the NED Procedures Manual Work Unit, within The Planning Methodologies Research Program. Mr. Robert Daniel (CECW-PD) is the Program's Technical Monitor.

# OVERVIEW MANUAL FOR CONDUCTING NATIONAL ECONOMIC DEVELOPMENT ANALYSIS

Table of Contents

Table of Contents (Continued)

Table of Contents (Continued)

Table of Contents (Continued)

LIST OF FIGURES (Continued) Page



LIST OF TABLES

# Chapter 1: INTRODUCTION

"Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation. Contributions to NED include increases in the net value of those goods and services that are marketed, and also of those that may not be marketed." ...*Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, p. 1, March 1983

## INTRODUCTION

This manual provides an overview of the **national economic development (NED)** principle that is essential to determine whether the Federal government will construct any water resource project. The NED principle articulates a framework to assist in making this decision. Analysts working within this framework and decision makers who must understand it are the manual's intended audience.

The NED principle is often misunderstood by analysts and a mystery to decision makers. Such misunderstanding and mystery can lead to problems in formulating projects. The manual seeks to unravel some of the mystery of the NED principle for laymen and to provide new and reignite old insights for Corps' economists and planners. By clarifying the NED principle, projects can be formulated and evaluated with greater consistency and better informed decisions can be made and understood by all interested parties.

Corps projects produce outputs. Project outputs have value because they satisfy people and contribute to their happiness. Inputs are required to produce Corps projects. Inputs have value because we have the opportunity to use them for other purposes. The challenge is deciding how to use these inputs to achieve socially valued outputs.

The NED principle articulates a very specific perspective to be used in valuing project outputs, or benefits, and project inputs, or costs. The NED principle represents the current state of a continuously evolving Federal policy on water resource projects. The NED principle is not fundamentally an economic principle. It is fundamentally a normative economic policy, i.e., one that addresses what decision makers feel *ought to be* the Corps' economic priorities. As such, it is a matter of law, policy and interpretation rather than one of economic fact or theory, although it is a policy firmly rooted in economic theory.

**Benefit-cost analysis** is undertaken to assure that the value of the outputs exceeds the value of the inputs. Benefit-cost analysis is not the NED principle. Benefit-cost analysis is an evaluation technique used to aid decision makers in determining the economic worth of a project. The NED principle provides the basis for identifying appropriate benefits and costs, from a Federal perspective, to include in the benefit-cost analysis.

## AUDIENCE

This manual has been written for those who are involved in the development of water resource projects and who need to know how and why the NED principle can affect the scope and magnitude of such projects. It is intended for Corps and other professional planners as well as interested non-Federal parties. Though we hope it will provide an instructive introduction to the NED principle for new Corps economists and a useful refresher for experienced economists, this manual is not intended solely for economists.

## WHAT THIS MANUAL IS NOT

Many of the topics introduced in this manual are the subjects of entire courses and texts in the field of economics. All readers should be aware that there is much more to the subject matter than is introduced here. This manual does not describe techniques for conducting NED analysis. These techniques are described in the National Economic Development Procedures Manuals referenced in Appendix 1. The manual tries to present as much intuition on a topic as possible, with a minimal amount of theory and technical detail. Economists will frequently recognize this as a limitation of the manual. The principles and analyses in actual practice will rarely be as simple as they are made to appear in this manual.

In some instances, economists will recognize that the manual does not provide complete descriptions of underlying assumptions or well-known exceptions to the principles and statements the manual makes. It is not the intention of this manual to teach economics. Nor is it intended to clarify the details of the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, March 1983 (P&G). Our goal is to foster intuition about relevant economic concepts, rather than to provide a rigorous explanation of them. The non-economist reader of this manual need not be concerned about receiving an inaccurate picture of the concepts presented. The principles are not wrong; their complexities have just not been completely developed in some cases.

Perhaps most importantly, this is not a policy manual. There are many conflicts between economic theory and principles (i.e., positive economics) and the economic policies (i.e., normative economics) of the Corps of Engineers that have been developed over time as a result of legislation and other policy decisions. Where appropriate, these conflicts will be identified. This manual intends no advocacy positions on any of these conflicts. Economic theory is the domain of the economist. Economic policy, in the context of this manual, is the domain of the decision makers. Where economic theory has been compromised in favor of policy it is almost invariably done to make the task of economic analysis and evaluation more manageable within the context of project study constraints. Though Corps policy and economic theory may diverge at times the policies are generally formulated to approximate **willingness to pay** or opportunity costs, since rational government decisions and policies may depend on the resulting estimates, even though they are imperfect.

On a closely related note, it must be pointed out that this manual does not address any of the many plan formulation issues related to the NED principle. These issues are perhaps the most difficult facing Corps and non-Federal personnel alike. What constitutes "acceptability" of a plan is a question of great importance. Designation of the **NED plan** hinges on the answer. This manual will not address this or other questions that are the domain of policy makers and planners.

In summary, the manual attempts to provide both a broader and deeper understanding of the NED principle. It does not provide an economically rigorous treatment of the issues. The manual strives for a sound intuitive understanding of the basic economic principles involved.

## ORGANIZATION OF THE MANUAL

The Foreword provides a summary of the process by which this manual was developed. The manual consists of 6 chapters and 2 appendices organized into three basic parts. Chapters 2 through 5 provide an overview of the economic concepts that underlie the NED principle and, hence, economic analysis of Corps projects. Chapter 6 provides example applications of the principles and concepts introduced earlier in the manual. The manual concludes with 2 appendices that provide suggestions for further reading, additional material on the history of the NED principle, and current guidance related to it.

Chapter 2 deals with some general concepts and economic principles that are used to help improve decision making. The basic problem is that we can't do everything. Given this fact of life, economics provides some guidelines on how to look at choices and decisions to at least avoid waste, or what economists call "inefficiency". The principles of economic decision making criteria, one of which is the **benefit-cost ratio**, are introduced in this chapter.

The economic nature of **NED benefits** is the subject of Chapter 3. This chapter provides an introduction to **demand** and **supply** theory and presents more economic concepts than any other chapter. It addresses the question, "What are we trying to measure under the NED principle?" and takes it from the general concepts to examples of specific project purposes.

**NED costs** are the subject of Chapter 4. While a great deal of guidance has been written on the subject of project benefits, relatively little has been written about project costs. Costs are of paramount interest to **non-Federal partners**, and the taxonomy of costs is becoming more and more complex. Cost concepts introduced in Chapter 3 are expanded here, and different perspectives in common usage are explained.

Chapter 5 addresses a small, but significant, collection of other issues relevant to the Corps' NED principle. First among these is the value of marginal thinking. Stifle the snickers, we do not mean the value of just barely thinking, but the value of considering only those benefits and costs that are relevant to the decision problem, i.e., the marginal values. This discussion leads to consideration of the benefit maximizing requirement of the NED plan.

Chapter 5 also addresses the with- and without-project conditions with emphasis on the requirement of assuming **economic rationality** and its meaning for the with and without analyses. Imposing this assumption of rationality on the with and without analyses precludes certain illogical results that could otherwise arise during plan formulation.

Chapter 6 provides discussion of selected topics that were identified by a group of practicing Corps planners during the development of this manual. Appendix 1 contains suggestions for further reading on the topics contained in the manual as well as references to selected Corps' documents. Appendix 2 provides a brief historical summary of the evolution of the NED principle.

# Chapter 2: GENERAL CONCEPTS UNDERLYING NED ANALYSIS

## INTRODUCTION

Why do we need an NED objective to assist in formulating and evaluating water resource projects? Because of the fundamental economic problem--we can't do everything! This chapter explains some of the underlying economic concepts upon which NED analysis is based.

## SCARCITY--THE FUNDAMENTAL ECONOMIC PROBLEM

The NED principle is a policy developed to guide Federal water resource planners in their choice of problem solutions. Choice is the fundamental business of economics. Economics is the science of making rational choices, based on a set of assumptions that have been remarkably successful in predicting behavior.

Consider a single stretch of river. It can be preserved in its natural state with restricted access. Or, it can be moderately developed for recreational uses, such as hiking, fishing, hunting, and canoeing. Or, the banks could be cleared and developed for industrial, commercial, and residential usage. Yet another alternative would be to dam the lower end of the reach and flood the entire stretch of river to provide flood protection, hydropower, water supply and recreation to thousands of people. The reach can't be used for all these purposes, so the fundamental problem becomes how, and on what basis, to decide among these competing choices.

Because all resources are **scarce**, we are forced to make choices when they are used. Choose more of one thing and you simultaneously are choosing less of another. Thus, every choice costs us something. If we make the best choice from among the river reach alternatives, at a minimum it costs us the opportunity to do the next best thing with the reach, this is called **opportunity cost**.

The process of developing a plan for the use of a water resource is an exercise in dealing with the fundamental economic problem of scarcity. The fundamental problem of scarcity is not confined to such broad issues as what to do with a unique reach of river. The concrete and steel used in a flood wall could be used in many other ways as well. Using these resources in a flood wall means they will not be available for alternative use elsewhere in, for example, an office building. Thus, the flood wall costs the Nation an opportunity to do something else with the resources. In essence, the NED principle is intended to ensure that the benefits to the Nation of the use of these resources in a project exceed the costs of the project to the Nation. In other words, the NED principle ensures that concrete and steel will be used in a flood wall only if the benefit to the Nation of using it exceeds the cost of using it. Though non-economists might be inclined to argue that concrete and steel are not "scarce" in the common usage of the word, that is precisely the point. All resources are scarce, their prices are an indication of their relative scarcity. Thus, concrete and steel, though easy to obtain are indeed scarce.

## DETERMINING BENEFITS AND COSTS TO THE NATION

Water resource projects produce outputs--goods and services that have value. Producing water resource projects requires inputs--goods and services that have value. The basic question economic analysis tries to answer is, "Does the value of the project's outputs exceed the value of the inputs used to produce the project?" What could be simpler?

Any experienced planner will attest that this is much easier said than done. Nonetheless, to answer the question "Is a project worth it?" requires understanding a few simple concepts.

To understand the NED objective requires some understanding of a field of economics known as **welfare economics**. Welfare economics focuses on using resources optimally so as to achieve the maximum well-being for the individuals in society.

Evaluating Corps projects is complicated by the fact that "welfare" is not an observable variable like bushels of wheat, kilowatts of energy, or pounds of fish. The economic welfare of an individual is formally given by his or her **utility** level. Utility is a term that is generally synonymous with happiness or satisfaction. Thus, project outputs have value because they make people happy or provide them with satisfaction.

It is commonly accepted among economists that the only objective basis under which one can say that society is better off with a water resource project than without it, is when some people are made better off and no one is made worse off by the project. This adaptation of what has come to be known as the ***Pareto principle*** is not experienced in the Corps' realm of practice. Corps' project benefits are generally localized, while the Federal share of costs come from taxpayers across the country. Thus, though the residents of a protected flood plain are made better off, some taxpayers are made worse off because they receive no benefits from the project and must pay some of the costs. If even one person is made worse off, there are no objective grounds to support the project on the basis of increased utility because it is impossible to objectively compare the increased happiness of the protected beneficiaries with the decreased happiness of the taxpayers.

If economic theory stopped here, there would be no such thing as economically justified public works projects. In an effort to extend the class of issues that can be addressed by welfare economics, the ***compensation principle*** was developed in 1939. Again adapting the principle to water resource development, it says a project should be undertaken if potential "with-project" gains are sufficiently large that everyone could be

**Decision Criteria**

**Criterion 1: Net Present Value**

The *net present value (NPV)* method reduces a stream of benefits and costs to a single number. The flow of benefits over time is reduced to a single discounted value. Costs are likewise discounted. Discounted costs are subtracted from discounted benefits, and if the result, the NPV, is positive, the project is worth undertaking, (i.e., the winners could compensate the losers and still be better off, after we adjust for the differences in the time value of money).

The NPV is generally regarded as the best decision criterion. The requirement that a Federal project have net NED benefits is a clear adaptation of this decision criterion by the Corps. Maximizing annual net NED benefits is formally equivalent to selecting a plan with the maximum NPV.

**Criterion 2: Cutoff Period**

Under this criterion, a project is acceptable only if it covers all its costs by a certain time. For example, we might consider only those projects whose time-adjusted benefits exceed its costs within, say, ten years. This criterion is used most often by those concerned with cash flow issues. Local interests financing revenue bonds may be limited to projects that generate revenues within the period of the bonds. In our example it is biased against projects with substantial benefits that occur beyond ten years into the future.

**Criterion 3: Pay-Back Period**

Under this criterion, the project that pays back all of its costs in the shortest period of time is considered best. This

made better off by some redistribution of goods or income following implementation of the project[1].

The significant difference is that the compensation principle recognizes the existence of "winners" and "losers". It goes on to allow that if the winners gain enough from the project that they could, hypothetically, reimburse the losers, then the project is worth undertaking whether there is a reimbursement or not. Society as a whole is better off, even if some of its members are worse off.

For example, if a project costs 1,000,000 people $1 each and 100,000 people realize $20 in benefits each, there are clearly winners (the 100,000) and losers (the 1,000,000). However, the $2,000,000 in benefits could be redistributed in such a way that each of the 1,000,000 gets his $1 back so no one is made worse off and each of the 100,000 could still have $10 each. This compensation principle provides the theoretical basis for undertaking water resource projects--society can, hypothetically, be better off.

## ECONOMIC DECISION CRITERIA

For any given water resource project, we would like to know if the "winners" could hypothetically compensate the "losers", i.e., does the value of the outputs exceed the value of the inputs? There are many decision criteria suitable for answering this question (see box). The Corps uses the benefit-cost ratio (BCR) as its decision criterion. It is only one of many such criteria.

Benefit-cost analysis is used to determine if total benefits produced by the project exceed the **total costs** of the project. Benefits are measured as the willingness to pay for project outputs, and costs are the true opportunity costs of the project.

[1] A more accurate statement of the compensation principle is that a project is preferred to no project only if the gainers can compensate the losers in implementing the project and the losers cannot bribe the gainers into not implementing the project. The original principle developed by Kaldor and Hicks, and this refinement offered by Scitovsky, eliminates the possibility of the reversal paradox, wherein there are cases where a project is preferred to no project and no project is preferred to a project. This footnote provides the non-economist reader with an example of the type of detail you do not get from this manual!

**Criterion 3: Pay-Back Period (Continued)**

criterion also discriminates against projects with benefits that occur later in the project's life. The Corps has encouraged the use of a close variation on this criterion, i.e., identification of the project year in which benefits first equal or exceed costs, since the days of the Principles and Standards (P&S) which preceded P&G (see Appendix 2 for a historical perspective on Corps economic policy).

**Criterion 4: Internal Rate of Return**

The discounting process requires the use of an appropriate interest rate. The **internal rate of return (IRR)** criterion identifies the interest rate that will yield a net present value of $0. Thus, if money for the project can be obtained at a cost less than the IRR, the project should be undertaken (i.e., the winners can compensate the losers). If the money costs more than the IRR, the project is a money loser and would represent a net decrease in society's welfare.

Used primarily in private enterprise where decision makers must be concerned about the costs of money, use of the IRR has also been encouraged by the Corps since P&S. In the context of Corps analysis, the IRR is the rate at which the benefit-cost ratio will exactly equal one.

**Criterion 5: Other Techniques**

There are a variety of other techniques that are generally used less frequently than those above. *Net average rate of return* is the sum of net benefits over the life of the project divided by the number of years over which the benefits are incurred, and then by the total cost of the project. *Annual value* is formally equivalent to the NPV, except that monetary values

The Corps uses two decision criteria in its formulation process, the benefit-cost ratio and **net benefits.** All alternative projects must have a BCR equal to or greater than one to be considered for implementation. Under the NED principle, the best, or NED, plan is the one that maximizes net benefits. The Corps traditionally expresses all monetary values as equivalent annual values. The BCR is annual benefits divided by annual costs. Net benefits can be readily expressed as a Net Present Value (NPV) and vice versa. Other decision criteria are often reported to provide additional information.

## ANALYTICAL TECHNIQUES

Apart from the decision criteria described above, there are a variety of tools and techniques for conducting economic analysis in general and NED analysis in particular. For example, while the benefit-cost ratio is a decision criterion, benefit-cost analysis is an analytical technique. This manual does not address analytical techniques. The Corps is developing a series of Procedures Manuals to describe the techniques applicable for NED analysis.

## STREAMS OF BENEFITS AND COSTS

The bulk of project costs are generally incurred during the construction period. Benefits, on the other hand, typically are realized as uneven flows of income or monetary benefits that accrue over a long period of time. Decision criteria must provide a means of comparing the values of these streams of money on an equal basis.

We all recognize that a dollar today is worth more than a dollar five years from now or at any reasonable time in the future. To account for these differences in the time value of money, monetary values are "discounted", i.e., amounts of money realized in the future are expressed as equivalent amounts of money today. This topic is taken up again in Chapter 3 in the section on **interest rates.**

## PREVIEW TO CHAPTER 3

This chapter has provided an introduction to the fundamental economic problem of scarcity which requires us to make choices. Decision criteria for evaluating choices have been introduced. Chapter 3 provides an introduction to the basic concepts needed to identify and evaluate project benefits, and to a lesser extent, project costs.

**Criterion 5: Other Techniques (Continued)**

are presented as a single average annual value (in the case of the Corps, net annual NED benefits) rather than as a single present worth value. The Corps uses annual values rather than present values, apparently as a matter of tradition. *Minimum average cost* assumes that the project that produces output with the least average cost is the most desirable project scale.

**Criterion 6: Benefit-Cost Ratio**

Benefit–cost analysis encompasses all the analytical work necessary to estimate a *benefit-cost ratio (BCR).* The benefit cost ratio compares total (i.e., gross values) benefits to total costs. Once again, it is necessary that these monetary values be expressed in comparable time values. Generally, Corps projects express benefits and costs as average annual values.

Dividing benefits by costs yields a benefit–cost ratio. If the BCR is greater than one, winners could compensate losers and the project can improve social welfare. A BCR less than one means the cost of the project exceeds the benefits of the project. A BCR of exactly one means costs are just covered.

# Chapter 3: NED BENEFITS

## INTRODUCTION

The P&G generally defines NED benefits as follows:

> "Beneficial effects in the NED account are increases in the economic value of the national output of goods and services from a plan; the value of output resulting from **external economies** caused by a plan; and the value associated with the use of otherwise unemployed or under-employed labor resources..." *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, p. 8, March 1983

This chapter concentrates on economic concepts necessary to understand the nature of NED benefits. The first sections develop critical economic concepts and relationships. By the end of the chapter, these concepts will be used to illustrate several categories of benefits in the NED account. The chapter concludes with a discussion of the differences between benefits to the Nation and benefits to the local economy.

## OVERVIEW OF NED BENEFIT ESTIMATION

Anticipating what follows, we want the reader to see that, at best, measurement of NED benefits is a difficult task. Project outputs have value because they make people happy. We can't measure happiness so we use a proxy; how much would a person be willing to pay for that change in happiness? This willingness to pay can be measured rather precisely as areas under demand and supply curves. Unfortunately, the necessary demand and supply curves are not always available. When they are not, alternative techniques are used to approximate the relevant areas. At times, the tools for implementing these alternative techniques are less than perfect.

Thus, the economist has to measure what cannot be measured using concepts that cannot be observed. So he must resort to using less-than-perfect tools as proxy measures of approximate values of things that don't really exist! Not an easy task! It's understandable that so many people get so confused.

## WILLINGNESS TO PAY

Willingness to pay can be measured in one of two ways, depending on how we compare the alternatives people are choosing between. One estimates the amount of money one would be willing to pay for a project, the other estimates the money one would have to receive to willingly forego a project and be as satisfied in each case. These two measures will be presented in the context of a simple **flood control** project with and without condition comparison.

First, to see what a project is worth we could start with the **with-project condition** and move back to the **without-project condition.** How much money could we take away from a person who is protected by a flood control project that would leave her just as well off as she was before she was protected?

Flood control increases her utility, i.e., it increases her happiness. Conceptually, it would be possible to take away some amount of income such that she would be just as happy with flood protection and less income as she was without flood control and with more income. This difference in income is one measure of her willingness to pay for flood control[2].

[2] This measure of willingness-to-pay is called ***compensating variation.*** It is the amount of money which, when taken away from an individual after an economic change, leaves the person just as well off as before. In other words, her utility before the project is exactly the same as her utility after the project, once the income is taken away.

For an increase in her utility, we are looking for the maximum amount she is willing to pay for the change. If the with-project condition decreased her utility for any reason, say she valued a pristine environment more than flood protection, we would be looking for the minimum amount the person would require as compensation for the change.

The second approach to estimating a project's value begins with the without-project condition and proceeds to the with-project condition. How much money would we have to give to an individual who, if the flood control project is not built, is as well off as she would have been had the project been built?

Again, flood control would increase her utility. By not providing flood control, she is deprived of utility and it would be possible to give her some amount of income that would leave her as well off as she would have been with the project. This difference in income is an alternative measure of her willingness to pay[3].

For an increase in her utility, this income is the minimum compensation she would have to receive to forgo flood control. If the project decreased her utility, it is the negative of the maximum amount she would be willing to pay to avoid the project.

**The Rational Person**

Economics proceeds on the assumption that people act rationally. Perhaps this is what makes so many people suspicious of economics. If so, it is important to recall that the true test of theory is its ability to predict behavior. Experience has shown time and again that human choice is influenced in a predictable way by changes in economic incentives.

**Rationality**, in economics, means that individuals make choices that are consistent with achieving a set of expressed goals. The assumed goal for individuals is that they will make choices that are consistent with making themselves as "well off" as possible, subject to their available income. We assume firms will make choices that are consistent with maximizing their profits. Since profits are defined as total revenues minus total costs, profit maximization also includes cost minimization. If costs of producing are not as low as possible, profits could always be increased by cutting costs.

Corps planning is conducted in a with- and without-project context. By comparing forecasts of future conditions in a community without a project to forecasts of conditions with a project, the differences in costs incurred by and benefits accruing to the community as a result of the project are more readily identified. In order to ensure that plan alternatives are economically efficient, it is necessary to impose the condition of economically rational behavior on individuals and firms in both the with- and without-project condition. The significance of this assumption will be taken up in Chapter 5's discussion of the with- and without-project conditions.

[3] This is the ***equivalent variation***, the amount of money paid to an individual which, if the economic change does not happen, leaves her as well off as if the change had occurred.

These utility and willingness to pay concepts are equally applicable for firms as well. On the producer side of our economy, however, more well-known quantities, such as **profits**, substitute for utility[4].

Economists generally measure these willingness to pay values as the areas under curves. For consumers, we measure areas, called **consumer surplus**, under demand curves and for firms we measure areas, called **producer surplus**, over supply curves. Consumer surplus is defined as the area below the demand curve and above the price line[5]. Producer surplus is defined as the area above the supply curve and below the price line. Consumer and producer surplus are discussed in greater detail later in this chapter.

## PRICES AND THE NED PRINCIPLE

All the techniques used to estimate NED benefits and costs rely on the availability of prices or the ability to reasonably estimate prices if they are unavailable. If prices are so important to NED, and they are, we need to understand a little bit about them.

**Utility Maximization**

Rational individuals are assumed, in economics, to make choices that make them as well off as they possibly can be with the income available to them. This behavior is called "utility maximizing" by economists.

A basic proposition of economics is that utility increases as the amount of goods and services consumed increases. Thus, Corps projects have value because they increase the utility of individuals by providing goods and services. While this seems reasonable, a major problem results from the fact that we cannot measure that utility.

Even if we could measure utility directly, we would still have a problem. For example, if one has to chose between providing flood control that will increase residents utility by, for argument's sake, say 100 points, and shelters for the homeless that will increase their utility by 75 points, we still cannot conclude that flood control is socially desirable. Society may well consider the homeless twice as important as those living in flood plains; then 75 points for an important group may well be worth more than 100 points to a less important group, and shelter for the homeless should be provided. The basic problem is that there is no objective way to make interpersonal comparisons of utility. If this seems unnecessarily complex to the non-economist reader, bear with us, help is on the way.

Utility gains and losses cannot be measured or compared, so an alternative measure of the fundamental satisfaction people get from goods and services must be chosen. An observable alternative for measuring the intensities of an individual's preferences for one situation versus another (e.g., with-project condition vs. without-project condition) is the amount of money the individual is willing to pay or accept to move from one situation to another. Thus, the *willingness to pay principle* is the foundation for the NED principle and welfare economics as practiced by the Corps.

[4] Actually, profits serve this function only when firms continue to operate in both scenarios, i.e., with and without the economic change. It would be technically more correct to say that quasi-rents are the quantities we should measure for firms. However, profits will do fine for our purposes here.

[5] For individuals, the willingness to pay estimation matter is more complex. In order to avoid a protracted discussion of demand theory, we will simply suggest that an individual's welfare can be estimated by consumer surplus. In certain cases, this measure of an individual's willingness to pay can be seriously flawed. However, for a fairly wide range of circumstances, it is a reasonable estimate of an individual's willingness to pay for a change.

Exact measures of compensating and equivalent variations can be found from areas under the Hicksian or utility-constant demand curve. Hicksian demand curves are generally unobservable. The demand curves that most people are familiar with are the Marshallian, a.k.a. ordinary or income-fixed demand curves. These curves are different from the Hicksian curves. To the extent they are reasonably close to one another, the area under an ordinary demand curve will provide a reasonable estimate of the true willingness to pay.

In the following sections, supply and demand curves are introduced separately. Then we look at how the forces of supply and demand combine to produce prices. Finally, we will consider how the equilibrium price determined by supply and demand represents a social optimum.

## DEMAND CURVE

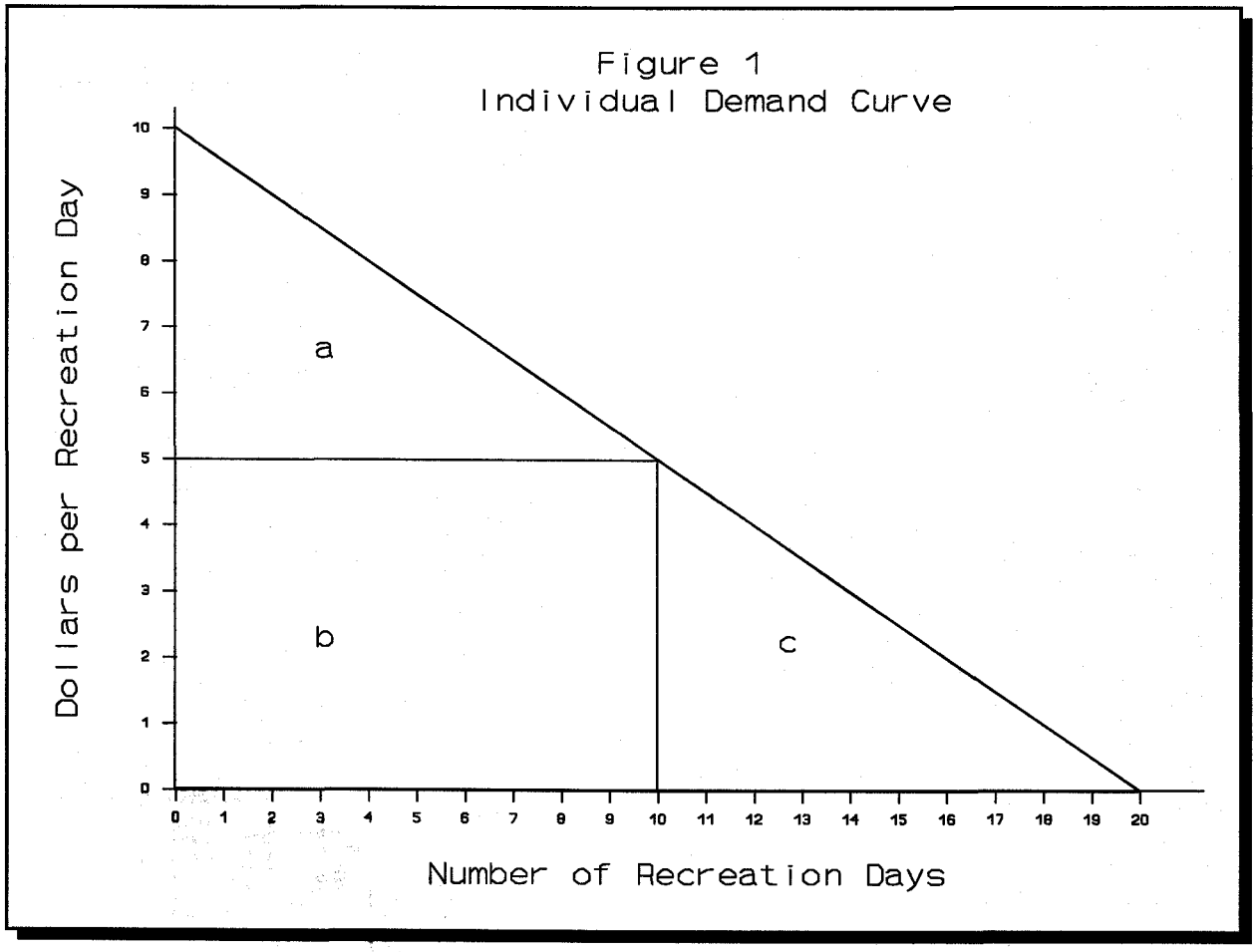
Demand is the maximum quantity of a good or service people are willing and able to purchase at various prices. The **"Law of Demand"** states that, all other things equal, if the price of a good goes up, the quantity purchased will go down, and vice versa.

The demand curve is sometimes referred to as a willingness to pay curve because it measures how much people are willing to pay for each additional unit of the good or service. People buy additional amounts of a good until the last unit is worth exactly what it costs.

Figure 1 shows a hypothetical consumer's demand curve for recreation days at a specific Corps project. If a $5 user fee is in effect, the consumer will purchase 10 recreation days. The 10th recreation day is worth exactly five dollars to the consumer.

Each of the first nine recreation days is worth more than $5 to the consumer. She would have purchased them if the price were higher than $5. In fact, the figure shows that the consumer would still have purchased 8 of the 10 recreation days at a price of $6. Even though the price of each day is $5 she was willing to pay more than that for them. Willingness to pay should not be confused with price.

The area under the demand curve is an approximation of the total benefit a person derives from being able to consume a certain amount of a good. It is the person's total willingness to pay for the good. In Figure 1 total willingness to pay is $100



(areas a+b+c), i.e., 20 days of recreation at this site is worth a maximum of $100 to our consumer[6]. How many days our consumer will actually buy depends on the price.

For example, our consumer won't use the site at all if the fee is $10. She is willing-to-pay a maximum of $9.50 for the first recreation day because the utility she gets from this one day is worth $9.50 to her. Because the price is only $5, and the day is worth $9.50, she'll surely purchase it. The utility of the second day is worth $9 to her, and it costs only $5, so she'll clearly purchase it, and so it goes until the 10th recreation day, which is worth $5 and costs $5. Though she will purchase the 10th day, the 11th day is worth only $4.50 to her and it costs $5. She will not buy it. Her purchase rule is, like your own, if you are willing to pay an amount equal to or greater than the price, you buy. If you aren't, you pass.

## CONSUMER SURPLUS

The willingness to pay interpretation of the demand curve allows us to measure how much better (worse) off a person is when the price decreases (increases). At a price of $9.50, our consumer buys one day of recreation use. To induce the purchase of a second day, the price must be reduced to $9. At a price of $9, she pays $9 for each of the two recreation days she buys even though she would have paid $9.50 for the first day. The area under the demand curve and above the price (area a in Figure 1) represents the surplus the consumer realizes from having the lower price. This consumer surplus is only an approximation of the value of the increased utility to our consumer, but it will do well for our purposes. The area under the demand curve to the left of a quantity of 10 is $75[7] (areas a+b in Figure 1). This represents the total benefit of 10 recreation days to our consumer; hence, it also

[6] Total willingness to pay is the entire area under the demand curve. It is obtained by finding the area of the triangle, i.e., 0.5(20)($10) = $100.

[7] The rectangle formed by a price of $5 and a quantity of 10 has an area of $50. The triangle above it has an area of $25, for a total willingness to pay of $75 for the 10 days of recreation.

### Extensions Of The Consumer Surplus Concept

The unique characteristics of certain resources have caused some economists to question whether standard demand analysis incorporates all of the resource's value. Consumer surplus is an area under a demand curve. Demand curves reflect the willingness and ability of people to buy a resource. It has been suggested that not everyone who values a resource is both willing and able to pay for it at a given point in time.

Individuals, who are not consuming the good or service, may be willing to pay some amount of money to preserve their option to consume the service at some later date. This value, called **"option value"** is a value over and above the consumer surplus because these people are not included in the market demand curve. This option is important if there is some possibility that the resource will not be available at some time in the future.

Considerable controversy has developed among economists over the sign of this option value. In other words, option value may increase or decrease benefits depending on what are, for purposes of this manual, rather esoteric arguments. The empirical evidence has not been conclusive, so suffice it to say that any attempt to estimate option value or other values in addition to consumer surplus should be carefully documented.

The economics literature broadens this option value concept to include **"existence value"** and **"bequeathment value"**. It has been argued that some individuals who are not consuming the resource might be willing to pay some amount of money just to know the resource exists, though they have no intention of ever consuming it. Voluntary organizations, such as the one organized to preserve the Statue of Liberty, provide evidence of existence value. People who will never visit the site contributed to its preservation. A more esoteric extension of this idea is that some people may be willing to pay some amount of money to be able to pass a unique resource on to future generations. These people, who are not and will not be consuming the resource, affix some value to a resource because of what it might mean to future generations.

represents her total willingness to pay for 10 days of recreation at this site. At a price of $5, she pays only $50 (area b in Figure 1) for 10 recreation days though she was willing to pay $75. She realizes a consumer surplus of $25, i.e., the difference between her total willingness to pay and what she actually pays or the area below the demand curve and above the price line.

If we add all the individual demand curves to get the market demand curve, we can obtain a measure of consumer surplus for all consumers by taking the area under the demand curve and above the price line. Figure 2 shows the consumer surplus for our consumer. Consumer surplus for the entire market would be measured in the same way, but the quantities of recreation days would reflect the quantity demanded by all users of this site, as shown in Figure 3.

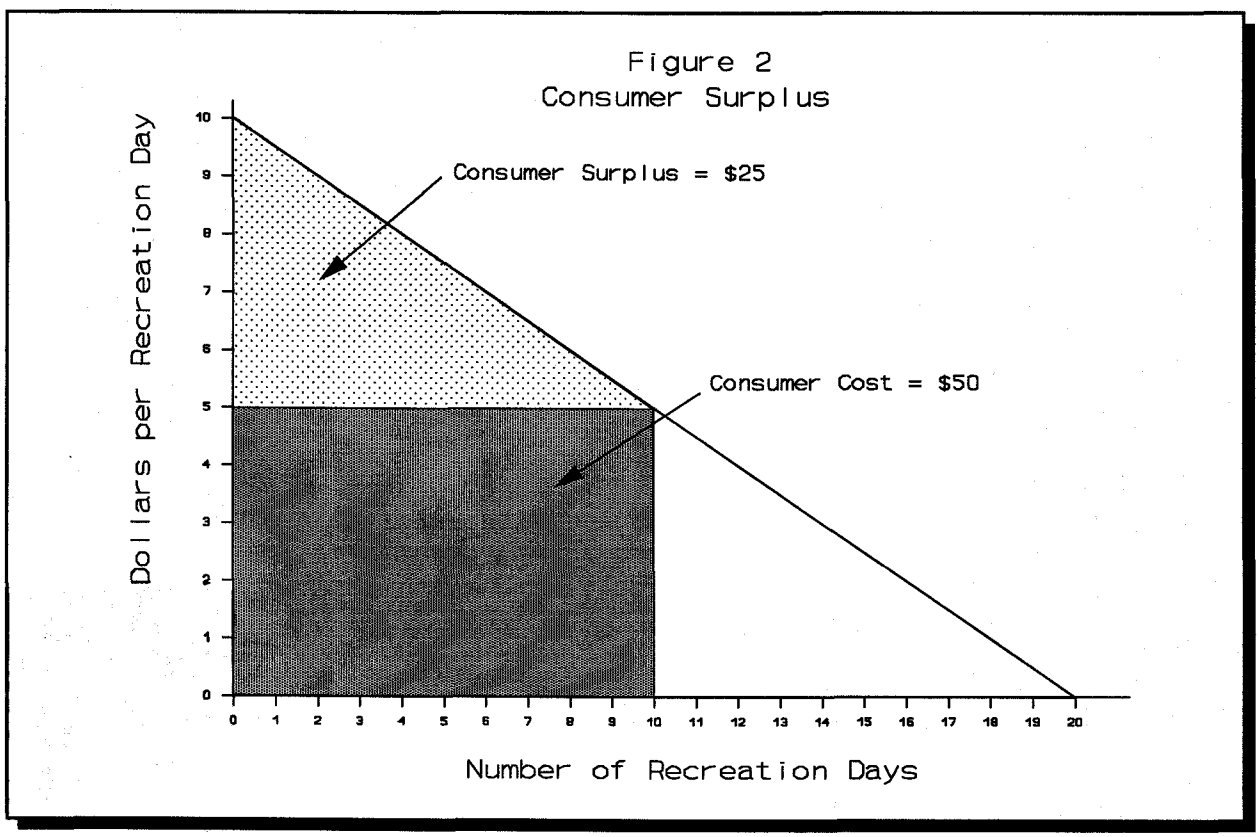
Relating this to benefits is a simple matter. The area under the individual's demand curve ($75 in the Figure 2 example) is a measure of total benefits for the quantity of output (10 in the example). The cost of these benefits is the area below the demand curve and the price line ($50). The consumer surplus of $25 is, analogously, the consumer's net benefits.

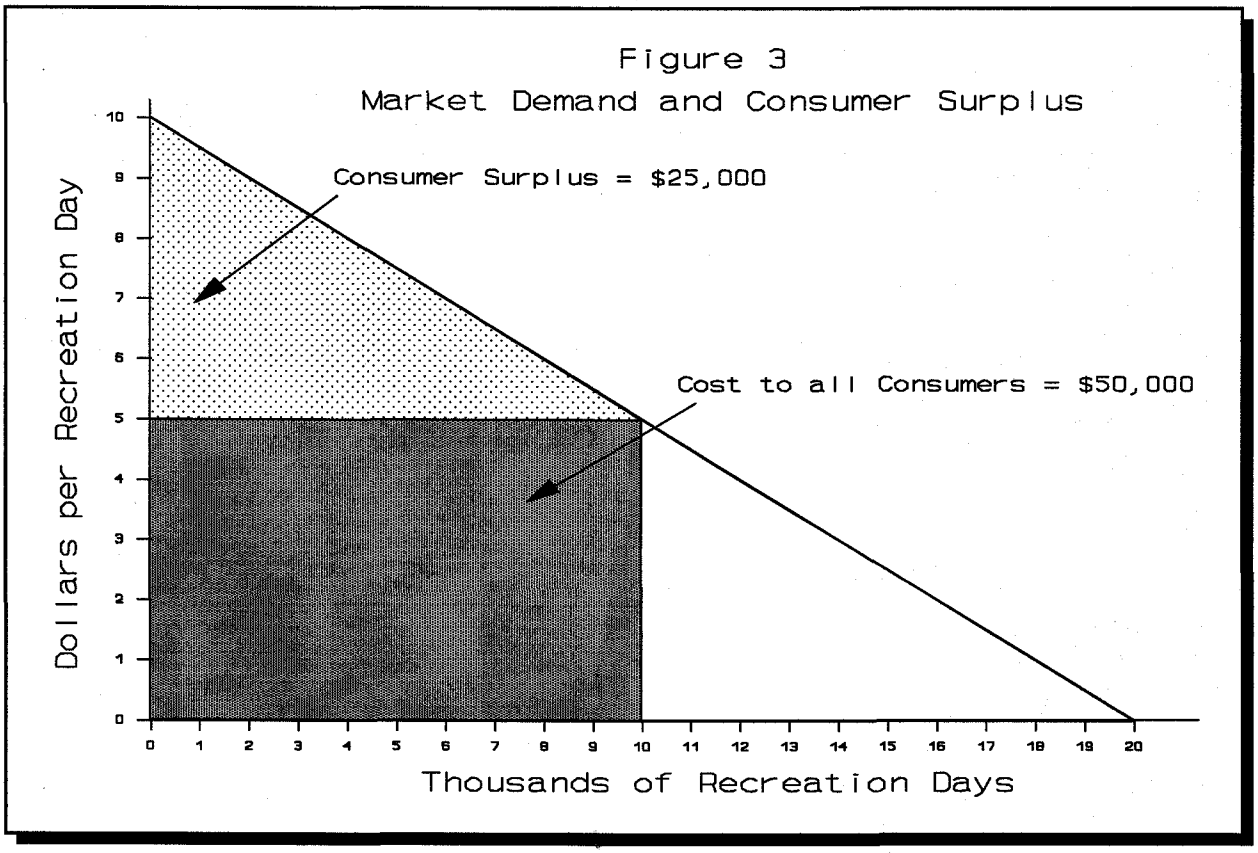
## PROFIT MAXIMIZATION

Rational people are assumed to maximize their utility subject to their available budgets. When those rational people organize as firms, we can be a bit more specific about how they maximize their utility. Firms are assumed to be profit maximizers. If profit is defined as **total revenues (TR)** minus total costs (TC), it is impossible to maximize profits unless costs are minimized. If total revenues are fixed at any level, profit will not be as large as possible unless costs are as small as possible. Thus, **profit maximization** implies **cost minimization.**

It is a simple matter to make the jump from profit maximization to net benefit maximization. Total revenues become total benefits (TB), total costs remain total costs. The Corps becomes the rational firm and the difference between TB and TC are net benefits.

In some instances actual benefits are not known and are not estimated. For example, municipal water supply benefits are generally assumed to exceed






the costs of water supply but they are rarely estimated. In such cases benefits, though unknown, are assumed to be fixed at some level that exceeds costs. To maximize net benefits in such cases, it is necessary to minimize the costs of providing that level of water supply.

**Environmental mitigation** is often based on the assumption that the benefits of providing some fixed level of mitigation (TB) exceed the costs (TC) of doing so. Rational economic behavior requires the analysts to minimize the costs of providing these benefits.

Thus, cost minimizing behavior is an important subcategory of profit maximizing behavior used when the level of benefits is unknown but assumed to exceed costs.

## OPPORTUNITY COST

Because we have scarcity, we have to make choices. Whenever we make a choice, it costs us something. A choice to do one thing is a choice not to do another. Choosing to use a resource, say reservoir storage, for any one purpose costs us the opportunity to use that storage for another purpose. Thus, if storage is allocated to flood control it cannot be allocated to water supply. If water supply is the next best alternative use of the storage, the cost of the flood control storage is the value of that storage as water supply.

Price is routinely used as the measure of the cost of a good or service. While $50 per acre-foot may be the price of water, that may not be its cost. The economic definition of cost is *that which must be foregone to use the resource in a given way.* The opportunity cost of any decision is the foregone value of the next best alternative not chosen. Fortunately, for most goods purchased in a competitive market, price is opportunity cost. Unfortunately for water resource planners, there are many goods and services used and produced by water resource projects that are not produced in competitive markets, and for which price does not exist, or price does not equal opportunity cost.

Opportunity costs are taken up in more detail in Chapter 4.

## SUPPLY CURVE

Supply is the quantity of a good or service a firm is willing and able to produce at different prices. A supply curve, as shown in Figure 4, shows the amount of output the firm will offer for sale at any given price. The industry supply curve for a competitive firm shows the opportunity cost to the economy of providing the last unit of output[8].

Figure 4 shows how the output choice of the firm, in this case a fisherman, will respond to market price. Let's assume that if the price of fish is $3 per pound, he will produce 900 pounds per week. At any production beyond this amount, it costs him more than $3 per pound to catch the fish. This may be because 900 pounds is the maximum he can catch alone. To increase the catch, he may have to add a laborer or buy new equipment. If the price rises to $4, the fisherman finds that the higher price covers the higher cost (i.e., the extra wages or the cost of new equipment) of catching more fish, and at the new price he would be willing to provide 1,000 pounds of catch.

The opportunity cost of the 1,000th pound of fish is $4. The fisherman won't produce more because he would incur costs greater than the $4 per pound he receives. A rational fisherman would not incur costs to catch fish that would exceed the value of the fish.

Just as areas under the demand curve show total willingness to pay, areas under the supply curve show total opportunity costs of producing a

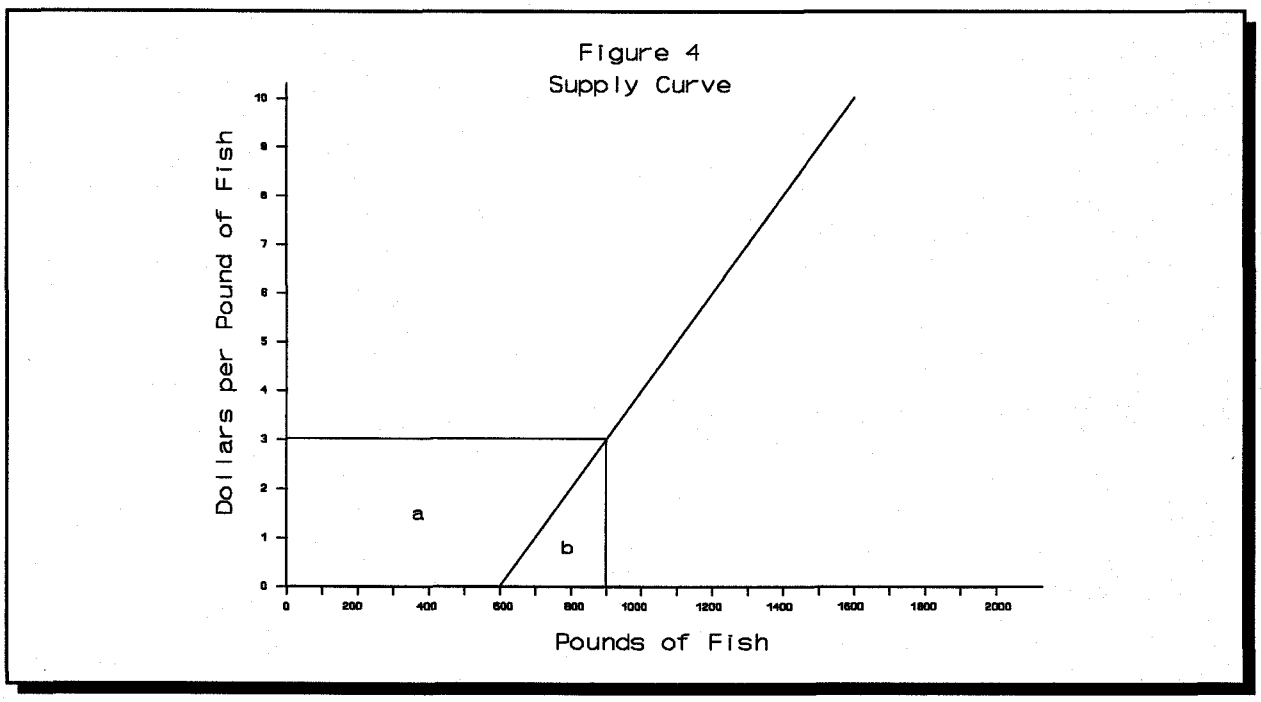
**Opportunity Cost And The Real World**

Some readers of this manual may have spent time working behind the counter of a fast food restaurant in the past. This may have represented the best use of their time at that point in their career, better than the paper route alternative. Few readers would now be willing to work behind that counter. This is so, not because the work lacks dignity, but because of opportunity costs. The readers' time is much more valuable in an alternative use, his current job. That allocations of resources, such as one's labor, make sense at one point in time but may not make sense later is entirely reasonable; opportunity costs change.

**Reallocation studies** provide an excellent example of the principle of opportunity costs at work. Reservoirs built long ago had their storage allocated for a specific mix of purposes. Presumably that mix of purposes was optimal at the time the project was constructed. Many of these reservoirs are being studied now to determine if the existing storage should be reallocated for a different mix of purposes. Why? Changing opportunity cost is the answer.

The cost of storage allocated to, say, flood control has gotten too high. Leaving storage dedicated to flood control precludes the opportunity to use that same storage for water supply or recreation, which may now be valued more highly than flood control. The value of resources changes over time as supply and demand for goods and services change.

[8] There are complications if we want to be precise, but this explanation is good enough for our purposes.




given level of output. The total cost of producing 900 pounds of fish is \$450[9] (area b in Figure 4).

To get the market supply curve, the procedure can be more complicated than simply adding the output that each fisherman would produce at each possible price[10]. Nonetheless, the intuition developed from thinking of market supply in this way best suits this manual's purposes.

## PRODUCER SURPLUS

A "willingness to pay the costs of production" interpretation of the supply curve allows us to measure how much better (worse) off a producer is when the price increases (decreases). This measure is called producer surplus. Interpretation of the supply curve in a willingness to pay concept is just a little bit trickier than is the case for the demand curve.

At a price of \$4 per pound, our fisherman is willing to produce 1,000 pounds of fish. His total revenue is \$4,000. The maximum amount the producer would be willing to pay (or, if you find it more intuitive, the maximum cost he would be willing to incur) to catch the 1,000 pounds of fish is \$4,000. Revenues, at the margin, would exactly cover his marginal costs, which include a fair return to him for his time and the use of his boat and equipment.

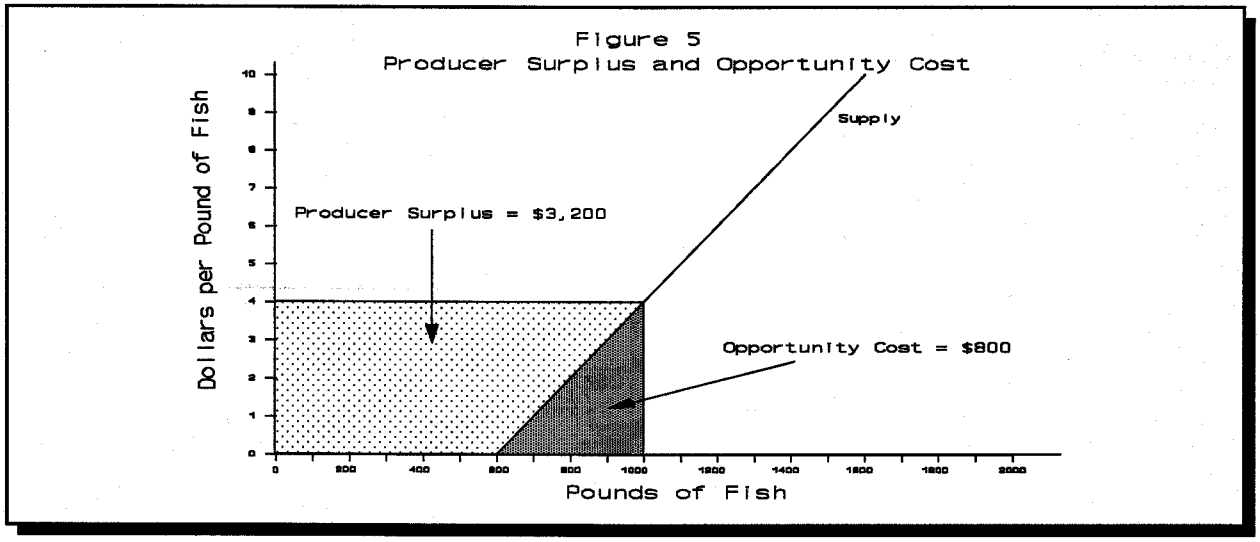
It is evident from Figure 5 that the fisherman does not have to pay \$4,000. The shaded rectangle represents the fisherman's total revenues, \$4,000. The triangle beneath the supply curve, represents the producers total opportunity costs of \$800 for catching these fish. The area above the supply curve and below the price line represents producer surplus of \$3,200[11].

Relating this to benefits is a simple matter. The area under the price line, \$4,000, is a measure of total income (or total revenue) for the quantity of output. The cost of this output, \$800, is the area below the supply curve. What is left over, \$3,200, is the

[9] The area of the triangle in Figure 4 is given by 0.5(900-600)(\$3) = \$450.

[10] If there are many firms and each increases its use of inputs, the prices of these inputs could increase. Thus, opportunity costs could be affected by changes in prices as well as changes in quantities, rendering the simple addition of individual supply curves insufficient for determining the market supply.

[11] The rectangle formed at a price of \$4 and a quantity of 600 has an area of \$2,400. The area of the triangle formed at a price of \$4 for the quantity from 600 to 1000 is \$800, for a total producer surplus of \$3,200.



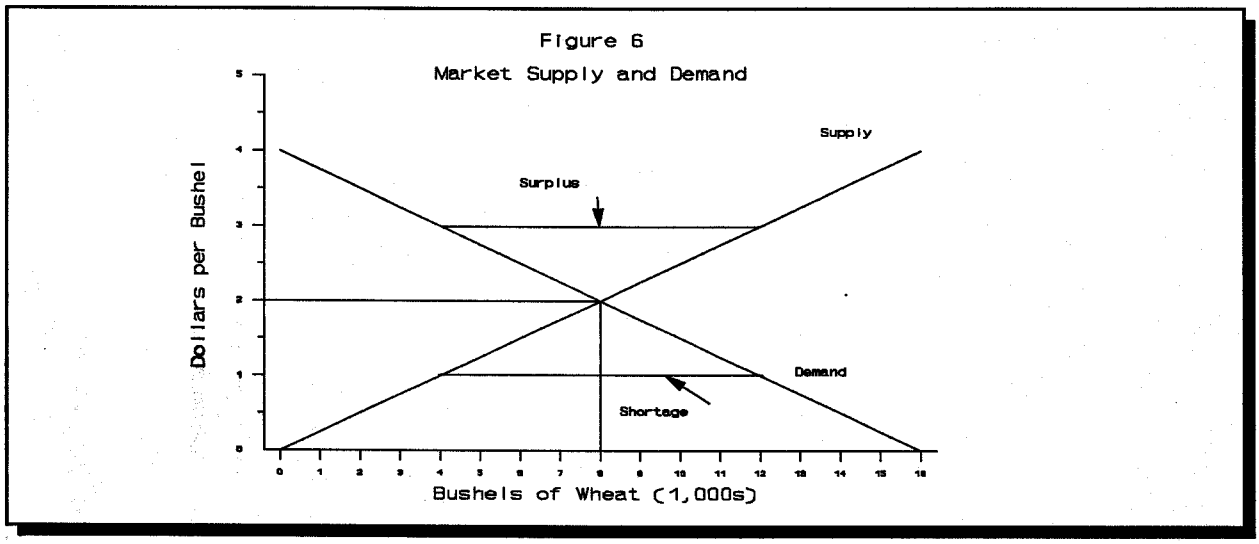

amount the producer would have been willing to pay, but did not have to. Hence, it is akin to net benefits or profit in this context.

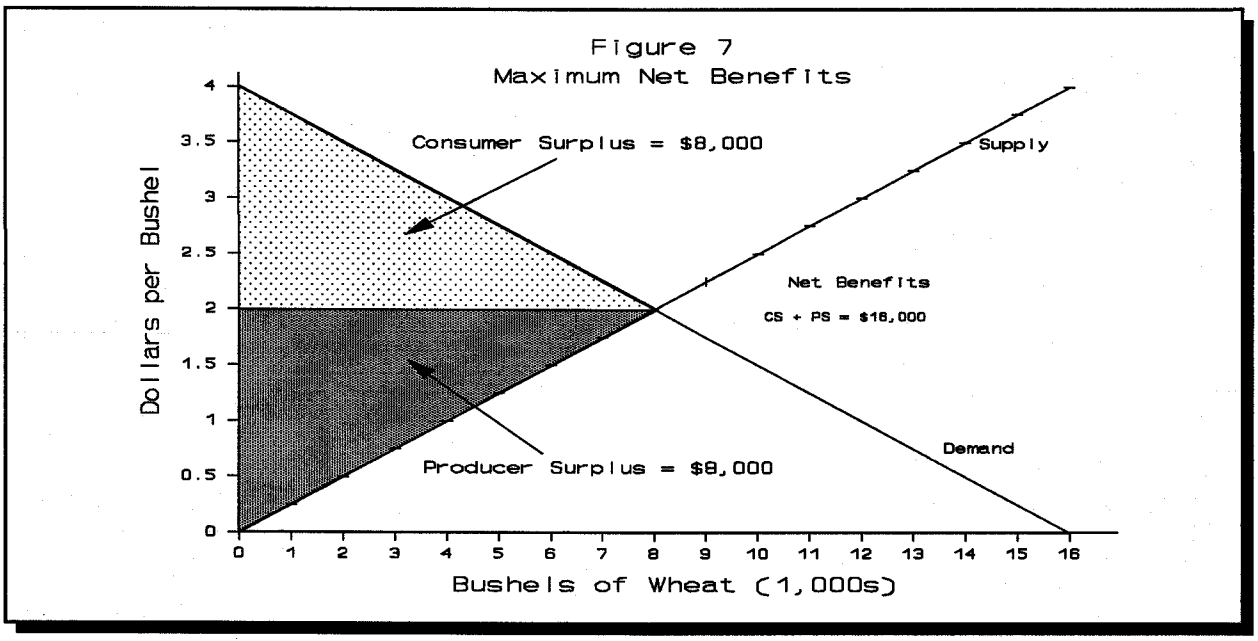
## MARKETS AND PRICES

A competitive **market equilibrium** allocates resources efficiently. The intent of the NED principle is, likewise, to allocate resources efficiently. Thus, it's useful to consider market equilibrium.

Consumers/buyers and producers/sellers make plans independently of one another, plans fundamentally in conflict. One seeks the lowest price possible, the other the highest price possible. Consider the market for wheat. "If wheat costs $2 per bushel, I'll buy so much; if it's $1.75 I'll buy more," the consumer plans. This is the basis of the demand relationship above. "If wheat sells for $2, I'll produce so much; if it sells for $2.50, I'll produce even more," the producer plans. This is the basis of the supply relationship. These independent plans are coordinated and their actions influenced by the market.

Figure 6 shows supply and demand for the wheat market. Each good is assumed to provide benefits only to the person who consumes it. Each seller is assumed to pay all the costs of producing the output. The intersection of supply and demand






represents the market's equilibrium position. Equilibrium is essentially a state of balance between consumers and producers who have conflicting interests.

When the price of wheat is above equilibrium, say at $3.00, consumers want only 4,000 bushels, while producers are willing to provide 12,000 bushels. There is a surplus of wheat at this price. Everyone who is willing to buy wheat at this price has done so, so the only way to sell the surplus wheat is to drop the price. Thus, if price is above the equilibrium there will be forces at work, the "force" of self-interest, that will drive prices lower.

If the price of wheat is below equilibrium, say at $1.00, consumers want 12,000 bushels but producers provide only 4,000 bushels. Now, there is a shortage of wheat. Consumers who want wheat and fear they won't get it will offer a higher price to assure they get some wheat, producers in search of profits will raise the price. Once again, self-interest assures that a price that is too low will rise.

Only at the **equilibrium price** of $2.00 per bushel will there be no tendency for prices to change. The quantity of wheat produced at this price, 8,000 bushels, will be exactly what people want to buy. Everyone who produces wheat at that price can sell it. Everyone who wants wheat at that price can buy it. No one has an incentive to lower or raise prices.

Prices are the result of a dynamic balance of the self-interests of buyers and sellers as they meet in the marketplace.

## SUPPLY, DEMAND AND SOCIAL WELFARE

Social welfare is maximized at the equilibrium price. The demand curve represents the consumers' willingness to pay for additional output, and the supply curve represents the producers' opportunity cost of producing additional output. At equilibrium, society's opportunity cost and its willingness to pay are exactly equal. We will have neither too much nor too little produced.

Consider the market for wheat again. Total benefits are shown as the area under the demand curve. Opportunity costs are shown as the area under the supply curve. The maximum possible difference between benefits and costs occurs at an output of 8,000 bushels of wheat. The shaded areas of Figure 7 are the maximum net benefit possible in the wheat market. Net benefits are defined as consumer surplus plus producer surplus at any level of output.

Any increase in quantity beyond 8,000 bushels would reduce net benefits because the opportunity cost of producing the wheat, read from the supply curve at that quantity, exceeds consumers willingness to pay for it, read from the demand curve at that quantity. It

would be possible to raise net benefits by dropping the last additional unit of wheat. For example, the opportunity cost of the 10,000th bushel of wheat is $2.50, while consumers are only willing to pay $1.50 for it. Net benefits are diminished by $1.00 for the 10,000th bushel produced. What may seem to be a peculiar insistence on stressing one more or one less unit of a good or resource will be made more clear in the section on Marginal Analysis in Chapter 5. Net benefits at an output of 10,000 bushels are $15,000[12].

At any quantity below the equilibrium, the benefits of an additional bushel would exceed the costs of producing it so it would be impossible for a quantity in this range of output to be optimal.

Figures 8 and 9 show **over-** and **underproduction** of wheat. In Figure 8, net benefits would be reduced by the shaded triangle which represents an excess of costs over benefits. In Figure 9, net benefits are shy of their maximum value by the shaded triangle.

Underproduction makes consumers worse off than they could be because the benefits (willingness to pay) from each additional bushel of wheat would be great enough to allow them to pay the equilibrium price and still be better off than they are without the additional wheat. Producers are also worse off because they could produce the wheat at a cost less than the revenues they would receive for it at the equilibrium price. The sum of the consumers' and producers' loss is a loss to society. For example, at an output of 4,000 bushels total net benefits are only $12,000.

Overproduction would never be voluntarily arrived at. Buyers do not value the additional wheat enough to even pay the equilibrium price. Producers must pay more than the equilibrium price to produce the additional wheat. If this quantity of wheat is produced there would be a lost opportunity to make better use of the resources used in the extra production. This lost opportunity is an efficiency loss to society.

[12] The production of each of the 2,000 bushels of wheat beyond the equilibrium quantity incurs costs in excess of their value. The net loss for these 1,000 bushels is $1,000. Thus, net benefits for the first 8,000 bushels of $16,000 are reduced by $1,000 in producing the next 2,000 bushels.

**When Demand And Supply Curves Don't Exist**

Estimating the area under a demand or supply curve can become a simple matter when the curves exist and prices and quantities are known. Unfortunately, in the case of water resource development, such is rarely the case.

Deriving demand and supply curves can be difficult, costly, time consuming, or just plain impossible. When demand and supply curves do not exist or can't be estimated, consumer and producer surpluses can't be directly measured. In these cases, other techniques are used to approximate these areas. The P&G says:

> "Since it is not possible in most instances for the planner to measure the actual demand situation, four alternative techniques can be used to obtain an estimate of the total value of the output of a plan: Willingness to pay based on actual or simulated market price; change in net income; cost of the most likely alternative; and administratively established values."...*Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, p. 9, March 1983

Similar techniques are used when supply curves are unavailable. Examples of these techniques are presented later in this chapter when estimates of benefits by project purpose are presented. The most important thing to remember at this point is that all benefit measurement techniques are trying to estimate the willingness to pay for changes brought about by a project.

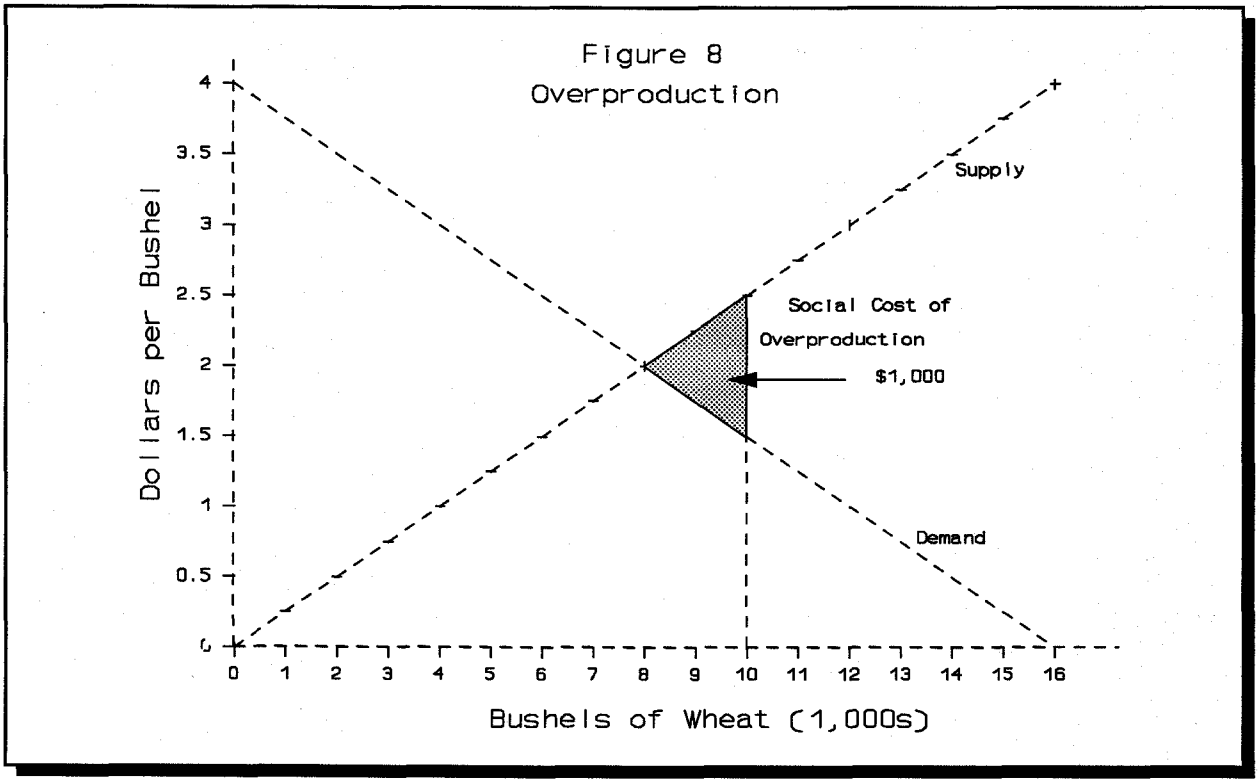


Figure 8
Overproduction
Dollars per Bushel
4
3.5
3
2.5
2
1.5
1
0.5
0
Supply
Social Cost of
Overproduction
$1,000
Demand
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Bushels of Wheat (1,000s)

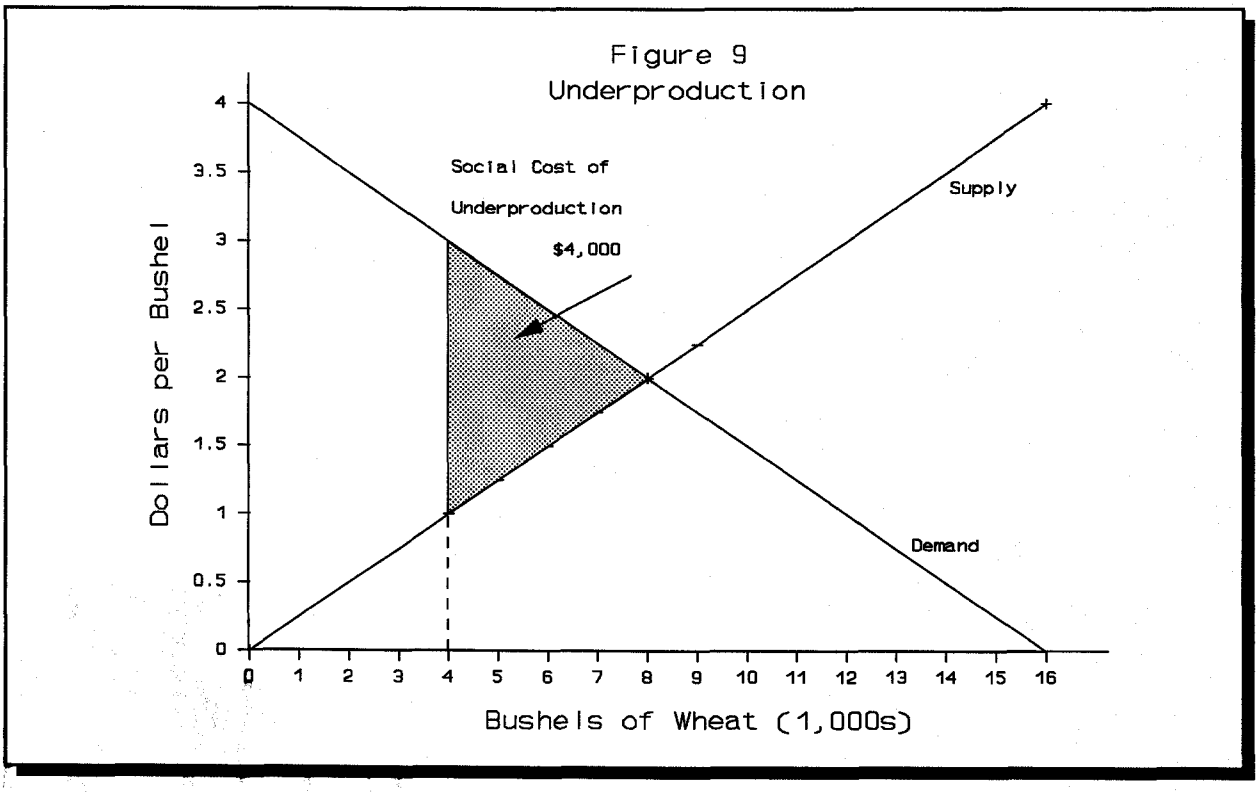


Figure 9
Underproduction
Dollars per Bushel
4
3.5
3
2.5
2
1.5
1
0.5
0
Social Cost of
Underproduction
$4,000
Supply
Demand
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Bushels of Wheat (1,000s)

It is impossible for society to improve over the market equilibrium output. Thus, in estimating NED benefits and costs it is important that competitive market prices be used or very closely approximated, because without them society is not as well off as it could be and resources will be misallocated. The value of the increased wheat output from a water resource project would be obtained by comparing net benefits with the project to net benefits without the project.

## MARKET FAILURE

Situations that prevent efficient market-determined allocations of resources are called market failures. There are many reasons for **market failure. Externalities** and **public goods**, two of the best known examples, are briefly described below.

### Externalities

Many economic activities provide incidental benefits to people for whom they were not intended. Other activities indiscriminately impose incidental costs on others. These effects are called externalities. When externalities are present, the private sector will underproduce or overproduce goods, resulting in an inefficient allocation of resources. The external economies referenced in the definition of NED benefits at the beginning of this chapter are externalities.

Externalities are defined as benefits or costs generated outside of any market transaction. **Positive externalities** make someone better off without that person being required to reimburse the party responsible for the positive effect. Flood control projects frequently generate positive externalities.

Consider a large cannery in the flood plain that is the primary customer for a can factory several miles removed from the flood plain. Flood control protects the cannery and in so doing incidentally benefits the can factory as well. The can factory realizes a positive externality for which it does not have to pay.

**Negative externalities** make someone worse off without that person being compensated for the negative effect. Floodwalls and levees can produce higher flood stages or more frequent flooding at downstream locations. The residents of communities affected by this induced flooding suffer a negative externality they are not compensated for.

Corps policies have been developed to deal with induced flooding. The very fact that policies were needed indicates the nature of externalities. Externalities do not take care of themselves. There is no built-in incentive for the private sector to produce outputs that produce positive externalities. They have no way to charge for them and hence have no incentive to produce them. In the private marketplace goods that produce positive externalities tend to be undervalued and, hence, are not produced in efficient quantities.

On the other hand, firms that produce goods that cause negative externalities do not have to pay those costs. Thus, they do not pay the full opportunity cost of their output, so it is undervalued and overproduced[13].

The NED principle requires that externalities be accounted for in order to assure efficient allocation of resources. Figure 10 shows how failure to account for the positive externalities of a flood control project can result in underproduction of flood protection. Demand[14], $D_1$ in the figure, consists of benefits to flood plain occupants only. Maximizing net benefits to flood plain occupants only leads to an output of $Q_1$ which falls short of the efficient output $Q_2$. $D_2$ includes the benefits of $D_1$ plus positive externalities to beneficiaries like the can factory.

[13] If the non-economist reader is confused by the fact that what is undervalued can be both under- and overproduced, keep in mind that demand and supply are opposing forces in our economy. From the consumer's perspective, a price that is too low will have them demanding more than is optimal, while producers will not produce enough of what is priced too low. A fuller understanding of this apparent contradiction requires knowledge of factors that shift demand and supply curves, and that is beyond the scope of this manual.

[14] The demand curve can also be interpreted as a marginal benefit curve. At every point on the demand curve price is exactly equal to the marginal benefit (actually the marginal utility) of the last unit of output purchased.

Figure 11 shows how failure to account for negative externalities can result in overproduction of flood protection. When only the direct costs of the project are considered ($S_1$), the level of flood protection is $Q_1$. When the negative externality of induced flooding is included $S_2$ becomes the true supply curve[15] and the efficient output is $Q_2$.

**Public Goods**

Another area in which the market fails to allocate resources efficiently is in the production of public goods. Public goods are best defined by first considering private goods. Private goods have two important attributes. First, they are depletable, i.e., they are used up when they are consumed. Second, they are excludable, i.e., anyone who does not pay for the good can be excluded from enjoying it.

Public goods do not have these attributes. Flood control is not depletable. Once a local flood protection project is built, anyone in the protected floodplain enjoys flood protection. Your consumption of flood control does not use it up and make it unavailable to me. We all consume the same level of protection.

Neither are public goods excludable. Once flood control is provided for one person it becomes available to many more people whom it is difficult, if not impossible, to exclude from the benefits.

Since nonpaying users cannot be excluded from enjoying a public good, private suppliers of such goods find it difficult or impossible to collect for providing the benefits of such services. This is because of the "free rider" problem. How many people would voluntarily pay $5,000 for flood protection if they know that if their neighbors buy it they'll get it for free? Such goods cannot be provided by free enterprise because people will not pay for what they can get for free.

A second, more subtle point about free goods is that if one person's consumption of the good does not use it up or deplete it, then the additional, or marginal, cost of one more person using the good is zero. With zero marginal cost, efficient resource allocation requires that anyone who wants the good or service be provided it at no cost (see Chapter 4 for a discussion of marginal cost). So, not only is it often impossible to collect for consumption of a public good, it is also undesirable[16].

There is a legitimate role for government to provide public goods and to create conditions (e.g., taxes or local cooperation agreements) for cost recovery. The economists' challenge is identifying the optimal quantity of such goods in the absence of market prices. Benefit-cost analysis is a general technique for doing this. NED analysis is a more specific application of this technique.

## SOME NED PRINCIPLE ASSUMPTIONS

The answer to any economic question must begin with the phrase, "It depends". All economic analysis begins with a set of working assumptions and definitions upon which the analysis "depends". Without understanding the basic assumptions and definitions, there can be no clear understanding of what the results of an analysis represent.

The NED objective and the guidance that support it establish a set of assumptions that have particular significance for the economic analysis of Corps projects. If one or more of these assumptions were changed, the implications for analysis of Corps projects could be significant.

[15] The supply curve can be interpreted as a marginal cost curve. At every point on the supply curve price equals marginal cost.

[16] An efficient allocation of resources requires that the price of a good equal the marginal cost of producing it. If the price exceeds the marginal cost of producing a good then more should be produced. If price is less than the marginal cost of producing a good, less should be produced. Only when the price of a good equals the marginal cost of producing it do we have the efficient amount of the good. Thus, if the marginal cost of producing a good is zero, as it is with a public good, the price should be set equal to the marginal cost and the good should be provided free of charge.

Figure 10
Underproduction of Flood Control

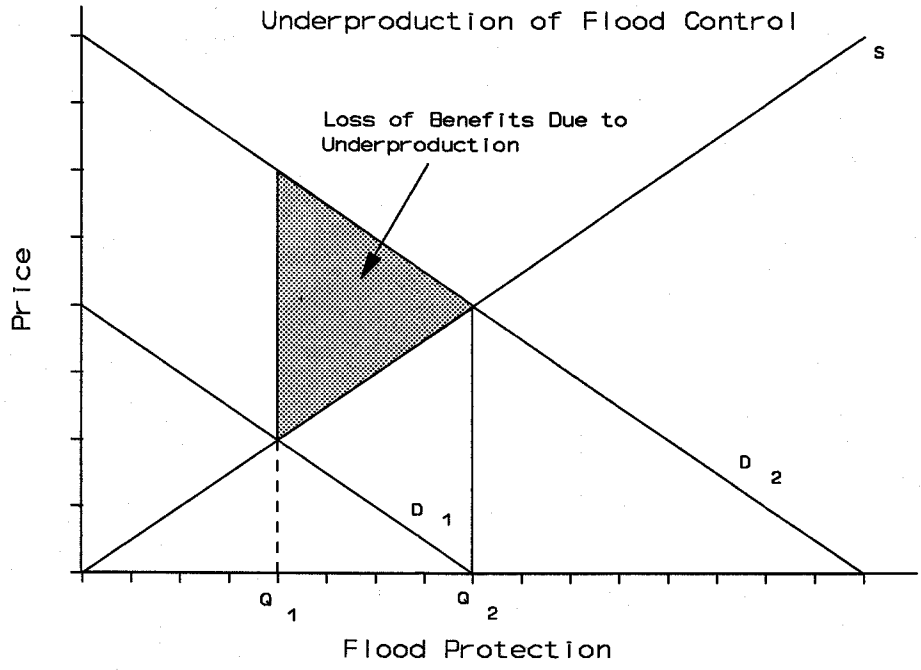
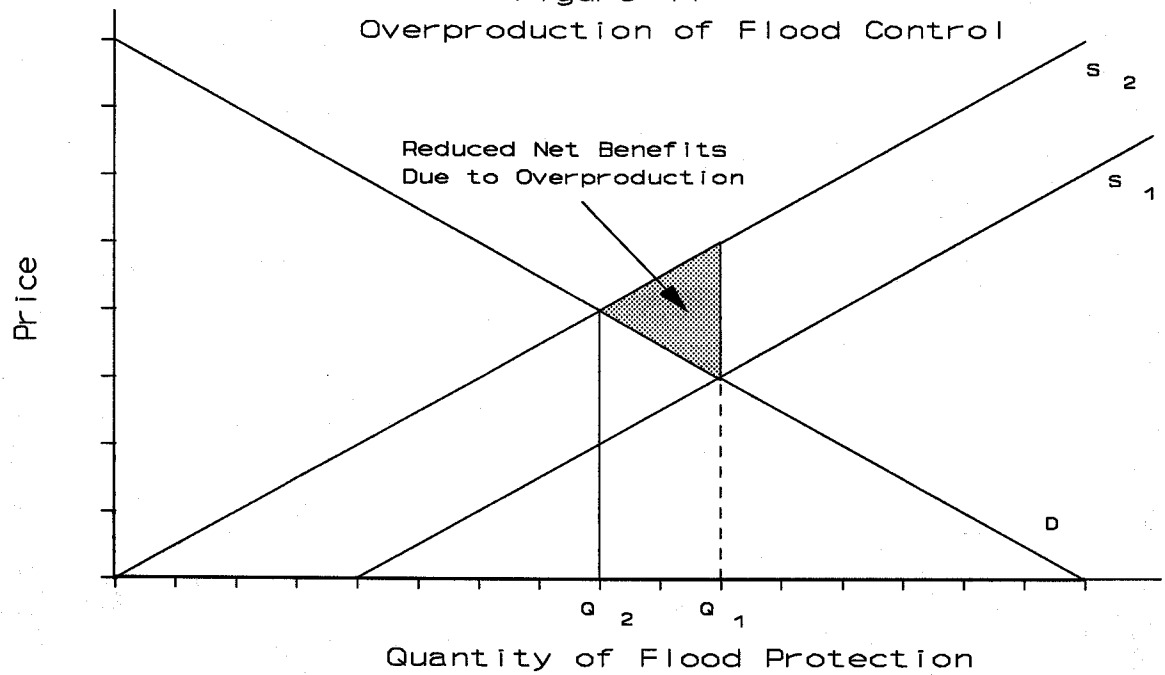



Figure 11
Overproduction of Flood Control



## CONSTANT PRICES (P&G PARAGRAPH 1.4.10)

There are two basic types of price changes. First, general **price level changes** result in all prices rising by roughly the same amount. Planners are directed to use price levels prevailing during the planning period. Thus, general price levels of benefits and costs are effectively assumed to remain constant; this simplifies the economic analysis considerably. Non-Federal partners realize that construction costs do rise. While these increases are of critical importance in financing the project they are of no consequence in the NED.

The second type of price change is a **change in relative prices**. Prices, as used in economics, are relative prices. Relative prices are assumed to remain constant.

If a candy bar costs $0.50 and a gallon of gas costs $1.00, the relative price of a gallon of gas is two candy bars. If the general price level rises 10 percent, candy costs $0.55 and gas $1.10 but the relative price is still 1 gallon of gas for two candy bars. However, if the price of gas rises to $2.00 because of decreased supply of oil due to conflict in the oil-producing parts of the world while candy prices are unchanged, then the relative price of gas is now four candy bars per gallon. To get a gallon of gas, one must give up more. The price of gas, relative to the price of other goods (candy bars) has increased drastically.

If the relative prices of goods are allowed to change, this could significantly affect the values of project benefits and costs. Corps policy has allowed for projecting changes in the real price of petroleum products in the past. When projects affect the relative prices of goods, those price changes are to be accounted for. For example, a project that increases an agricultural crop output enough to lower its relative price should use the changed relative price.

## FULL EMPLOYMENT (P&G PARAGRAPH 1.4.9)

All national forecasts are to assume a **full employment** economy. If all resources are fully employed, this means that all resources have alternative uses, i.e., all resources have opportunity costs. The significance of this assumption is that it provides the planner with a rationale for using market prices.

To an economist, "full employment" of labor resources does not mean the absence of unemployment. It is generally recognized that there is some normal level of unemployment in our economy. Even when the economy is strong, with plentiful jobs, there are people who are unemployed because they are changing careers, moving to another part of the country, graduating from school, entering the work force for the first time, or reentering the workforce after some absence. Chapter 6 provides a discussion of **unemployed labor resources.**

In recent years, mobility in the United States has resulted in a general consensus that a normal rate of unemployment is about six percent. Thus, the P&G assumption of full employment is that over the planning horizon the economy will generally have an unemployment rate of about six percent.

## RISK NEUTRALITY

One of the more esoteric assumptions imposed on Corps analyses concerns the public's attitudes toward risk. This has significance for Corps projects because of what **risk attitudes** imply about willingness to pay for project outputs.

Let's consider this issue in the context of a flood control project. Each year a person lives in the flood plain he faces the possibility of zero damages if there is no flood, or some unknown amount of dollar damages if there is a flood. Suppose his **expected annual damages** are $1,000 per year and would be entirely eliminated by the project. What would he be willing to pay to avoid those damages? The answer depends on his risk attitudes.

A person who is **risk averse** prefers to avoid the risk of flooding. Hence, he would be willing to pay something in excess of $1,000 a year to avoid the possibility of flood damages in any given year. Flood control benefits would exceed the reduction in expected annual damages for this person. Risk averse behavior is very common and, in fact, it is the basis for this nation's vast insurance industry. If people weren't willing to pay premiums in excess of their expected losses, it would be impossible for the insurance industry to settle claims, pay expenses and turn a profit.

A **risk-seeking** individual gets some pleasure from the risk itself. He enjoys the gamble, and the most he would pay for the $1,000 reduction in expected annual damages would be something less than $1,000. Thus, **inundation reduction benefits** for a risk-seeking individual would be less than $1,000.

**Risk neutral** individuals would be willing to pay the expected value. Risk neutrality imposes the assumption that the maximum willingness to pay for an uncertain outcome is the expected value of that outcome. Flood control benefits are equal to the expected annual damage reductions.

In general, the assumption of risk neutrality excludes the possibility that risk averse individuals would pay more than the expected value of any project output and that risk-seeking individuals would pay less than expected value because they enjoy the gamble. This assumption could understate benefits if people are risk averse and overstate them if they're risk-seekers. Corps analysts are to assume risk neutrality, enabling them to use expected annual damages as the measure of a beneficiary's willingness to pay for flood control.

## PERIOD OF ANALYSIS

Specifying an effective 100-year maximum on the **period of analysis** is a policy decision. It's most important implication for economic analysis is that it presumes a long-range outlook. Analysts and decision makers alike often have difficulty in maintaining a long-range outlook. It is all too tempting to overreact to short term fluctuations in trends and market conditions. This is an issue taken up in more detail in Chapter 6.

## OTHER POLICY ASSUMPTIONS

There are any number of additional assumptions imposed on the economic analysis of Corps projects by government and agency policy. Designation of **low-priority outputs**; direction to use rail rates rather than **marginal costs**; the assumption that there will be no transfers of tonnage from one port to another; guidance on freeboard, underkeel clearance, etc., all have important implications for economic analysis that are unrelated to economic theory. These and other policy decisions are often based on pragmatic compromises between economic theory and time, budget and data constraints.

For example, designation of low priority outputs helps allocate limited agency funds among the many projects under consideration, a pragmatic policy decision. The use of rail rates is predicated on additional requirements that the rates are "similar, competitive, and prevailing". Controls exist in the collection and analysis of rates that have the objective of screening rates that are not representative of **long run variable costs**. Though these and other policy decisions may cause project analysis and economic theory to diverge at times, these are pragmatic compromises rather than a wholesale abandonment of economic principles.

# INTEREST RATES

## TIME VALUE OF MONEY

Project costs are incurred primarily at the time of construction. Benefits, on the other hand, accrue over a period of years in random amounts. Though both costs and benefits are measured in dollars, the dollars spent on construction today cannot be directly compared to the benefit dollars that will be realized years from now.

One million dollars in costs today is not the same as $1 million in benefits 20 years from now. We could easily take $1 million today, put it in a bank where it earns 10 percent interest annually and in 20 years we will have $6.7 million. If we had a choice between building a $1 million dollar project that yields a $1 million benefit in 20 years and saving the money at 10 percent, clearly saving is the best option. This is because of the time value of money.

All other things equal, a rational person prefers $1 now to $1 in the future. Why? Because $1 today can be saved and it will be worth more than $1 in the future. On the other hand, if we want to have $1 a year from now, we need only $0.91 today, saved at 10 percent annual interest. In one year's time, the $0.91 will grow to $1.

The reason that people regard money today and money in the future as of different value is because money has an opportunity cost. If the receipt of a sum of money, e.g. a monetary benefit, is delayed until

some time in the future, the recipient suffers an opportunity cost--the interest the money could have earned if it had been received earlier and saved. If someone owes you $100 and the rate of interest is 10 percent, and you can persuade them to pay you back a year earlier than originally planned, you come out $10 ahead. Alternatively, if the payment is postponed one year, you lose the opportunity to earn $10.

The process of equating a sum of money today with its equivalent amount of money in the future is called **compounding**. The more common practice of equating money values across time is to equate future sums of money with their equivalent today, through the process of **discounting**.

The **discount rate** differs conceptually from an interest rate in that it is society's opportunity cost of current consumption. That is, it's the rate society would use to equate amounts of money at different points in time.

## WHAT ARE INTEREST RATES MADE OF?

In a society of utility and profit-maximizing individuals, the only reason for lending money is to make money. If you have $1,000, you can choose to spend it or not. If you spend it, you enjoy it now. If you save it, you enjoy it later. Presumably, you expect some reward for delaying your consumption.

If you could lend your money to another person, you would expect that when you are paid back you can purchase more than you could at the time you lent the money. You would expect some real return on your money. For argument's sake, let's assume you want to be able to buy 3 percent more if you lend your money and delay consumption.

Suppose, however, that prices go up 4 percent each year. If you lend money at 3 percent interest and prices go up 4 percent, you lose purchasing power by lending money at a rate of interest less than the inflation rate. So, if you want to buy 3 percent more after adjusting for changes in the price level, the nominal rate of interest you charge will be 7 percent.

### REAL AND NOMINAL VALUES

To compare values at different points in time economists often use terms such as real prices, real wages, real gross national product (GNP), etc. The "real" means the values have been adjusted for changes in the general price level, i.e., inflation. Real economic values have been adjusted for changes in the purchasing power of the dollar. **Real values** are expressed in "real" or "constant" dollars.

In contrast, **nominal values** are not adjusted for the effects of inflation. A general increase in price level will cause nominal values to rise even when there is no change in the variable being measured. For example, inflation may cause your income to increase even though the things you can buy with it stays the same or declines. Nominal values are expressed in "nominal", "current", or "money" dollars.

Nominal values are converted to real values through the use of price indices. A price index measures the ratio of the cost of a specific bundle of goods at one point in time to the cost of that same bundle of goods during a previously defined base year. The base year index is arbitrarily assigned a value of 100. Prices higher than base year prices will yield an index greater than 100 while prices lower than the base year yield an index less than 100.

The most general price index is the GNP deflator. Its bundle of goods is comprised of all final goods and services produced by the U. S. economy. The consumer price index (CPI) is based on a bundle of goods purchased by a typical consumer during a specific period of time. The *Engineering News Record*'s building and construction cost indices are based on bundles of goods used in typical building and construction projects.

Whenever you lend money there is some chance you will not be paid back. Any loan involves risk. If you lend money to the U.S. Government in the form of bonds, there is little risk of not being paid back. Lending money to your eccentric uncle who wants to buy a bar is a different story. Riskier projects generally must offer a higher rate of return, or risk premium, to induce lenders to part with their money.

While this is neither an exhaustive nor sophisticated explanation[17] of the components of an interest rate, it will suffice for our purposes. Figure 12 provides an example of the components of an interest rate[18].

## CHOICE OF INTEREST RATE

What is the interest rate? Is it the rate you earn on your savings? The rate you pay for your car loan? For your mortgage? Is it the Federal Funds rate? There are literally thousands of interest rates in our society, and the choice of the rate at which project benefits and costs are evaluated has been a constant source of controversy with the Corps' program.

The basic economic problem is still one of allocating resources--this time, between the present and the future. Is it better to consume more now, or to invest now so we can consume in the future? Do we eat the grain of wheat or plant it? Society invests in water resource projects through the Corps' program so that future generations can consume. The rate of interest determines the size of the opportunity cost to society for realizing benefits at some future date rather than now.

Low interest rates encourage society to invest more now, since the opportunity cost is low. For example, a typical flood control project evaluated with both a high and a low interest rate will yield a higher benefit-cost ratio and higher net benefits when evaluated at the low rate. High interest rates present a high opportunity cost to consuming now and make investment, less attractive. Society's incentives are much the same as those of the consumer who is considering the purchase of a new car. The consumer is more likely to invest when the interest on loans is low than when it is high.

Figure 12
The Risk-Adjusted
Nominal Interest Rate

| | |
|---|---|
| Real Rate of Return | 3.0 |
| Expected Rate of Inflation | 4.0 |
| Risk Premium | + 2.0 |
| Interest Rate | 9.0 |

Economic theory suggests that the discount rate used by the Corps, i.e., the social rate of discount, should reflect the return that can be earned on resources employed in alternative private use. To avoid losses of well-being, resources should not be transferred from the private sector to the public sector if those resources can earn a higher return in the private sector. Setting the discount rate equal to the social opportunity cost of funds ensures an efficient allocation of resources across time. There are, of course, certain complications that prevent us from

[17] For example, we have not addressed liquidity preferences and premiums or the distorting effects of the corporate income tax.

[18] The figure and the discussion preceding it have been oversimplified. In fact, the actual interest rate would not be a simple summing of its component parts. The relationships among these parts can be considerably more complex.

identifying and even agreeing on what the social opportunity cost of funds should be.

Economists themselves are not of one mind when discussing the social opportunity cost of funds, hence no final resolution of this matter is forthcoming from economic theory. The issue has been resolved for the Corps through Section 80 of PL 93-251, which sets the interest rate based on the cost of government borrowing.

## AN UNCOMFORTABLE IMPASSE OR PEACEFUL COEXISTENCE?

Though a policy decision has determined the discount rate to be used by the Corps, that decision satisfies few people. Proponents of a lower rate argue that Corps projects are evaluated assuming constant prices and the discount rate should not include an expected rate of inflation. Likewise, through risk-pooling and risk-sharing arguments, they argue the risk premium should be zero or near zero. Thus, in the extreme, proponents of lower rates argue for something closer to the real rate of return.

Proponents of a higher rate argue that private investments earn rates of return much greater than the 7 to 9 percent range of returns that have been applied to Corps projects in recent years and even greater than the 10 percent return required by the Office of Management and Budget. They feel the appropriate rate is more like 14 percent or so.

The current discount rate formula was prescribed by Section 80 of the Water Resources Development Act of 1974. This Act produced a rate that effectively represents a compromise between these two positions.

## COST OF THE MOST LIKELY ALTERNATIVE

When demand curves are unavailable, benefits are sometimes taken as the cost of the **most likely alternative** project. If demand for an output, like hydropower or water supply, is so strong that the power or water is going to be provided no matter what the cost, we assume the benefits of the power/water exceed the costs of providing it. Society's decision to provide the power/water is considered prima facie evidence that the benefits exceed the costs, though we do not have actual estimates of the benefits. For example, if the best project is a hydropower dam that will cost $1 billion and the second-best project is a coal-fired generator with the same capacity that costs $1.2 billion, given benefits are the $1.2 billion, net benefits are the difference in cost or $0.2 billion.

The cost of the most likely alternative is subject to abuse in the absence of proof that the second-best alternative will actually be built if the best is not. It's always possible to find a more expensive way to build any project or solve any problem. At the other extreme, the net benefit may be made as small as you like by comparing the project with an alternative that differs only by a slight modification.

The cost of the most likely alternative method inherently assumes some project is justified from the outset because the cost of the second best alternative, which will be undertaken, is always more than the best alternative cost. The assumption that certain levels of goods like hydropower or water supply are essential, voids much of the value of economic analysis. We might all "need BMWs" if costs were not a factor, but, most of us buy cheaper transportation and use the savings for other purposes. Thus, the assumption that power or water will be provided at any cost may be far removed from the reality of providing that power or water. The cost of the most likely alternative approach should be used only as a last resort.

## PROJECT BENEFITS

The value of a Corps project is the value of its outputs to all members of society. We measure the value of those outputs by summing everyone's willingness to pay for them. This is the benefit standard for all project purposes, and it's what economic analysis tries to measure.

In the following paragraphs, benefit estimation for several of the Corps' project purposes are presented in terms of the concepts developed above. What follows is neither a complete nor a rigorous treatment of benefit estimation. Instead, it is an attempt to show that current Corps NED benefit estimation procedures are consistent with the theory and concepts presented above.

There is frequently more than one type of benefit for a project purpose. There may be more than

one way to think about the problem, as well. For example, flood control benefits can include inundation reduction, location, intensification, and restoration of land value. Both consumers and producers may be affected by flood control. In the following descriptions a single, simple example is presented for flood control, navigation, and hydropower/water supply.

## FLOOD CONTROL

Consider a market for a hypothetical service called flood plain living as shown in Figure 13(a). Without-project condition consumer and producer surplus or net benefits[19], aka social welfare, are shown as the shaded area. The quantity of flood plain living depends on the price of living in the flood plain. To understand the nature of flood control benefits we need only think about the price of flood plain land a little creatively. The price of flood plain living includes all the costs of living on the flood plain. One of these costs, in addition to purchase price, includes flood damages that will be incurred while living on this land.

Flood damages can be thought of as a tax levied by nature against homeowners on a random basis. In our example, the annual price of living on flood plain land is $2,500. For simplicity, let this include the mortgage payment of $1,500 and expected annual damages of $1,000. A flood control project eliminates some flood damages. Continuing the analogy, flood control lowers the cost of nature's tax to homeowners, thus shifting the supply curve down, as shown in Figure 13(b), and reducing the price to $2,250[20]. Social welfare with the project is given by the shaded areas. Society would, theoretically, be willing to pay an amount of money equal to the increased consumer and producer surplus they realize from flood protection in order to obtain the flood control. These surpluses are the shaded areas representing project benefits shown in Figure 13(c).

All that is needed to measure flood control benefits for these homeowners are these hypothetical curves[21]. Unfortunately, they do not exist. In the absence of a demand curve, it seems reasonable to assume that homeowners would be willing to pay up to the amount of income they would save by this project.

What the planner needs is simply an estimate of the shaded areas. It is not necessary to know what total willingness to pay is or the existing consumer surplus values. We are only interested in changes that take place as a result of the project.

Expected annual damages (EAD) are computed by Corps' planners to approximate part of these areas. Let there be 100 houses in this community, each with existing EAD of $1,000. Assume with-project damages are $750 per house, resulting in an inundation reduction benefit of $250 per house. If each homeowner would be willing to pay up to $250 for a $250 reduction in flood damages, then $250 per house times 100 houses or $25,000, provides a reasonable estimate of the rectangular portion of the increase in consumer surplus shown in Figure 13(c).

That leaves the triangular portion of the change in consumer surplus to be explained. The decrease in effective price of living on flood plain land brings with it an increase in the quantity demanded. The increase in consumer surplus that results can represent location or **intensification benefits**. In the case of **location benefits**, formerly undeveloped land is made developable. In the case of intensification benefits, developed land is used more intensively. For example, a family may be able to use their basement as livable space or a family may build an addition onto their home.

[19] In this example there is no producer surplus because the supply curve and price line coincide. This is done to keep the example simple.

[20] As the cost/price of living on the flood plain decreases there would be a simultaneous increase in the value of flood plain land. The annual cost decrease that results from flood control is a benefit that would be capitalized in an increase in land prices. Hence, changes in the market value of flood plain land is a theoretical alternative approach to measuring this benefit. Identical willingness to pay estimates can be obtained from different markets under certain circumstances. See, for example, Section 4.4 of the Just, Hueth, and Schmitz text referenced in Appendix 1.

[21] It is a simple matter to demonstrate these benefits in terms of the supply and demand for flood plain land. In this case the supply curve remains the same but demand increases (i.e., shifts to the right) as a result of flood control. The changes in producer and consumer surplus are, conceptually, identical in magnitude. The difficulty with this approach is that it is not as easy to see the logic of using expected annual damage reductions as the proxy measure of project benefits.

Figure 13(a)
Flood Plain Benefits

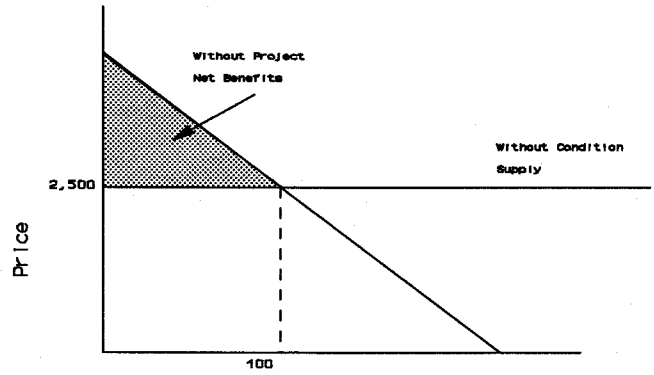



Figure 13(b)
Flood Plain Benefits

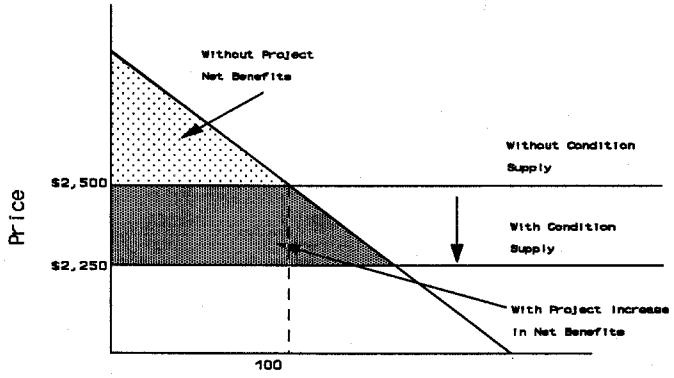
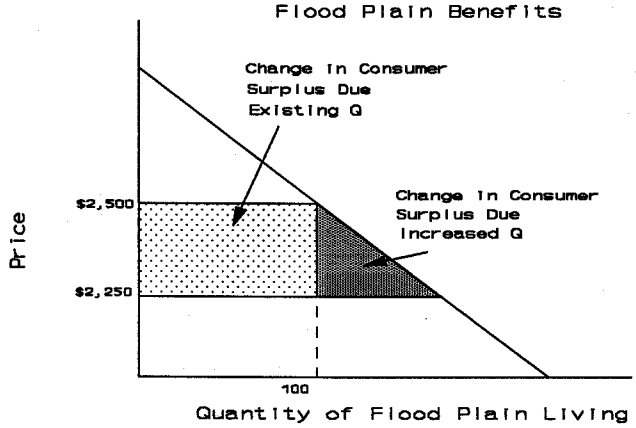



Figure 13(c)
Flood Plain Benefits



## NAVIGATION

Consider a navigation project that lowers the cost of transporting commodities by water. Deepening a coastal port or increasing capacity of a lock on the inland waterway could have this effect. In both cases, the result is a decrease in unit costs.

Assume the initial levels of consumer and producer surplus in the water transportation market shown in Figure 14(a). The result of the project could be to lower the costs of producing transportation services, thus shifting the supply curve to the right as shown in Figure 14(b). An increase in total consumer and producer surplus results. Figure 14(c) isolates the difference in the with- and without-project condition. These are the project benefits. Producers and consumers realize increased surplus for the original tonnage moved as well as a surplus increase for the new tonnage moved.

If the supply and demand curves for transportation services are not available, the shaded area of Figure 14(c) can be approximated by estimating the difference in cost for each ton moved (roughly the vertical difference between the two curves) and the number of tons moved with and without the project. In the example, this is $1 for 1 million tons or $1 million, the area of the parallelogram. The surplus represented by the triangle results from increases in tonnage induced by the project. For example, tonnage that could not move profitably at the price without the project, can now do so because of the decrease in costs of providing the transportation service. It should be noted, however, that although the P&G and Corps guidance allow consideration of project induced increases in traffic, such projections may be extremely difficult to support in actual planning studies.

## HYDROPOWER AND WATER SUPPLY

In some cases, it is too costly or time-consuming to estimate a demand curve for outputs, and the cost of the most likely alternative is used to estimate willingness to pay. This technique is frequently used for hydropower and water supply projects.

For convenience, assume the market for water in a project area is as shown in Figure 15(a). The supply curve shows the marginal cost of providing varying quantities of water if the second-best alternative is built[22]. The price of water would be $2 as shown. Construction of the best project lowers the price of water to $1. The area under the without condition supply curve is the cost of the second-best alternative. The area under the with condition supply curve is the cost of the best alternative. The shaded area represents the decrease in cost of supplying the water. This shaded area can also be interpreted as the increase in consumer surplus as shown in Figure 15(b). The change in willingness to pay is, thus, also given by the shaded area.

Though the supply and demand curves may not be available, the change in consumer surplus can be approximated by the difference in cost between the alternatives. If the second-best alternative costs $1 million more than the first-best alternative, it's reasonable to expect that consumers would be willing to pay as much as $1 million for the first best alternative. It would be irrational to pay more than this because the second-best choice would be cheaper than the first-best choice plus some amount of money in excess of $1 million.

[22] A horizontal supply curve implies a constant marginal cost of producing water. Such a curve is used to simplify the presentation.

Figure 14(a)
Navigation Benefits

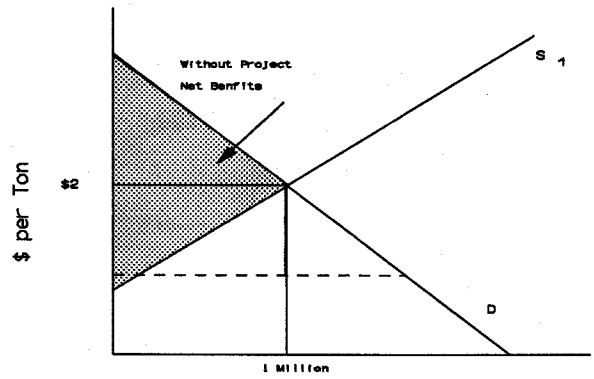



Figure 14(b)
Navigation Benefits

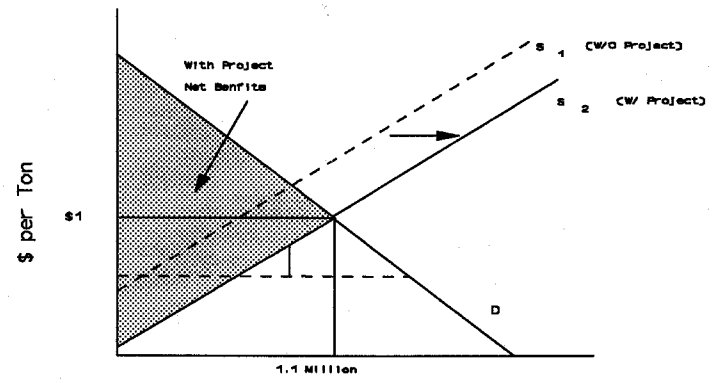



Figure 14(c)
Navigation Benefits

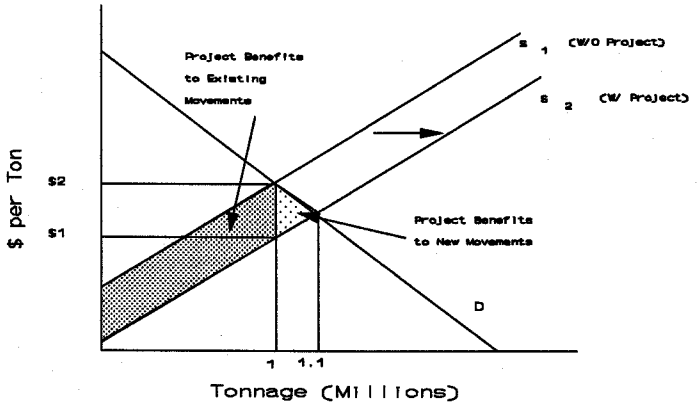


Figure 15(a)
Water Supply Benefits

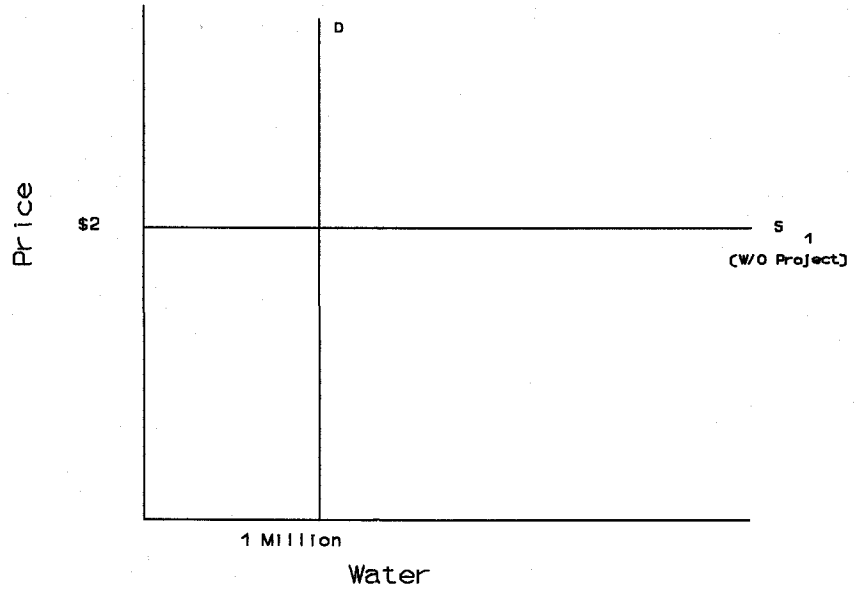
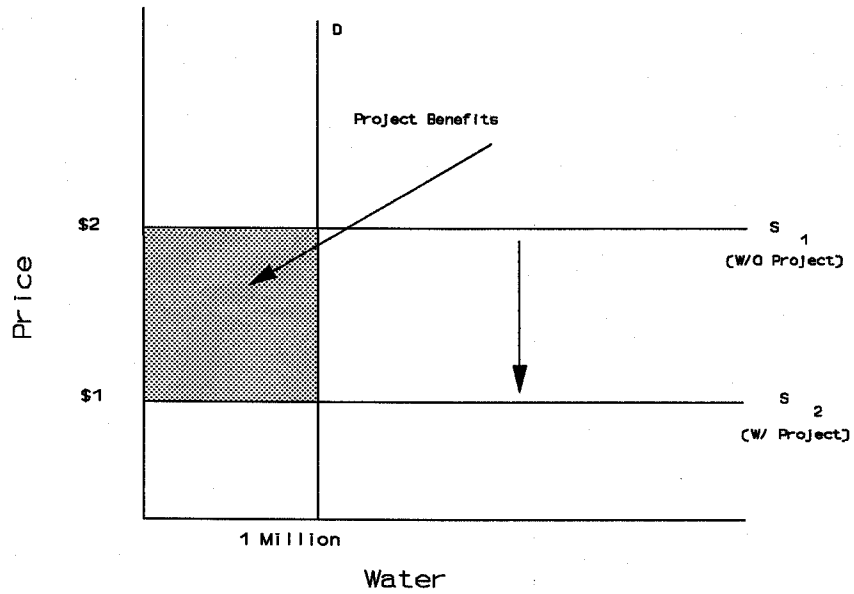



Figure 15(b)
Water Supply Benefits



## NED VS RED

Perhaps the most frustrating experience for any non-Federal partner is to hear that something she knows will be a benefit for her community is not counted by the Corps because it is **RED**, not NED. The local partner may see red, but she's not likely to see the distinction the Corps' planner is trying to make.

Anything that increases the utility of an individual or firm is a benefit. The person's or firm's willingness to pay for that increase is the measure of the value of that benefit. The distinction between RED and NED is a matter of perspective, not economics.

RED stands for **regional economic development**. RED is never really defined in any precise way by any of the Corps' past or current guidance. Perhaps the most informative statement on RED is the following one from the Principles and Standards of September 10, 1973 (see Appendix 2):

> " Through its effects--both beneficial and adverse--on a region's income, employment, population, economic base, environment, social development and other factors, a plan may exert a significant influence on the course and direction of regional development. The regional development account embraces several types of beneficial effects, such as (a) increased regional income; (b) increased regional employment; (c) population distribution; (d) diversification of the regional economic base; and (e) enhancement of environmental conditions of special regional concern."

Benefit-cost analysis attempts to assess social benefits and social costs, i.e., benefit-cost analysis takes the public point-of-view. As stated at the outset of this chapter, benefits and costs depend on our definition of society. The Federal objective in water resources planning is national economic development. Under this objective, society consists of all U.S. residents. This is a matter of perspective and national policy, not economics. There is logical appeal to the notion that Federal dollars should be spent in the national interest. Corps' projects measure benefits and costs of all U.S. residents and only U.S. residents. If a Federal project induces a firm to leave one state to locate in the newly-protected floodplain of another state, the increase in regional income for the project area may well be a benefit to that area. Perhaps you think it should be included among project benefits. If, however, such effects are included as benefits, we must also include the loss of income in the state that loses the firm as a project cost. This is necessary to be consistent with a perspective that values the benefits and costs of a project to all U.S. residents. In most cases, the project area's gain is another area's loss and the two effects represent a transfer of income that cancels out any net change[23].

To the extent that a navigation project simply enables one port to lure traffic from another port is similarly a transfer. Corps guidance in navigation project evaluation is to include only net increases in traffic as project benefits. This is a policy consistent with the objective of national economic development.

It has long been recognized that foreign interests may benefit substantially from improvements to our Nation's coastal ports. These benefits are never quantified or considered in the decision process--not because they are not real economic benefits, but because from the national perspective, we are unconcerned about benefits in other countries. On the other hand, if a flood control project lured a foreign firm to the project area, the increase in national output that results would clearly be a benefit to all U.S. residents. We would be unconcerned about the host nation's loss.

[23] Can increases in regional incomes be legitimately considered to be benefits? Sure, but losses of regional incomes must also be considered if we take a national perspective. As a practical matter, it is much simpler to simply ignore such transfers than it is to try to determine what net increases or decreases in willingness to pay for the firm's outputs might result from the transfer. However, there is no theoretical reason why the move of a firm from one state to another could not produce an NED benefit. As a practical matter it is quite difficult to estimate this benefit within the time and budget constraints of a typical study budget. As a practical matter such moves and related transfers are considered zero sum games.

The above distinction between foreign and U.S. perspectives has its analogy when considering NED and RED perspectives. At the regional, state or local levels, the operational definition of society is different, because the perspective is different. There is nothing different about the economic principles we have considered. For value-based, i.e., normative reasons, local policy makers choose to take a perspective on benefits and costs that does not consider all U.S. residents. Instead they consider only the residents of their own "society".

Thus, when a state is the non-Federal partner it would quite naturally be unconcerned about foreign interests, and interests in other parts of the nation. It would not be willing to contribute money to a project unless it were reasonably assured the benefits to its residents exceed the costs to the state. That people from another state will enjoy benefits from the construction of a reservoir is of little or no concern to a local partner who cannot charge for the benefits others receive. If a project induces a firm to move from one part of the state to another, there is no net gain for the state, and this will represent a benefit and equal cost that cancel each other. If a firm can be attracted from another state, however, that would represent a significant benefit in the eyes of the partner, though the Federal government sees it as a transfer.

Likewise, if a city is the non-Federal partner, they could care less about benefits to anyone except their own residents. The city would, however, view attracting a firm from another part of the state as a benefit. From the state and national perspective, this is a simple transfer of benefits from one locale to another that generates a cost equal to the benefit.

In a Federalist system, each level of government has certain areas of responsibility and concerns of particular importance to it. It is entirely appropriate that a local level of government be concerned only with the impacts on its residents and areas of concern. It need not be concerned with the effects of their projects on other governments or areas. However, it is entirely appropriate and consistent with the compensation principle mentioned in Chapter 2, that higher levels of government take a different perspective in guiding resource allocation decisions.

Non-economists and economists alike can become befuddled in trying to determine what effects constitute a transfer and what effects are net increases in outputs. There is no cure for this confusion. Life gets complicated sometimes. At such times, the best recourse is to return to the proper perspective and begin to think in terms of who is willing to pay for or to prevent the effect in question.

## PREVIEW TO CHAPTER 4

This chapter has provided an introduction to NED benefit analysis using supply and demand relationships to develop the notions of consumer and producer surplus that are the basis for social welfare and NED benefits. In Chapter 4, the emphasis turns to consideration of **NED costs**. The chapter devotes considerable space to developing cost concepts that are helpful in understanding the NED cost concept and issues related to it.

# Chapter 4: NED COSTS

## INTRODUCTION

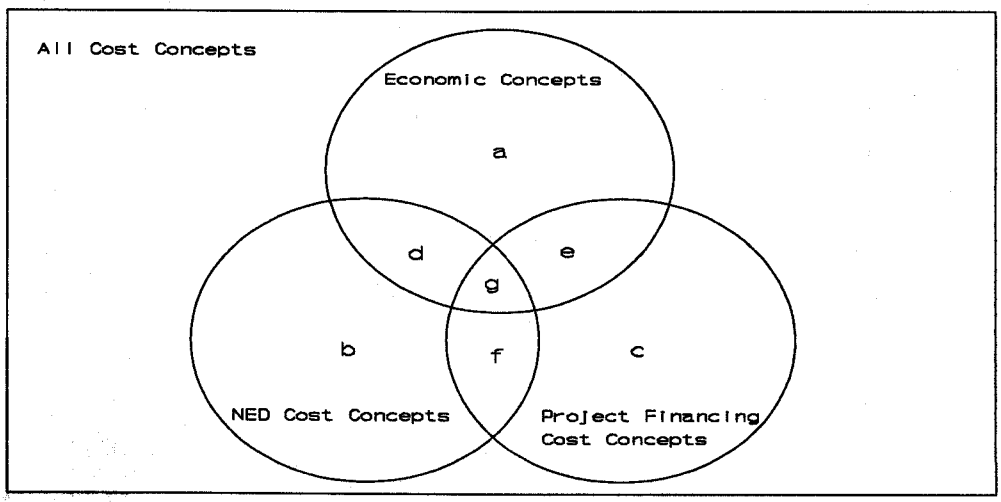
**Cost** analysis plays a central role in water resource planning because virtually every management decision requires a consideration of costs. Study costs, design and formulation trade-offs, project costs, benefits and costs--in each case critical decisions depend on costs. In this chapter we examine a number of cost concepts. Costs are presented in three major sections. First, economic concepts of cost are presented followed by specific NED cost concepts. The chapter concludes with a brief discussion of project financing costs.

Economists are interested in interest during construction. Design engineers are interested in the costs of concrete and steel, not in interest during construction. Local partners care about their share of costs and their debt service on these costs and little else. Every player in the planning process cares about costs. Frequently the costs they care about are of little or no interest to other players. The apropos cost concepts depend on the context of the decision process. Figure 16 is a stylized illustration of both the independence and interdependence of the economic, NED and financial cost concepts addressed in this chapter.

Each conceptual context has jargon uniquely its own. These are represented by the areas a, b, and c. For example, economics is concerned with marginal costs; NED with **associated costs**; and, finance with fully-funded costs. Nonetheless, there is considerable cross-over in concept, if not always in jargon. For example, the costs of a pump station are relevant for all three conceptual contexts as indicated by the commonality of area g in Figure 16.

Whatever their nature, all costs involve a sacrifice of some kind. If you must give up something in order to get something else, you incur a cost. What you give up may not always be measured in money. It may not even be tangible. In the following sections three conceptual contexts are offered and though each

Figure 16
Cost Concepts



has its own jargon and role in the analysis none of them can stand alone.

## ECONOMIC COST CONCEPTS

### RELEVANT COST

*Cost* can be defined any number of ways. Costs are incredibly complex, with all kinds of accounting, economic, financial, engineering and legal implications. There frequently is controversy over the nature of costs, how they are defined, and what costs are relevant for decision making. Most of the controversy evaporates once it is realized that different decision problems require different cost information and that the necessary cost information varies from situation-to-situation.

In everyday usage, cost generally refers to the price paid for an item. For non-Federal partners fulfilling financial and legal reporting requirements, the actual dollar amount spent on labor, materials, etc., may be relevant. For many purposes actual historical dollar outlays are sufficient. For planning and resource management decisions, however, historical costs may not be relevant. Current and projected future costs are usually more important.

For example, consider a foresighted non-Federal partner who earlier stockpiled "rip-rap quality" rock at the cost of $50,000 for hauling the rock away during excavation for a highway. If that rock, now needed for project construction, would cost $1.5 million to acquire today, what cost should be assigned to the rock for the project? The partner would have to pay $1.5 million to replace the rip-rap it has, or he can sell the rip-rap for $1.5 million if he elects not to use it on the project. Therefore, $1.5 million is the relevant cost of the rip-rap, even though $50,000 may be the cost of the rip-rap for financial reporting purposes.

*Relevant cost* is somewhat subjectively defined as any cost that will make a difference in a given decision process. The notion of a sacrifice or an alternative use for resources is crucial to the understanding of **relevant costs**. The Federal government has indicated that for purposes of evaluating the economic feasibility of water resource projects, NED costs are the relevant costs.

### OPPORTUNITY COSTS

The term "opportunity costs", first introduced in the Chapter 3 discussion of supply curves, expresses the idea that relevant costs of a resource are determined by its value in the best alternative use. Opportunity cost is the cost of forgoing certain opportunities or alternatives in favor of pursuing others. When markets are competitive, opportunity costs of resources equal their market prices.

When the Corps uses reinforcing steel to build a project, it bids against alternative users of the steel. The cost of that "rebar" is determined by its value in alternative uses. The Corps must pay a price at least equal to the value of this steel in use for other construction projects, automobiles, airplanes, ships, cookware, etc. If the steel manufacturer can get better value by using the steel in another way, she will do so.

The P&G define NED costs as opportunity costs of resource use. Economists look at costs differently than do most people, especially accountants. Concerned primarily with the efficient allocation of resources, economists define costs as opportunity costs. A couple of examples will help illustrate how economists and others see costs differently.

Say you pay $35 for a ticket to a sold-out concert. On the way in to the concert, you are offered $100 for your ticket by a rabid fan. "How much did the concert cost?" a friend asks the next day. "Thirty-five dollars," you respond, remembering what you paid for the ticket. "Wrong!" says the economist. When you were offered $100 for your ticket, you had the opportunity to take $100 or see the concert. You chose the concert and it cost you the opportunity to make $100[24]. Though you did not have to write a check for $100 to see the concert, the concert cost you $100 as surely as if you had.

[24] You made $100 only to the extent that the original purchase price is regarded as a sunk cost and no longer relevant to the decision to sell to the person bidding for your ticket. Perhaps a more intuitive, though less satisfying theoretically, explanation is that going to the concert cost you $35 for the ticket and a $65 profit for a total cost of $100.

Let's consider another example. Say you make $40,000 per year in your current occupation but always wanted to work for yourself. You quit your job, open a donut franchise and have sales of $300,000. After you pay rent, franchise fees, your employees, and various other bills, you have $35,000 left over. Your accountant says you made $35,000 profit. Your economist says you lost $5,000 last year. The difference lies in how costs are defined--the relevant costs. The accountant sees anything you pay to another as a cost of doing business. Thus, after these costs are paid, whatever is left over is your profit.

The economist recognizes your time as a resource that could be used in many ways. Presumably you choose to use it in the best way, as entrepreneur of a franchise. You forego the opportunity to make $40,000 in your prior occupation. This $40,000 is the opportunity cost of your time and a cost of doing business. You end up with lost income of $5,000 because of your choice. The facts of the case are invariable; it is a matter of how one looks at the facts.

What have at times been referred to as **"disbenefits"** or "negative benefits" are generally nothing more than opportunity costs. The loss of recreation benefits from a reallocation study is a cost to society. This impact should be included among project costs rather than as a reduction in project benefits.

## EXPLICIT AND IMPLICIT COSTS

Opportunity costs involve comparisons with foregone opportunities. Foregone opportunities can frequently involve costs that never show up in an accountant's records. Thus we make a distinction between explicit, or out-of-pocket, costs and implicit, or noncash, costs.

When someone reaches into his pocket for cash or writes a check, it is very easy to recognize these explicit expenses as costs. **Implicit costs** do not involve cash and are often overlooked in decision analysis. Since cash payments are not made for implicit costs, the opportunity cost concept must be used to measure them.

An example will help to illustrate the nature of implicit costs. If I borrow $75,000 at 10 percent to build a ring levee around my home, I have an explicit interest cost of, for simplicity, say, $7,500 per year. If my neighbor builds the same ring levee, and pays cash for it, does that mean that the cost of the levee is greater for me than for my neighbor? For decision purposes, the answer is no. Though I have higher **explicit costs**, the true costs, implicit plus explicit, are the same for both of us. If my neighbor was earning 10 percent interest on his money, or could have earned 10 percent interest by lending it to me, then she has an implicit cost of $7,500 per year. The levee costs each of us $7,500 per year. I write a check for $7,500 each year, my neighbor forgoes the opportunity to earn $7,500 each year.

More familiar implicit cost examples for many Corps planners are interest during construction and the value of land in a project. There is no actual expenditure of funds to cover interest during construction. Land necessary for the project and owned by the non-Federal partner will not entail any explicit cost for acquisition. There is an implicit cost for using the land, however. The land once committed to the project can no longer be used in any alternative fashion. The implicit cost of the land depends on its opportunity cost, i.e., its value in its next best use. If the land is developable, its implicit cost could be great. If the land is open space, its implicit cost might be the value of the recreation output it no longer will produce. In other cases the implicit cost will be minimal.

## ECONOMIC VERSUS FINANCIAL COSTS

The distinction between economic and **financial costs** is primarily, though not entirely, based on the distinction between explicit and implicit costs. **Economic costs** are all explicit and implicit opportunity costs. Financial or accounting costs are generally considered to be explicit costs or actual expenses.

It is possible that any of the three possibilities in Figure 17 will exist for a given project. Economic costs may equal, exceed, or be less than financial costs. The most common case is that economic costs will exceed financial costs. It is possible, however, that financial costs will exceed economic costs, i.e., explicit costs exceed explicit plus implicit opportunity costs. Economic and financial costs are considered again in Chapter 6.

Figure 17
Economic and Financial Costs

Economic Costs > Financial Costs

Economic Costs = Financial Costs

Economic Costs < Financial Costs

Labor that would have been otherwise unemployed may have a financial cost that exceeds its economic cost. In a competitive market, the wage of labor represents the opportunity cost of that labor. When people would have been unemployed without the project, the wage overstates the opportunity cost of their time. Opportunity cost is not zero, because people presumably do something with their time that has value to them; but it is not the full wage either. The Corps' current policies on unemployed or **underemployed labor resources**, formerly called redevelopment benefits, is based on this divergence in financial (market prices) and economic (opportunity) costs.

## INCREMENTAL AND SUNK COSTS

***Incremental costs*** are another essential dimension to the concept of relevant costs. When a decision has to be made in which costs are a factor, only those costs that will change as a result of the decision need to be considered. Incremental costs are costs that vary with the decision, and they are the only relevant costs of the decision.

Incremental costs are similar to marginal costs in that they vary with the decision. The major difference is that marginal costs are normally associated with an arbitrarily small or unitary change in output while incremental costs are considerably broader. It embraces any change in the total cost of producing output. Marginal costs are a subset of incremental costs.

Incremental costs may relate to changes in costs that arise from any aspect of the decision problem. For example, the cost of including a river reach in a flood control project entails a large discrete jump in costs that is more properly an incremental change in costs rather than a marginal change. Incremental costs include all costs affected by a decision. Future as well as current costs must be considered and opportunity costs must not be ignored.

Inherent in this definition of incremental costs is the fact that any cost that is not affected by the decision is irrelevant to that decision. Costs that do not vary across alternatives are labeled ***sunk costs***. Sunk costs play no role in determining the optimal course of action. Corps' budgetary analyses frequently require an analysis of the **remaining benefits** and **remaining costs** of a project. In these exercises costs already incurred, or sunk costs, are ignored.

## TOTAL AND MARGINAL COSTS

For any level of output, total costs (TC) are defined as the sum of fixed costs (FC) plus variable costs (VC). Total costs, then, are a function of output and the prices of the inputs used to produce it. Fixed costs are the costs of production that do not vary with the quantity of output produced. Variable costs do vary with the amount of output produced. Both fixed and variable costs depend on input prices.

Fixed and variable costs are relevant concepts for certain benefit categories. For example, if a flood makes it impossible to use a building for a month, society loses the use of capital resources including the building. The value of the building capital is approximated by the fixed cost of the building, whether they are explicit or implicit. If flood protection would eliminate this damage, the value of the prevention of this lost resource is the monthly fixed costs in a competitive market[25].

A second example is increased fish catch as a project benefit. It must be borne in mind that the benefit of the catch is the income net of variable costs incurred in catching that fish. In this example fixed costs are irrelevant; they would not change whether the additional fish are caught or not.

Perhaps the most important economic cost concept is that of marginal cost. Marginal cost is the change in total cost that results from producing one more unit of output. Since fixed costs don't change with the level of output, marginal costs are the change in variable costs incurred to produce one more unit of output. Marginal cost is a significant concept in resource allocation decisions and it is taken up again in Chapter 6's discussion of marginal analysis.

## NED COSTS

The **relevant costs** for project evaluation have been determined by policy to be NED costs. NED costs are defined as follows:

> "Resources required or displaced to achieve project purposes by project installation and/or operation, maintenance, and replacement activities represent a NED cost and should be evaluated as such. Resources required or displaced to minimize adverse impacts and/or mitigate fish and wildlife habitat losses are also NED costs. Costs for features not required for project purposes, avoiding adverse effects, and/or mitigating fish and wildlife habitat losses are not project-related NED costs and should not be evaluated."... *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, p. 97, March 1983

The definition is not so much based on economic theory as it is on the perspective of the decision makers. The last sentence in the above excerpt says that some opportunity costs connected with the project will not be considered as NED costs. This is a policy decision entirely within the discretion of the policy makers. It has the effect of separating NED costs from opportunity costs in certain situations. Insofar as NED costs are purported to be opportunity costs, these policy exceptions can confuse analysts and the public.

NED costs are not defined on the basis of who incurs the cost. For example, NED costs may be incurred by the Federal government, any non-Federal level of government, by individuals, or society in general. The primary contribution made by the P&G definition of NED costs is to identify and define specific examples of fixed and variable opportunity costs associated with Corps projects.

The distinctions economists make among costs, the subject of preceding sections of this chapter, are for the most part unnecessary in discussing NED costs. The NED costs are divided into **implementation outlays**, associated costs, and **other direct costs**. Examples of these costs are provided in terms of the resources used and costs incurred to produce a typical Corps project.

"NED cost" is not an economic concept. The definitions of various cost categories presented in the P&G are more policy directives than sound economic definitions, and in some instances NED costs may not be the opportunity costs they profess to be.

This fundamental confusion in defining costs arises from slight differences in determining relevant costs for the decision situation. From an economist's point of view, opportunity costs are always the relevant costs. Policy makers are free to depart from the

[25] Once again it is important to understand that economic costs mean opportunity costs, i.e., explicit plus implicit costs. For example, if a company owned its building, its explicit fixed cost might be modest, perhaps limited to insurance and taxes. But, if its building could be rented for $5,000 per month, then implicit fixed costs must include the amount of the rent foregone by the company. Thus, fixed costs should include all costs, explicit and implicit.

economist's perspective and at times they do so in the P&G.

In some cases, analysts are directed to use current bid items and market values. An economist would argue that if a monopolist is offering the bid for an item or if there is a discrepancy between the market price and opportunity cost, then following this guidance will yield NED costs that are not opportunity costs.

P&G's suggestion that actual costs incurred for similar activities for similar projects be used as cost estimates, could lead to similar divergences between NED costs and opportunity costs if market conditions change between the time and/or location of the actual cost estimate and the project construction under consideration[26].

Implementation outlays, as defined by the P&G, are primarily based on market values and opportunity costs. Curiously, they appear by title to preclude the inclusion of implicit costs which are an important part of opportunity costs[27].

Associated costs are a subset of costs over and above the "project costs" necessary to realize the benefits; they are usually, but not necessarily, non-Federal costs. The distinction between implementation outlays and associated costs is rather artificial from an economic theory standpoint. From a purely economic sense, project implementation costs would include the costs of all inputs necessary to produce the project outputs or benefits, regardless of by whom they are paid.

[26] The spirit of P&G Section XII NED Costs is one of consistency with sound economic principles. Whether the fact that the P&G directs analysts to adjust some market values when necessary but fails to direct this adjustment for all categories is one of simple oversight or policy intent is an argument beyond the scope of this manual.

[27] NED **relocation costs** associated with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 are to include only housing costs for replacement in kind. Costs in excess of this are to be treated as financial costs for nonproject purposes. This is a policy exception that conflicts with economic principles. An economist would argue that the entire cost of the replacement housing should be included among the economic costs of the project and the benefit measured by changes in willingness to pay for the improvements, which could well exceed the costs of improvements, would constitute a valid benefit.

The NED distinction between implementation outlays and associated costs appears to be based on the identity of the party that incurs the cost. Implementation outlays appear to be the responsibility of the Federal government and the non-Federal partner, while associated costs frequently, but not always, are the responsibility of the non-Federal partner or a third party. A Soil Conservation service project necessary for the Corps project's benefits to accrue is an example of an associated cost that is a Federal responsibility.

ER 1105-2-100 indicates that if the associated costs of a project can be recovered through user fees or other revenues generated by the resources purchased through the associated costs, they can be excluded from NED costs. For example, associated costs of a navigation project may include new docks and terminals needed for with but not without-project conditions. Often there is a revenue (benefit) stream that would accrue to these features. If the revenue stream has been incorporated into the benefit analysis, NED costs must include the associated costs. If the revenue stream is not incorporated, an analysis is needed that demonstrates the revenue stream is adequate to cover the costs to omit both revenues and costs from the NED analysis.

The NED category "other direct costs" is defined more by example than sound economic criteria. Other direct costs appear to be comprised primarily of implicit costs of a project. Even this interpretation is not entirely adequate because some examples include explicit costs to others. For example, increased water supply treatment costs are explicit costs of the project that do not fit neatly into either of the other categories. However, from an economic standpoint they are all opportunity costs of the project.

## FINANCING THE PROJECT

No matter how many net NED benefits a project produces, the project will not be built unless someone is willing and able to finance project construction. The fact that a community has the funds to build a project does not mean that it should be built. On the other hand, that a project produces net benefits is no assurance that it will be built.

Economic analysis answers the questions: should the project be built? should it be built this way

or that? should it be built all at once or in stages? when should it be built? etc. Financial analysis answers the questions: who should pay the project costs? what are the payment obligations? can they meet the payment obligation? In the public's mind, financial analyses that address willingness and ability to pay for a project are viewed as serving the function of economic analysis; they do not. While there can be considerable overlap in the data, terminology and methods of the two types of analysis, they are conceptually different.

Nonetheless, the need to pay for a project produces a unique and important perspective--that of the project sponsor(s), especially the non-Federal partner. In order to respond to this newly evolving perspective, it has been necessary to identify a new taxonomy of cost terminology. There are some financial cost concepts whose working definitions are evolving still. Baseline costs, authorized costs, fully-funded costs and maximum costs are but a few examples of these evolving terms.

## PREVIEW TO CHAPTER 5

This chapter has provided an introduction to many cost concepts necessary to understand an NED **cost analysis** and completes the manual's presentation on benefits and costs. In Chapter 5 the emphasis turns to a few specific economic concepts of particular interest to Corps analysts and planners. These include marginal analysis which is the basis for designating the NED plan; with- and without-project conditions and there role in NED analysis; and, the **value of time saved**, a project effect of growing interest.

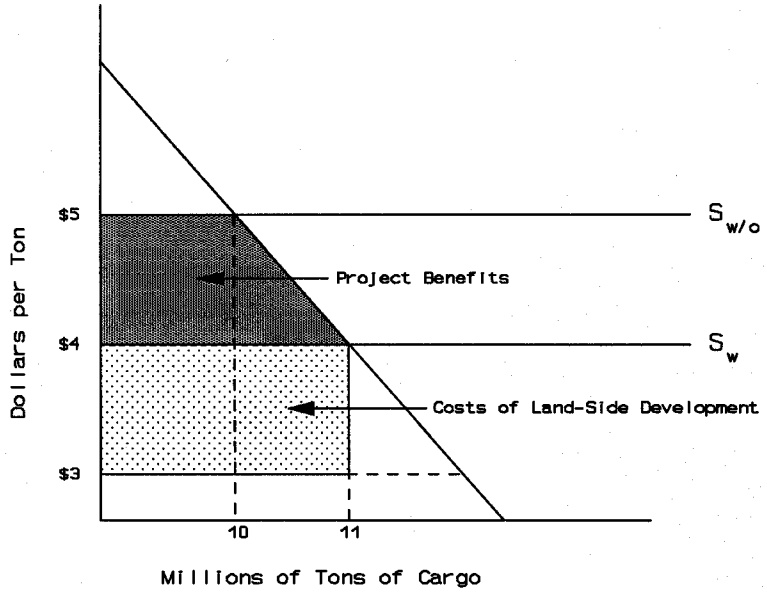
### WHEN BENEFITS INCLUDE COSTS

A number of Corps Districts have argued that sometimes the benefit estimate already includes some of the project costs. The response to such a statement is often a headache for the person trying to sort out the validity of such an argument. With the concepts developed to this point in the manual it's no longer so difficult.

Consider a project where the without project cost of moving a commodity is $5 per ton; $4 of this cost is due to the variable water-side costs of moving a ton, $1 of it is due to variable landside costs. Suppose a Corps project lowers the commodity movement cost to $4 per ton. The water-side costs have been reduced to $2 but land-side costs have increased to $2 because of new facilities that had to be built to take advantage of the deeper channel. The local partner will finance the land-side improvements through user fees that raise the land-side cost. From the planner's long run perspective all costs are variable so the land-side improvements are variable costs in this analysis.

Figure 18 provides a graphic illustration of this situation. The supply curve is horizontal. Economists will realize this simply implies that the marginal and average costs of moving a ton of cargo are equal, again for simplicity. At an average/marginal cost of $5 per ton 10 million tons move annually. As the cost drops to $4 per ton movements increase to 11 million tons.

Figure 18
Associated Costs Example



**When Benefits Include Costs (Continued)**

The change in benefits that results from project construction is $10.5 million, shown as the darker shaded trapezoid. Ten million dollars is the consumer surplus due to the $1 per ton decrease for 10 million commodity tons and $0.5 million is the consumer surplus for the 1 million ton increase in movements. The private costs of moving this tonnage is given by the area under the with project supply curve, $44 million. This includes all the costs that comprise the $2 per ton water-side costs and the $2 per ton land-side costs. It does not include the costs of deepening the channel. Thus the $10.5 million in benefits should be compared to the annual costs of deepening the channel only. The cost of landside improvements have already been accounted for when consumer surplus was reduced by the $44 million in private costs.

Where are the costs of the land-side improvements? If we look again at Figure 18 we'll see they were right before our eyes all along. Suppose for the moment that there were no land-side cost increases and that the per ton cost dropped to $3. The difference in costs of moving 11 million tons of cargo at a cost of $3 rather than $4 is another $11 million shown as the lighter shaded rectangle. Thus, the cost of the land side development has been incorporated into the benefit estimation.

The most straightforward way to present the economic analysis in such a case is to include all project costs, i.e., the first costs of the Corps project along with all the land-side development costs as well as the fuel, labor and other costs of moving the cargo on the water. The total benefit estimate would be the total willingness to pay for the cargo moved and net benefits would be total benefits less total costs. However, because we are only interested in the change in net benefits that results from this analysis and because the actual supply and demand curves are not available, net benefits can be reasonably estimated by considering the cost reduction per ton. In this case, care must be taken not to double count any of the associated costs of these benefits, like the cost of vessel fuel and labor or land-side developments.

# Chapter 5: SELECTED TOPICS

## MARGINAL ANALYSIS

### MAXIMIZING NET NED BENEFITS

The NED plan is described as:

> "A plan that reasonably maximizes net national economic development benefits, consistent with the Federal objective.." ...*Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, p. 7, March 1983

The NED plan maximizes net benefits, but not just any benefits. The net benefits maximized are only NED benefits. This is a source of frustration and bewilderment for many non-Federal interests more concerned with regional benefits than national benefits. Be that as it may, marginal analysis is a necessary step for maximizing net NED benefits.

### MARGINAL THINKING

Consider the following question. Planners formulated a flood control plan protecting 1,000 identical structures at a total cost of $1 million, or an **average cost** of $1,000 per house. Benefits average $900 per house. Net benefits are -$100,000 and the project is unjustified. The study team economist has determined that if 500 more homes are protected, the benefits from these homes average $500 each. It is impossible to provide protection just to these homes because of the topography, i.e., these additional homes cannot be protected unless the first 1,000 homes are. Should the extra houses be protected?

On first glance this appears to be a bad deal. Thus far, the average cost per house is $1,000 and the plan is already unjustified. On an average cost calculation, how can the plan be improved by protecting houses that yield even less benefits than those already protected? Aren't these additional houses just going to add -$500 each to net benefits? Not necessarily, and that is exactly the point!

Table 1 shows the relevant information for the initial plan formulated. Total costs were $1 million, and average costs were $1,000 per house. Missing is the most important piece of cost information. How much will the total costs change if we protect these 500 houses?

Assume the study team determines that each additional house can be protected at a marginal cost of $200 per unit. i.e., total costs will increase $200 for each house protected. In deciding whether to protect the additional houses, the only relevant cost is the marginal cost. Average costs are irrelevant. Total costs, while they cannot be ignored for long, have no place in this decision process.

Knowing the marginal cost of each house is $200, should it be protected? To answer that question we need one more piece of information. What are the **marginal benefits** of the house being added--that is, how much will total benefits change if we protect one more house? Average benefits and total benefits are irrelevant to the question of adding 500 houses to the protected area. The marginal benefit of each house is $500. Add a house to the protected area and it not only covers the cost of protecting that house, it yields a net marginal benefit of $300 ($500 in marginal benefits less $200 in marginal costs) that can be used to offset the -$100,000 in net benefits from the original 1,000 houses we have conveniently assumed are necessary to the larger project.

Table 2 shows the project benefit summary after adding houses with benefits below average costs. Total benefits now exceed total costs. The moral of the story? Any individual or group, such as a study team, that must make economic choices for the use of scarce resources should use marginal analysis.

In any decision to expand an output, whether it be from the without-project condition to the smallest feasible project or from one level of protection to the next, it is *always* the marginal costs and the marginal benefits that are the relevant values. Calculations based on average costs and benefits are likely to lead decision makers to miss all sorts of opportunities, some of them critical. *Optimal* decisions, identification of

Table 1
Initial Plan Formulation

| | | |
|---|---|---|
| Total Cost | $ | 1,000,000.0 |
| Cost/Structure | | 1,000.0 |
| Total Benefits | | 900,000.0 |
| Benefits/Structure | | 900.0 |
| Net Benefits | | (100,000.0) |
| BCR | | 0.9 |

Table 2
Final Plan Formulation

| | | |
|---|---|---|
| Total Cost | $ | 1,100,000.00 |
| Cost/Structure | | 733.00 |
| Marginal Cost | | 200.00 |
| Total Benefits | | 1,150,000.00 |
| Benefits/Structure | | 767.00 |
| Marginal Benefits | | 500.00 |
| Net Benefits | | 50,000.00 |
| Marginal Net Benefit | | 300.00 |
| BCR | | 1.05 |

the NED plan among them, must use marginal analysis.

## RELEVANT COSTS AND BENEFITS

Marginal costs are generally considered to be the change in total costs that results from increasing the output by one more unit. Likewise, marginal benefits are the change in total benefits by increasing the output by one more unit. Corps planners rarely have the luxury of designing plans that protect one more structure, pass one more ton of cargo, generate one more kilowatt of energy or provide one more acre-foot of water. Projects are more likely to vary by discrete jumps in project scale. Levees one foot higher, a channel five feet deeper or 100 feet wider, etc.

The principle of marginal analysis remains the same. The interpretation is perhaps more familiar to Corps planners in terms of "incremental costs and benefits". Incremental analysis is the term used when the changes in project outputs are more than marginal, more than increases or decreases of one at a time.

Figures 19, 20 and 21 show the relationships among total costs and benefits, marginal costs and marginal benefits, and marginal net benefits using the data from the wheat example of Chapter 3 and Figures 6 and 7. Each of the figures shows that the optimal quantity is 8,000 bushels of wheat.

**Decision Rule For Marginal Analysis**

When considering a change in any resource use, it is the marginal or incremental NED costs and NED benefits that matter if the goal is to maximize net NED benefits. Thus, NED plan identification is the direct result of marginal analysis. There are two equivalent ways to approach this problem.

Net NED benefits can be identified by subtracting total costs from total benefits for all relevant project alternatives and choosing the project with the largest positive difference. The other approach is to deal exclusively with marginal or incremental values. If the marginal (incremental) benefits from expanding an output, i.e., expanding the scope of the project, are at least enough to cover the marginal (incremental) costs of the expansion, the additional output should be produced. Further additions to output are considered in the same manner until the marginal benefits just equal the marginal costs. No further expansion is warranted when the marginal benefits fail to cover the costs of providing them.

The decision rule for identifying the NED plan is to formulate the project such that

(1) Marginal Benefits (MB) = Marginal Costs (MC)

or, alternatively, formulate the project to the point where

(2) Net Marginal Benefits (NMB) = 0

i.e., when MB = MC and MB – MC = NMB, then MB – MC = 0 = NMB.

Figures 19, 20 and 21 show the relationships among total costs and benefits, marginal costs and benefits, and net marginal benefits.

Referring to Figure 19, one would never produce a quantity less than $Q_1$ or greater than $Q_2$ because costs exceed benefits in these ranges. The optimal size project, i.e., the NED plan, lies between $Q_1$ and $Q_2$. The NED plan is the quantity $Q^*$, where the difference between total costs and total benefits is greatest.

Figure 20 should be familiar. The supply curve of Chapter 3 is now interpreted as a marginal cost (MC) curve, the demand curve as a marginal benefit (MB) curve. Net benefits are maximized only at the equilibrium quantity $Q^*$. Figure 21 indicates that $Q^*$ is the quantity at which net marginal benefits equal zero, i.e., where MB = MC.

Figure 19
Total Costs and Total Benefits

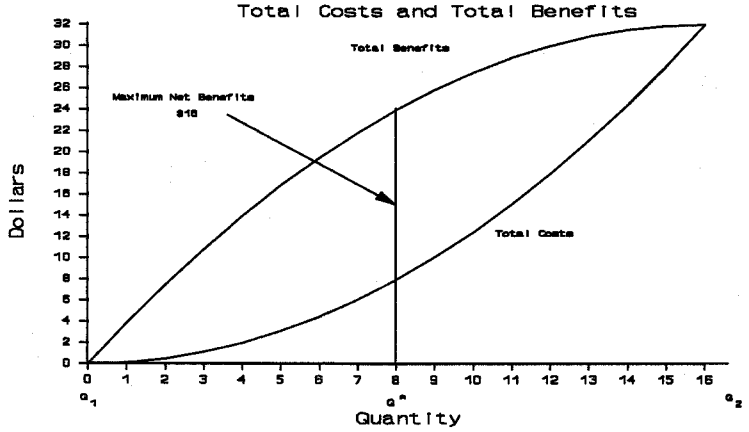



Figure 20
Marginal Cost and Marginal Benefits

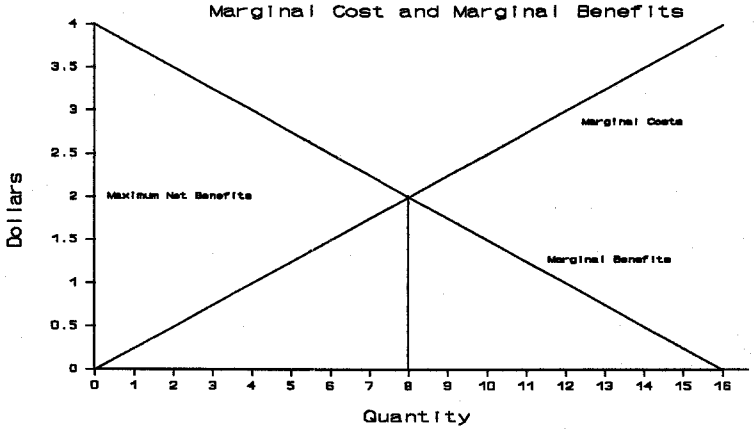
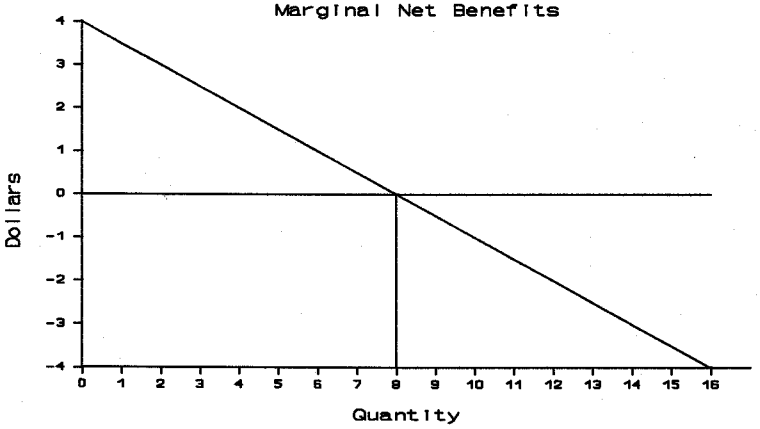



Figure 21
Marginal Net Benefits



## WITH- AND WITHOUT-PROJECT CONDITIONS

NED benefit estimation in the Corps' planning process proceeds by comparing forecasts of economic conditions without the project to forecasts of economic conditions with the project, a subject taken up again in the next chapter. Hence, identification of reasonable with- and without-project conditions is a critical step in the planning process. With this much we can all agree. The problem comes in defining what is "reasonable".

Economics offers its principle of economic rationality to help define what is reasonable. Pragmatic definitions of reasonableness are also dependent upon current guidance and policy, a host of formulation issues, and considerations unique to each planning study. Economics is, nonetheless, an important component of the working definition of reasonableness and is the only subject of this section.

## ECONOMIC RATIONALITY

Economists assume people make choices and act in their own self-interest. As individuals they maximize their utility. As firms, they minimize costs and maximize profits. In the Corps' planning context, it may be convenient to add that planners maximize net benefits. Behavior that violates these assumptions is economically irrational and should not be part of any without or with-project condition forecast. A general recognition of the fact of scarcity also implies that blatant inefficiencies of any kind are irrational.

Economic behavior is not the only kind of behavior that people exhibit, however. Laws frequently prohibit behavior that certain people would find in their personal interest. Restraint of trade and unregulated monopoly power are two ways to increase profits that have been heavily regulated in the U.S. Thus, there may well be valid reasons why economically irrational behavior can be observed in reality. In such cases, it is wise to address the rationale for that behavior in sufficient detail to convince the critic of its pragmatic rationality.

### NED Plan And Economics

In economics, marginal analysis is appropriate for all net benefit maximizing decision problems. But, what constitutes an incremental or marginal change in output? In economics that's easy—any increase or decrease in output is an incremental or marginal change. What constitutes an incremental change in plan formulation is not so easy.

Mindless application of marginal analysis would have the planner analyzing each flood plain structure separately, protecting only those with positive net marginal benefits. If a 50-foot deep channel provides more net benefits than a 45- or 55-foot channel, it would appear wise to consider whether a 51-foot channel is better still; then a 51-foot 1-inch channel, etc. The principle cannot be applied in this manner for a variety of reasons; including political, legal, engineering, and environmental concerns, as well as study costs and time constraints.

Marginal analysis improves decision making. Policy guides and regulates the decision making process. While economics is unambiguous about what an increment is, policy is not. The reader should not confuse the sound principle of marginal analysis with policies regarding incremental analysis. Many long and vituperative battles have been fought over what constitutes a project increment. That issue will not be engaged here.

## WITH AND WITHOUT IN THE LONG RUN

The Corps' period of analysis frequently extends to 100 years. Change is the only constant in such a time period. Forecasts of economic variables should be made with a long run perspective appropriate for such a planning horizon.

Corps' planners must forecast commodity shipments, fleet composition, flood plain conditions,

and countless other variables when describing the without- and with-project conditions. It is inevitable that deviations from these forecasts will occur, often even before the study is completed. Some of these anomalies will be due to errors in the forecasts; others will be due to **short run** deviations from the long run trend.

Stepping back from the content of the study and considering the process itself, it makes no economic sense to alter the long run forecast for every short term aberration in a variable. Before a large flood damage survey can even be completed, it is almost inevitable that uses for some of the land and structures in the survey will have changed. Families move, businesses expand, businesses fail, people die, conditions change. It is naive to think that individual changes in structure use, warrant a new flood damage survey.

From an economic perspective, it is far more reasonable to try to place the current level of development in some long run perspective than it is to worry about whether a building is used as a book store or a florist shop, even though the damages may differ substantially between the two. For example, a flood damage survey conducted during the depths of a recession may be unrepresentative of the economic conditions that will prevail for the majority of the flood plain's next 100 years. If so, it should be adjusted.

The without- and with-project forecasts should be long run forecasts that avoid giving disproportionate weight to short run events.

## VALUE OF TIME SAVED

**Time savings** are a frequent benefit of water resource projects. Flood control projects prevent the loss of roads or bridges that could disrupt transportation patterns for extended periods of time. Navigation projects can shorten delays at locks or prevent delays caused by one-way traffic through narrower channels. Recreation projects may shorten the **travel time** for users of the project. In these and all other cases, the principle to be used is to evaluate the saving of travel time as the amount of money that the beneficiaries of the saving would be willing to pay to obtain the saving.

Time saving is valuable because it frees time for alternative uses. To properly evaluate time saving, it is important to specify the alternative use to which the time saved will be put. In a broad sense, time saved may be spent working or in leisure.

In a competitive economy, in which firms are able to make productive use of the time saved from traveling, the value of the time saved is the value of the increase in output made possible by the time saving or the **wage rate**. The appropriate wage rate to use is the gross wage rate, or before tax wage, since, in a competitive economy, that is the value of the marginal product of labor. The wage rate is the opportunity cost of labor. In many cases, resources other than labor are saved as a result of the project. For example, as tows are queued to pass through a lock they consume diesel fuel and deteriorate their capital equipment as time passes. These resource losses may be reduced by a lock rehabilitation. In such cases, the value of the resource losses prevented may be included among the value of the time savings.

Some of the travel time saved may be used to increase **leisure time**. Time saved commuting to and from work may be used entirely at home in non-work activities. The problem with measuring the value of leisure time that replaces travel time is that the value of leisure time is not reflected in any market prices.

The wage rate does not accurately reflect the value of leisure time. An individual allocating her travel time saved between work and leisure will choose work if the value of the wage (in this case, the after-tax wage) plus the benefits of working an hour (for many, if not most, people these benefits would be negative) exceeds the value of an hour of leisure.

Let's assume our individual is allocating her time at the margin so the benefit of taking more leisure time ($MB_l$) just equals its opportunity cost, i.e., the foregone wage payment (w) and the foregone benefits of working ($MB_w$). In mathematical terms:

(3) $MB_l = w + MB_w$

Since few people work without pay, we can reasonably assume that $MB_w$ is negative[28]. This being the case, we expect the marginal benefit of leisure time to be less than the wage.

For example, suppose the marginal hour is time and one half overtime paying $18 per hour. Staying another hour has a disutility of say -$4, i.e., in this case $MB_w$ = -$4. If the marginal benefit of having that hour off is $12, our worker will take the overtime. She will continue to take overtime up to the point where equation (3) holds. With each additional hour we can expect that the disutility of staying longer grows more negative and the $MB_l$ grows larger.

Additional complications arise when you consider adults who are retired, students, children and others for whom equation 3 is not relevant.

This doesn't quite capture all the opportunity cost of savings in commuting time, however. Presumably, there is some utility or disutility to the actual commute. The value of a reduction in commuting time ($R_c$), is the value of the leisure time ($MB_l$) less the marginal benefits of commuting ($MB_c$) or:

(4) $R_c = MB_l - MB_c$

Substituting equation (3) for $MB_l$ into this equation yields:

(5) $R_c = w + MB_w - MB_c$

Since we expect the marginal benefits of work and the marginal benefits of commuting time foregone to be negative, we have the wage rate plus a negative value minus a negative value. Thus, the right hand terms in the above expression are positive, negative, and positive, respectively. $R_c$, the benefit of time savings we seek, will be less than the wage rate as long as $MB_c > MB_w$.

Thus, the value of leisure time may be more or less than the wage rate depending on the individual's utility or disutility from her job and commute.

Several attempts have been made to find $R_c$ indirectly. The usual method is to run regressions relating the proportion of trips taken by one of two or more alternative modes of transportation to differences in time cost, differences in money costs and any other differences between the modes considered to be significant.

## PREVIEW TO CHAPTER 6

This chapter has provided discussion on the use of economic principles in areas of particular interest to planners and analysts involved with NED analysis. Chapter 6 draws on the material and concepts in the preceding chapters to illustrate examples of NED analysis in specific settings familiar to Corps analysts. It begins with a look at discrepancies between financial and economic costs followed by a discussion of land in the with-project condition. The chapter continues with a look at the importance of long run vs. short run analysis followed by drawing some distinctions between national and regional economic development. The chapter concludes by considering the economic basis for potential **GNP benefits.**

[28] It is entirely possible that $MB_w$ is positive. If this were not so there would be no volunteer labor. A rational individual who values her leisure at all will not willingly work for a zero wage unless the work itself provides satisfaction, i.e., $MB_w > 0$.

# Chapter 6: SELECTED APPLICATIONS OF NED PRINCIPLES

## INTRODUCTION

In this chapter, the economic concepts presented earlier in the manual are applied in several Corps-specific settings. The purpose of the chapter is to illustrate the use of the concepts.

## FINANCIAL AND ECONOMIC COSTS

Chapter 4 provides a discussion of financial and economic costs built around basic economic concepts. In essence, if you have to pay cash or write a check for something, it's a financial cost. Price is the usual measure of financial cost. Economists see costs a little differently. Cost has to do with comparing options, not with evaluating a single option by itself. Cost is that opportunity which must be foregone to use resources in a given way. Economic costs are opportunity costs and they may include explicit and implicit costs. If a resource has no alternative uses, it has no cost in use.

Benefit-cost analysis is based on economic costs. Local cooperation agreements and contract awards are based on financial costs. Because the two costs differ, there is frequently much confusion about what "the" costs of a project are. The confusion emanates from differences in perspective that the various parties of interest fail to recognize. One perspective is--is this project an efficient use of scarce resources. The second perspective is--what's it going to cost to build this project?

Corps analysts are frequently faced with situations that perplex new analysts and the public. Some of these examples are considered in this section.

## NON-NED COSTS

Some costs are explicitly excluded from consideration as costs in the benefit-cost analysis though they clearly are economic costs. These costs are usually included among financial costs, but they are purposely ignored in the economic evaluation as a matter of national or agency policy.

Relocation and evacuation costs are a prime example of how policy can override economics. A nonstructural flood control project may provide for the evacuation (permanent removal) or relocation of structures from the flood plain. The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) outlines the payments that must be made to persons displaced by Federal and Federally assisted programs. The treatment of these costs is a matter of policy.

Corps policy[29] provides that costs over and above replacement in kind are not considered economic costs for purposes of project evaluation. A specific policy decision has been made to limit consideration of the project's economic costs to a specific subset of the total costs. The inferred economic rationale for excluding relocation assistance payments is that the betterments received have a value at least equal to their cost. It has been deemed preferable, from a policy perspective, to exclude both the costs and benefits from the NED accounting framework.

Economic concepts can clearly be applied in the instance of evacuation and relocation. The economic costs are all the opportunity costs of the measure, e.g., costs to purchase and raze the structure, relocation costs along with the costs of any

[29] As summarized in paragraph 5-7c(2)(f) of the Corps' *Digest of Water Resources Policies and Authorities*, 15 February 1989.

**betterment**, and site preparation costs. If a betterment is provided, the entire cost of the betterment is a relevant economic cost. Benefits produced by that betterment are likewise relevant for the project. Financial costs are clearly the entire money cost of implementing the plan.

In this instance, policy has assured that economic and financial costs will differ. It is clearly within the Corps' purview to make such distinctions. Indeed the Corps has gone on to say for flood control projects that, "Costs for betterments are not included in the total project cost estimate or economic evaluation[30]."

For example, consider the case in which a road must be relocated as part of a project. Suppose the two-lane road could be replaced at a cost of $5 million, but is, at the non-Federal partner's discretion, replaced by a four-lane road at a cost of $8 million. The true economic cost of replacing the road is $8 million. That someone has elected to improve the road at the same time it is being replaced is of no consequence when applying economic principles. Financial costs are also $8 million; that is what must be paid to build the road.

Corps policy says that only the replacement in kind cost of $5 million is an NED cost. At this point, NED costs, which purport to be opportunity costs, diverge from economic principles. It is entirely proper that the agency be allowed to do this, though, as a result, NED costs are no longer identically equal opportunity costs. When some costs are not included for policy rather than economic reasons confusion can result.

The additional $3 million would not even be considered as a financial cost of the project. The Corps would regard this as a local expenditure that non-Federal interests elected to undertake at the time of project construction. Because the additional lanes of traffic have nothing to do with the Corps' project, there is a certain bookkeeping logic to treating it separately. In this example, the Corps would consider only $5 million of the total $8 million cost as economic costs for purposes of benefit-cost analysis and would likewise consider financial costs to be $5 million. The extra $3 million in financial costs would be considered a local public works project unrelated to the Corps project.

The project sponsor pays 100 percent of betterments and elements, or project scale increases, that are beyond the NED plan. The Federal Government just does not take a position on the benefits for these add-ons and merely assumes that the willingness of the sponsor to pay these costs is a sufficient indicator of the benefits. The NED principle is invoked to guide the expenditure of Federal monies on Federal water resource projects and need not be applied to expenditures of a purely local nature.

In the last example, there is no difference between economic and financial costs. If homes were being evacuated at a similar cost, i.e., $8 million total, $3 million of which is betterment and excluded from the economic costs of the benefits cost analysis, then financial costs would be $8 million while economic costs are only $5 million.

The major problem with policies that contradict economic theory is that by not considering all project costs and benefits, resources may be allocated inefficiently, resulting in less-than-maximum public welfare improvements. The lesser danger of such is that confusion will abound among analysts and the public.

## COST OF LAND

Land is a scarce resource that in all but the most extreme cases has alternative uses. Proper treatment of **land costs** is a recurring headache for many projects.

One of the most common problems encountered is the case in which lands needed for the project are already owned by project sponsors. Suppose the non-Federal partner owns land that is currently undeveloped bottom land upon which a levee is to be constructed. What are the costs of this land?

There will be no financial cost for the land. The non-Federal interest will not have to pay anyone for a right-of-way or fee simple; they already own the land. Is there an economic cost for the land? Almost certainly. As long as this land can be used in some

[30] Ibid., paragraph 6-5c.(1).

alternative manner to supporting a levee there is an opportunity cost.

If the land is developable and could be used for homes or industry at some point in the future (remember the plan has a 100-year planning horizon), commitment of this land to the levee precludes that development. Foregoing the opportunity to develop this land could have a substantial opportunity cost. Though no one will have to write a check, local interests are foregoing the opportunity to sell this land for a substantial gain at some point in the future. This is a very real economic cost.

It is more likely that river bottom land will have severely limited options for future use. Zoning regulations, topography, an excess supply of land or any other number of factors could limit the land's alternative uses. Nonetheless, land almost always has alternative uses like farming, developed recreation, the passive use of an occasional hiker, or use as habitat. In such cases, the economic cost of the land is likely to be modest.

In these cases there would be a zero financial cost but some positive economic cost. This cost is used in the benefit-cost analysis to assure that there is no misallocation of resources and to capture the cost to society of devoting the land to this use. But no one will ever have to make a financial payment for this cost.

A second example that has caused some confusion was recently encountered in a Corps project. Rights of way (ROW) for channel banks and channel bottoms already serving as channel banks and bottoms had to be purchased. This was clearly a financial cost. However, based on the argument that this represented no change in use of the resource it was not an opportunity cost. This may not be consistent with the economic principle of opportunity cost.

The Corps' principle of with- and without-project analysis is based on good common sense; it is not a tenet of economics. That there is no change in the use of a resource does not mean there is not an opportunity cost. Whether there is an opportunity cost or not hinges more on reasonable with-and without-project condition forecasts. If the without-project condition allows for alternative uses of the resource that the with-project condition precludes then there may well be an opportunity cost without an actual change in resource use.

If the ROW permanently commits the land to use as channel bank and bottom there is an opportunity cost, so long as this land has other potential uses at any point in the future. If the ROW entails maintaining the land in a different condition, for example, clear of tree and brush growth there could be a foregone opportunity to use this land as habitat or a shady bank from which to fish. Granted, these alternative uses may not be intense, but they are alternative uses, presumably with some value that can be estimated by application of the willingness to pay principle.

## WHEN ECONOMIC COSTS ARE LESS THAN FINANCIAL COSTS

Though relatively rare, there are instances where the incurred financial cost exceeds the economic cost. It is entirely possible that the financial cost of the ROW in the above example exceeds the economic costs of the ROW. The value of a shady bank from which to fish may be well below the financial cost of a ROW.

A more familiar example is that of unemployed or underemployed labor resources. Corps' policy provides that projects in areas designated as having "substantial or persistent" unemployment are eligible for benefits equal to payments to **unemployed and underemployed labor resources** used in project construction.

Wages are the cost of a worker's time. To hire a worker to build a project in an area with other employment opportunities entails an opportunity cost equal to the wage earned in the next best job. For example, one hour of carpenter labor for a project means one hour less of carpenter labor for some other job. The value of the carpenter's time is the value of the production of his hour on the other job. In a competitive market this is the wage rate. The economic cost of a carpenter hour is the same as its financial cost. He's paid $15 per hour and the economy loses $15 worth of production on another project.

If the carpenter is unemployed with no reasonable alternatives for employment the financial cost of an hour of his time on a water resource project

is still $15. However, the economy is not losing an hour of productivity on some other job because he would not have been working in the absence of this project. If the unemployed carpenter would've used the hour as leisure time then all his hour of labor costs society is the value of one hour of leisure lost. Because the unemployed carpenter has an abundance of leisure time it's not likely he valued the hour he gives up very highly. Thus the economic cost of the carpenter's hour is likely to be much less than the $15, say $4. The financial cost is $15 per hour and the economic cost is $4 per hour.

At present, Corps policy provides that the financial and economic costs, though different, be presented as equal. The difference between them is included as a project benefit. Economists would prefer to present the labor costs of a project valued at their true opportunity cost, which is less than the financial cost. There would be no benefit to offset the difference in costs. Presenting the difference between financial and economic costs as a benefit rather than a lower economic cost can have a distorting effect on the benefit-cost ratio. Table 3 illustrates this point with a simple example. The only project costs are for labor which costs $70. Due to the use of unemployed resources the economic cost of this labor is only $60. Project benefits for flood control are $80. Labor benefits are included in the Corps policy scenario but not the other. Labor benefits are the benefits allowed for the use of under-employed and unemployed labor resources to construct the project. In this example, current Corps policy yields a different result. Though net benefits are the same, the BCR is slightly less under the Corps policy scenario.

By handling this situation where financial costs exceed economic costs on the benefit side of the ledger, policy contributes to the lingering confusion of analysts and the public about what is an economic cost and what is a financial cost.

## LAND AND FIXED ASSETS IN THE WITH-PROJECT CONDITION

In the economics of water resource projects, few concepts are simultaneously as essential and as misunderstood as the concept of rent and the value of land and other fixed assets. Flood control includes inundation reduction, location, intensification, and restoration of land value as legitimate benefit

Table 3
Labor Costs or Labor Benefits?

| | Corps Policy | Economic Principles |
|---|---|---|
| Labor Costs | $ 70.00 | $ 60.00 |
| Total Economic Costs | 70.00 | 60.00 |
| Total Financial Costs | 70.00 | 70.00 |
| Project Benefits | 80.00 | 80.00 |
| Labor Benefits | 10.00 | 0.00 |
| Total Benefits | 90.00 | 80.00 |
| BCR | 1.29 | 1.33 |

categories. Each is related in some peculiar way to **land values**--how remains a mystery to many planners. In this section, we will attempt to unravel some of the mystery surrounding land value and its role in benefit estimation.

## THE BASIS FOR LAND VALUES

Land is a factor of production. It is the one truly indispensable input. No matter what is produced, you always have to be somewhere to produce it. Land, then, has value because of its location. One piece of land can have an advantage over another piece of land because of its location in relation to the market for the things that are produced on the land. Land in the center city has an advantage in commercial uses because it is located in an area where large numbers of people congregate daily. Land in the closer suburbs has an advantage over outlying lands in residential uses because it puts people closer to their jobs.

Location is not the only reason land is valuable. One piece of land can have an advantage over other pieces of land in terms of its physical-environmental properties like soil quality, climate, topography, etc. These properties, or "free gifts of nature", in combination with locational advantages, give value to land to people who want to use it.

The value of land depends on the number of consumers who would like to "hire" its locational and physical services and what return they expect from using the land. The consumer who succeeds in getting the land would, in a world running according to economic theory, be the one who expects to get the highest return from the land.

## ECONOMIC RENT

In everyday usage, "**rent**" refers to the amount of money we pay for our apartment or the charge for a rental car. In economic analysis, the term has a different definition. We'll restrict this discussion to consider only land, though the rent concept may apply to any factor of production.

**Economic rent** is the difference between the payment actually received for a piece of land and the landlord's reservation price (the minimum amount necessary to induce the landowner to permit the land to be used). Rent is the producer surplus realized in competitive markets for land or any fixed asset (described in Chapter 3).

## LOCATION, RENT, AND FLOOD PLAIN LAND

Flood plain land, by virtue of its fertility, flatness and proximity to water transportation has historically been among the first land settled. Because our modern communities, towns, and cities have grown up around these early settlements, flood plain land has acquired significant locational advantages in many places. Population pressures and the limited supply of developable land have assured that much of today's undeveloped flood plain lands remain attractive resources for a variety of uses.

The value of land, or any fixed asset, is based on the income stream that the land can produce into the future. Consider a piece of flood plain land for sale with four possible uses: open-space, agriculture, residential, and commercial. The bidder for the open-space is an environmentalist who would enjoy the view and the openness of the land, valuing this benefit at $500 annually. The farmer could produce crops that would net him $1,000 annually. The home developer could build and rent houses that would net her $2,000 annually. The commercial developer finds it infeasible to locate on this land because of the existing flood problem. What will each person bid for the land?

In order to determine a fair price for the land, each of these people has to figure out what the future stream of income or benefits they will get from the land is worth today. This is done by capitalizing the annual value[31]. Using an interest rate of 10 percent for simplicity, the maximum each would pay for the land is $5,000 by the environmentalist and $10,000 and $20,000 by the farmer and home developer, respectively. The commercial developer does not bid. In such a market, we would expect the developer to win the competitive bid. Because he can expect to make more money on this piece of land, he can afford to offer more for the land. Thus in a competitive

[31] **Capitalization** involves dividing the annual return from an asset by an appropriate return on investment or interest rate to determine the equivalent present value of the asset. It is not a simple matter to determine an appropriate rate of return. The issues involved are beyond the scope of this manual.

market, the scarce locational and physical characteristics of the land are efficiently allocated and this land is worth $20,000.

An annual stream of $2,000 is exactly the same as a one-time payment of $20,000 if the interest rate is 10 percent. If you had $20,000 to invest, you could save it in the form of a certificate of deposit or stocks and bonds with an effective yield of 10 percent annually. These financial assets would provide you with $2,000 per year. Or, you could buy this land and earn $2,000 per year by building and renting houses. In terms of personal preferences or options available to individuals, there may be great differences between the two options. In terms of value, there is no difference between the two.

Now that the land has been allocated for residential usage, let's take a closer look at how the value of this land is determined. The developer incurs substantial costs to build and manage the houses he counts on for income. There are construction costs, finance charges on his loan, operation and maintenance, periodic replacement costs for the roof, furnaces, etc., a normal rate of return on his investment, and annual taxes, among other costs. Again, for simplicity, assume the total annual costs are $10,000 per year, bearing in mind that this includes explicit and implicit costs, and total revenues generated by renting the homes are $12,000. The net income is $2,000.

**The Flood Tax**

One of the expenses of renting these homes is taxes. Taxes are easily anticipated annual charges levied by the government against the property. One of the physical-environmental attributes of the land is that it is prone to flooding. This can be likened to a tax that nature levies on a random basis as payment for the land's proximity to water, its fertility, topography, etc.

Nature's flood tax can be expressed as an expected annual value that is comparable to any other annual expense of operation. Let's assume the flood tax is $1,000 annually, i.e., on average over a very long period of time[32], flood damages to the houses that must be paid by the landlord average $1,000 per year.

If a flood control project could completely eliminate the flood problem, and hence the flood tax, the land would become more valuable. There are several different ways this could happen; we'll take the simple case in which demand for the houses does not change simply because the houses are now protected. The revenues are still $12,000 annually, while costs have now fallen from $10,000 to $9,000 per year as a result of the "repeal" of the flood tax. Net income is $3,000 instead of $2,000 and the maximum price the developer could pay for the land if it is protected is $30,000.

**Inundation Reduction Benefits**

The gross benefits of flood control in this case are $1,000 annually or $10,000 on a one-time basis. These benefits occur simply because physical damages to the houses are reduced by an expected $1,000 per year. Use of the land does not change at all, i.e., the land's output stays the same; it simply becomes less costly to produce that same amount of residential housing. This is an inundation reduction benefit.

**Intensification Benefits**

A second possibility is that the developer is unable to rent the below grade garden apartments in each building because of the flood problem, rather than that the landlord sustained expected annual damages of $1,000. The foregone net revenues that could have been realized from renting these unused units, i.e., the $1,000 damage, represents an implicit cost of the flood problem to the developer. If a project eliminates the flood problem and the developer can rent the additional units, these net revenues will now be realized. Under this scenario, the land is still used for residential purposes, but it is used more intensively with the project than it is without the project. This is an **intensification benefit.**

[32] We do not want to get side-tracked on issues related to the estimation of expected annual flood damages here. However, it is evident that in most years there would be no flood damage, while in some others there could be damages ranging from minor to catastrophic. If the houses did not change in any significant respect for a few thousand years and we added up all the damages and divided by a few thousand, we would have an estimate of the average annual damages. Expected annual damage estimates provide a statistical estimate of what that average would be without having the thousands of years of data.

**Location Benefits**

The third possibility is that the protected land rekindles the interest of the commercial developer. Now that the property is flood-free, it may be well-suited for use as a new regional shopping mall. The land may be capable of generating $10,000 per year in this new use. An offer of $100,000 (neglecting for convenience such issues as the value of the buildings, existing leases, etc.) would cause a reallocation of land resources from residential to commercial uses. This change in land use would yield a location benefit.

**Restoration of Land Market Values**

The P&G (paragraph IV-2.4.13.d, p. 38) provides that if the market value of existing structures and land is lower because of the flood hazard, the restoration of market values represents a quantification of otherwise intangible benefits. The commingling of economic terminology with policy intent produces confusion for analysts in this benefit category.

Though a more detailed explanation of this benefit category is offered in the discussion of short run and long run effects below, an intuitive treatment is offered here. Prices, i.e., the market value referred to by this benefit category, are determined in the market by the interaction of differently motivated groups of buyers (demand) and sellers (supply).

In the absence of recent flood events, land in a flood plain may be at its long run equilibrium price. In the immediate aftermath of a flood, we can expect prices of flood plain land to drop precipitously. The market is inundated with new information about this land. The drama that accompanies a recent flood event makes it difficult for buyers and sellers to properly evaluate the true nature of the flood risk. The threat of flooding may be greatly overestimated by both groups. In the short run, there may be a surplus of flood plain land as people seeking to leave the flood plain are unable to find any buyers.

In extreme cases, there may be no buyers of flood plain land at any price. Let us return to our hypothetical property for an example. Assume the land is worth $20,000 prior to a flood event. This value already reflects the expected annual flood damages of $1,000 per year. Now assume a flood, entirely consistent with the expected annual damage computation, devastates the flood plain in a dramatic event. The value of land now drops to $10,000, reflecting a sudden drop in buyers' and sellers' confidence about the ability of this land to sustain a $2,000 income stream into the future.

What has changed? It is not the actual flood damages; they're fixed at $1,000. It is people's expectations about the future at this flood plain location that have changed. Because of the trauma and inconvenience associated with a flood location, buoyed by recent experience, market values have fallen to a new low. If market values can be restored to the long run value that gives appropriate weight to the flood risk, most if not all of the reduction in price, attributable to the trauma, will be restored.

Thus, in this example, a project would cause land values to rise from $10,000 to $30,000. Ten thousand dollars of this rise is due to the elimination of damages; the other $10,000 rise in market value is due to the elimination of the short term effects of trauma in the market price.

## SHORT RUN VS. LONG RUN

Planning horizons for Corps projects typically range from 50 to 100 years. Planning for such a long time period requires analysts, planners, and decision makers to maintain a perspective that does not come naturally. It is a perspective that many find impossible to keep in practice, no matter the obvious logic of the position.

We can define the long run to coincide with a project's planning horizon. Conditions without and with a plan, commodity forecasts, development trends, climate, public policy, and the project's performance are but a few of the things that must be forecast over the planning horizon. A long run perspective, then, consists of conditions that are reasonably representative of the entire planning horizon. It is imperative that short run deviations from the long run trend not be given too much emphasis.

For example, a 1979 structure-by-structure damage survey of a 25,000+ structure flood plain yielded a stage-damage curve used in a project report. In 1983-84 an Army Audit Agency (AAA) review of the stage-damage data for a selected few of the largest industrial firms revealed that at the time of the AAA

review, damages would be significantly lower than previously estimated. AAA concluded that the stage-damage data were flawed and out-of-date. This may have more appropriately been a problem of not keeping the proper long run perspective.

The 1983-84 review was conducted as the U.S. was beginning to recover from its worst recession since the Great Depression of the 1930's. Demand for industrial products was significantly reduced during this time. As a result the firms reviewed had fewer employees, less raw material, smaller inventories and shorter work weeks. This means less damage would occur if flooded during a recession than during normal times.

If damages for these firms had been reduced, as AAA recommended, to reflect more current conditions would this community's stage-damage relationship, representative of a 100-year period, have been improved? The recession was followed by the nation's longest uninterrupted peacetime expansion. The firms reviewed earlier in the decade had recovered to their more normal levels of capacity. Some had even surpassed those levels.

It would be more reasonable to document the community's economic conditions at the time of a stage-damage survey and place this in some sort of long run perspective for the decision maker. Stage-damage surveys conducted in the depths of a recession or the heights of an economic boom are not likely to be as representative of long run conditions as surveys conducted during more normal times.

Few analysts will welcome the opportunity to put their survey work into some sort of long run perspective. It is difficult enough to gather the data. Budgets and schedules do more to determine when and how surveys are conducted than do concerns about long run representativeness. Nonetheless, few analysts would expect that many of the commercial/industrial structures identified during a damage survey will be there on the 100th anniversary of the project.

It is very difficult to bear in mind, in a pragmatic way, that the true goal of a damage survey is to describe a reasonable representation of the damage potential in the flood plain over the next 100 years. It is less important to have a minutely detailed snapshot of the damages at a point in time than it is to have a reasonably focussed movie of the next 100 years.

In the short run there will be all sorts of perturbations and deviations from the long run trend. No analyst, planner or decision maker should give unwarranted weight or attention to these short run fluctuations. A change in the long run trend, on the other hand, warrants reanalysis.

Planning for a 100-year period in 1990, what is the appropriate weight to give to the effect of the Persian Gulf crisis on oil prices? If navigation projects had been formulated based on summer 1990 oil prices of about $16 per barrel, transportation costs would have been a lot lower than they would have been had the project been formulated based on October 1990 prices which rose as high as $40.40 per barrel. Oil prices changed daily with each rumor of impending peace and war. By February, 1991 prices were down to about $18 per barrel. Clearly, there is much to be said in favor of a long run perspective.

A flood plain savings and loan in 1990 may have been taken over by the Resolution Trust Corporation and sold to another institution and closed. Should the damages be based on the temporarily vacant S&L building?

A proper long run planning perspective requires the analyst, planner and decision maker to adhere to the secular trend in data and events. The temptation is to be unduly influenced by cyclical, seasonal or random effects.

As a pragmatic matter it may be difficult or impossible to adhere to a long run trend in rising oil prices when a temporary oil glut has caused prices to plummet. Failure to reflect the latest data is, to many, the definition of poor planning. And that statement is true as far as it goes. It just does not go far enough. The latest data should be used but it should be the latest data relevant for a 50- or 100-year planning horizon, not simply the latest market data.

## SUPPLY AND DEMAND IN THE LONG RUN

In Chapter 3 project benefits are presented in terms of areas under supply and demand curves. Only the rudiments of supply and demand were presented. Missing from the explanation to this point has been the ***ceteris paribus***, or "all other things equal" condition.

The supply and demand curves presented in Chapter 3 are all perfectly reasonable but only under a very narrow set of circumstances. Let's illustrate with some intuition from a personal example. You walk into a convenience store and see a popular soft drink on sale. How many will you buy? Your answer should begin with "it depends". Do you even like this soft drink? How much money do you have on you? Are you walking or driving? How many do they have? How many people are you buying for? On and on the questions go. Once each of those questions has been answered for you, you can say with reasonable certainty how many sodas you would buy. Then we could ask you how many sodas you would buy if the price is lowered another 10 percent, all other things equal; meaning your tastes are the same, the same amount of money in your pocket, etc.

Thus, your demand for sodas depends on a lot of things other than price. In order to consider only the relationship between price and quantity purchased we must determine values for all the those other things and hold them constant[33]. Change the amount of money in your pocket from $100 to $0.50 and your answers are obviously going to be different.

The same reasoning applies to project outputs. The demand for navigation transportation depends on many things. It may depend on the cost of alternative transportation modes, the origin-destination of movements, the type of commodity, market size for the commodity, time of year, international events, weather, consumer tastes, availability of substitutes for the goods moved, etc. Once the planner answers (explicitly or implicitly) all of these questions a demand curve can, conceptually if not actually, be drawn. That demand curve is good only as long as all other things are equal.

[33] This may appear to be a daunting process. It need not be. If we are empirically estimating demand curves we must have precise measurements of all those things we are going to hold equal. Otherwise, it is often sufficient to assume that whatever the values of those other things are, they are not changing.

**Time Series Analysis And Projection**

Most methods of forecasting by trend projection are predicated on the assumed relationships between the trend variable and the passage of time continuing into the future. All time series data, regardless of the nature of the economic variable involved, can be described by the following four characteristics:

1. **Secular trend** – the long run increase or decrease in the data.

2. **Cyclical variations** – rhythmic variations in the economic series.

3. **Seasonal variation** – variations caused by weather patterns and/or social habits that produce an annual pattern in the time series.

4. **Random influences** – unpredictable shocks to the system such as wars, strikes, natural catastrophes, key deaths, revolutions.

Figures 22 and 23 provide hypothetical illustrations of these four patterns for oil prices. The long run or secular trend is for prices to increase. Over a number of years the cyclical pattern follows the business cycle of the international economy. Recessions cause a decrease in the demand for oil and a drop in its price. Booms, on the other hand are accompanied by rising prices.

Each year cold weather increases demand for heating oil. Summer brings with it increased demand for gasoline. Prices rise and fall annually with these changes in demand. Random fluctuations are caused by such things as the invasion of Kuwait by Iraq. Prices rise and fall on subsequent rumors of war and peace. An extremely cold or mild winter will have an unpredictable effect on demand and prices, as could any number of other influences.

Figure 22
Secular and Cyclical Trends

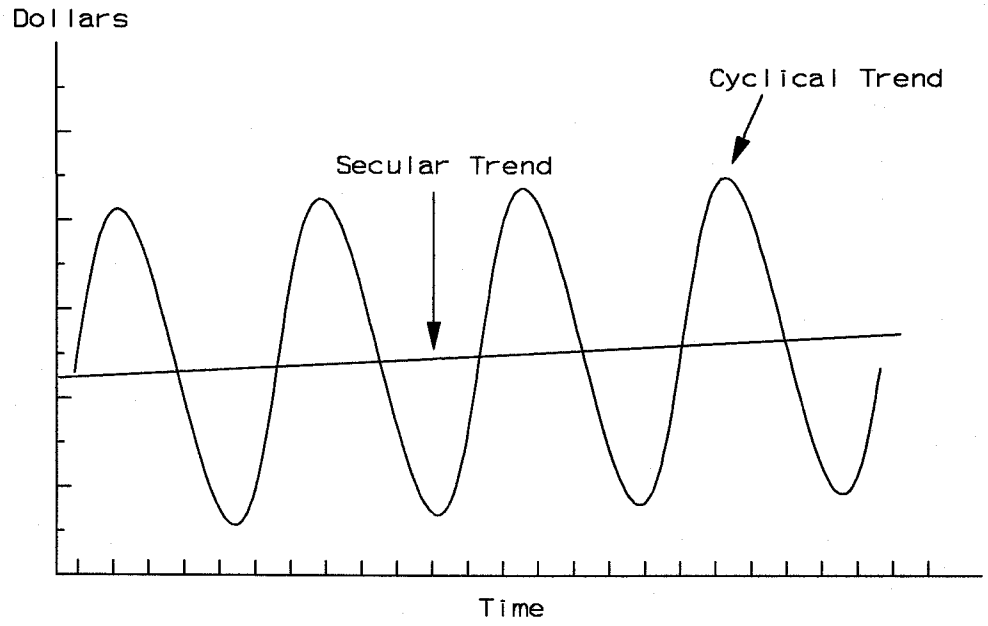
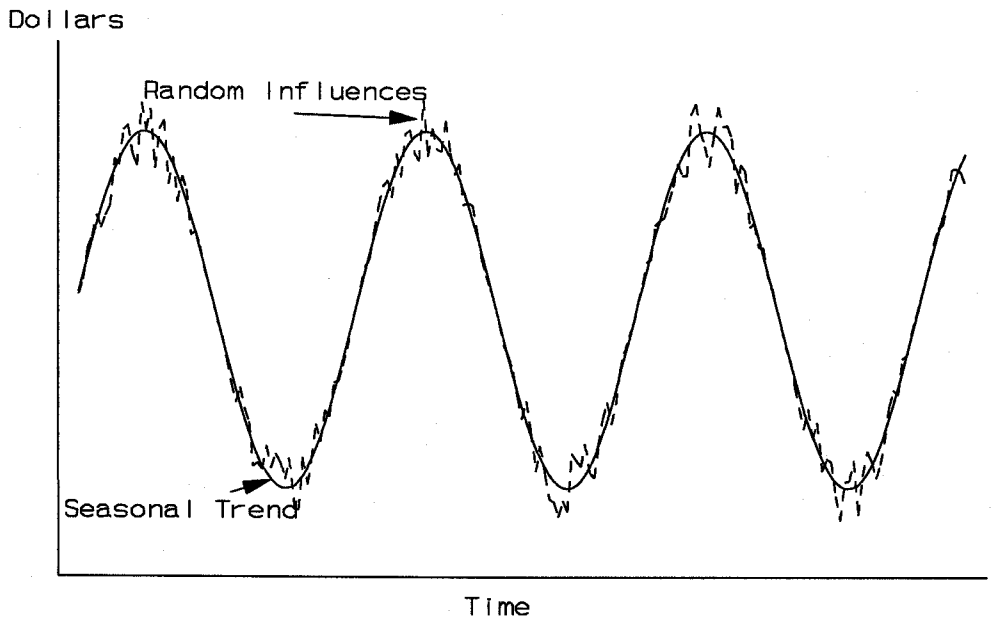



Figure 23
Seasonal Trend and Random Influences



In the short run there can be many demand curves because all other things are not equal, things change constantly. In the long run demand is more stable because short run deviations among all the other things held equal even out and are ignored. Long run average values for these variables permit estimation and use of a long run demand.

Supply curves are likewise dependant upon the assumption that all other things are held equal. The supply of developable land[34] in a community depends on many things; the price of land, zoning, technology for preparing sites, the price of land for undeveloped uses, etc. $S_1$ in Figure 25, represents the without-project supply of land in a community. $S_2$ represents the with-project supply of land in a community where flood protection lowers the cost of occupying land making it more attractive under the new conditions. The condition that has changed, i.e., the "other thing equal" that is no longer equal is flood control. Supply curves can shift about as conditions unrelated to price change.

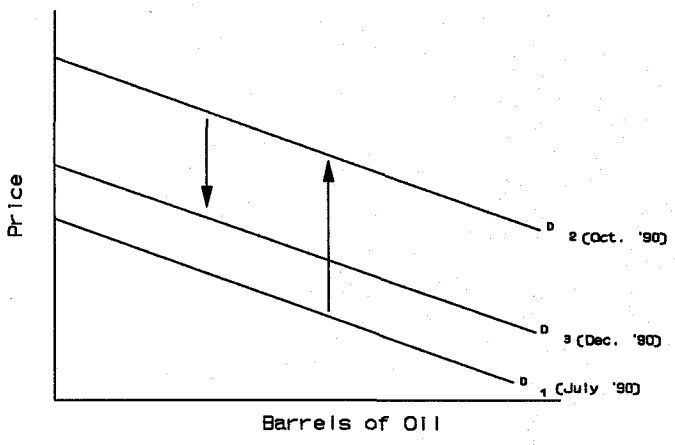
In Chapter 3 single and stationary supply and demand curves allowed us to demonstrate the NED benefit principle quite nicely. In reality, things other than price are changing all the time causing the supply and demand curves to shift about constantly in the short run. The best hope in such cases is to approximate some stable long run supply and demand relationships.

[34] In the current context supply does not refer to the fixed amount of land available. Instead, it refers to economic supply; i.e., the amount of land people are willing and able to offer for development at various prices. Thus, for example, there may be existing land that is not available for development because the cost of preparing it for development exceeds the price it would bring on the market.

**CHANGING DEMAND FOR OIL**

The demand for oil depends on the price of oil, the price of coal, the weather, the number of automobiles, consumer tastes for travel, the state of the economy, geopolitics, expectations about future prices, and numerous other factors. Consider $D_1$ in Figure 24 as the demand for oil in July, 1990. When Iraq invaded Kuwait we no longer had all other things equal. Fearing war and the loss of significant oil supplies, consumers increased their demand for oil, which drove prices up rapidly. $D_2$ represents the demand for oil in October. Because people were feeling less optimistic about the availability of oil in the future, they were willing to pay more for the amount they consumed. Curve $D_3$ could represent the demand for oil in December 1990 as hopes for peace made consumers feel more comfortable about future oil availability. They were no longer willing to pay as much as they were in October, but they were still willing to pay more than they did in July. Imagine superimposing a single unchanging supply curve on Figure 24 and obtaining three different oil prices. Which should be used for formulation?

Figure 24
Changes In Demand



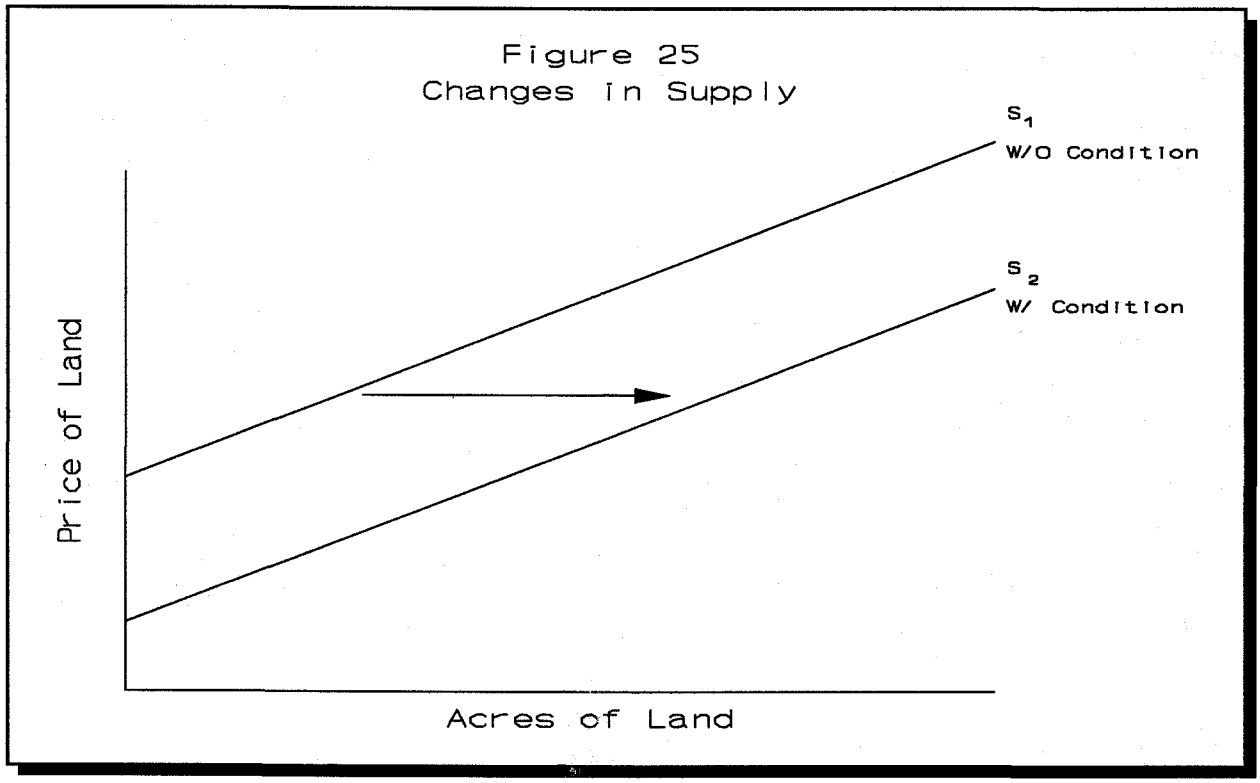



Figure 26 shows the equilibrium condition for flood plain land, all other things equal. It has been 20 years since the last flood. As a result of a flood consumer tastes for flood plain land drops drastically. Figure 27 reflects this change in a demand curve that has dropped dramatically. At the original pre-flood equilibrium price of $P_1$ there is now a surplus of land. More people are willing to sell their land at that price than are willing to buy it. The only way that people with land for sale will be able to move it is to drop the price. Price will eventually fall to $P_2$.

Corps analysts who initiate a study in the aftermath of a flood have often used market values as the basis for damage estimates or other flood control benefits. A price depressed by short run changes in market conditions could be devastating to a project's feasibility. Given a 100-year planning horizon it makes more sense to use a market value that is likely to prevail for most of that period, this would be the long run value which may be much closer to $P_1$ than $P_2$.

The effect described in Figures 26 and 27 is so commonplace that current Corps policy steers analysts away from using market values. While it is easy to argue that long run values should be used in economic evaluations it can be much more difficult to actually estimate and agree upon such values. Rather than take the path of least resistance and use the most current data, that may be woefully distorted by short run considerations, it is much more advisable to at a minimum use risk and uncertainty analysis to address the long run value issue.

## WITH AND WITHOUT CONDITION

During development of this manual, the with- and without-project conditions were identified as the most important issue for project formulation more frequently than any other. Identifying reasonable with- and without-project conditions is a chronic problem for Corps analysts. The majority of the concerns expressed were at best policy issues (e.g., why can real oil price increases be accounted for in estimating hydropower benefits but not navigation benefits) and at worst questions without answers (e.g., how much support for a with- or without-project condition is enough?). The NED principle shines little light on either of these areas. Economic analysis, on which the NED objective is based, provides some very general, but perhaps useful insight into the with- and without-project conditions.

Figure 26
Long Run Equilibrium Price

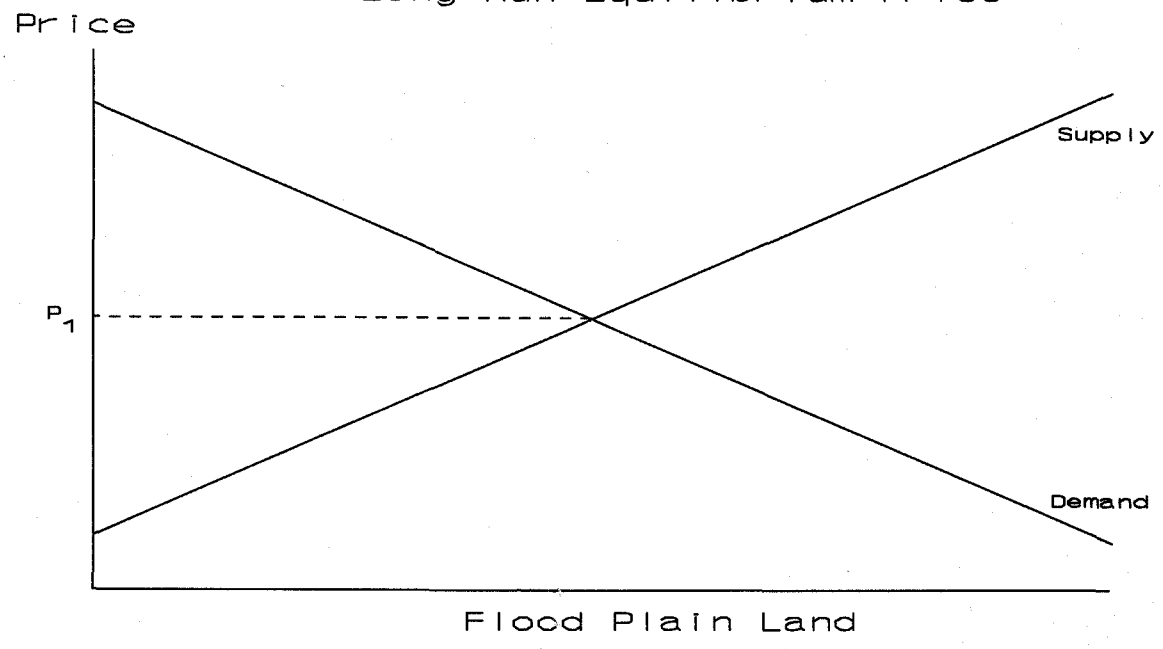
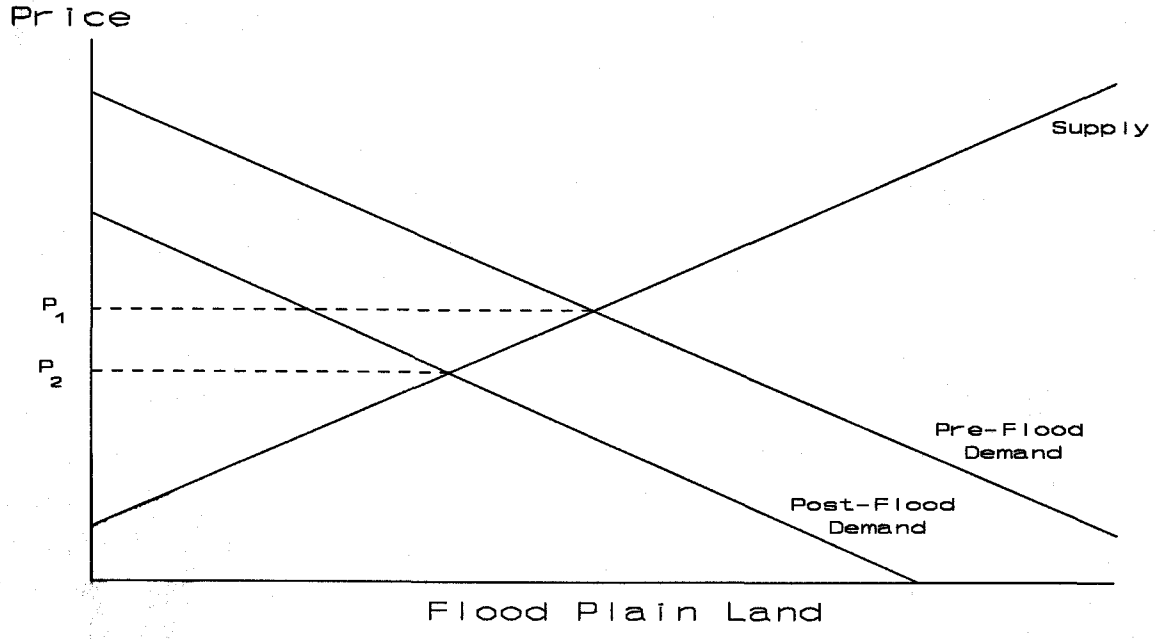



Figure 27
Short Run Equilibria Prices



How much is enough? What is reasonable? These are two critical questions that deal with defining with- and without-project conditions that are beyond the scope of economics. Economic analysis can offer the analyst some help in answering these questions, however.

Rational behavior is an assumption that underlies all economic theory. The assumption is that people and firms act as if they are trying to maximize their utility or profits or to minimize their costs. Rational behavior should be assumed when defining the with-project and without-project conditions. Use this basic concept, but do not take it to the extreme of assuming that under the without-project condition parties will automatically act together as if, in the absence of federal participation, they are a single beneficiary or single owner.

For example, consider a hypothetical streambank erosion problem. The without-project conditon assumes streambank erosion will eventually destroy a section of public road. As a result, people will sustain $125,000 of increased costs each year until the road is fixed, due to longer commutes, etc. In other words, they would be willing to pay $125,000 annually to avoid the increased transportation cost. A bank stabilization plan, costing $250,000 would prevent the loss of the road and the forecast increase in communiting costs. With a 10 percent interest rate and a 25-year project life, the annual project costs are $25,000.

Theoretically those benefited would be willing to pay for the bank stabilization project to prevent loss of the road. In our example, however, the beneficiaries include a mix of vactioners, cross-country delivery companies, one-time visitors, occasional users, local residents, emergency vehicles, meter readers, newspaper delivery cars, mail people, a boy scout troop, farm trucks and equipment, the dairy tanker, the school bus, a regional bus line, some commuters that transit the area from far away to jobs in the city, off-post troops at an Army Reserve Unit, and workers at a local fish hatchery.

The $125,000 benefit appears to be widespread so a federal interest in the improvement seems to be present. If the benefits were of a windfall nature, benefitting only a few individuals or companies and not widespread, the federal interest would be less clear and the beneficiaries might be expected to take a rational action and fix it themselves. No matter who fixes it though, our assumption is that a rational decision will be made based on the transportation savings that can be realized. So in either case, it is the without-condition that drives the economic evaluation.

When the without-condition is realistically identified, alternative or incremental improvements can be evaluated. If the without-condition is not realistically identified, however, the benefit evaluation for any alternative is questionable since benefits are basically quantified on the basis of the difference between the with-versus the without-project condition.

The NED evaluation does not determine who will take action, it merely evaluates alternatives from the NED point-of-view by comparing them against a without-project condition. There is considerable judgement needed in identification of the without-project condition, but there is no tolerance for promoting a without-condition merely because it will enhance justification. Good judgement will most likely result in developing a without-condition that will pass the test of fitting the description of a "most likely" future, and will also be supportable by consensus of the planning team. Risk analysis should be used when the "most likely" future is a range of possibilities.

## NED VS RED

You paint your house and can sell it for $3,000 more than you could before it was painted. You paint your house and your neighbor gets $5,000 more than he could get, now that his home is no longer next to a house badly in need of paint. The paint produces $8,000 in benefits. How much of those benefits are relevant to you when making the decision to paint or not? Obviously, you are concerned only with the $3,000 benefit that accrues to you. It's a matter of perspective.

And so it is with National Economic Development and Regional Economic Development; it's a matter of perspective. There should be no doubt that RED benefits are real and legitimate benefits. As pointed out in Chapter 3, these benefits are often offset by RED costs in other regions. National policy has directed that the proper perspective for Federal water resource project evaluations is an NED perspective. Examples of NED and RED effects are presented here to illustrate the difference in perspective.

Recreation is a major output of many regions in the U.S. Slackwater recreational opportunities for fishing, boating and bathing comprise major components of some local economies. Recreation that attracts new participants is clearly an increase in the nation's recreation output and is an NED benefit. In other cases people stop visiting one site in favor of a new one.

Consider the hypothetical Lake Liter at a newly built reservoir. The non-Federal partner favors the lake because, among other things, it will attract an estimated 150,000 out-of-state visitors annually. These people will spend an estimated $50 each adding 7.5 million much needed dollars to the local economy. The money will be spent on licenses, food, supplies, gasoline, lodging, etc. This spending by visitors will become the income of local residents. These local residents will in turn spend this money in local barber shops, taverns, furniture and clothing stores, etc. creating income for these shop owners. And so it goes until the money introduced to the economy leaks out through taxes, savings and purchases outside the region. The $7.5 million brought into the region by visitors will represent an increase in local income that will greatly exceed $7.5 million before these multiplier effects diminish.

It is because these multiplier effects can be so large relative to the size of the local economy that they are so important to local people. These are major economic effects. They are often the real effects for which non-Federal interests are paying. It is not difficult to understand why they are often stunned to learn that these very real and important effects are not considered project benefits.

To see why RED benefits are not considered project benefits we must consider the effects of Lake Liter on other regions of the country. This is not the responsibility of the Lake Liter region's officials but it has been judged to be the responsibility of the Federal government.

For simplicity assume that all the people who visit Lake Liter come from the Lake Heavy region in a distant state. The $7.5 million spent at Lake Liter was once spent at Lake Heavy. With the completion of Lake Liter, spending at Lake Heavy decreases $7.5 million. The lodge, gas station, souvenir stand, food store and other shop owners at Lake Heavy realize a $7.5 million decrease in spending in their stores as people take their money to the new lake. These shopowners suffer a $7.5 million decrease in income that means they will have less to spend in the barber shops, taverns, etc. in the Lake Heavy region. The barbers and bartenders, etc. will in turn have less income and so the effect continues. The loss to the Lake Heavy region is a very real and important one.

Lake Liter's gain is Lake Heavy's loss. A RED perspective can ignore this, an NED perspective cannot.

There are many such examples in water resource projects. Navigation improvements for channels and harbors are often extremely successful for regional development. Harbor improvements along the Gulf Coast may attract many new workboats and thousands of tons of catch. As a result marina owners, suppliers, dry dock operations and local shopowners may realize tremendous increases in income. If the increased activity is simply a transfer from another harbor, i.e., shrimp that was once landed at Port East is now landed at Port West, there is no real benefit to the nation[35]. The multiport emphasis in navigation project analysis arises largely from this concern that projects could do nothing but continuously reslice the same pie instead of increasing the size of the pie, if careful planning and analysis are not used.

Many local officials feel that NED benefits are irrelevant to them, and in many cases they are. Bridging the gap between NED and RED effects is not a matter of finding some new or clever way of analyzing benefits. That will never happen. The effects are fundamentally different because each assumes a different perspective on project effects. This is a value-based policy judgment that cannot be reconciled through theory or analysis. It is simply a fact that NED is often irrelevant to local interests and RED is irrelevant to Federal interests.

As reanalysis of existing projects becomes a more important part of the Corps' program, more and more RED analysis will be required, regardless of its relevance. Though the P&G neither impose nor restrict

[35] To say there is no real benefit to the nation is not likely to be strictly true. Assuming rational behavior by the fishermen, there must be some advantage or the move would not be made. However, only the net increase in consumer/producer surplus should be counted. Local residents will see all the new business as an increase and will not net out the loss to the previous location.

requirements for RED analysis it can be reasonably anticipated that non-Federal sponsors are going to want to know what the projects they are financing are going to do for them, i.e., what are the RED effects. RED analysis would appear to be a fundamental necessity for garnering local support and enthusiasm for Corps projects.

As there is a fundamental difference in approach to benefit estimation between NED and RED perspectives, analysts should rest assured they are not failing if they cannot reconcile NED and RED effects. They are different. At the same time Corps analysts should consider the wisdom of including RED benefits in all their studies.

## NED VS GNP

In an effort to look creatively at project effects, a number of Corps offices have experimented with increases in **Gross National Product (GNP)** as an NED benefit category. GNP and NED are two entirely different concepts created to serve different purposes. GNP is a measure of the economy's performance. NED is a Federal objective for water resource projects. NED benefits cannot be adequately defined as increases in GNP. Some NED benefits are increases in GNP but others are not included in GNP at all.

### GNP

Gross National Product is the most widely used measure of our nation's economic performance. GNP is defined as the market value of all final goods and services produced by the economy during a year. There are two ways of measuring GNP, the expenditure approach and the income/cost approach. The former counts the money we spent on final goods and services, the latter the cost of producing it which produces our income.

The expenditure approach sums the expenditures of each sector of the economy on final goods and services. The four major sectors of the economy are households (personal consumption expenditures), businesses (gross private investment expenditures), government (government purchases of goods and services by all levels of government), and the international sector (exports of goods and services less imports of goods and services). The income/cost approach sums the flow of costs incurred in the production of goods and services. These costs include wages, self-employment income, rents, profits, interest, indirect business taxes and depreciation. Both approaches lead to the same estimate of GNP.

GNP is not a perfect measure of economic performance. There are many items that are clearly productive activity that are not included in GNP. GNP only includes the value of goods and services that pass through the market. If you repair your own car, sew your own clothes, mow your own grass, or paint your own house there is no market transaction so your activity adds nothing to GNP. If you pay someone to perform any of these services, however, they are part of GNP.

On the other side of the ledger, GNP makes no adjustment for harmful side effects that can arise from production, consumption and the events of nature. GNP makes no allowance for pollution caused in the course of production. Nor does it include the value of timber and habitat lost in forest fires each year. To further complicate matters, GNP makes no distinction between the production of new goods and services and clean-up and recovery in the aftermath of a flood.

It is not difficult to see that GNP and NED benefits are not well-matched concepts. When a homeowner spends time in flood fighting or cleaning-up after a flood, this effort is not measured by GNP though the homeowner will surely be willing to pay some amount of money to be relieved of this necessity. A great deal of flood damages do not involve market transactions. So, some NED benefits are not part of GNP. On the other hand, GNP makes no distinction between NED and RED production, hence it includes much that the NED concept does not.

## RELATED INCOME MEASURES

GNP has been defined as the broadest measure of our economic performance. It is not the only measure, as can be seen in Figure 28. Net National Product (NNP) is GNP less a depreciation allowance for the wearing out of machines and buildings during the year. Subtracting indirect business taxes from NNP, we obtain National Income (NI). NI represents the income payments to all factors of production. Personal Income (PI) is the total of all income received by individuals. PI is obtained by subtracting corporate

profits and social security taxes from NI while adding transfer payments, net interest, and dividends back in. Once personal taxes are subtracted from personal income, we are left with Disposable Income (DI).

The P&G describe contributions to NED as "...increases in the net value of the national output of goods and services...". GNP is a gross output measure, NNP provides a net measure of output.

## GNP BENEFITS?

A navigation project in the southwest brings iron ingots from Brazil bound for Mexico into the U.S. for trans-shipment. While in the U.S., $12 million is spent. The District argues that since this is foreign income attracted to the U.S., it is a change in net income that should be an NED benefit.

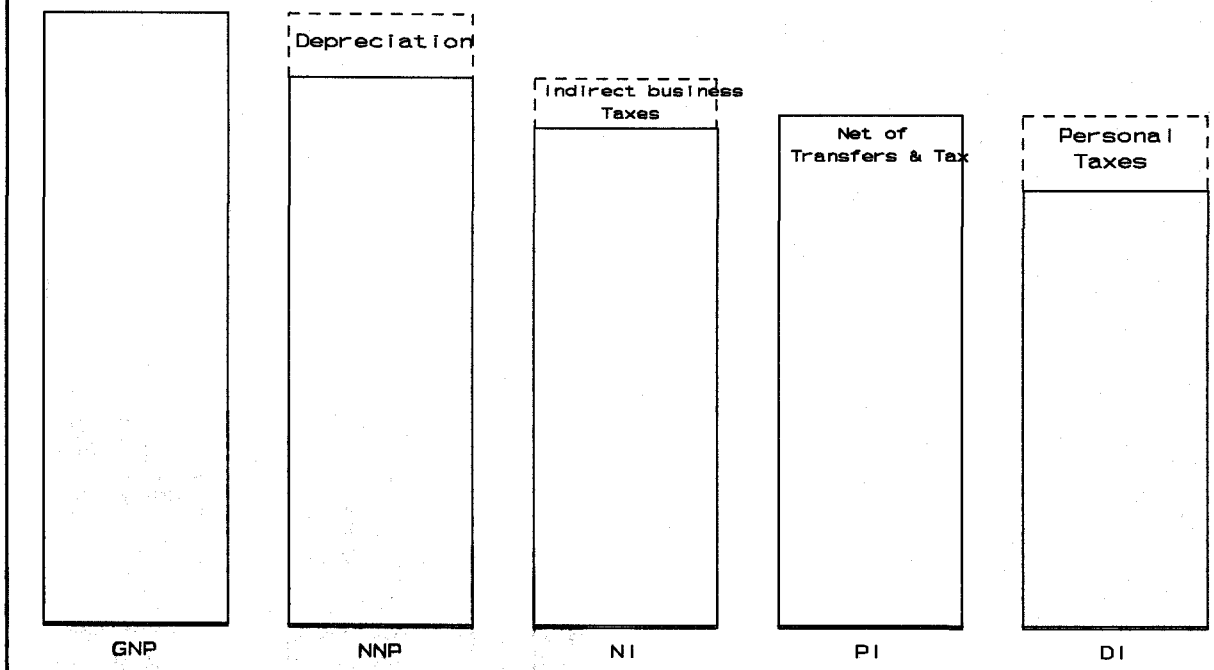
A navigation project in the northwest results in an increase in the number of Japanese tourists visiting the project area. The District argues that the tourists' expenditures are NED benefits.

To understand the relationship between GNP and NED, we need to consider a subtle point that is well beyond the scope of this manual. Nonetheless, the following section provides an intuitive introduction to the critical link in the thought process necessary to respond to the Districts' concerns.

### The Real Income-Real Output Link

National income accounting methods illustrate that the flow of real goods and services to households, business, government and foreign sectors must equal the flow of income from firms to the suppliers of the resources. In other words, the actual supply of goods and services or aggregate output must be equal to the actual total income or aggregate income. Since aggregate output and aggregate income must be equal, it is impossible to change one without changing the other.

Figure 28
Five Alternative Measures of Income



The only way a nation can increase its real income[36] is to increase its real output. Unless the production of goods and services increases, there will not be an increase in the nation's real income. Growth in real income is entirely dependent upon growth in real output.

When evaluating planning alternatives designed to stimulate the growth of income, one must focus clearly on this link between income and output. Proposals such as those above are purported to lead to a higher level of income. The careful analyst will identify how the project will affect output. Unless there is good reason to believe the project will stimulate the production of desired goods and services, it will clearly not increase income. If the project does increase output, it surely would meet the definition of an NED effect as quoted above.

The focus, then, must clearly be on output. If a tourist rents a hotel room, this is clearly part of the GNP. If that hotel room would have been rented by someone else anyway, there is no increase in output, no increase in income and no NED benefit. If a project causes output to increase, then there is no reason this increase in output cannot be considered a project output analogous, if you will, to increased agricultural outputs from irrigation projects.

## NED ANALYSIS HERE TO STAY

NED analysis of water resource projects is not going to go away. History shows that the emphasis on economic analysis has only grown stronger and more focussed with the passage of time. As we as a society become increasingly aware of the limitations of our resources, the role of solid economic analysis will only be increased.

This manual has introduced some basic economic concepts essential to understanding the NED analysis of Federal water resource projects. There is much more to the economic theory and its application than could ever be presented in a manual and the reader is reminded that they have been provided with only an introduction to a complex field of study. The manual has likewise presented examples, that have conveniently always worked out just right. The world in which the Corps operates is not nearly as tidy as the figures and examples herein suggest.

Nonetheless, the concepts presented and the intuition developed in this manual can serve most non-economists well as an introduction to understanding NED principles and their role in plan formulation and evaluation.

[36] We have introduced the concept of "real income" because changes in price levels can cast the arguments we offer here in a different light for reasons well beyond the scope of this manual. Real income is a measure of income that has been adjusted for changes in the general price level.

# INDEX

# INDEX

# Appendix 1: SUGGESTIONS FOR FURTHER READING

# Appendix 1: SUGGESTIONS FOR FURTHER READING


Baumol, William J. and Alan S. Blinder. *Economics Principles and Policy.* San Diego: Harcourt Brace Jovanovich, 1991, 5th ed.
One of many economics principles texts that provides an introduction to many of the concepts presented in this manual, with a good introduction to utility and profit maximizing behaviors, supply, demand and price determination. This edition should be accessible to most college-level readers.

Conrad, Jon M. and Colin Clark. *Natural Resource Economics, Notes and Problems.* Cambridge: The Cambridge University Press, 1987.
This recent work is a graduate level mathematical treatment of resource allocation problems in environmental and natural resource contexts. It provides the rigor missing from many other texts on the subject and provides a treatment of dynamic equilibrium issues that are well beyond the scope of this manual.

Davis, Stuart A., Editor. *National Economic Development Procedures Manual--Urban Flood Damage.* U.S. Army Corps of Engineers, Water Resources Support Center, Institute for Water Resources Report 88-R-2, Fort Belvoir, Virginia, 1987.

Dolan, Edwin G. and David E. Lindsey. *Microeconomics.* Chicago: The Dryden Press, 1988, 5th ed.
One of many economics principles texts that provides an introduction to many of the concepts presented in this manual, with a good introduction to supply, demand and price determination. This edition should be accessible to most college-level readers.

Freeman, A. Myrick. *The Benefits of Environmental Improvement, Theory and Practice.* Baltimore: Johns Hopkins University Press, 1979.
One of the first texts to address much of the material presented in this manual in an environmental context it is still one of the best. The book is oriented toward identifying and addressing issues associated with benefit estimation.

Gwartney, James D. and Richard L. Stroup. *Economics Private and Public Choice.* San Diego: Harcourt Brace Jovanovich, 1990, 5th ed.
One of many economics principles texts that provides an introduction to many of the concepts presented in this manual with a good introduction to supply, demand and price determination. This edition should be accessible to most college-level readers.

Hansen, William J. et. al. *National Economic Development Procedures Manual--Recreation, Volume III: A Case Study Application of Contingent Value Method for Estimating Urban Recreation Use and Benefits.* U.S. Army Corps of Engineers, Water Resources Support Center, Institute for Water Resources Report 90-R-11, Fort Belvoir, Virginia, 1990.

Hansen, William J., Editor. *National Economic Development Procedures Manual--Agricultural Flood Damage.* U.S. Army Corps of Engineers, Water Resources Support Center, Institute for Water Resources Report 87-R-10, Fort Belvoir, Virginia, 1987.

Hartwick, John M. and Nancy D. Olewiler. *The Economics of Natural Resource Use.* New York: Harper & Row, 1986.
This is a modern treatment of general resource economics and issues that is suitable for practicing economists, advanced undergraduates and graduate students. A well written text makes it possible for readers to glean the salient points of the theory without requiring him to follow all of the mathematical treatments.

Henderson, James M. and Richard E. Quandt. *Microeconomic Theory a Mathematical Approach.* New York: McGraw-Hill, 1980, 3rd ed.
This is an advanced text providing a calculus approach to rational economic behavior. It provides excellent coverage of classical economic theory including relatively recent extensions in duality theory.

Hirsch, Werner and Anthony M. Rufolo. *Public Finance and Expenditure in a Federal System.* San Diego: Harcourt Brace Jovanovich, 1990.
A public finance text that provides a concise and lucid introduction to benefit-cost analysis, consumer and producer surplus and related concepts.

Holmes, Beatrice Hort. *History of Federal Water Resources Programs and Policies, 1961-70.* Washington: U. S. Government Printing Office, 1979.
This and her first volume that covered the years prior to 1961 are the best source documents available for the student of water resource policy. Though they do not provide details on the Corps own policy development they provide sufficient detail on National policies, interests, and politics to be must reading for all students of water policy.

Hyman, David. *Public Finance a Contemporary Application of Theory to Policy.* Chicago: The Dryden Press, 1990.
One of many public finance texts presenting an introduction to benefit-cost analysis.

James, L. Douglas and Robert R. Lee. *Economics of Water Resources Planning.* New York: McGraw-Hill, 1971.
Somewhat dated, but still the most comprehensive treatment of water resources economics with a treatment of benefit-cost analysis. Suitable for all Corps employees.

Just, Richard E., Darrell Hueth and Andrew Schmitz. *Applied Welfare Economics and Public Policy.* Englewood Cliffs, NJ: Prentice Hall, 1982.
One of the most complete treatments of welfare economics available, this is a text for advanced undergraduate and graduate students of economics. It has both calculus and non-calculus developments of consumer and producer surplus. This text is highly recommended for practicing Corps economists.

Kohler, Heinz. *Intermediate Microeconomics Theory and Applications.* New York: Scott, Foresman and Company, 1990, 3rd ed.
A text for a second course in microeconomics, this book provides a good treatment of many of the themes of this manual.

Layard, P.R.G. and A.A. Walters. *Microeconomic Theory.* New York: McGraw-Hill, 1978.
This text provides an advanced undergraduate and graduate introduction to the rudiments of welfare theory.

Maddala, G. S. and Ellen Miller. *Microeconomics: Theory and Applications.* New York: McGraw-Hill, 1989.
A text for a second course in economics, this book provides a good treatment of many of the themes of this manual.

Moser, David A. and C. Mark Dunning. *National Economic Development Procedures Manual--Recreation, Volume II: A Guide for Using the Contingent Value Methodology in Recreation Studies.* U.S. Army Corps of Engineers, Water Resources Support Center Institute for Water Resources, Report 86-R-5, Fort Belvoir, Virginia, 1986.

Newman, Donald G. *Engineering Economic Analysis.* San Jose, CA: Engineering Press, Inc., 1980.
One of many texts addressing the discounting procedures used in evaluating public works projects.
Sassone, Peter G. and William A. Schaffer. *Cost-Benefit Analysis: a Handbook.* New York: Academic Press, 1978.
A good introduction to many of the most commonly used decision criterion is provided for readers comfortable with some basic mathematical notation.

Smith, Gerald W. *Engineering Economy: Analysis of Capital Expenditures.* Iowa State University Press, 1981.

U. S. Department of Commerce, National Oceanic and Atmospheric Administration. *The Use of Economic Analysis in Valuing Natural Resource Damages.* Washington, 1984.
This monograph provides an excellent review of a wide variety of issues that arise in evaluating damages to natural resources.

Vincent, Mary K., David A. Moser and William J. Hansen. *National Economic Development Procedures Manual--Recreation, Volume I: Recreation Use and Benefit Estimation Techniques.* U.S. Army Corps of Engineers Water Resources Support Center, Institute for Water Resources, Report 86-R-4, Fort Belvoir, Virginia, 1986.

# Appendix 2: NED BACKGROUND

# Appendix 2: NED BACKGROUND

The Nation's economic development is not a new concern of water resource development, quite the contrary. The first public works project undertaken by the Federal government was the construction of a lighthouse at Cape Henry, Virginia, authorized on August 7, 1789 in recognition of the fact that coastal and foreign shipping was the lifeblood of the nation's economy. In 1808, Treasury Secretary Albert Gallatin presented a foresighted summary guide to future development of a system of roads and inland water routes that would unite the states and provide access to the nation's interior. Economic development of the West, i.e., west of the Appalachian mountains at the time, was one of the principal motivations for the report.

The history of the Corps, and indeed the Nation, is replete with examples of legislation and committee reports providing for the economic development of our Nation. Interest in the nation's economic development is as old as the Nation itself. The requirement to evaluate the economic effects of a project dates back over 50 years to the Flood Control Act of 1936. What is relatively new IS the requirement to explicitly evaluate and quantify these effects according to a specific set of standards and procedures and the emphasis this work receives.

Early enabling legislation of the water resource development agencies consistently required that reports demonstrate the economic value of the projects. Widespread use of benefit-cost analysis as a test of a project's economic worth is generally considered to have grown out of section I of the Flood Control Act of 1936. This section provided that:

> "...the Federal Government should provide or participate in the improvement of navigable waters or their tributaries including watersheds thereof, for flood control purposes *if the benefits to whomsoever they may accrue are in excess of the estimated costs*...Section I, 49 Stat. 1570, 33 U.S.C. 701a."

Benefit-cost analysis did not become the principal basis for agency project recommendations until the post-World War II period. The directive to estimate the benefits and costs of flood control projects was soon extended to all water resource development purposes.

A 1941 report of the National Resources Planning Board recommended the development of "standard methods of social accounting" to provide a dollar basis on which to evaluate such benefits. That same report recognized the responsibility for costs and the willingness to pay criteria as follows:

> "As a general principle costs should be repaid as far as practicable by the beneficiaries, with due consideration for the amount of benefits received."

After the demise of the National Resources Planning Board, Congress and the Bureau of the Budget (precursor to the Office of Management of Budget) insisted that all projects must at least pass a test of economic feasibility. Agencies continued to use estimation methods that varied widely among agencies. For example, the Subcommittee on Evaluation Standards of the Inter-Agency Committee on Water Resources prepared the following reports describing the economic practices of water agencies: 1) Qualitative Aspects of Benefit-Cost Practices-1947, 2) Measurement Aspects of Benefit-Cost Practices-1948, 3) Allocation of Costs of Federal Multiple-Purpose Projects-1949, and 4) Proposed Practices for Economic Analysis of River Basin Projects.

In December, 1952 the Bureau of the Budget issued Circular A-47 to agency heads to inform them of the standards it intended to use to accept or reject agency evaluations of water projects. It is of some historical interest to note that Circular A-47 addressed issues such as incremental justification (of project purposes), land enhancement of flood protection, and what should be included in project costs among other issues.

Each water resource agency adopted different and often inconsistent criteria for estimating benefits

and costs. As benefit-cost analysis developed during the 1950s, the Water Resources Committee, a committee of the National Resources Committee formed in 1935, became concerned that adequate attention be given to:

> "social benefits as well as economic benefits, general benefits as well as special benefits, potential benefits as well as existing benefits."

In May 1958, "Proposed Practices for Economic Analysis of River Basin Projects", originally issued in May 1950 by the Subcommittee on Evaluation Standards, was revised. This document was to become known by its cover as the "Green Book". The Green Book states that the objective of economic analysis is:

> "...to provide a guide for effective use of the required economic resources..."

The Green Book viewpoint for economic analysis is a barely discernible embryonic version of the NED objective that states:

> "For Federal projects, a comprehensive public viewpoint should be taken."

The general objective of project formulation is:

> "...to maximize net economic returns and human satisfactions from the economic resources used in the project."

The Green Book addresses regional effects, formulation issues, benefit and cost evaluation, among other topics. The genesis of much of the Corps current economic guidance can be found in the pages of the Green Book.

In May, 1962 the Water Resources Council issued its "Policies, Standards and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources". Better known as Senate Document 97, this document replaced the superseded Budget Bureau Circular A-47. SD 97 provides that the basic objective of plan formulation is to provide for the best use of resources. It appears to provide the first mention of the term "national economic development". In pursuit of this objective, full consideration is to be given to the objectives of Development, Preservation and Well-Being of People. Development was described, in part, as follows:

> "National economic development, and the development of each region within the country, is essential to the maintenance of national strength and the achievement of satisfactory levels of living."

At this time, this guidance still referred to the preeminence of a "comprehensive public viewpoint" that needs to be applied in formulation and evaluation. Nonetheless, it did provide for the consideration of all viewpoints--national, regional, state and local.

The Water Resources Planning Act of 1965 (P.L. 89-80) required the newly created Water Resources Council (WRC) to establish principles, standards and procedures for Federal water resources planning. In September, 1973 the WRC established the "Principles and Standards for Planning Water and Related Land Resources" (P&S). The P&S, as they came to be called, followed the December 21, 1971 publication of the proposed P&S. For the first time, National Economic Development (NED) is mentioned explicitly as one of two overall purposes of water resource planning, the other being environmental quality.. The P&S said:

> " The overall purpose of water and resource planning is to promote the quality of life , by reflecting society's preferences for attainment of the objectives defined below:
> A. to enhance national economic development by increasing the value of the Nation's output of goods and services and improving national economic efficiency...."

The P&S first defined NED effects. Beneficial effects in the NED account are:

> "...increases in the value of the output of goods and services and improvements in national economic

> efficiency resulting from a plan. These include: a. The value to users of increased outputs of goods and services; and b. The value of output resulting from external economies."

The adverse effects on NED are described as:

> "a. The value of resources required for or displaced by a plan; and b. Losses in output resulting from external diseconomies."

Corps of Engineers guidance began to explicitly address the NED objective; most significantly with the June, 1975 publication of ER 1105-2-351, "Evaluation of Beneficial Contributions to National Economic Development for Flood Plain Management Plans".

The Standards were slightly amended in August, 1974 and WRC, in response to the President's June 1978 direction, developed a single set of procedures to ensure benefits and costs are estimated using the best current techniques. "Procedures for Evaluation of National Economic Development (NED) Benefits and Costs in Water Resources Planning (Level C)" were published in December, 1979. These Procedures are the step-by-step procedures for evaluating benefits for M&I water supply, urban flood damage, etc., well-known by Corps planners. This was the first systematic description of the NED benefit and cost evaluation procedures formally presented.

In September, 1980 the P&S were revised and procedures for evaluating deep draft navigation and commercial fishing were added to the NED evaluation procedures. In September, 1982 the P&S were repealed and replaced in March, 1983 by the "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies" (P&G).

P&G firmly established NED as the Federal objective saying, in part:

> "The Federal objective of water and related land resources project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements."

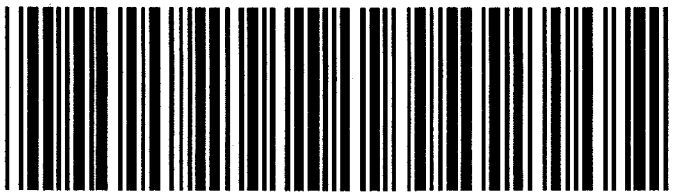
The operational definition of NED, presented in Section II of Chapter I-Standards, is:

> "Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation. Contributions to NED include increases in the net value of those goods and services that are marketed, and also of those that may not be marketed."

From "economic lifeblood" in 1789 to what many planners consider the be-all and end-all of water resources planning 200 years later, economics has been and remains a critical component of water resource development in the United States.

IMAGEWORLD

National Economic Development Procedures Manual - Overview Manual for Conducting National Economic Development Anatysis




91-R-11

**2721 COPPER CREEK RD**
**HERNDON, VA 20171**

**www.imageworldllc.com**
**703-793-9692**