Asian Development Bank

Handbook for the Economic Analysis of Water Supply Projects

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CHAPTER 1

INTRODUCTION

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1.1 All about the Handbook

1.1.1 Introduction

1. Water is rapidly becoming a scarce resource in almost all countries and cities with growing population on the one hand, and fast growing economies, commercial and developmental activities on the other.

2. This scarcity makes water both a social and an economic good. Its users range from poor households with basic needs to agriculturists, farmers, industries and from commercial undertakings with their needs for economic activity to rich households for their higher standard of living.

3. For all these uses, the water supply projects (WSPs) and water resources development programs are being proposed for extension and augmentation; likewise with the rehabilitation of water supply for which measures for subsequent sustainability are being adopted.

4. It is, therefore, essential to carry out an economic analysis of projects so that planners, policy makers, water enterprises and consumers are aware of the actual economic cost of scarce water resources, and the appropriate levels of tariff and cost recovery needed to financially sustain it.

5. In February 1997, the Bank issued the *Guidelines for the Economic Analysis of Projects* for projects in all sectors, and subsequently issued the *Guidelines for the Economic Analysis of Water Supply Projects*" (March 1998) which focuses on the water supply sector. The treatment of subsidies and a framework for subsidy policies is contained in the *Bank Criteria for Subsidies* (September 1996).

6. This Handbook is an attempt to translate the provisions of the water supply guidelines into a practical and self-explanatory work with numerous illustrations and numerical calculations for the use of all involved in planning, designing, appraising and evaluating WSPs.

7. In this document, short illustrations have been used to explain various concepts of economic analyses. Subsequently, they are applied in real project situations which have been taken from earlier Bank-financed and other WSPs, or from case

studies conducted in different countries in Asia as part of a Bank-financed Regional Technical Assistance Project (RETA).

1.1.2 Uses of the Handbook

8. This Handbook is written for non-economists (planners, engineers, financial analysts, sociologists) involved in the planning, preparation, implementation, and management of WSPs, including: staff of government agencies and water utilities; consultants and staff of non-governmental organizations (NGOs); and staff of national and international financing institutions.

9. Since the Handbook focuses on the application of principles and methods of economic analysis to WSPs, it is also a practical guide that can be used by economists in the economic analysis of WSPs.

10. The Handbook can also be used for the following purposes:

(i) as a reference guide for government officials, project analysts and economists of developing member counries (DMC) in the design, economic analysis and evaluation of WSPs;

(ii) as a guide for consultants and other professional staff engaged in the feasibility study of WSPs, applying the provisions of the Bank's *Guidelines for the Economic Analysis of Water Supply Projects*; and

(iii) as a training guide for the use of trainors of "Economic Analysis of Water Supply Projects"

1.2 Characteristics of Water Supply Projects

1.2.1 Water as an Economic Good

11. The characteristic features of water supply include the following:

(i) Water is usually a location-specific resource and mostly a nontradable output.

(ii) Markets for water may be subject to imperfection.
Features related to the imperfect nature of water markets include physical constraints, the high costs of investment for certain applications, legal constraints, complex institutional structures, the vital interests of different user groups, limitations in the development of transferable rights to water, cultural values and concerns of resource sustainability.

(iii) Investments are occurring in medium term (typically 10 years) phases and have a long investment life (20 to 30 years).

(iv) Pricing of water has rarely been efficient. Tariffs are often set below the average economic cost, which jeopardizes a sustainable delivery of water services. If water availability is limited, and competition for water among potential water users (households, industries, agriculture) is high, the opportunity cost of water (OCW) is also high. Scarcity rent occurs in situations where the water resource is depleting. OCW and depletion premium have rarely been considered in the design of tariff structures. If the water entity is not fully recovering the average cost of water, government subsidies or finance from other sources is necessary to ensure sustainable water service delivery.

(v) Water is vital for human life and, therefore, a precious commodity. WSPs generate significant benefits, yet water is still wasted on a large scale. In DMC cities and towns, there is a very high incidence of unaccounted-for-water (UFW). An ADB survey among 50 water enterprises in Asian countries over the year 1995 revealed an average UFW rate of 35 percent.

(vi) Economies of scale in WSPs are moderate in production and transmission but rather low in the distribution of water.

The above characteristics have implications on the design of WSPs and should be considered as early as the planning and appraisal stages of project preparation.

1.3 The Water Supply Project

1.3.1 Economic Rationale and Role of Economic Analysis

12. The main rationale for Bank operations is the failure of markets to adequately provide what society wants. This is particularly true in the water supply sector. The provision of basic water supply services to poorer population groups generates positive external benefits, such as improved health conditions of the targeted project beneficiaries; but these are not internalized in the financial cost calculation.

13. The Bank provides the finance for water supply services to assist DMCs in providing safe water to households, promoting enhanced cost recovery over time, creating an enabling environment including capacity building and decentralized management of water supply operations, and setting up of autonomous water enterprises and private companies which are run on a commercial basis.

14. While economic analysis is useful in justifying the Bank's intervention in terms of economic viability, it should also be considered as a major tool in designing water supply operations. There is a scope for better integrating social and economic considerations in the overall project design. Demand for water depends on the price charged, a function of the cost of water supply which, in turn, depends on demand. This interdependence requires careful analysis in all water supply operations. Safe water should be generally provided at an affordable price and using an appropriate level of service matching the beneficiaries' preferences and their willingness to pay.

1.3.2 Macroeconomic and Sectoral Context

15. The purpose of the economic analysis of projects is to bring about a better allocation of scarce resources. Projects must relate to the Bank's sectoral strategy and also to the overall development strategy of the country.

16. In a WSP, the goal may be "improved health and living conditions, reduction of poverty, increased productivity and economic growth, etc.". Based on careful problem analysis, the Project (Logical) Framework establishes such a format showing the linkages between "Inputs and Outputs", "Outputs and Purpose", "Purpose and Sectoral Goal" and "Sectoral Goal and Macro Objective". The key assumptions regarding project-related activities, management capacity, and sector policies beyond the control and management of the Project Authority are made explicit.

1.3.3 Procedures for Economic Analysis

17. The economic analysis of a WSP (urban or rural) has to follow a sequence of interrelated steps:

(i) Defining the project objectives and economic rationale as mentioned above.

(ii) Demand analysis and forecasting effective demand for project outputs. This is to be based on either secondary information sources or socio-economic and other surveys in the project area.

(iii) Establishing the gap between future demand and supply from existing facilities after ensuring their optimum use.

(iv) Identifying project alternatives to meet the above gap in terms of technology, process, scale and location through a least-cost and/or cost-effectiveness analysis using economic prices for all inputs.

(v) Identifying benefits, both quantifiable and nonquantifiable, and determining whether economic benefits exceed economic costs.

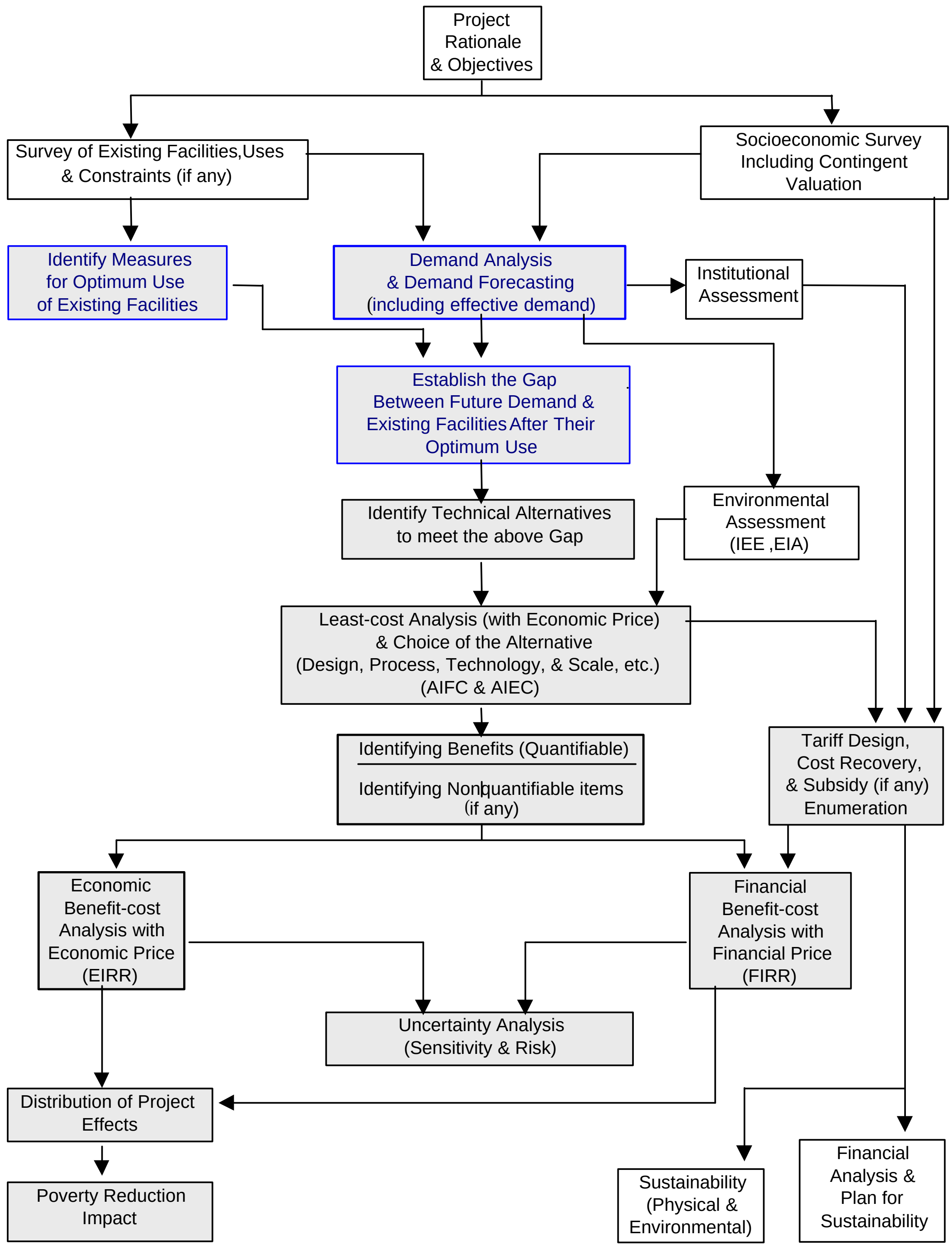
(vi) Assessing whether the project's net benefits will be sustainable throughout the life of the project through cost-recovery, tariff and subsidy (if any) based on financial (liquidity) analysis and financial benefit-cost analysis.

(vii) Testing for risks associated with the project through sensitivity and risk analyses.

(viii) Identifying and assessing distributional effects of the project and poverty reduction impact.

Figure 1.1 shows a flowchart for the economic analysis of a water supply project.

Figure 1.1 **Flow Chart for Economic Analysis of Water Supply and Sanitation Projects**



- parts of the economic analysis

AIFC - average incremental financial cost; AIEC - average incremental economic cost; EIRR - economic internal rate of
EIA - environmental impact ; FIRR - financial internal rate of return; IEE - initial environmental

1.3.4 Economic Analysis and ADB's Project Cycle

18. Economic analysis comes into play at the different stages of the project cycle: project identification, project preparation and project appraisal.

19. *Project identification* largely results from the formulation of the Bank's country sectoral strategy and country program. This means that the basic decision to allocate resources to the water supply sector for a certain (sector) loan project has been taken at an early stage and that the project has, in principle, been identified for implementation with assistance from the ADB.

20. In the *project preparation* stage, the planner has to make an optimal choice of the design, process, technology, scale and location etc. based on the most efficient use of the countries' resources. Here, the economic analysis of projects again comes into play.

21. In the *project appraisal* stage, the economic analysis plays a substantial part to ensure optimal allocation of a nation's resources and to meet the sustainability criteria set by both the recipient country and the ADB from the social, institutional, environmental, economic and financial viewpoints.

1.3.5 Project Preparation and Economic Analysis

22. Before any detailed preparation is done, it is necessary for the design team to get acquainted with the area where the project is identified. This is to acquire knowledge about the physical features, present situation regarding existing facilities and their use constraints (if any) against their optimal use, the communities and users specially their socio-economic conditions, etc.

23. To get these information, the following surveys must be undertaken in the area:

(i) Reconnaissance survey – to collect basic information of the area and to have discussions with the beneficiaries and key persons involved in the design, implementation and management of the project. Relevant data collection also pertains to information available in earlier studies and reports.

(ii) Socio-economic survey – to get detailed information about the household size, earnings, activities, present expenditure for water supply facilities, along with health statistics related to water-related diseases, etc.

It is important to analyze the potential project beneficiaries, their preferences for a specific level of service and their willingness to pay for the level of service to be provided under the project. The analysis of beneficiaries should show the number of poor beneficiaries, i.e., those below the country's poverty line, and their ability to pay. Such information is required to ensure that poor households will have access to the project's services and to know whether, and to what extent, "cost-recovery" can be done.

(iii) Contingent Valuation Method – An important contribution in arriving at the effective demand for water supply facilities, even where there are no formal water charges, is the contingent valuation survey. This is based on questions put to households on how much they are willing to pay (WTP) for the use of different levels of water quantities. These data may help build up some surrogate demand curve and estimate benefits from a WSP.

(iv) Survey of existing water supply facilities – Knowledge of the present water supply sources, treatment (if any) and distribution is also needed. It is also necessary to know the quantity and quality of water and unaccounted-for-water (UFW) and any constraints and bottlenecks which are coming in the way of the optimum use of the existing facility.

24. Using the information taken from the survey results and other secondary data sources, effective demand for water can then be estimated. Two important considerations are:

(i) Effective demand is a function of the price charged. This is ideally based on the economic cost of water supply provision to ensure optimal use of the facility, and neither over-consumption nor under-consumption especially by the poor should occur. The former leads to wastage contributing to operational deficits and the latter results in loss of welfare to the community.

(ii) Reliable water demand projections, though difficult, are key in the analysis of alternatives for determining the best size and timing of investments.

25. Approaches to demand estimation for urban and rural areas are usually different. In the urban areas, the existing users are normally charged for the water supply; in the rural areas, there may not be any formal water supply and the rural households often do not have to pay for water use. An attempt can be made in urban areas to arrive at some figure of price elasticity and probably income elasticity of demand. This is more difficult in the case of water supply in rural areas with a preponderance of poor households.

1.3.6 Identifying the gap between Forecast Need and Output from the Existing Facility

26. Once demand forecasting has been done, it is necessary to arrive at the output (physical, institutional and organizational) which the project should provide. The existing facilities may not be optimally used due to several reasons, among them:

(i) UFW due to high technical and nontechnical losses in the system;

(ii) inadequate management system, organizational deficiency and poor operation and maintenance leading to deterioration of the physical assets; and

(iii) any bottleneck in the supply network at any point starting from the raw water extraction to the households and other users' end.

27. Before embarking on a detailed preparation of the project, it is necessary to take measures to ensure optimal use of the facilities. These measures should be both *physical* and *policy* related. The physical measures are like leakage control, replacing faulty valves and adequate maintenance and operation, etc.; policy measures can be charging an economically efficient tariff and implementing institutional reforms, etc.

28. The output required from the proposed WSP should only be determined after establishing the gap between the future needs based on the effective demand and the restored output of the existing facilities ensuring their optimal use. Attention needs to be focused on the identification and possible application of instruments to manage and conserve demand, such as (progressive) water tariffs, fiscal incentives, pricing of raw water, educational campaigns, introducing water saving devices, taxing of waste water discharges, etc.

1.4 Least-Cost Analysis *for Choosing an Alternative*

1.4.1 Introduction

29. After arriving at the scope of the WSP based on the gap mentioned above, the next task is to identify the least-cost alternative of achieving the required output. Economic costs should be used for examining the technology, scale, location and timing of alternative project designs. All the life-cycle costs (market and non-market) associated with each alternative are to be taken into account.

30. The alternatives are not to be confined to technical or physical elements only, e.g., ground water or surface water, gravity or pumping, large or small scale, etc. They can also include activities due to policy measures, e.g., leakage detection and control, institutional reforms and managerial reorganization.

1.4.2 Choosing the Least-Cost Alternative

31. There can be two main cases for the choice from mutually exclusive options:

(i) the alternatives deliver the same output or benefit, quantity wise and quality wise;

(ii) the alternatives produce different outputs or benefits.

Case 1.

32. In the first case, the least-cost analysis compares the life cycle cost Streams of all the options and selects the one with the lowest present value of the economic costs. The discount rate to be used is the economic opportunity cost of capital (EOCC) taken as 12 percent in real terms.

33. Alternatively, it is possible to estimate the equalizing discount rate (EDR) between each pair of mutually exclusive options for comparison. The EDR is also equal to the economic internal rate of return (EIRR) of the incremental cash flows of the

mutually exclusive options. The EDR/EIRR of the incremental cash flows can then be compared with the EOCC for choice among alternatives.

34. The least-cost choice can also be done by calculating the average incremental economic cost (AIEC) of each alternative. The AEIC is the present value of incremental investment and operating costs in with-project and without-project situations divided by the present value of incremental output (say, in m^3) also in both with-project and without-project alternative. The discount rate to be used is the EOCC = 12 percent. This will establish the project alternative with the lower per unit economic cost.

Case 2.

35. In this second case, it is possible to select the least economic cost option by calculating per unit economic costs of all the project options. Because water demand, supply cost and price charged for water tend to be closely interrelated, least-cost analysis should account for the effect of uncertain demand. Lower-than-forecast demand results in higher average costs, which can push up water prices and depress demand further.

36. Sensitivity analysis can be used to show whether the project option remains the least-cost alternative under adverse changes in key variables. The scale of the project may vary in relation to prices charged to consumers and the size may influence the least-cost alternative.

1.5 Financial and Economic Analyses

1.5.1 With- and Without-Project Cases

37. After choosing the best among alternatives, the next step is to test the financial and economic viability of the project, which is the chosen, least-cost alternative. The initial step in testing the financial and economic viability of a project is to identify and quantify the costs and benefits.

38. To identify project costs and benefits and to compare the net benefit flows, the without-project situation should be compared with the with-project situation. The without-project situation is different from the before-project situation. The without-project situation is that one which would prevail without the project vis-à-vis

factors like population increase. As water is getting more scarce, the water use pattern and the cost are also likely to change.

1.5.2 Financial vs. Economic Analysis

39. Financial and economic analyses have similar features. Both estimate the net benefits of an investment project based on the difference between the with-project and the without-project situations.

40. However, the concept of financial net benefit is not the same as economic net benefit. While financial net benefit provides a measure of the commercial (financial) viability of the project on the project-operating entity, economic net benefit indicates the real worth of a project to the country.

41. Financial and economic analyses are also complementary. For a project to be economically viable, it must be financially sustainable. If a project is not financially sustainable, there will be no adequate funds to properly operate, maintain and replace assets; thus the quality of the water service will deteriorate, eventually affecting demand and the realization of financial revenues and economic benefits.

42. It has sometimes been suggested that financial viability not be made a concern because as long as a project is economically sound, it can be supported through government subsidies. However, in most cases, governments face severe budgetary constraints and consequently, the affected project entity may run into severe liquidity problems, thereby jeopardizing even its economic viability.

43. The basic difference between the financial and economic benefit-cost analyses of the project is that the former compares benefits and costs to the enterprise in constant financial prices, while the latter compares the benefits and costs to the whole economy measured in constant economic prices. Financial prices are market prices of goods and services that include the effects of government intervention and distortions in the market structure. Economic prices reflect the true cost and value to the economy of goods and services after adjustment for the effects of government intervention and distortions in the market structure through shadow pricing of the financial prices. In such analyses, depreciation charges, sunk costs and expected changes in the general price should not be included.

44. In financial analysis, the taxes and subsidies included in the price of goods and services are integral parts of financial prices, but they are treated differently in economic analysis. Financial and economic analyses also differ in their treatment of

external effects (benefits and costs), favorable effects on health and the UFW of a WSP. Economic analysis attempts to value such externalities, health effects and nontechnical losses.

1.5.3 Financial vs. Economic Viability

45. The steps in determining the financial viability of the proposed project include:

(i) identifying and quantifying the costs and revenues;

(ii) calculating the project net benefits;

(iii) estimating the average incremental financial cost, financial net present value and financial internal rate of return (FIRR).

The FIRR is the rate of return at which the present value of the stream of incremental net flows in financial prices is zero. If the FIRR is equal to or greater than the financial opportunity cost of capital, the project is considered financially viable. Thus, financial benefit-cost analysis covers the profitability aspect of the project.

46. The steps in determining the economic viability of a project include the following:

(i) identifying and quantifying (in physical terms) the costs and benefits;

(ii) valuing the costs and benefits, to the extent feasible, in monetary terms; and

(iii) estimating the EIRR or economic net present value (NPV) discounted at EOCC = 12 percent by comparing benefits with the costs.

The EIRR is the rate of return for which the present value of the net benefit stream becomes zero, or at which the present value of the benefit stream is equal to the present value of the cost stream. For a project to be acceptable, the EIRR should be greater than the economic opportunity cost of capital. The Bank uses 12 percent as the minimum rate of return for projects; but for projects with considerable nonquantifiable benefits, 10 percent may be acceptable.

1.6 Identification, Quantification, Valuation

of Economic Benefits and Costs

1.6.1 Nonincremental and Incremental Outputs and Inputs

47. Nonincremental outputs are project outputs that replace existing water production or supply. For example, a water supply project may replace existing supply by water vendors or household/community wells.

48. Incremental outputs are project outputs that add to existing supply to meet new demands. For example, the demand for water is expected to increase in the case of a real decline in water supply costs or tariffs.

49. Incremental inputs are for project demands that are met by an overall expansion of the water supply system.

50. Nonincremental inputs are inputs that are *not* met by an expansion of overall supply but from existing supplies, i.e., taking supply away from existing users. For example, water supply to a new industrial plant is done by using water away from existing agricultural water.

1.6.2 Demand and Supply Prices

51. In economic analysis, the market prices of inputs and outputs are adjusted to account for the effects of government intervention and market structure. The adjusted prices are termed as shadow prices and are based either on the supply price, the demand price, or a weighted average of the two. Different shadow prices are used for incremental output, nonincremental output, incremental input and nonincremental input.

1.6.3 Identification and Quantification of Costs

52. In estimating the economic costs, some items of the financial costs are to be excluded while other items, which are not part of financial costs are to be

included. The underlying principle is that project costs represent the difference in costs between the without-project and the with-project situations. Cost items and the way they are to be treated in project economic analysis, are as follows:

(i) **Sunk Costs.** They exist in both with-project and without-project situations and thus are not additional costs for achieving benefits. They are, therefore, not to be included.

(ii) **Contingencies.** As the economic benefit-cost analysis is to be done in constant (or real) prices, the general price contingencies should not be included.

(iii) **Working Capital.** Only inventories that constitute real claims on the nation's resources should be included in the project economic costs. Others items of working capital reflect loan receipts and repayment flows are not to be included.

(iv) **Transfer payments.** Taxes, duties and subsidies are transfer payments as they transfer command over resources from one party (taxpayers and subsidy receivers) to another (the government, the tax receivers and subsidy givers) without reducing or increasing the amount of resources available in the economy as a whole. Hence, these transfer payments are not economic costs. However, in certain circumstances when valuing the economic cost of an input or an output, taxes are to be included:

(a) If the government is correcting for external environmental costs by a correcting tax to reduce the production of water, such a transfer payment is part of the economic costs.

(b) The economic value of incremental outputs will include any tax element imposed on the output, which is included in the market price at which it sells.

(v) **External Costs.** Environmental costs arising out of a project activity, such as river water pollution due to discharge of untreated sewage effluent, is an instance of such costs. It may be necessary to internalize this external cost by including all relevant effects and investments like pollution control equipment costs and effects in the project statement.

(vi) **Opportunity Cost of Water.** If, for example, a drinking water project uses raw water diverted from agriculture, the use of this water for drinking will result in a loss for farmers. These costs are measured as the opportunity cost of water which, in this example, equals the "benefits foregone" of the use of that water in agriculture.

(vii) **Depletion Premium.** In water supply projects where the source of water is ground water and the natural rate of recharge or replenishment of the aquifer is less than its consumptive use, the phenomenon of depletion occurs. In such cases, significant cost increase may take place as the aquifer stock depletes; the appropriate valuation of water has to include a depletion premium in the economic analysis.

(viii) **Depreciation.** The stream of investment assets includes initial investments and replacements during the project's life. This stream of expenditure, which is included in the benefit-cost analysis, will generally not coincide with the time profile of depreciation and amortization in the financial accounts and as such, the latter should not be included once the former is included.

1.6.4 Identification and Quantification of Benefits

53. The gross benefit from a new water supply is made up of two parts:

(i) resource cost savings on the nonincremental water consumed in switching from alternative supplies to the new water supply system resulting from the project; and

(ii) the WTP for incremental water consumed.

54. Resource cost savings are estimated by multiplying the quantity of water consumed without the project (i.e., nonincremental quantity) by the average economic supply price in the without-project situation.

55. The WTP for incremental supplies can be estimated through a demand curve indicating the different quantities of water demand that could be consumed at different price levels between the without-project level of demand and the with-project level of demand. The economic value of incremental consumption is the average value derived from the curve times the quantity of incremental water. Where there is inadequate data to estimate a demand curve, a contingent valuation methodology can be applied to obtain an estimate of WTP for incremental output.

56. The gross benefit stream should be adjusted for the economic value of water that is consumed but not paid for, i.e., sold but not paid for (bad debts) and consumed but not sold (non-technical losses). It can be assumed that this group of consumers derives, on the average, the same benefit from the water as those who pay.

57. Other benefits of a WSP include health benefits. These benefits are due to the provision of safe water and are also likely to occur provided that the adverse health impacts of an increased volume of wastewaters can be minimized.

1.6.5 Valuation of Economic Costs and Benefits

58. The economic costs and benefits must be valued at their economic prices. For this purpose, the market prices should be converted into their economic prices to take into account the effects of government interventions and market structures. The economic pricing can be conducted in two different currencies (national vs. foreign currency) and at the two different price levels (domestic vs. world prices).

59. To remove the market distortions in financial prices of goods and services and to arrive at the economic prices, a set of ratios between the economic price value and the financial price value for project inputs and outputs are used to convert the constant price financial values of project benefits and costs into economic values. These are called conversion factors, which can be used for groups of typical items, like energy and water resources.

1.6.6 Economic Viability

60. Once the economic benefit and cost streams are derived, a project resource statement can be developed and the EIRR for the project can be calculated. Bank practice is to use 12 percent as the minimum rate of return for projects for which an EIRR can be calculated, although for projects with considerable nonquantifiable benefits, 10 percent may be acceptable. For rural WSPS, there may be limitations to value the economic benefits, thus making it difficult to calculate a reliable EIRR. However, the economic analysis may be undertaken on the basis of the least-cost or cost effectiveness analysis using the economic price of water.

1.7 Sensitivity and Risk Analysis

61. In calculating the EIRR or ENPV for WSPs, the most likely values of the variables are incorporated in the cost and benefit streams. Future values are difficult to predict and there will always be some uncertainty about the project results. Sensitivity analysis is therefore undertaken to identify those benefit and cost parameters that are both uncertain and to which EIRR and FIRR are sensitive.

62. The results of the sensitivity analysis should be summarized, where possible, in a sensitivity indicator and in a switching value. A sensitivity indicator shows the percentage change in NPV (or EIRR) to the percentage change in a selected variable. A high value for the indicator indicates project sensitivity to the variable. Switching values show the change in a variable required for the project decision to switch from acceptance to rejection. For large projects and those close to the cut-off rate, a quantitative risk analysis incorporating different ranges for key variables is recommended. Measures mitigating against major sources of uncertainty are incorporated into the project design, thus improving it.

1.8 Sustainability and Pricing

63. For a project to be sustainable, it must be both financially and economically viable. A financially viable project will continue to produce economic benefits, which are sustained throughout the project life.

64. Assessing sustainability includes:

(i) undertaking financial analysis at both the water enterprise level and the project level (i.e., covering the financial liquidity aspect of the project at both levels);

(ii) examining the role of cost recovery through water pricing; and

(iii) evaluating the project's fiscal impact, i.e., whether the government can afford to pay the level of financial subsidies that may be necessary for the project to survive.

65. Subsidies aimed at helping the poor may not always benefit them in a sustained manner. Underpricing can lead to waste of water (by the non-poor in particular), deterioration of the water system and services, and ultimately to higher

prices for all. Cross subsidies could also distort prices and should generally be discouraged. To minimize economic costs and maximize socioeconomic development impact, any level of subsidies should be carefully targeted to lower the price charged for water to poor and low-income households.

66. To minimize financial subsidies, projects should be designed to supply services that people want and are willing to pay for.

1.9 Distribution Analysis *and Impact on Poverty*

67. Water supply provision, especially in the rural areas and shantytowns in urban areas, is considered to be important for poverty reduction. The poverty-reducing impact of a project is determined by evaluating the expected distribution of net economic benefits to different groups such as consumers and suppliers, including labor and the government.

CHAPTER 2

PROJECT FRAMEWORK

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Figures

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2.1 The Project Framework

2.1.1 Introduction

1. The Project Framework (PFW) is a conceptual tool for preparing the design of a project. It is a disciplined approach to sector and project analysis. This part of the Handbook is based on the ADB publication *Using the Logical Framework for Sector Analysis and Project Design: A User's Guide* (June 1998).

2. In February 1998, the ADB Post Evaluation Office has issued the first draft of a new Project Performance Management System (PPMS). With regard to project design, the PPMS incorporates the PFW but adds other techniques, like problem analyses, formulation of solutions, identification of baseline and target values and definition of accountabilities. Because the draft PPMS is yet to be finalized and approved, this Handbook will only refer to the PFW as the basic tool for project design. It is expected, however, that the PPMS will gradually be adopted as the methodology to be utilized.

2.2 Purpose

3. The first step in carrying out a feasibility study for a water supply project (WSP), and as such also the first step in the economic analysis of such projects, is to prepare a PFW. Its purposes are:

(i) to establish clearly the objectives and outputs which the project will be accountable to deliver (these objectives and outputs must be quantifiable and measurable);

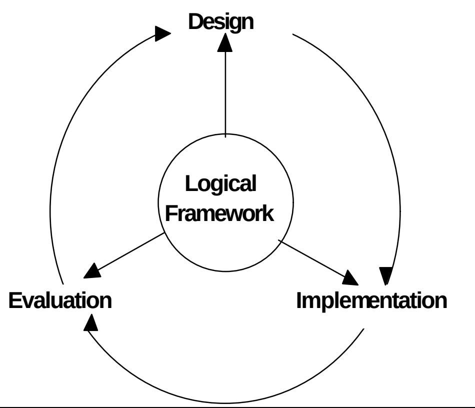
(ii) to promote dialogue and participation by all stakeholders;

(iii) to facilitate project implementation planning and monitoring;

(iv) to establish a clear basis for project evaluation during the operational phase; this requires a systematic comparison of project objectives, outputs and with actual achievements.

4. The PFW establishes the linkages between project design, project implementation and project evaluation. This is illustrated in Figure 2.1.

Figure 2.1 The Project Cycle



5. The PFW is a tool for preparing the project design. It describes the goals, objectives, expected outputs, inputs and activities, key risks and assumptions and project costs. Preparing the PFW ensures that the project design is responsive to specific needs, constraints and opportunities, since it requires an analysis of problems and objectives to be achieved as a preparatory step leading to the design of a project.

6. The preparation of the PFW is a team effort in which, ideally, all stakeholders involved in project preparation, should participate. The PFW facilitates project design and preparation by focusing attention on key project issues and laying out a process for establishing the main features of a project. As such, the preparation of a PFW should be an integrated and mandatory part of the Terms of Reference of any feasibility study.

2.3 The Concept of the Project Framework: *Cause and Effect*

7. The core concept underlying the PFW lies in creating a logical order of cause and effect. This is stated in Box 2.1.

Box 2.1 **Logical Order of Cause and Effect**

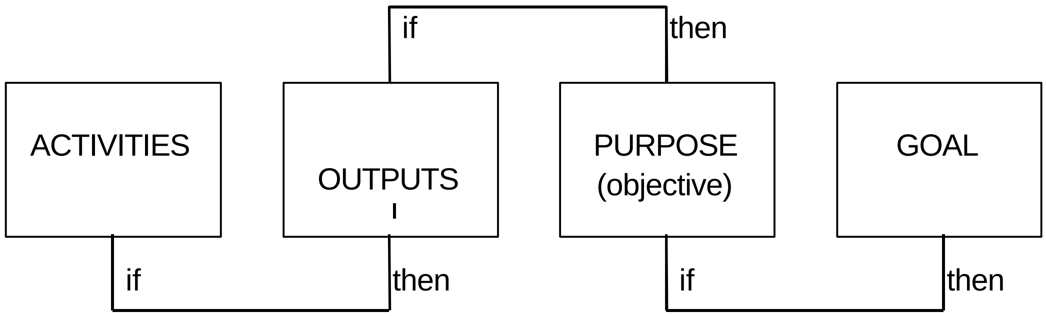
if *certain inputs are provided and activities carried out,*
then *a set of project outputs will be realized and*

if *these outputs materialize,*
then *the project will achieve certain project objectives, and*

if *these objectives are achieved*
then *the project will contribute to achieve the overall goal of the sector.*

8. The above statement indicates a certain hierarchy between the different components of the PFW. The basic relations between inputs, activities, outputs and impacts, objectives and goal can be seen in Figure 2.2.

Figure 2.2 Basic Relations Between PFW Elements



2.4 The Design of a Project Framework

9. The basic building blocks of a PFW are five key project elements, each one linked to another in a cause-effect relationship. These five elements are described as the design summary. They are presented in Table 2.1 and can be described as follows:

Table 2.1 Project Design Summary

DESIGN SUMMARY	PROJECT TARGETS	PROJECT MONITORING MECHANISMS	RISKS/ ASSUMPTIONS
1. Goal			
2. Purpose			
3. Project Components Project Outputs			
4. Activities	5. Inputs		

10. **The Goal**: the PFW begins with identifying the overall sector or area goal to be targeted by the project. It is the higher order or general objective to which the project contributes. Together with other projects, the proposed WSP will contribute to achieving such sector and area goals. An example is presented in Box 2.2.

> Box 2.2 **Example of Project Goal**
>
> In the case of water supply projects, a common goal is 'improved health and living conditions, reduced poverty and increased economic growth and productivity (goal)'. This goal has multiple dimensions as both human development and economic growth are targeted.

11. **The Purpose, Immediate or Project-Specific Objective** (**why** the project is being done): describes the immediate output or direct impact that we hope to achieve by carrying out the project. By achieving the immediate objective, the project will contribute to achieving the broader sector goal. An example is provided in Box 2.3.

> Box 2.3 **Example of the Purpose of the Project**
>
> **If** access to and use of clean water by the community is assured (purpose), **then** the project will contribute to improving community health and productivity (which is the broader sector goal).

12. **Project Outputs** (**what** the project will deliver): the tangible and measurable deliverables that the project is directly accountable for and for which it is given budgeted amounts of time and resources. Outputs are specific results, produced by managing well the project components. They should be presented as accomplishments rather than as activities. This is illustrated in Box 2.4.

> Box 2.4 **Example of Project Outputs**
>
> A typical project output could be phrased as: 'water supply systems rehabilitated and/or constructed' and 'O&M systems upgraded and operational'. Typical project components would include the procurement of materials and equipment, construction works, institutional strengthening and capacity building, community development and consultancy services.

13. **Activities** (**how** the project is carried out): each project output will be achieved through a series or cluster of activities. An example is shown in Box 2.5.

> Box 2.5 **Example of Activities**
>
> Typical examples of activities taking place in water supply projects include the acquisition of land, the procurement of materials and equipment, implementation of construction works, the preparation of an Operation & Maintenance Manual, training of staff, implementation of community education programs.

14. **Inputs**: the time and physical resources needed to produce outputs. These are usually comprised of the budgeted costs needed for the purchase and supply of materials, the costs of construction, the costs for consultancy services, etc. An example is shown in Table 2.2.

Table 2.2 **Example of Inputs in Water Supply Projects**

EXPENDITURE CATEGORIES	COSTS (US$mn)
1. Land	2
2. Material Supplies	32
3. Physical Works	16
4. Consultancy Services	6
Total Cost of Inputs	55

2.5 Project Targets: *The Verifiable Indicators of Project Achievement*

15. Practical and cost-effective project measures need to be established to verify accomplishment of goal, objective and outputs. These performance indicators are referred to as the project's operational targets. The project targets essentially quantify the results, benefits or impacts expected from the project and thus make them measurable or at least tangible. Performance measures at the 'objective level' measure End of Project Impact.

16. Project targets are measurable indicators which should be presented in terms of **quantity, quality** and **time**. This is illustrated in Box 2.6.

Box 2.6 **Example of Project Targets**

A **quantitative** target could be 'to provide adequate water supply to 15,000 households in district Adebe'. The **quality** characteristic can be added to this target: 'provide drinking water in accordance with WHO standards for 24 hours per day at a pressure of 10 mwc'. The **time** dimension can also be added: 'before 31 December 1999'.

2.6 Project Monitoring Mechanisms: *The Means of Verification or "How Do We Obtain the Evidence?"*[1]

17. The project manager, the government and the Bank need a management information system (MIS) that provides feedback on project progress at all levels of the Design Summary. This includes progress in disbursements, completion of activities, achievement of outputs, purpose and goals. Both measurable or verifiable indicators and means/mechanisms of verification provide the basis for project monitoring and evaluation systems.

18. To establish an effective monitoring and evaluation system or project performance management system, it is necessary to establish as part of the project design, flexible, inexpensive and effective means of verifying the status of project progress, at goal, objective and output level. In WSPs, sources of information could be progress reports, reports of review missions, water utility reports, statistical data, survey data, etc.

2.7 Risks and Assumptions

19. Risks and assumptions are statements about external and uncertain factors which may affect each of the levels in the Design Summary, and which have to be taken into account in the project design through mitigating measures. They may include the assumption that other projects will achieve their objectives. If worded positively, these statements are assumptions; if worded negatively, they are indicative of risk areas. This is illustrated in Box 2.7.

Box 2.7 **Example of Risks and Assumptions**

In water supply projects, **assumptions** could include:

- the timely availability of land for construction of water intake;
- the timely disbursement of funds;
- a stable political situation;
- the timely completion of the dam; and
- regular adjustment of water tariffs.

In terms of **risks**, these assumptions would be formulated as follows:

- land not timely available for construction;
- funds not timely disbursed;
- political instability;
- dam not ready in time;
- water tariffs not regularly adjusted.

[1] The newly-developed ADB-Project Performance Management System (PPMS) provides additional information and techniques on how to establish means and measures of verification.

20. Assumptions are conditions that must be fulfilled if the project is to succeed, but which are not under the direct control of the project. It is important to identify the so-called “killer assumptions” which, if not fulfilled, could stop the project from achieving its objectives. The following actions can be taken to manage killer assumptions:

(i) assess the consequences of doing nothing;
(ii) change project design;
(iii) add a new project;
(iv) closely monitor the project; and
(v) ensure sufficient flexibility in the project design.

21. Certain risks can be eliminated by putting them as a condition to be fulfilled before project implementation. For example, water tariffs must be increased to achieve a targeted level of cost recovery; or the water enterprise should receive autonomous status before the loan can become effective. In rural WSPs, another example would be to set certain criteria which must be met by sub-projects before they are approved.

22. Risks and assumptions made should be carefully taken into account in the risk and sensitivity analysis to be conducted as part of the economic and financial analysis.

2.8 The Project Framework Matrix: *An example*

23. Project Framework Matrices have been prepared for many projects. An example of such a matrix for a typical WSP is presented in Table 2.3.

Table 2.3 **Water Supply Project Framework**

Design Summary	Project Targets	Proj. Monitoring Mechanisms	Risks / Assumptions
1.Sector / Area Goals 1.1 Improved Health Situation 1.2 Improved Living Conditions 1.3 Sustained Socio-Economic Dev.	-Prevalence of water-related diseases among target population reduced by 15% by 1999. -50% of people below poverty line have access to water supply facilities by 1999. -Increased industrial development. -10% reduction of absenteeism by 1999 due to improved socio-economic / living conditions. -70% of women of target population have improved living conditions (more time, convenience, etc.) by 1999.	- Yearly epidemiological reports of the Ministry of Health - Water Enterprisereports - Country report - End of project reports - Health Surveys	- no political instability - no natural disasters - sound macro-economic policies
2. Project Objective / Purpose 2.1 Provide improved and sustained water supply to the population of a specified area.	-Increase access to safe water supply to 70% of the target population by December 1999.	- Water Enterprise reports - Progress reports	-no unexpected population growth in target areas. -current ground water tables will decrease dramatically because of drought (risk). -loan effectiveness by first of January 1996.
3. Components / Outputs 3.1. - Existing infrastructure rehabilitated; -Physical infrastructure constructed;	- four intakes, two treatment plants, 20,000 house connections by 1997; - 33.5 km transmission and distribution pipes completed / replaced by 1997; - 24 hours service level operational; - reduction of unaccounted for water from 40% to 30% by 1999.	- Progress reports - Water Enterprise reports	- no delays in contracting (building) contractors and delivery of materials

Table 2.3 **Water Supply Project Framework**

Design Summary	**Project Targets**	**Proj. Monitoring Mechanisms**	**Risks/Assumptions**
3.2 Mitigating measures for negative environmental effects in place.	-Water resources study completed by 1995; -water quality protection measures in place by 1996; -facilities to transport and treat wastewater in place by 1997; -target population educated about water related environmental hazards; -water reduction program operational by end of 1996.	- Environmental profile (and three yearly updates); - Progress reports - Reports of Ministry of Water & Provincial Water Authorities - Reports of Environmental Protection Agency/Water Basin Authority	- no environmental disasters - government ability to enforce environmental protection measures.
3.3 Sustainable Org. and Management established.	- 100% of required postings fulfilled with trained and motivated staff by 1999; - effective O&M systems in place; - management systems and procedures operational by 1997; - autonomous status water enterprise approved by 1997.	- Progress reports - Water Enterprise reports - Management training reports and training needs assessments of staff; - Data from management info systems; - Organogram of water enterprise/staffing list indicating qualifications of staff.	- sufficient qualified local staff available and willing to work in remote areas; - no halt on governmental vacancies; - autonomy to water enterprise granted.
3.4 Financial sustainability of water enterprise achieved	-water enterprise ability to recover full costs by 1998; -billing and collection system operational by January 1997; -financial management system effective; -achieve reduction in “unaccounted for water” from 40% to 30% by 1999.	- monthly and yearly financial reports of water enterprise; - progress reports.	- proposed tariff increases approved by government.

3.5 User-oriented Activities -Customers aware about new services and about the safe use of water; -Customers use water supply facilities safely	-achieve 90% coverage of target population (m/f) with hygiene education program by 1999; -70% of target population (m/f) know at least two out of three communicated hygiene messages; -collection rates increased from 60% to 85% by 1998; - 50% of target population (m/f) apply at least two out of three communicated hygiene behavior messages;	- Special reports (Hygiene education/ environmental education at schools) - Progress reports - Water enterprise reports (consumer complaints list) -Reports of the Ministry of Health and the Ministry of Education	- no health disasters
4. Activities 4.1Develop Physical Infrastructure -Detailed Eng'g. Design -Land acquisition -Procurement -Construction -Supervision -Environmental Management	**5. Inputs** 5.1 - consultancy services for detailed eng'g. design / supervision (US$3 mn) - $2 mn government funding for land acquisition; - $50.5 mn funding for procurement of equipment and materials - provision for operational expenses	- Progress reports and Review missions - Special reports	- loan awarded; - government funds awarded;
4.2.Environmental component -water rescues study -water quality protection measures -facilities	5.2. - local consultancy services planned studies (10 person months) - international consultancy services (6 person months) - local staff + government funding - US$1.5 mn funding for procurement of equipment and materials - US$3 mn for construction works	- Progress reports and Review missions - Special reports	- materials available on time; - no delay in consultancy services;

4.3Establish Organization and Management -Institutional Dev. -Organization Dev. -Human Resource Dev.	5.3. - US$ 0.8 mn p.a. government funding for local staff (operational costs) - US$ 0.6 mn for consultancy - US$1.4 mn for training	- Progress reports and Review missions - Special reports	- resettlement program effective - contractors available on time;
4.4 Establish sustainable financial framework -establish tariff structure -financial management system operational	5.4. - US$0.3 mn for computer and management information system - international consultancy services (4 mm) - local consultancy services (12 mm) - computer hardware US$0.7 mn	- Progress reports and Review missions - Special reports	
4.5 Community-Oriented Activities -community info programs -Health education -community org -PublicRelations programs	5.6. - US$0.5 mn for training and extension materials; - 36 person months local consultancy staff, 12 person months international consultants; - US$0.2 mn for vehicles/other transport means; - US$0.5 mn for public relations and mass media activities; - local staff	- Progress reports and Review missions - Special reports	

Source: RETA 5608 Case Studies on Selected Water Supply Projects

CHAPTER 3

DEMAND ANALYSIS AND FORECASTING

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3.1 Effective Water Demand

3.1.1 Defining Effective Demand for Water

1. The "effective demand" for water is the quantity of water demanded of a given quality at a specified price. The analysis of demand for water, including realistically forecasting future levels of demand, is an important and critical step in the economic analysis of water supply projects. The results of demand analysis will enable the project team to:

(i) determine the service level(s) to be provided;
(ii) determine the size and timing of investments;
(iii) estimate the financial and economic benefits of the project; and
(iv) assess the ability and willingness to pay of the project beneficiaries. Furthermore, the surveys carried out during the demand assessment will provide data on cost savings, willingness to pay, income and other data needed for economic analysis.

2. It is useful to note the difference between "effective demand" for water and "actual consumption" of water. Water consumption is the actual quantity of water consumed whereas effective demand relates that quantity to the price of water. For example, a low level of water consumption may not represent effective demand but may instead indicate a constraint in the existing supply of water. This is illustrated in Box 3.1.

Box 3.1 **Example of Constrained Water Demand**

In Rawalpindi, Pakistan, the existing water supply system provided water for only an average of 3.8 hours per day and, on average, six days per week. Families connected to the public water supply system used an average 76 lcd. An additional 16 lcd was collected from secondary sources. From the household survey it appeared that during the (dry) summer, 86 percent of the population found the supply of water insufficient compared to 50 percent during the winter. Effective demand for water was higher than the quantity the utility was able to supply. This suggests that effective demand was constrained by existing supply levels.

Source: RETA 5608 - Case Study on the Water Supply and Sanitation Project, Rawalpindi, Pakistan

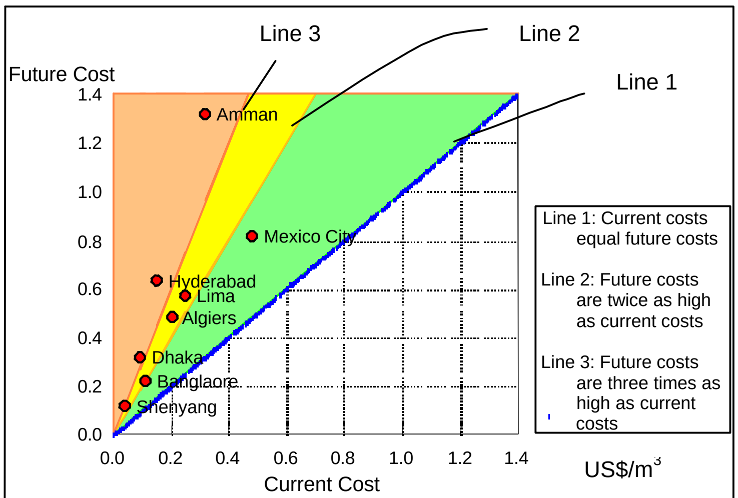
3.1.2 Increasing Cost of Water Supply

3. The demand for water is rising rapidly, resulting in water becoming increasingly scarce. At the same time, the unit cost of water is increasing, as water utilities shift to water sources farther away from the demand centers. Water from more distant sources may also be of lower quality. The costs of transporting water from the source to the consumer and that of water treatment necessary to meet potable water standards are becoming significant components of the unit cost of water.

4. The increase in the cost of water can be seen when the cost per cubic meter of water used by current water utilities is compared with the cost per cubic meter of water in new water supply projects (WSPs). This relation is shown in Box 3.2.

Box 3.2 **The Future Cost of Water**

For example, the current cost of water in Hyderabad is below \$0.2 per m^3 whereas in the figure below, the calculated cost of future water to be supplied through new schemes is more than \$0.6 per m^3. This means that future water is more than three times as expensive as water from the existing resources. Note that the points on line 1 indicate that future costs of water equal the current cost; the points on line 2 indicate that the future costs per unit are twice the current costs.



Source: Serageldin, Ismail. 1994. *The Financing Challenge*.

5. Box 3.2 reinforces the importance of making optimum use of scarce water resources by avoiding inefficiencies and wastage in existing supplies and designing efficient future investment projects. In designing new projects, it is becoming increasingly important to make optimum use of existing resources to be able to avoid or postpone costly investments in the future.

3.2 The Demand for Water: *Some Concepts*

3.2.1 Incremental vs. Nonincremental Demand for Water

6. A WSP usually increases the supply of water either by making more effective use of existing supply capacity or by adding additional supply capacity. To the consumer, the additional capacity supplied will either displace and/or add to already existing water sources. Every person uses water for drinking, cooking, bathing, washing of clothes, for sanitation purposes, etc. Sources of water include piped water supply systems, dugwells, hand pumps, canals, ponds, rivers, bottled water, water from vendors, rainwater, etc.

7. If the additional supply of water is used to displace already existing sources, it is called nonincremental demand. For example, a household which obtains a new connection to the piped water supply system may no longer make use of the existing dugwell.

8. If the additional supply of water generates an increase in existing consumption, it is called incremental demand. For example, a household obtaining its water from a well at a distance of 300 meters may increase its water consumption from 450 liters to 650 liters per day after a public tap is installed in closer proximity to the house.

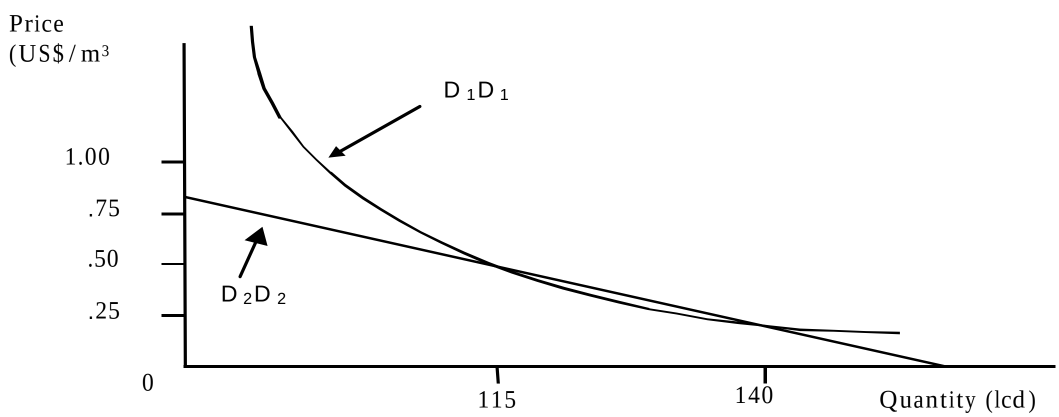
3.2.2 The Relation between Price and Quantity

9. From an economic perspective, the price of water is an important determinant of per capita water consumption. The relation between the quantity of water used and the price is illustrated by a demand or willingness-to-pay curve for water, an example of which is given in Figure 3.1.

10. The downward sloping demand curve indicates the "decreasing marginal value" of water. The first five liters of water per capita per day will be extremely valuable as they are necessary to sustain life. This is illustrated by curve D_1D_1 in Figure 3.1. The second five liters will also be valuable, (e.g. in their use for hygienic purposes). The next five liters are valuable for food preparation, cooking and washing of clothes. All other factors being equal, for each additional increment of water, the marginal value of water tends to decline as the individual is putting the water to less and less valuable uses. Consequently, the individual's willingness to pay for each increment of water will gradually decrease.

11. D_1 D_1 in Figure 3.1. represents a non-linear curve for an average household and shows an example of an individual's water demand or willingness-to-pay curve. If the water tariff is increased from $0.25 to $0.50, this individual would (all other factors remaining equal) reduce daily consumption from 140 liters to 115 liters.

Figure 3.1 **An Individual's Water Demand Curve: Linear and Non-linear Relationships**



12. In this Handbook, a linear demand curve will often be used for illustrative purposes, as indicated by line D_2 D_2. However, the nonlinear relationship between quantity and price is probably a better approximation of the actual behavior of water users.

3.2.3 The Concept of Price Elasticity of Demand

13. One question which often arises when considering the demand curve is how much the quantity demanded by an individual will change when the price per unit of water changes. The price elasticity of demand is a measure that describes the degree of responsiveness of the quantity of water to a given price change and is defined as follows:

$$e_p = -\frac{\text{percentage change in the quantity of water demanded}}{\text{percentage change in the price per unit of water}}$$

$$e_p = -\frac{dQ/Q}{dP/P} = -\frac{dQ}{Q} \times \frac{P}{dP} = -\frac{dQ}{dP} \times \frac{P}{Q} = \text{slope} \times \frac{P}{Q}$$

14. The price elasticity of demand for water is normally negative because the demand curve is downward sloping, which means that an increase (decrease) in price is expected to lead to a reduction (increase) in demand.

15. If $e_p < |1|$, demand is **'inelastic'**. For example, if an increase of 25 percent in water fees leads to a 10 percent reduction in the demand for water, this would result in a price elasticity of -0.40. The relative change in quantity demanded (dQ/Q) is, in this case, smaller than the relative change in price (dP/P).

16. If $e_p > |1|$, demand is **elastic**. For example, if a 25 percent increase in water fees leads to a 50 percent reduction in demand, this would result in a price elasticity of -2. The percentage change in quantity demanded is larger than the percentage change in price.

17. For a linear demand curve as can be verified through the formula for e_p, the higher the price, the higher the absolute value of price elasticity. Using a nonlinear demand curve (Figure 3.1), it can be seen that for the first few liters of water, demand will be very inelastic, meaning that the consumer is willing to pay a high price for the given volume of water. As the marginal value of the water gradually declines, the consumer's demand will become increasingly elastic, meaning that price fluctuations will result in larger changes in quantity demanded.

18. In studies carried out by the World Bank (Lovei, 1992), it has been found that the price elasticity for water typically ranges between -0.2 and -0.8, indicating

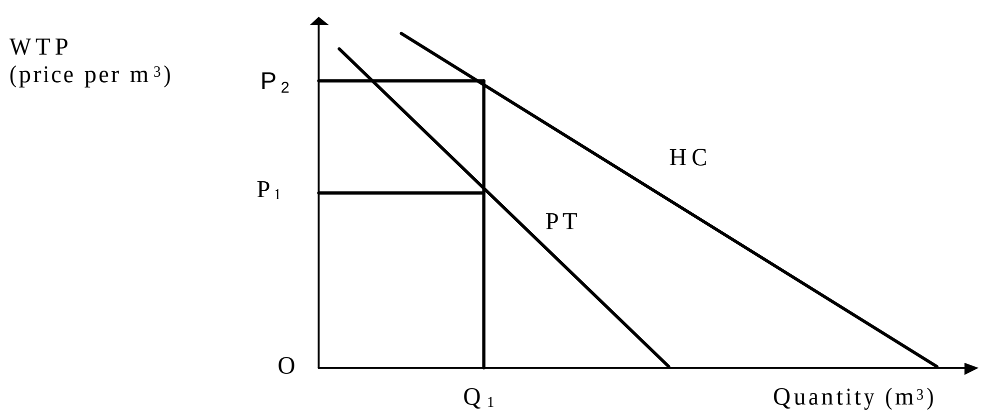
inelastic demand. For example, e = -0.2 means that a 10 percent increase in price would lead to a reduction in the quantity demanded by only 2 percent.

3.2.4 Different Demand Curves for Different Products

19. The definition of effective demand mentions " the demand for water of a certain quality". The quality of the product "water" is not easily explained and a number of characteristics are normally included in defining it, including chemical composition (e.g., WHO standards), taste and smell, water pressure, reliability of supply, accessibility and convenience. The first two characteristics determine the quality of water in the stricter sense. The other characteristics define water quality in its broader sense.

20. The combination of these characteristics will determine the "product" water or service level. Up to a certain point, an individual is prepared to pay a higher price for a product with a higher quality. For the same "quantity" of water, an individual will be willing to pay a higher price for a higher quality product. For example, consumers are normally willing to pay a higher price for water from a house connection than for water from a public tap. In this case, there are two different demand curves: one for house connections (HC) as shown in Figure 3.2, and one for public taps (PT) as shown in Figure 3.3.

Figure 3.2 **Demand Curves for Water from Public Taps vs. House Connections**

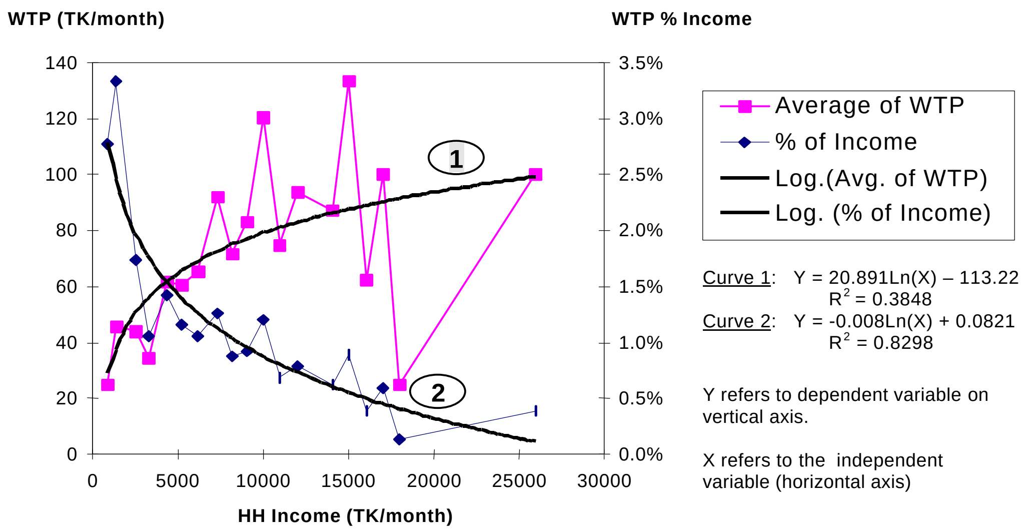


3.2.5 The Relation between Household Income and the Demand for Water

21. Households with high income are normally able and willing to pay more for a given quantity of water than households with lower incomes. In relative terms (as a percent of income) however, people with higher incomes are prepared to pay smaller percentages of their income for water than people with lower incomes. These statements were confirmed in the case studies and are illustrated in Box 3.3.

Box 3.3 **Relationship Between WTP and Income**

The relationship between willingness to pay and month income has been confirmed in the case studies. For example, in Jamalpur, Bangladesh, the relationship as illustrated below was found.

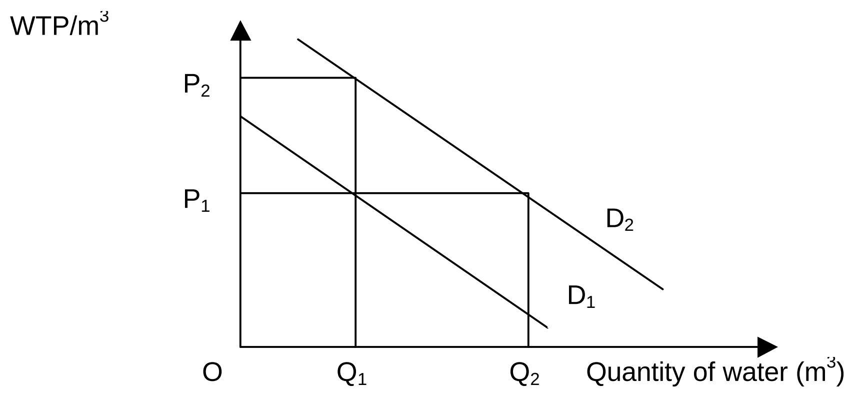


Curve 1 explains the relationship between income and WTP in absolute terms. Households with higher income are willing to pay more for the total quantity of water consumed. Curve 2 illustrates the relation between income and WTP as a percentage of income. When income increases, a smaller proportion of household income is set aside to pay for water.

Source: RETA 5608 Case Study on the Jamalpur Water Supply and Sanitation Project, Bangladesh

22. An increase in income will cause the demand curve for water to shift to the right (from D_1 to D_2), as illustrated in Figure 3.4. At price P_1 the quantity of water consumed increases from OQ_1 to OQ_2. The shift in the demand curve to the right also indicates a higher willingness to pay (from P_1 to P_2) for the same quantity of water OQ_1.

Figure 3.3 Relation between Demand and Income: Shift of Demand Curve



23. The relation between water consumption and income can be expressed in terms of "income elasticity". The formula for income elasticity is as follows:

$$e_i = \frac{\text{Percentage change in quantity of water consumed}}{\text{Percentage change in Income}}$$

$$e_i = + \frac{dQ/Q}{dI/I} = \frac{dQ}{dI} \times \frac{I}{Q}$$

24. The literature on the relation between income and water consumption is rather limited, but a value between 0.4 and 0.5 appears to be reasonable (see e.g. Katzman 1977, Hubbell 1977 and Meroz 1986). A positive income elasticity of 0.4 means that if an individual's household income increases by 10 percent, consumption is expected to increase by 4 percent. A value which is less than one shows that the demand for water is rather inelastic to changes in income.

25. For example: consider the case that income increases from Rp200,000 (I_1) to Rp300,000 (I_2), and water consumption increases from 15 m^3/month (Q_1) to 18 m^3/month (Q_2). In this case, income elasticity is calculated as follows:

$$
\begin{aligned}
e_i &= (dQ/DI \times I/Q) \\
&= ((Q_2-Q_1)/(I_2-I_1)) \times I_1/Q_1 \\
&= ((18-15)/(300{,}000-200{,}000)) \times 200{,}000/15 \\
&= 0.4
\end{aligned}
$$

3.2.6 Other Determinants of the Demand for Water

26. In addition to price and income, other factors or determinants can also influence the demand for water. A checklist of possible water demand determinants is presented in Table 3.1. Each project may have its own set of water demand determinants and the importance of a given factor may differ from one project to another. The major determinants of water demand are briefly discussed below:

(i) Domestic Demand

(a) *Population*. Population (especially population growth) is a very important factor in determining future demand. Population growth may consist of natural growth or, in certain cases, migration (e.g. from rural to urban areas). Small differences in demographic trends have large effects on water consumption. For example, all other factors remaining constant, an annual population growth of 2 percent over a period of 20 years results in an increase in consumption of approximately 50 percent; whereas an annual growth of only 1.5 percent generates an additional consumption of about 35 percent over the same period.

(b) *Access to and Costs of Alternative Sources*. If water from other sources of good quality is readily available, people will generally be less interested to displace their current sources. For example, in areas where shallow ground water of good quality is available throughout the year and when households have their own dugwells, people may be less inclined to apply for a connection to a new piped system especially if the price of piped water is higher than the unit cost of water from the alternative source.

(c) *Availability and Quality of Service*. If existing water supply companies provide a fully satisfactory service to their customers, households not yet connected will usually be more interested in connecting to an expanded water supply system.

(ii) Nondomestic Demand

(a) *Size and Type of Industry*. Logically, size and the type of industry will, to a large extent, determine the quantity of future consumption of water.

(b) *Industrial growth*. Economic development and regional or urban development may strongly influence future demand for water.

(c) *Legal obligations*. In certain countries or industrial areas, industries must apply for a permit to make use of alternative sources (for example, ground water) or are obligated to connect to piped systems, if available.

27. The demand for water is often analyzed for relatively homogeneous groups of users. In many cases, a distinction is made between domestic and nondomestic users. Furthermore, demand from domestic users is often separately analyzed for :

(i) users currently connected to the system (existing connections) and

(ii) those to be connected to the system under the proposed project (new connections).

Table 3.1 **Major Determinants of Water Demand**

A. Domestic Demand

1. Number and size of households
2. Family income and income distribution
3. Costs of water presently used
4. Cost of future water used
5. Connection charges
6. Availability and quality of service
7. Cost and availability of water using devices
8. Availability of alternative water sources
9. Present water consumption
10. Legal requirements
11. Population density
12. Cultural influences

B. Commercial Demand

1. Sales or value added of non-subsistence commercial sector
2. Costs and volume of water presently used
3. Price of future water used
4. Connection charges
5. Costs of water using appliances
6. Quality and reliability of service
7. Working hours of various types of commercial establishments
8. Legal requirements

C. Industrial Demand

1. Present and future costs of water
2. Type of industry and water use intensity
3. Relative price of alternative sources
4. Quality and reliability of supply
5. Costs of treatment and disposal of waste water
6. Legal requirements

D. Agricultural Demand (for [non] piped water supply)

1. Present and future costs of water
2. Availability of other sources
3. Quality and reliability of supply
4. Supply cost of alternative water systems
5. Number of cattle
6. Legal requirements

E. Public Services Demand

1. Present and future costs of water
2. Per capita revenue of local governments
3. Number and size of public schools, hospitals etc.
4. Legal requirements

28. The factors which determine domestic demand may differ between the urban and the rural sector. In the rural sector, special attention needs to be given to such things as the availability of alternative water sources, the income and ability to pay for or contribute to the project facilities and their management, the choice of technology and the use of water for other purposes like agriculture (e.g. livestock or vegetable growing) and, the ability to operate and maintain facilities. In the rural context, the assessment of effective demand will have to be carried out in close consultation with the local population, and attention needs to be given to issues such as community participation and hygiene education.

29. The factors which determine demand will, to a large extent, define the need for information. The project analyst will have to determine the key factors which need to be considered into the analysis and design of the project.

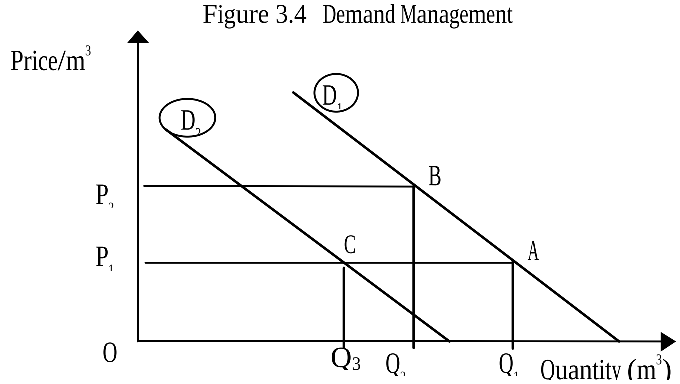
3.3 The Use of Water Pricing to "Manage" Demand

30. In Section 3.2 the relation between the price of water and the quantity of water was explained. This section deals with some applications of this concept.

3.3.1 Instruments of Demand Management

31. To understand how the quantity of water demanded can be influenced, let us look again at the demand curve for water, as illustrated in Figure 3.4.

Figure 3.4 Demand Management



32. Assume that present demand is Q_1 at price P_1. This refers to point A on demand curve D1. To reduce demand, one can try to:

(i) reduce the quantity demanded by increasing the price of (excessive) water use. This will result in a reduction of demand from, for example, point A to B (movement along the same demand curve). At a higher price (OP_2), a smaller quantity of water (OQ_2) is demanded. By introducing financial incentives, consumers (domestic and nondomestic) can be expected to reduce their water consumption. Often, the objectives and reasons for such a policy will have to be thoroughly explained to the users through public education programs. Examples of introducing financial measures include:

(a) increasing the average water tariff;

(b) introducing progressive water tariff structures, aiming at reduction of excessive water use;

(c) increasing tariffs for wastewater discharge: (industries will be particularly sensitive to this measure);

(d) introducing ground water abstraction fees;

(e) fiscal incentives (e.g. for investments in water saving devices or treatment plants);

(f) utilization of water markets: experience from water markets in the United States and Gujarat, India indicates that water markets create a framework which contributes to the efficient use of water.

An example of application of pricing effects is given in Box 3.4.

Box 3.4 **Increased Water Tariff in Bogor, Indonesia**

In 1988, after increases in average water tariffs for domestic users (about 115 percent) and nondomestic users (170 percent), the consumption of water per household dropped from an average of about 38 m^3 per household per month to an average of about 27 m^3 per month. This price increase was accompanied by an intensive public education program. This has resulted in consumption being maintained below previous levels, notwithstanding the fact that real water prices have since declined and incomes have continued to increase until mid-1997.

Source: IWACO-WASECO. 1989(October). *Bogor Water Supply Project: The Impact of the Price Increase in June 1988 on the Demand for Water in Bogor*.

Price increases may also have undesirable effects. In the case of a significant increase in the price of water by a utility, consumers may, whenever feasible, divert to other water sources. For example, in Jakarta, excessive use of ground water causes land levels to go down. If, in this situation water tariffs are significantly increased, many consumers would again divert to ground water as a main source of water. A tariff increase introduced by the utility would, therefore, have to be accompanied by other measures to control the use of ground water, such as: (higher) fees for the use of ground water to industries; taxes to domestic users of ground water; and educational programs.

(ii) move the demand curve to the left, resulting in a reduction in the quantity demanded from point A to point C. This means that at the same price level (P_1), the quantity of water demanded will be reduced from OQ_1 to OQ_3. This can be achieved through:

(a) introduction of water saving devices;

(b) changing consumer behavior through educational programs;

(c) legal measures (e.g. regulating the use of ground water);

(d) industrial "water-audit" programs. This entails a review of the use of water and waste water in industrial plants, with the purpose of reducing the use of water.

(iii) save the use of water or avoid waste of water resources on the supply side. Such measures could include:

(a) increase in efficiency at the utility level (reduction of production losses, UFW); and

(b) institutional changes (merger of utilities may create economies of scale).

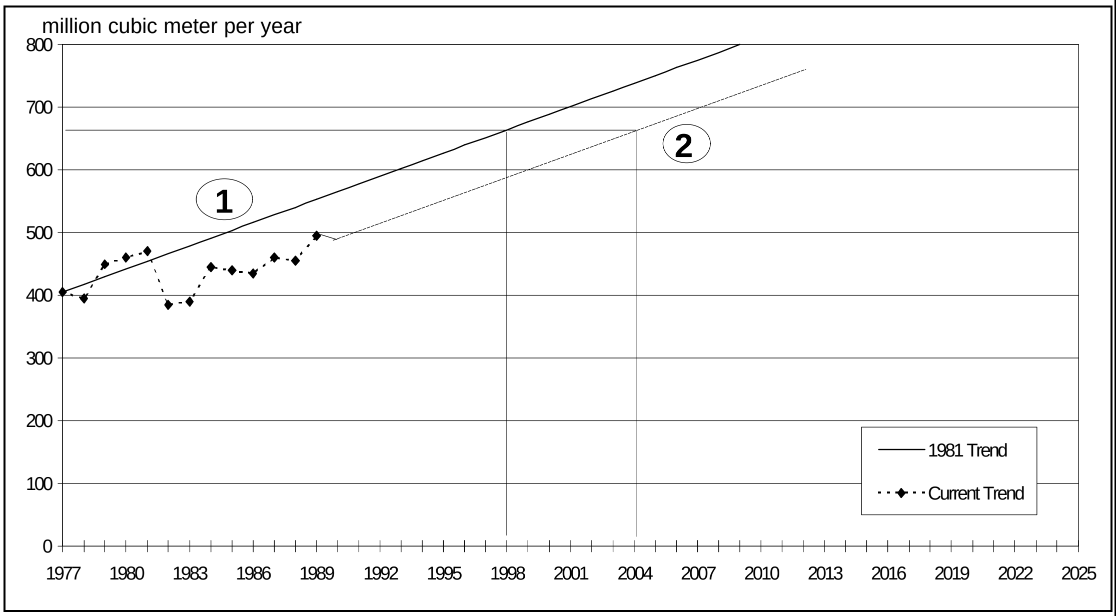
In most cases, water demand management and conservation policies will consist of a comprehensive set of measures to be carried out over a longer period of time to achieve the desired results.

3.3.2 Cumulative Effects of Water Demand Management and Conservation Programs

33. There is empirical evidence that domestic and nondomestic water consumption can be reduced by at least 20 to 30 percent by adopting appropriate demand management and conservation policies. Reduced water consumption will also result in reduced volumes of polluted water and will, in general, have positive environmental effects. Reductions in demand, in turn, will lead to substantial savings in needed investments as shown in Box 3.5. Finally, the water saved can be used for higher valued uses by other sectors in the economy.

Box 3.5 **Demand Management and Investment Planning in Australia**

In Melbourne, Australia, a combination of water demand management measures was used, such as: water pricing reforms, water saving devices, public education, etc. As a result, Melbourne's 1993 water demand projection (line 2) differs substantially from the 1981 trend (line 1). The shift to the right of the water trend curve has delayed the need to invest in additional supplies by about six years. The deferral in investment was valued at $25 million. This is illustrated in the figure below.



Source: Bhatia, Ramesh; Rita Cestti and James Winpenny. *Water Conservation and Reallocation: Best Practice Cases in Improving Economic Efficiency and Environmental Quality.* A World Bank-ODI Joint Study.

3.4 Data Collection

3.4.1 Cost Effectiveness of Data Collection

34. Data collection should be cost efficient and cost effective. The purpose of data collection is to improve the accuracy of the estimates and predictions made in designing and analyzing a WSP. It is therefore important to carefully consider which data are needed and where and how to obtain them.

35. The collection of data will require resources in terms of time and money. The benefit or value of additional data will gradually decrease. The project analyst will have to decide at which point the benefits of the additional data will no longer justify the cost made. At minimum, conducting a limited but representative household survey should provide essential information which could save large sums of money in terms of reduced investment.

3.4.2 Sources for Data Collection

36. Some methods of data collection, as they were used in the preparation of the case studies on which this Handbook is partly based, are presented in Appendix A. Section 1 of this appendix deals with:

(i) collection of secondary data from existing studies, water enterprises, government agencies, etc.;

(ii) conducting reconnaissance surveys in the area to observe the actual field situation; and

(iii) collection of primary data through field observations and household surveys.

37. Household surveys normally provide:

(i) data about family size, occupation, income etc.;

(ii) data about the quantity, quality and costs related to the current water supply (and sanitation) situation; and

(iii) data about the future use of water supply and sanitation: the preferences of respondents with regard to the future level of service, type of facility and what they are willing to pay for the preferred level of service.

3.4.3 Contingency Valuation Method

38. Using Contingency Valuation Method (CVM), the consumer is asked how much he or she is willing to pay for the preferred level of service. The data can be analyzed to provide the project analyst with an indication of the actual shape of the demand curve for water, thus helping to estimate the price elasticity of demand which is an important parameter in demand management. An example is given in Appendix A.

3.5 Demand Forecasting

39. Some of the initial steps in demand forecasting is defining the different service levels and preparing a rough estimate of the price of supplying these service levels in a specific village or town. Subsequently, water quantity demanded is estimated for the different combinations of service level and price.

40. Estimating a demand curve for a new WSP is difficult in practice and will, in most cases, require adequate resources and extensive field research. The Handbook emphasizes the need to undertake a comprehensive analysis of water demand for without-project and with-project situations for reasons explained earlier. Data on the factors which determine the demand for water will provide the project analyst with a better understanding of what is required and will enable him/her to formulate a better project.

3.5.1 Forecasting Urban Water Supply: *the Case of Thai Nguyen*

41. The techniques and methods used in water demand forecasting will be explained in this section by making use of a case study. The case study describes the steps in demand forecasting as it was carried out for Thai Nguyen, Viet Nam, one of the case studies developed in preparing this Handbook. Some of the data have been slightly adapted for illustration purposes.

42. The general process and specific considerations in forecasting water demand are explained in the text. The application of these principles to demand

forecasting in Thai Nguyen is described in the boxes. The data needed to carry out the demand analysis are presented in Table 3.2. A short description of Thai Nguyen is presented in Box 3.6.

Box 3.6 **Thai Nguyen Case Study: Description of the Project Area**

Thai Nguyen is located 80 km to the north of Hanoi on the Cau River. At the end of 1995, the population was 191,600 persons. The existing water supply system had 5,114 metered connections, which provided approximately 24 percent of the population with water.

The economy of Thai Nguyen is based on state enterprises, mainly heavy industry. There are also universities in the town. The main source of non-piped water supply is shallow groundwater, obtained through open wells or with electric pumps. A very small part of the population uses water from the river.

Source: RETA 5608 Case Study on the Provincial Towns Water Supply and Sanitation Project, Thai Nguyen, Viet Nam

Step 1: Estimating present and future population

43. A starting point in demand forecasting is determining the size and future growth of the population in the project area. This step is explained below, whereas the application of this step in Thai Nguyen is given in Box 3.7.

(i) The first step is to estimate the size of the existing population. In most cases, different estimates are available from different secondary sources. Often, the survey team will have to make its own estimate based on the different figures obtained.

(ii) The second step is to determine the service or project area (the area which will be covered by the project) and the number of people living there. The most important consideration in this respect is the expressed interest from potential customers. Furthermore, the service area will have to be determined in consultation with the project engineer, the municipal authorities and/or the water enterprise. Technical, economic and political considerations will play a role.

(iii) The third step is to estimate future population growth in the project area. This estimate will be based on available data about national, provincial or local population growth. It should also take into account the effects of urban and/or regional development plans and the effects of migration from rural to urban areas.

Box 3.7 **Thai Nguyen Case Study: Assumptions Used, Ability to Pay and Willingness to Pay**

Assumptions:

In the case of Thai Nguyen, these figures and assumptions have been applied (Table 3.2, lines 1-10):

(i) The annual population growth for Thai Nguyen has been estimated at 3% up to the year 1999 and 2.5% after that (line 1). These figures are lower compared to other Vietnamese towns because of its location in the mountainous northern part of Viet Nam; this percentage is applied to the population figures (line 2).

(ii) At present, the service area in Thai Nguyen covers only part of the town area with a 1995 population of 140,442 (line 4). The service area will remain the same in the new project. The population in the service area is assumed to grow faster compared to the general population growth because of better infrastructure facilities (line 3). The major expansion in the number of connections is assumed to take place between 1996 and 2000, then gradually after that,until 75% coverage is achieved (line 5).

(iii) One of the targets of the project was to achieve 75% coverage in the year 2020 (line 10). This figure was checked with the findings of a household survey, as follows:

First, 93% of the population expressed an **interest in connecting to the system** by means of a house connection. Interest for other service levels (public tap) was very low.

Second, **willingness to pay for water** in Thai Nguyen amounted to an average of VND3,005 per m^3 (VND2,317 per m^3 for connected households and VND3,119 per m^3 for non-connected households). WTP for connected households is lower than WTP for non-connected households. This might be explained by the fact that connected households are most likely influenced by the current average water tariff of VND900 per month. It can be assumed that willingness to pay will increase when income and service levels increase. For these reasons, it was concluded that the set target of 75% coverage was realistic.

Third, with regard to **ability to pay for water,** a so-called “affordability tariff” was calculated. The affordability tariff indicates the average tariff at which a certain percentage of the population can afford to use a minimum amount of water and not spend more than a given percentage of his/her income. An example of this calculation is given below:

Items	Unit	1996	2000
Average Monthly Income	VND‘000	1,052	1,184
Lowest Income at 75% Coverage	VND‘000	600	675
Min. expenditure on water (5% of income)	VND‘000	30	33.8
Minimum consumption	Lcd	60	60
Average HH size	persons	4.26	4.26
Average monthly consumption	m^3	7.78	7.78
Affordability tariff	VND/m^3	3,856	4,344
Estimated costs of water	VND/m^3	4,000	4,000

In Thai Nguyen, average monthly income in 1996 was VND1,052,000. 75%of the population had an income higher than VND600.000. Taking 5% as an indicator of the maximum ability to pay, this means a maximum amount of VND30,000 per month. Assuming a minimum consumption of 60 lcd and an average household size of 4.26 results in a minimum required monthly consumption of 7.78 m^3 per month. The affordability tariff is calculated as VND30,000/ 7.78 m^3 = VND3,856/m^3.

This indicates that in the year 1996, 75% of the population can afford to pay an average tariff of VND3,856 per m^3 (based on a minimum consumption of 60 lcd) and not spend more than 5% of his/her income. Comparing the affordability tariff with the estimated average costs of water to be provided by the project, indicated that the target of 75% was realistic.

Source: RETA 5608 Case Study on the Provincial Towns Water Supply and Sanitation Project, Thai Nguyen, Viet Nam

(iv) Finally the project has to determine which level of coverage it intends to achieve. Often, project objectives contain statements such as:

"provide safe water supply to 75 percent of the population of town x".

In this statement, it is assumed that the town area and service or project area are the same.

44. It is strongly recommended that such statements are verified in the field by asking potential customers:

(i) whether or not they are willing to connect to a new or expanded water supply system;

(ii) which service level they prefer;

(iii) whether or not they are willing and able to pay for the related costs; and

(iv) how much they are willing to pay.

Step 2: Estimating the number of persons to be connected

45. The number of persons making use of one connection needs to be determined.

(i) One figure which is often available is the average size of the household. This figure may, however, differ from the number of persons making use of one connection. Other persons may live in or near the house, making use of the same connection. Sometimes this information is available from the water enterprise; otherwise, it should be checked in the survey. An assumption will have to be made whether or not this number will remain the same over the project period. With increasing coverage in the service area and decreasing family size over the years, it may be assumed that the number of persons making use of one connection will gradually decrease.

(ii) Depending on the coverage figures assumed in step 1(iv) and the data found under step 2(i), the annual increase in the population served and the annual increase in the number of connection can be calculated.

Box 3.8 **Thai Nguyen Case Study: Number of Persons per Connection**

In Thai Nguyen, the number of connections in 1995 was 5,114 (Table 3.2, line 6). The average household size was 4.26. In the household survey it was found that the average number of persons making use of one connection is 6.5. In many cases, private connections were in fact used as a kind of yard connection. It was assumed that with the increasing number of connections in town, the number of persons making use of one connection would gradually decrease from 6.5 in 1995 to the level of 4.26 in year 2010 (line 8). By multiplying the end of year number of connections by the number of persons per connection and comparing this to the total population in the service area, the end of year coverage in the service area is calculated (line 9 and 10).

Source: RETA 5608 Case Study on the Provincial Towns Water Supply & Sanitation,Thai Nguyen, Viet Nam

Step 3: Estimating water consumption from the piped system[1] before-project

46. The starting point for estimating demand for water in the with-project situation is to estimate demand or consumption before-project. In piped water supply systems with working watermeters, estimating existing consumption is straightforward. In some cases, consumption before the project will provide a reasonable indicator of demand for water at a certain price level. In cases where the current system capacity is insufficient, consumption may be lower than actual demand. In those cases, data from other utilities may provide indications of normal consumption patterns.

47. In the case of piped water supply systems without installed watermeters, it is often difficult to estimate water consumption before-project. In general, households do not have a clear idea of how much water they consume per day; therefore, directly asking these households does not provide reliable answers. In the case studies, the following methods were suggested to address this problem:

(i) measuring the volume of water storage facilities available in the house and estimating how much of the storage capacity is used on a day-to-day basis;

(ii) carrying out a small in-depth survey among a selected number of users;

(iii) installation of temporary water meters at a selected number of connections, including consideration of seasonal variations;

[1] Existing consumption from nonconnected households will be estimated later as part of step nine (estimating incremental and nonincremental demand). Refer to Box 3.16.

(iv) estimating the number of buckets of water which are carried/hauled by a household on a day-to-day basis from each supply source, and

(v) if data on total production and/or distribution of water are available, an estimate can be made about consumption per household, after deducting the estimated UFW.

Step 4: Estimating Demand for Water Without-Project

48. The without-project situation is not necessarily the same as the before-project situation

(i) The water company may be under pressure to connect additional customers to the system even though the system capacity is not sufficient. This, in turn, may reduce average consumption per capita and service levels and people would have to start looking for alternative sources. In case the project includes a rehabilitation component, it is reasonable to assume that the current level of water service will gradually deteriorate in the without-project scenario.

The application of steps 3 and 4 in Thai Nguyen is given in Box 3.9.

Box 3.9 **Thai Nguyen : Demand before-project and without-project**

In the case of Thai Nguyen, existing consumption was found to be 103 lcd. Because the water pressure was considered sufficient by the large majority of customers and an average supply of about 23 hours per day could be maintained throughout the year, it was therefore assumed that the consumption before-project of 103 lcd equals demand at the current price level.

Furthermore, because the project basically aims at an expansion of supply to achieve a higher coverage, it has been assumed that demand without-project will remain equal to demand "just before the project".

Source: RETA 5608 Case Study on the Provincial Towns Water Supply and Sanitation Project, Thai Nguyen, Viet Nam

Step 5: Estimating Demand for Water With-Project

49. Future demand for water at the household level will depend on a number of factors. The most important factors are changes in service level, water tariffs and income. When extrapolating demand to cover new supply areas, other factors such as

differences in income, housing, alternative sources, etc. will have to be taken into account.

(i) *Service Level.* Improvements in service level include for example:

(a) increased number of supply hours;

(b) improved water quality;

(c) higher water pressure;

(d) a shift from public tap to piped house connection; and

(e) a shift from own facilities to a connection to a piped system.

In general, it is difficult to assess the effect of these physical improvements on individual water consumption. Households will, in most cases, not be able to provide accurate estimates. In case the project will result in considerable improvements in existing supply conditions, the best source of information is data from other water enterprises that supply water in comparable conditions.

In case the present water supply system functions satisfactorily and demand is not constrained, existing consumption data may be taken as the basis for future water demand estimates.

(ii) *Water Tariffs.* An increase in water charges will generally result in a decrease in the demand for water. In case the household remains on the same demand curve, the extent of the decrease will be determined, among others, by the numerical value of the price elasticity of the demand for water . Difficulties in estimating the price elasticity include:

(a) new WSPs often generate a better level of service and may, therefore, cause a shift from one demand curve to a new demand curve as another product is offered. In this case, price elasticities pertaining to the old demand curve could only be used as a proxy for the true price elasticity which is very difficult to determine.

(b) a situation of constrained supply exists and therefore, existing demand is not known;

(c) it is very difficult to estimate how much individual households will reduce water consumption when prices are increased because individual households will have great difficulty in providing reliable estimates.

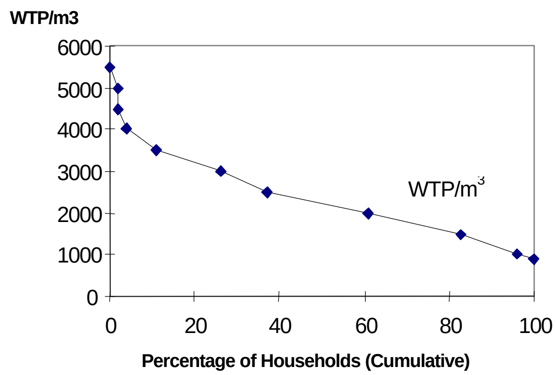
If available, data on earlier price increases and subsequent reduction in water consumption can be examined. If such data are not available, it is recommended to use conservative estimates based on experiences described in the literature.

An indication of changes in demand as a result of price increases can also be obtained from willingness-to-pay surveys. An example is provided in Box 3.10. However, it should be noticed that the percentage of households is only a rough proxy for the true dependent variable which is the quantity of water consumed expressed in m^3.

Box 3.10 **Thai Nguyen: Relation between WTP and Number of Households**

In Thai Nguyen, the willingness-to-pay survey for already connected households provided the results as given in the Table below. The 1996 tariff is VND900/m^3 and therefore, all households are apparently willing to pay that amount. Subsequently, 83 percent of households is willing to pay a tariff of VND1,500/m^3, 61 percent is willing to pay VND2,000/m^3, etc. These figures can be depicted in a graph shown in the Box. The line connecting the dots could be considered as a "surrogate demand curve".

WTP (VND/m^3)	Percentage of Households (Cumulative)
5,500	0
5,000	2
4,500	2
4,000	4
3,500	11
3,000	26
2,500	37
2,000	61
1,500	83
1,000	96
900	100



Assume that in this case, the new tariff has been fixed at VND1,500/m^3. An indication of the relative change in the number of HH (q) to relative changes in tariff (p) for these values is as follows:

$$\frac{(q2-q1)/q1}{(p2-p1)/p1} = \frac{(83-100)/100}{(1{,}500-900/900)} = -0.26$$

Assuming a constant average consumption per HH, this figure provides an indication of the value of the point price elasticity for connected households.

(iii) *Income Levels.* In most cases, it is expected that the real income level of households will increase over the lifetime of a WSP, which is normally 20 to 30 years. When real income increases, the demand for water is also expected to increase, depending on the value of income elasticity. A generally accepted level of income elasticity is between 0.4 and 0.5. An application of the issues raised above for Thai Nguyen is presented in Box 3.11.

Box 3.11 **Thai Nguyen Case Study: Estimating Future Demand**

In Thai Nguyen, the following assumptions were made to estimate future demand:

- Existing per capita consumption equals existing demand: Q = 103 lcd (Table 3.2, line 12);
- The proposed tariff for the year 2010 is VND2,000/m^3 and for the year 2020, it is VND2,500/m^3. This results in required annual real price increases (dP/P) of 5.87 percent during the period 1997-2010 and 2.26 percent in the period 2011-2020 (line 38).
- A price elasticity was estimated at – 0.3 (line 37);
- increases in real income of 4 percent per annum (based on national forecasts) (line 42);
- an income elasticity of + 0.50 was assumed based on literature (line 41).

A sample calculation of the above estimate for the first year (1997) is given below:

Price Elasticity = [dQ/Q] / [dP/P];
dP/P = + 5.87%.
Therefore, - 0.3 = dQ/Q/ 0.0587; or:
dQ /Q = - 0.01761 = - 1.76% (when prices increase with 5.87 percent, demand for water will decrease with 1.76 percent: line 40). The decreased demand for water indicates the price effects.

Income Elasticity = dQ/Q / dI/I;
dI/I = + 4%.
Therefore, 0.5 = dQ/Q/0.04, or:
dQ/Q = 0.02 = 2 % (an increase in income of 4 percent will result in an increase in water demand with 2 percent, line 43). This increased water demand represents the income effects.

The combined effect of changes in price and income on quantity demanded shows a net result of: 2% - 1.76 % = 0.24% (see line 44 and line 11).
The positive effect of the income increase is slightly larger than the negative effect of the price increase. Per capita consumption in this case will increase from 1996 to 1997 by 103 x 0.0024 = 0.24 liter.

Source: RETA 5608 Case Study on the Provincial Towns Water Supply and Sanitation Project, Thai Nguyen, Viet Nam.

Step 6: Calculating Total Domestic Demand With-Project

50. Based on the projections for population and per capita water consumption, the domestic demand for water can be calculated by multiplying the number of persons served with the daily consumption as shown in Box 3.12.

Box 3.12 **Thai Nguyen Total Domestic Demand**

The total domestic demand for Thai Nguyen for the year 1995 is calculated as follows:

Basic calculations for estimating Total Domestic Demand[a]

Table3.2 Line no.	Item	Unit	Value	Explanation
9	Persons served	No.	33,241	
12	Per capita consumption	Lcd	103	
13	Total Consumption per day	m^3/day	3,424	(33,241 x 103)/1000
14	Total Consumption per year	'000 m^3/year	1,250	(3,424 x 365)/1000
15	Household consumption	m^3/month	20.4	1,250,000/ (12 x 5,114)

a/ - Calculations may slightly differ due to rounding off of original figures.

Step 7: Nondomestic consumers

51. In general, future demand for water from the nondomestic sector is difficult to estimate. Future demand will depend, among others, on the price of water, reliability of supply, type and size of industries, regional and urban development plans, legal requirements, etc.

52. In the short run, the nondomestic sector is less likely to quickly increase/decrease the use of water as a result of changes in prices, meaning that nondomestic demand for water is more inelastic than domestic water demand. Reasons for this include:

(i) the users of water are often not the persons who have to pay for it (for example, in offices, hotels);

(ii) for industries, the costs of water are, in general, very small as compared to other production costs; and,

(iii) any increase in the price of water is likely to be incorporated in the cost-price of the product produced and be charged to the consumer.

53. In the medium to long run, however, large nondomestic consumers will often compare the costs of water from other sources with the costs of water from the piped system. If they can obtain cheaper water from other sources, they may not be willing to connect to the piped system, unless there is a legal obligation.

54. In some cases, the government may wish to encourage industries to apply water saving technologies and the application of such technologies will be encouraged by higher water tariffs such as discussed in Box 3.13.

Box 3.13 **Example of Estimating Industrial Consumption**

When projecting industrial demand for three cities in China, industrial water consumption was expected to grow at a rate of 8.7 percent per annum, based on expected industrial growth rates for the next ten years. At the same time, a survey conducted by the municipal authorities revealed that water consumption of industries in the cities was two to five times higher than water use in comparable industries in many other countries. In an effort to conserve water, the cities now require industries to improve water consumption efficiency by imposing penalties for excessive use. At the same time, water allocations to new industries are now based on prudent water use for the concerned industrial sector. Based on these new policies and their strict enforcement, it is expected that water consumption levels will be reduced to about 70 percent of existing levels. This would result in an industrial water consumption growth of 4.7 percent per annum, compared with the initially much higher growth rate of 8.7 percent.

Source: WB-SAR. 1991. *Liaoning Urban Infrastructure Project*. China.

55. Depending on available information about existing nondomestic consumption, estimates of economic and industrial growth, regional and urban development plans, employment figures, (expected) legislation, the application of water saving technologies, etc., approaches in estimating nondomestic water demand include:

(i) the application of past growth rates for nondomestic water consumption;

(ii) the application of population growth rates to existing water consumption of, for instance, government institutions;

(iii) the application of industrial- or economic growth rates to existing nondomestic consumption;

(iv) estimate nondomestic consumption as a (changing) percentage of estimated domestic consumption; and

(v) estimate the effects of water conservation technologies on nondomestic consumption;

The estimates for nondomestic consumption in Thai Nguyen are given in Table 3.2 and illustrated in Box 3.14.

Box 3.14 **Example of Estimating Nondomestic Consumption**

In Thai Nguyen, a small survey was conducted among nondomestic users. It appeared that enterprises were willing to pay up to VND3,500/m^3. At higher tariffs, however, they would start developing alternative water sources.

Based on secondary data analysis, the following assumptions were developed:

- government/social sector at 2.5 percent per year based on forecasts for population growth (Table 3.2, line 16)
- commercial sector growth at 3.0 percent per year (line 21);
- industrial sector growth at 4 percent per year, based on forecasted industrial growth (line 26);

The calculations are presented in Table 3.2 lines 16 - 29. Calculations for the different sectors are basically the same. The number of connections is first multiplied with the annual growth figure for the sector. This figure is then multiplied by the average consumption per connection per day and subsequently with 365 to find the annual figures.

Example: Commercial consumption in 1996 amounts to 20 x 1.03 x 5,147 x 365/1000 = 38,700 m^3/year (figures in Table 3.2 may slightly differ due to rounding).

Source: RETA 5608 Case Study on the Provincial Towns Water Supply and Sanitation Project, Thai Nguyen, Viet Nam

Step 8: Application of Technical Parameters

56. After having added domestic and nondomestic demand (see lines 31/32 in Table 3.2), certain technical parameters need to be incorporated in order to determine the total demand for water.

Unaccounted for Water

57. Normally a certain percentage of the water supplied to consumers is lost due to technical losses (physical leakages) and/or nontechnical losses (unmetered consumption, illegal connections). This so-called Unaccounted For Water (UFW) is normally expressed as a percentage of the volume of distributed water. In 1995, the average percentage of UFW in 50 Asian cities was 35 percent of water distributed (*Water Utilities Data Book for the Asian and Pacific Region*, 1997). This high level of UFW illustrates the inefficient use of existing water resources and is of great concern to the management of water utilities. A reduction of the UFW rate is therefore normally a specific objective in the formulation of new WSPs.

58. It will be necessary to include a realistic estimate of UFW in a demand estimate for a WSP. This percentage will naturally relate to the existing UFW rate and should be based on realistic targets for UFW reduction.

59. It is also necessary to estimate the proportion of technical and nontechnical losses in UFW because, in economic analysis, nontechnical losses (which add to the welfare of the population served) are included in the assessment of economic benefits. This assessment is often difficult and the project analyst will have to make a reasonable estimate in consultation with water enterprise staff. The percentage reduction in UFW should be set realistically in consultation with the project engineers (for technical losses) and utility managers (for nontechnical losses). A reduction in UFW will normally require a sizable portion of the project investment cost.

Peak Factor

60. The demand for water will very seldom be a constant flow. Demand for water may vary from one season to another and throughout the day. Daily demand will show variations and there will be peak hours during the day, depending on local conditions. These seasonal and daily peak factors will influence the size of the total installed capacity. These are technical parameters and will be determined by project engineers.

61. The demand for water is seldom constant. Rather it varies, albeit seasonally, daily and/or based on other predictable demand characteristics. At different times of the year the demand for water may be higher than others due to factors such as heat which may increase the demand for water for hygiene, drinking and other purposes. At different times of the day the demand for water may be higher than others, based on people's and industries needs and patterns of consumption. At other periods, the stock and flow requirements of the system may be impacted by other predictable events, such as an industrial activity. These seasonal, daily and other predictable demand factors are known as peak factors.

62. In determining the total installed capacity of a planned project, the technical staff needs to consider both these peak demand factors and the projected growth in demand. Failure to do so could result in the project becoming supply constrained and unable to fully meet the demand requirements of its targeted beneficiaries from its outset.

63. Data about daily and seasonal water consumption patterns will normally be available from secondary data or may be collected in the household survey. The application of technical parameters in Thai Nguyen is given in Box 3.15.

Box 3.15 **Application of Technical Parameters**

In the case of Thai Nguyen, the objective was to reduce UFW from its existing level of 39 percent in year 1995 to 25 percent in year 2015 (Table 3.2, line 33). The Peak Factor has been estimated at 1.1.

The calculation, for example, in the year 1996 is as follows:

		'000 m^3/year
Water Demand (domestic + nondomestic; line 32)	=	2,665
UFW = (2,665,000/(1-0.38)) x 0.38 (line 34)	=	1,633
Peak factor 10% x (2,665,000+1,633,000)	=	430
Total Production Capacity required (line 36)	=	4,728

(Please note that the figures resulting from the above calculations slightly differ from the figures in Table 3.2, due to rounding off.)

Table 3.2 **Demand Forecast and Required Production Capacity**

	Financial Analysis Stages 1& 2	Unit	1995	1996	1997	1998	1999	2000	2005	2010	2015	2020
	1. POPULATION											
1	Population Growth	%	3.0%	3.0%	3.0%	3.0%	3.0%	2.5%	2.5%	2.5%	2.5%	2.5%
2	Total Population Thai Nguyen	Number	191,615	197,363	203,284	209,383	215,664	221,056	250,105	282,970	320,155	362,226
3	Growth (in service area)	%	3.0%	3.0%	4.5%	4.5%	4.5%	3.0%	3.0%	3.0%	3.0%	3.0%
4	Total Population in Service Area	Number	140,442	144,655	151,165	157,967	165,076	170,028	197,109	228,503	264,898	307,089
5	Increase in No of Connections	%		10%	37%	37%	37%	37%	7%	7%	3%	3%
6	No of Connections (end of year)	Number	5,114	5,625	7,683	10,494	14,332	19,574	27,495	38,620	45,695	54,065
7	Increase Person/Connection	%	0.0%	-2.8%	-2.8%	-2.8%	-2.8%	-2.8%	-2.8%	0.0%	0.0%	0.0%
8	Person per Water Connection	Number	6.5	6.3	6.1	6.0	5.8	5.6	4.9	4.26	4.26	4.26
9	Population Served	Number	33,241	35,549	47,204	62,681	83,231	110,518	134,843	164,522	194,659	230,317
10	Coverage	%	24%	25%	31%	40%	50%	65%	68%	72%	73%	75%
	2. DEMAND											
	A. HOUSEHOLDS											
11	Increase per capita consumption	%		0.22%	0.24%	0.24%	0.24%	0.24%	0.24%	0.24%	1.32%	1.32%
12	Per capita consumption	l/con/d	103	103	103	104	104	104	105	107	114	122
13	Total consumption/day	m³/d	3,424	3,670	4,884	6,501	8,653	11,518	14,222	17,561	22,189	28,036
14	Total consumption	000m³/yr	1,250	1,339	1,783	2,373	3,158	4,204	5,191	6,410	8,099	10,233
15	Total Consumption	m³/mo/conn	20.4	19.8	19.3	18.8	18.4	17.9	15.7	13.8	14.8	15.8
	B. GOVERNMENT											
16	Increase in No of Connections	%		2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
17	No of Connections (end of year)	Number	221	227	232	238	244	250	283	320	362	410
18	Consumption	l/con/d	8,895	8,984	8,826	8,670	8,518	8,368	7,656	7,006	6,772	6,546
20	Total Consumption	000m³/yr	718	745	748	753	758	766	791	818	895	982
	C. COMMERCIAL											
21	Increase in No of Connections	%		3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
22	No of Connections (end of year)	Number	20	21	21	22	23	23	27	31	36	42
24	Total consumption	m³/d	102	107	108	109	110	112	119	126	141	158
25	Total	000m³/yr	37	39	39	40	40	41	43	46	51	58
	D. INDUSTRIAL											
26	Increase in No of Connections	%		4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%
27	No of Connections (end of year)	Number	17	18	18	19	20	21	25	31	37	45

28	Consumption	l/con/d	82,848	83,676	82,203	80,756	79,334	77,937	71,313	65,251	63,072	60,966
29	Total consumption	m³/d	1,408	1,479	1,511	1,544	1,578	1,612	1,795	1,998	2,349	2,763
30	Total	000m³/yr	514	541	552	564	576	590	655	729	858	1,011
	TOTAL DEMAND											
31	No of Connections (end of year)	Number	5,372	5,890	7,955	10,772	14,618	19,868	27,830	39,002	46,130	54,562
32	Total Water Demand	000m³/yr	2,519	2,665	3,122	3,730	4,533	5,601	6,680	8,003	9,903	12,284
	3. PRODUCTION											
33	UFW (%)	%	39%	38%	38%	37%	36%	33%	30%	27%	25%	25%
34	UFW	000m³/yr	1,626	1,666	1,890	2,185	2,569	2,759	2,863	2,960	3,301	4,095
35	Peak factor (10%)	000m³/yr	414	433	501	591	710	836	954	1,096	1,320	1,638
36	Required Production('000m³/Year)	000m³/yr	4,559	4,764	5,513	6,506	7,813	9,195	10,497	12,059	14,524	18,016
	PER CAPITA DEMAND (HOUSEHOLDS)			1996	1997	1998	1999	2000	2005	2010	2015	2020
37	Price Elasticity			-0.300	-0.300	-0.300	-0.300	-0.300	-0.300	-0.300	-0.300	-0.300
38	Price Increase				5.87%	5.87%	5.87%	5.87%	5.87%	5.87%	2.26%	2.26%
39	Tariff			900	953	1,009	1,068	1,131	1,504	2,000	2,236	2,500
40	Price Effect		0	0	-1.76%	-1.76%	-1.76%	-1.76%	-1.76%	-1.76%	-0.68%	-0.68%
41	Income Elasticity			0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
42	Income Increase			4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%
43	Income Effect				2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
44	Combined Effect (Increase lcd)				0.24%	0.24%	0.24%	0.24%	0.24%	0.24%	1.32%	1.32%
45	Liters/Capita/Day			103	103	104	104	104	105	107	114	122

No - number; l/con/d - liters per connection per day; m³/d - cubic meter per day; '000m³/yr - thousand cubic meter per year; m³/mo/conn - cubic meter per month per connection

Step 9: Calculating Incremental and Nonincremental Demand

64. In demand forecasting, it is necessary to prepare separate estimates for incremental and nonincremental demand with-project. When estimating the project's economic benefits, both categories of demand are valued in different ways as will be further explained in Chapter 6. Because the average volume of nonincremental water generally differs between connected and nonconnected users, and because other variables such as income and price may also differ, it is useful to do a separate analysis for these two groups of users.

(i) Users already connected to a piped system. The calculation of nonincremental demand is best explained by a simple example as shown in Table 3.3.

Table 3.3 **Nonincremental Water from connected users** *(in lcd)*

	Without Project	With Project	Incremental Piped Water Supplied	Non Incremental demand piped water	Incremental demand for piped water
Average water use from piped system	75	100	25		
Average water used from other sources	15	0		15	
Average total Water Used	90	100			10

Before-project and without-project, already connected households use, on average, 90 lcd (75 lcd from the piped system and 15 lcd from other sources such as vendors or wells). With-project, production capacity will be increased, and the already connected users are expected to increase their consumption to 100 lcd. The additional supply of piped water in this case is an average of 25 lcd, consisting of 15 lcd which displaces water from other sources (nonincremental demand) and 10 lcd of incremental consumption.

There is also a need to consider the question whether or not the current demand figures with-project and without-project will change over time. Estimates of future water consumption with-project have been made in Box 3.11. In the without-project situation, current consumption figures may change over time as a result in changes in income, prices or changes in service levels. The project analyst will have to develop reasonable assumptions about taking these factors into account.

(ii) Users not yet connected to a piped system. Again, two questions need to be answered. The first question is: what will be the nonincremental use of water in the with-project situation? An example is given in Table 3.4.

Table 3.4 **Average Nonincremental Water of nonconnected users** *(in lcd)*

	Without Project	With Project	Additional Piped Water Supplied	Nonincremental piped water demand	Incremental piped water demand
Average water use from piped system	0	100	100		
Average water used from other sources	65	0		65	
Average total Water Used	65	100			35

In this example, the average user will:

(i) displace all the water currently used from other sources (non incremental demand = 65 lcd); and

(ii) increase consumption from 65 lcd to 100 lcd (incremental demand = 35 lcd). The additional supply of piped water will be 100 lcd on average.

The second question is: whether or not these figures will change over time. Box 3.16 provides an example which explains how the quantity of nonincremental water can be determined. A summary of step 9 is presented in Table 3.5 showing incremental demand for both connected and nonconnected households as well as nonincremental demand for water.

The above is applied to the case of Thai Nguyen in Box 3.16.

Box 3.16 **Determination of Incremental and Nonincremental Water**

In Thai Nguyen the existing supply capacity of about 10,000 m^3 per day is fully used. Increases in demand can only be met if the UFW is reduced, but this will require considerable investments.

Domestic demand:

Demand from presently connected households before-project is, on average, 103 lcd; and because the system is operating at full capacity, it is assumed that this figure will remain the same without-project. The household survey showed that the use of other sources by households, which are currently connected to the system, is negligible. It is assumed that this figure also will not change in the future. Furthermore, with-project, the average water use from the piped system will gradually increase (see Table 3.2, line 12). Therefore, the increased consumption of presently connected households can be considered as incremental water demand. The calculation for 1998 is as follows:

With the Project: (lines refer to table 3.5)

1998 Demand without the project	103 lcd	(line 8)
1998 Demand with the project	104 lcd	(line 9)
1995-98 Increase in per capita consumption:		
(1.0022 x 1.0024 x 1.0024 = 1.007 =)	0.70 %	(line 2)
1998 Demand without the project:	1,250,000 m^3/year	(line 1)
1998 Demand with the project:	1,258,750 m^3/year	(line 3)
1998 Incremental Demand	8,750 m^3/year	(line 4)

The average water use of non-connected households in Thai Nguyen before the project was estimated at 564 liters per day. With an average number of 5.5 persons per house, this means an average use of about 102 lcd (which is very close to the average consumption of users of the piped system). It is assumed that in without-project situation, this figure will not change in future. Furthermore, it is assumed that the average use of these households with-project and when they will be connected will increase in a similar way as the presently connected households.[1/] The increase in average consumption is considered as Incremental demand. Nonconnected households which will obtain a new connection are assumed to displace all their present sources with water from the piped system. Therefore, this is considered as nonincremental demand.

<u>The calculation is as follows:</u>

Line	6	1998 number of connections	10494
	5	1995 number of connections	5114
		Incremental number of connections	5380
	7	1998 persons per connection	5.97
	9	1998 average water use	103.7 lcd
	8	1995 average water use	103 lcd
	10	1998 Incremental demand	8,206 m^3/ year
			(= 5380 x 5.97 x (103.7-103) x 365/1000)
	-	1998 additional supply	1,215,705 m^3/year
		nonconnected HH	(= 5380 x 5.97 x 103.7 x 365/1000)
	-	1998 nonincremental demand	1,207,499 m^3/year
		nonconnected HH	(= 1,215,705 - 8,206)

(Please note that the figures resulting from the above calculations slightly differ from the figures in Table 3.5, due to rounding off).

[1/] It should be noticed, however, that this simplifying assumption may not hold in practice. As a result of the lower water price (with the project), the average water consumption of previously nonconnected households may actually increase more than the average water use of connected households. If empirical evidence is available, this should then be taken into account in the demand forecast.

Non Domestic Demand:

Without any further data available, it has been assumed that existing nondomestic consumers will continue to consume the same average volume of water with-project and without-project. Therefore, all additional nondomestic demand will come from industries not presently connected to the system which will fully displace existing sources. Therefore, all nondomestic water can be considered as nonincremental.

From the above it can be seen that except for the incremental demands from existing and future connections, all other demand can be considered nonincremental. It has been assumed that without-project demand from existing users will remain constant at 2,519,000 m^3 per year (Table 3.5,line 11) . The calculations for (non) incremental demand for the year 1998 are as follows:

1998 Total Demand without the project	2,519,000 m^3/year	(line 11)
1998 Total Demand with the project (refer to Table 3.2, line 32)	3,730,000 m^3/year	(line 12)
1998 Supply by the Project:	1,211,000 m^3/year	(line 13)
1998 Incr. demand connected HH	8,750 m^3/year	(line 14)
1998 Incr. demand non-conn. HH	8,447 m^3/year	(line 15)
1998 Nonincremental demand	1,193,803 m^3/year	(line 16)

As can be seen in the case of Thai Nguyen, the incremental water demand with-project is rather small, which is caused by the fact that the current use of water from other sources by non-connected households is relatively high and therefore, these households will only marginally increase their water consumption.

Table 3.5 Calculation of Nonincremental Demand

		Unit	1995	1996	1997	1998	1999	2000	2005	2010	2015	2020
	Connected Households											
1	Current conn HH consumption	‘000m³/yr	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250
2	Increase per capita consumption	%		0.22%	0.24%	0.24%	0.24%	0.24%	0.24%	0.24%	1.32%	1.32%
3	Future conn HH consumption	‘000m³/yr	1,250	1,252	1,255	1,258	1,261	1,264	1,280	1,295	1,383	1,477
4	Incremental Demand ConnHH	‘000m³/yr	0	2	5	8	11	14	30	45	133	227
	Nonconnected Households											
5	Current no. of connections		5,114	5,114	5,114	5,114	5,114	5,114	5,114	5,114	5,114	5,114
6	Future no. of connections		5,114	5,625	7,683	10,494	14,332	19,574	27,495	38,620	45,695	54,065
7	No. of persons per connection		6.50	6.32	6.14	5.97	5.81	5.65	4.90	4.26	4.26	4.26
8	Current Avg. water use	lcd	103	103	103	103	103	103	103	103	103	103
9	Future Avg. Water use	lcd	103	103	103	104	104	104	105	107	114	122
10	Incr demand		0	0	3	8	19	36	99	195	693	1,426
	Connected+Nonconn HH											
11	Total Existing Demand	‘000m³/yr	2,519	2,519	2,519	2,519	2,519	2,519	2,519	2,519	2,519	2,519
12	Total Future Demand	‘000m³/yr	2,519	2,665	3,122	3,730	4,533	5,601	6,680	8,003	9,903	12,284
13	Additional Supply by Project	‘000m³/yr	0	146	603	1,211	2,014	3,082	4,161	5,484	7,384	9,765
14	Incr Demand Conn HH	‘000m³/yr	0	2	5	8	11	14	30	45	133	227
15	Incr Demand Nonconn HH	‘000m³/yr	0	0	3	8	19	36	99	195	693	1,426
16	Nonincr Demand		0	143	595	1,194	1,984	3,031	4,033	5,245	6,558	

CHAPTER 4

LEAST-COST ANALYSIS

CONTENTS

Boxes

Tables

4.1 Introduction

1. Given the project's objectives and after having arrived at the demand forecast, the next task is to identify the options or alternative ways of producing the required project output. The selection of the least-cost alternative in economic terms from the technically feasible options promotes production efficiency and ensures the most economically optimum choice. The alternatives need not be limited to technical or physical ones only but could also include options related to policy measures. The options related to the technical measures may include:

(i) different designs and technologies;

(ii) different scale (large-scale or small-scale) and time phasing of the same project;

(iii) the same project in different locations.

2. The options related to policy measures may include demand and supply management. Both can achieve optimum use of the existing facilities: the former by introducing proper tariff or pricing and metering of supply; the latter by, for instance, leakage detection and control of an existing water distribution system to reduce the unaccounted-for-water (UFW) to the maximum extent possible. The options considered must be realistic, not merely hypothetical, and can be implemented.

3. Once the alternatives are identified, the next step is to estimate the entire life-cycle costs (initial capital costs and future operating and maintenance costs) for each option, first in financial prices and then in economic prices by applying appropriate shadow price conversion factors. Estimating the entire life-cycle costs involves close cooperation between the economist and the engineer.

4. Finally, the discounted value of the economic costs for each option is to be worked out using the economic discount rate of 12 percent. On this basis, the alternative with the least economic cost can be selected. The different methodological approaches are explained in this chapter.

5. It must be noted that least-cost analysis, while ensuring production efficiency, does not provide any indication of the economic feasibility of the project since even a least-cost alternative may have costs that exceed the benefits (in both financial and economic terms).

4.2 Identifying Feasible Options

4.2.1 Technological Measures and Options

6. Depending on the source of water supply and the configuration and characteristics of the area where the water is needed, the following technological options can be considered:

i) surface or ground water supply scheme; and

ii) gravity or pumping scheme.

These options are not necessarily mutually exclusive: a ground water supply scheme requires pumping while a surface water scheme may make use of gravity flow of water, at least, partially.

7. Again, for the choice of components in a water supply scheme, there may be several technological options for both urban and rural areas. Some of these options are listed in Box 4.1 and Box 4.2.

Box 4.1 **Technological Options in Rural Areas**

1. *Increasing the quantity of available water*
   - new source of water - ground water with use of hand pumps or community wells;
   - new source of water – surface water with house connections, yard connection or public standposts;
   - rainwater collection, treatment, and distribution;
   - water conservation through rehabilitation of existing distribution system, or through better uses of existing source.
2. *Storage systems*
   - building new community storage systems like ground level reservoir or overhead tanks;
   - extending existing storage systems (if possible).
3. *Distribution systems*
   - new systems incorporating either house connections and/or community standposts; and
   - extending existing water delivery systems.

Box 4.2 **Technological Options in Urban Areas**

1. *Increasing the quantity of available water*
   - water conservation through rehabilitation of existing distribution system;
   - new source of surface water - nearby river or canal, etc.;
   - ground water from deep or shallow wells.
2. *Treatment plants*
   - Different types and processes in treatment plants and installations.
3. *Storage systems*
   - building new storage tanks - overhead or ground level;
   - extending the existing storage systems.
4. *Distribution systems*
   - Standpipes (community use)
   - Yard connections
   - House connections
   - Tanker
   - Bottled water

8. Box 4.3 below illustrates the identification of feasible options for three Indonesian villages.

Box 4.3 **Identifying Feasible Project Options in a Rural Setting**

Three Indonesian villages identified for inclusion in a rural water supply project are exposed to the effects of degrading ground water quality and dry dugwells in the dry season. Rainfall, on the other hand, occurs with reasonable frequency. Options identified for the least cost analysis appropriately included the following:

- rainwater collection (with storage);
- hand pumps, small bore well;
- hand pumps, small bore well with upflow filter units; and
- piped water supply system.

By including all these options in the consideration of alternatives, the analysis explored not only the conventional water supply systems but also the use of relevant and potentially viable traditional options.

Source: RETA 5608 Case Study Report, RWS&S Sector Project, Indonesia.

4.2.2 Policy Measures and Options

9. Management measures and options may include any of the following:

(i) reducing the percentage of UFW (especially technical losses and particularly in urban areas) through leakage detection and control, thus increasing water availability from existing facilities;

(ii) reducing water consumption from consumers by introducing metering for the first time;

(iii) reducing water consumption through appropriate cost recovery measures where there was no or very little cost recovery before, or through the introduction of progressive tariff structures;

(iv) carrying out public health education programs to promote efficient use of water; and

(v) implementing a commercial management system.

10. In Box 4.4, an illustration shows how supply of water was augmented by reducing UFW.

Box 4.4 **Identifying Project Options in an Urban Setting**
Case 1 : Unaccounted-for-Water

The city of Murcia in Spain (pop. 350,000) was faced with a high unaccounted-for-water (UFW) level of 44 percent. By implementing a new commercial management system that better accounted for all water uses and users, the municipal company reduced UFW to 23 percent over five years. The resulting water savings proved adequate to increase the number of water connections by 19,000 and achieve 100 percent coverage.

Source: Yepes, Guillermo. 1995. Adopted from *Reduction of unaccounted-for-water, the job can be done*. The World Bank.

11. Box 4.5 shows an illustration of "metering" in combination with leakage reduction programs in Singapore.

Box 4.5 **Identifying Project Options in an Urban Setting**

Case 2: Metering and Leakage Control

The city-state of Singapore (pop. 2.8 million) has scarce water resources. By sustaining a consistent metering and leak reduction program, the Public Utilities Board has succeeded in reducing unaccounted-for-water (UFW) from the already low level of 10.6 percent in 1989 to 6 percent in 1994. "The goal of the utility is not to have zero UFW, but rather to reduce it to a point where benefits equal costs."

Source: Yepes, Guillermo. 1995. Adopted from *Reduction of unaccounted-for-water, the job can be done*. The World Bank.

12. Based on cross-sectional data for 26 industrial firms in Jamshedpur, India, a price elasticity of demand of –0.49 was estimated, meaning that a 100 percent price increase would cause industrial demand to fall by 49 percent. (Source: World Bank-ODI Joint Study. 1992 draft. *Policies for Water Conservation and Reallocation, "Good Practice" Cases in Improving Efficiency and Equity*.) The calculation is shown in Box 4.6.

Box 4.6 **Demand Management Through Pricing**

Price elasticity of demand = -0.49

Percentage increase of tariff = 100%

$$\text{Percentage change of water use} = \left(\frac{\text{Percentage change in demand}}{\text{Percentage change in price}} \right)$$

$$= -0.49 \quad x \quad 100\% \quad = \quad -49\%$$

Meaning a 49 percent decrease in water consumption.

13. In situations where tariffs are substantially below cost, an increase in tariffs is likely to lead to a reduced demand; in this way, more water will become available for additional supply. This measure stimulates a more efficient use of water (avoiding wasteful overuse) and will result in postponing physical expansion of the water supply system.

4.3 Identification and Valuation of Costs for Feasible Options

4.3.1 Identification of Cost Elements

14. The economic costs associated with each of the identified options should be the life-cycle costs: i.e., initial capital costs, replacement costs, and future operating and maintenance costs. Such costs should include both adjusted financial and non-market costs.

15. The non-market costs reflect costs due to external effects which are not reflected in the project's own financial cost stream. These costs may include:

(i) environmental costs, such as depletion premium (scarcity rent) for the use of ground water if the normal replenishment of the aquifer falls short of the extraction from it, and

(ii) opportunity cost of water, e.g. if water is diverted from existing uses such as agricultural uses, etc.

The costs may also include household costs (if any) to bring the quality of the water service to the same standard for all the comparable options. This would also be the case in rural schemes where, for instance, yard connections installed at different distances from the house would involve different values of collecting time for the household (Refer to Section 4.3.2.3).

4.3.1.1 Capital Costs

16. Typical items to be included in the capital cost streams of a ground water pumping scheme with output of say 60,000m^3/day supply in a town in Viet Nam is shown in Table 4.1.

Table 4.1 **Capital Cost Items for a Ground Water Pumping Scheme**

Capital Costs Items	Unit	Quantity	Unit Cost (VND'000)	Total (VNDmillion)
1. Rehabilitation of existing boreholes for supply of 10,000 m^3/day	m^3/day	10,000	L.S.	1,665
2. Constructing new boreholes for supply of 50,000 m^3/day	no.	28	1,111	28,305
3. Installing pumps	m^3/day	50,000	266	13,220
4. Treatment installation	m^3/day	50,000	444	22,200
5. Constructing elevated storage	m^3	6,000	1,221	7,326
6. Constructing ground storage	m^3	7,500	777	5,828
7. Water transmission pipelines				
i) 375 mm dia.	m	10,000	1,365	13,653
ii) 525 mm dia.	m	2,300	2,309	5,310
iii) 600 mm dia.	m	10,000	3,108	31,080
8. Distribution system				
i) Clear water pumping station	m	60,000	172.05	10,323
ii) Secondary and other connections	no.	70,000	621.60	43,512
Subtotal Costs				182,422
Physical contingency		8%		14,594
Total Costs excluding tax				197,015
Tax (weighted average)		7%		13,791
TOTAL COSTS				**210,806**

Source: Adopted from RETA 5608 Case Study of Thai Nguyen (Viet Nam) Provincial Towns Water Supply and Sanitation Project

17. Alternatively, the cost of a surface water scheme with the same output of 60,000m^3/day in the same town in Viet Nam will be as follows:

Table 4.2 **Capital Cost Items for a Surface Water Scheme**				
Capital Costs Item	Unit	Quantity	Unit Cost (VND'000)	Total (VND million)
1. Raw Water Pumping Station of 60,000 m³/day	m³/day	60,000	188.7	11,322
2. Storage Pond at intake of 60,000 m³/day	m³/day	60,000	5.55	3,330
3. Water Treatment plant of 60,000m³/day	m³/day	60,000	1,165.5	69,930
4. Elevated Storage tank	m³	6,000	1,221	7,326
5. Ground Level Storage tank	m³	7,500	777	5,827
6. Water Transmission Mains:				
i) Canal to treatment plant 525 mm dia.	m	6,000	2,308	13,853
ii) Clean water to distribution system				
- 600 mm dia.	m	1,200	3,108	3,4230
- 525 mm dia.	m	2,300	2,308.8	5,310
7. Distribution system				
i) Clear water pumping stations	m³/day	60,000	172.05	10,323
ii) Secondary and other connections	no.	70,000	621.60	43,512
SUBTOTAL COSTS				174,163
Physical Contingency		8%		13,933
Total Costs excluding Tax				188,096
Tax (weighted average)		7%		13,166
TOTAL COSTS including tax				**201,263**
Source: Adopted from RETA 5608 Case Study of Thai Nguyen (Viet Nam) Provincial Towns Water Supply and Sanitation Project				

18. According to the Tables 4.1 and 4.2, the capital cost in financial terms of the ground water-pumping scheme of VND210,807 million exceeds the capital cost in financial terms of the surface water scheme of VND201,263 million by some five percent.

4.3.1.2 Annual Operation and Maintenance Costs

19. The next step is to estimate the operation and maintenance costs for both options. In Table 4.3, the O&M costs are shown for the two options (ground water and surface water) in the town in Viet Nam. The capital cost used in the base capital cost excludes physical contingency and taxes.

Table 4.3 **Operation and Maintenance Costs for Two Alternatives**

ALTERNATIVE 1 (Ground Water) O&M Costs		
Costs of annual O&M (weighted average percentage of the Capital Costs	=	1.135%
Hence, annual O&M cost yearly in financial price	=	(182,422) x (0.01135)
	=	VND2,070 million
Add, physical contingency of 8 percent	=	(2,070) x (1.08)
	=	VND2,236 million
Add, taxes and duties of 7 percent	=	(2,236) x (1.07)
TOTAL O&M COSTS PER YEAR	=	VND2,393 million
ALTERNATIVE 2 (Surface Water Scheme) O&M Costs		
Costs of annual O&M (weighted average percentage of the Capital costs)	=	1.432%
Hence, annual O&M cost per year in financial price	=	(174,163) x (0.01432)
	=	VND2,494 million
Add, physical contingency of 8 percent	=	(2,494) x (1.08)
	=	VND2,694 million
Add, taxes and duties of 7 percent	=	(2,694) x (1.07)
TOTAL O&M COSTS PER YEAR	**=**	**VND2,882 million**

Source: Adopted from RETA 5608 Case Study of Thai Nguyen (Viet Nam) Provincial Towns Water Supply and Sanitation Project

4.3.2 Non-Market Cost Items

4.3.2.1 Opportunity Cost of Water

20. Some situations may arise where water availability is limited so that the town's demand for water cannot be fully met by the new, previously unused sources. In such cases, it may be necessary to divert water from its existing uses, e.g., from agriculture, to meet the town's demand for drinking water. In this example, the opportunity cost of water diverted from its use in agriculture will be the agricultural benefits foregone as a result of reduced agricultural production.

21. A sample calculation is shown in Table 4.4 for the town in Viet Nam for its water supply alternative 2 (surface water). A maximum of 25,000 m^3/day can be drawn from the existing canal source. This leaves a gap of 5,000 m^3/day, assuming that the water demand to be supplied is 30,000 m^3/day. This gap is to be met by diverting water from its existing agricultural use.

22. The value of water in agricultural use is estimated through the marginal loss of net agricultural output, at economic prices, per unit of water diverted to the town users (refer also to Chapter 6).

23. The net benefit in financial prices derived from the loss of agricultural output is estimated at VND2,800 per m^3 of water used in agriculture. Since agricultural prices for the staple crops grown are regulated and some of the inputs are subsidized, the conversion factor for the output from the agricultural water is estimated at 1.98. In economic prices therefore, it amounts to VND5,544 (=2,800 x 1.98) per m^3 of water. The opportunity cost of diverted water is therefore expected to be VND10,118 million per day (=(5,544 x 5,000) x 365) when 5,000 m^3/day is diverted from agricultural use.

Table 4.4 **Calculating the Opportunity Cost of Water for Alternative 2**
(Surface Water)

Year	*Quantity of water diverted from agriculture water use (m^3 per day)*	*Economic value of diverted water (10^6 VND)*
0 – 8	NIL	-
9	1,088	1.088 x 5.544 x 365 = 2,202
10 - 25	5000	5.00 x 5.544 x 365 = 10,118

24. Annex 4.1 presents a more detailed example of how the opportunity cost of water can be calculated, based on foregone irrigation benefits.

4.3.2.2 Depletion Premium for the Withdrawal of Ground water

25. The depletion premium is a premium imposed on the economic cost of depletable resources, such as ground water, representing the loss to the national economy in the future of using up the resource today. The premium can be estimated as the additional cost of an alternative supply of the resource or a substitute, such as surface water, when the least-cost source of supply has been depleted.

26. In this example, the time until exhaustion is assumed to be 25 years and the alternative source to replace the ground water is surface water to be brought from a long distance. The marginal economic cost of water supply (ground water) without depletion premium is assumed to be about VND2,535 per m^3. It is expected that the marginal cost of replacing water (surface water) will be around VND2,578 per m^3, which is VND43 per m^3 higher.

27. The formula to calculate the scarcity rent (refer to Appendix 6 of the *ADB Guidelines for the Economic Analysis of Projects*) is as follows:

$$\text{Depletion premium} = (C_2 - C_1)e^{-r(T-t)}$$

where C_2 = cost of water per m^3 of alternative source;
C_1 = cost of water per m^3 of exhausting source;
T = time period of exhaustion;
t = time period considered;
r = rate of discount ($r = 0.12$);
e = exponential constant = 2.7183

28. For example, the depletion premium in year 2 is calculated as:

$$(2{,}578 - 2{,}535) \times 2.7183^{-0.12(25-2)} = \text{VND}2.72 \text{ per } m^3;$$

and for year 3 as,

$$(2{,}578 - 2{,}535) \times 2.7183^{-0.12(25-3)} = \text{VND}3.07 \text{ per } m^3.$$

As can be seen, the premium or scarcity rent increases each year as the stock of water diminishes. Table 4.5 shows the depletion premium for the ground water supply.

Table 4.5 **Depletion Premium for Replacing Ground Water with Surface Water** (Alternative 1)

Year	Depletion Premium (VND/m³)	Annual Premium (VND million)	Discounted Value (10^6 VND)		
			at 12%	At 15%	at 10%
0	-	-	-	-	-
1	2	2	1.79	1.74	1.82
2	3	5	3.99	3.78	4.13
3	3	8	5.69	5.26	6.01
4	3	11	6.99	6.29	7.51
5	4	18	10.21	8.95	11.18
6	4	23	11.65	9.94	12.98
7	5	34	15.38	12.78	17.45
8	6	49	19.79	16.02	22.86
9	6	57	20.55	16.21	24.17
10	7	77	24.79	19.03	29.68
11	8	88	25.30	18.91	30.84
12	9	99	25.41	18.50	31.54
13	10	110	25.21	17.88	31.87
14	11	120	24.55	16.96	31.60
15	13	142	25.94	17.45	33.99
16	15	164	26.75	17.53	35.69
17	16	175	25.48	16.26	34.62
18	19	208	27.04	16.81	34.42
19	21	230	26.70	16.17	37.61
20	24	263	27.27	16.07	39.08
21	27	296	27.40	15.72	39.99
22	30	329	27.17	15.20	40.40
23	34	372	27.45	14.95	41.55
24	38	416	27.41	14.52	42.22
25	43	471	27.69	14.32	43.47
			517.54	347.25	686.68

4.3.2.3 Household Cost Associated with a Technological Option (Tubewell with Hand Pump).

29. This section considers the household cost associated with a technological option when such an option is analyzed vis-a-vis other options with no such associated costs, assuming that the benefits are the same. This could, e.g., be the case in a rural setting where rainwater collectors are compared with tubewells.

30. The following illustration shows how such a cost can be arrived at. In Jamalpur. a semi-urban town in Bangladesh, the following costs were identified in connection with the operation of tubewells with hand pumps:

(i) Economic life of tubewells = ten years

(ii) Capital Cost (Annualized) with Economic Price

Initial Installation Cost = Tk2,500

Capital Recovery Factor for 10 years @ 12 percent discount rate = 0.177.

Annualized capital cost = (2,500) x (0.177) = Tk442.5

The annual cost including operation and maintenance cost (10 percent of annualized capital costs) = (442.5) x (1.1) = Tk486.75

(iii) Time Cost in Collecting Water:

The total use of water per household per year with an average of six members per household is 153 m^3. Household members spend on average a total of 1.0 minute per 20 liters of water in travelling and collecting water. Hence, the number of hours spent on collection 153 m^3 of water per year is equal to:

$$= \frac{153 \times 1{,}000}{20 \times 60} = 128 \text{ hours}$$

Unskilled labor wage rate = Tk4.00 per hour

Value of travelling and collecting time in a year = 128 x 4
= Tk512 in financial price

Shadow Wage Rate Factor = 0.85 (refer to Chapter 6)

Value of travelling and collecting time in economic prices = 512 x 0.85
= Tk435.2

(iv) Storage Costs

The investment cost in economic terms of the household storage in connection with tubewell and hand pump is about Tk150 per household. With an economic life of five years and an economic discount rate of 12 percent, the annual value is estimated to be Tk41.61 (= 150 x capital recovery factor for five years and 12 percent interest).

With annual operation and maintenance cost of 10 percent of the annualized capital cost, the annual cost of storage facility works out to be 41.61 x 1.1 = Tk45.77.

(v) Total Cost per m^3 of Water

The total annual household cost in economic prices with the tubewell and hand pump in Jamalpur in Bangladesh is equal to: [Installation plus O&M Cost] + [Time Costs in Collecting Water] + [Storage Costs] or 486.75 + 435.2 + 45.77 = Tk967.72

Therefore, the economic cost per m^3 of water $= \frac{967.72}{153} =$ Tk6.32 per m^3

4.4 Conversion Factors for Costing of Options *in Economic Prices*

31. The cost in market prices must be converted to its economic price before applying least-cost analysis. The procedures for such conversion are detailed in Chapter 6.

32. The calculation of composite Conversion Factors (CF) for the capital and operating and maintenance costs of the two options for the Viet Nam town is illustrated in Tables 4.6 and 4.7.

Table 4.6 **Calculation of Composite Conversion Factor for Alternative 1**
(Ground Water Supply)

Items	Break-up of financial costs (A)	Basic C.F. (using domestic price numeraire (B)	C.F. (Composite) (A x B)
A. Capital Costs			
(i) Traded Elements:			
(Direct and Indirect)	0.67	1.25	0.838
(ii) Non-Traded Elements:			
Domestic material and Equipment	0.18	1.00	0.180
Labor (skilled)	0.02	1.20	0.024
Labor (unskilled)	0.06	0.80	0.048
(iii) Taxes and Duties	0.07	0.00	-
	1.00		1.09
B. Operation and Maintenance Costs			
(i) Traded Elements:			
(Direct and Indirect)			
(ii) Non-Traded Elements:	0.05	1.25	0.063
Domestic material (including			
Chemicals and Equipment)	0.20	1.00	0.200
Labor (skilled)	0.12	1.20	0.144
Labor (unskilled)	0.10	0.80	0.080
Power supply	0.46	1.30	0.598
(iii) Taxes and Duties	0.07	0.00	-
	1.00		1.085

Table 4.7 **Calculation of Composite Conversion Factor for Alternative 2**
(Surface Water Supply)

Items	Break-up of financial costs (A)	Basic C.F. (using domestic price numeraire (B)	C.F. (Composite) (A x B)
A. Capital Costs			
(i) Traded Elements:			
(Direct and Indirect)	0.50	1.25	0.625
(ii) Non-Traded Elements:			
Domestic material and Equipment	0.30	1.00	0.300
Labor (skilled)	0.02	1.20	0.024
Labor (unskilled)	0.11	0.80	0.088
(iii) Taxes and Duties	0.07	0.00	-
	1.00		1.037
B. Operation and Maintenance Costs	0.10	1.25	0.125
(i) Traded Elements:			
(Direct and Indirect)			
(ii) Non-Traded Elements:	0.20	1.00	0.200
Domestic material and Equipment	0.10	1.20	0.120
Labor (skilled)	0.12	0.80	0.096
Labor (unskilled)	0.41	1.30	0.533
(iii) Taxes and Duties	0.07	0.00	-
	1.00		1.074

4.5 Methodologies for Carrying Out *Least-Cost Analyses*

33. Least-cost analyses generally deal with the ranking of mutually exclusive options or alternative ways of producing the same output of the same quality. In some cases, there may be differences in the outputs (quantity wise or quality wise) of the alternatives. Two types of cases may arise in choosing between alternatives through the least-cost analysis:

(i) alternatives deliver the same output;

(ii) outputs of the alternatives are not the same.

4.5.1 Alternatives Delivering the Same Output: *Overview of Methods*

34. There exist different methods to choose between alternatives:

(i) the lowest Average Incremental Economic Cost or AIEC;

(ii) the lowest Present Value of Economic Costs or PVEC;

(iii) the Equalizing Discount Rate or EDR.

All methods are illustrated here. The *Guidelines for the Economic Analysis of Water Supply Projects* recommend the use of the AIEC method.

4.5.2 Lowest AIEC Approach

35. The average incremental economic cost is the present value of incremental investment and operation costs of the project alternative in economic prices, divided by the present value of incremental output of the project alternative. Costs and outputs are derived from a with-project and without-project comparison, and discounting is done at the economic discount rate of 12 percent. The equation is as follows:

$$\text{AIC} = \left(\sum_{t=0}^{n}(C_t / (1+d)^t)\right) / \left(\sum_{t=0}^{n}(O_t / (1+d)^t)\right)$$

where C_t = incremental investment and operating cost in year t;
O_t = incremental output in year t;
n = project life in years;
d = discount rate.

36. Tables 4.B.3 and 4.B.4 in the Annex show the calculation of AIEC using a discount rate of 12 percent for both alternatives 1 and 2 (ground water supply scheme and the surface water supply scheme respectively). The results are as follows:

	Alternative 1 *(ground water scheme)*		**Alternative 2** (*surface water scheme)*
AIEC	VND2,545 per m^3	<	VND2,616 per m^3

37. Since the AIEC for the ground water scheme of VND2,545 per m^3 is lower than the AIEC for surface water scheme of VND2,584 per m^3, the least-cost solution for the supply of water to the town is alternative 1 (ground water scheme).

4.5.3 Lowest PVEC Approach

38. This straightforward method can be applied to the cost streams (in economic prices) for all options. The choice of the least-cost option will be based on the lowest present value of incremental economic costs, discounted at the economic discount rate of 12 percent.

39. Tables 4.B.3 and 4.B.4 in the Annex show the application of this approach for the two options in the Viet Nam town mentioned above, i.e., ground water supply scheme and surface water supply scheme. The results are as follows:

Alternative 1 (ground water supply)

$PVEC_1$ = VND123.8 billion (see Table 4.B.3)

Alternative 2 (surface water supply)

$PVEC_2$ = VND127.8 billion (see Table 4.B.4)

As $PVEC_1 < PVEC_2$

The alternative 1 (ground water scheme) is the least-cost option.

4.5.4 Equalizing Discount Rate Approach

40. A third approach on which the choice between mutually exclusive options can be based, is to calculate the equalizing discount rate (EDR) for each pair of options. The EDR is the discount rate at which the present values of two life-cycle cost streams are equal, thus indicating the discount rate at which preference changes. The EDR can be interpolated if the present values of the cost streams have been determined at two different discount rates, or may be arrived at by calculating the IRR (internal rate of return) of the incremental cost stream, that is the difference between the cost streams for each pair of alternatives.

41. Table 4.B.5 in the Annex shows the calculation of EDR. Both diagrammatic and algebraic approaches are illustrated. They are shown for the two options considered (the ground water and the surface water schemes). Table 4.B.6 in the Annex shows the IRR of the incremental cost stream.

4.5.5 Comparative Advantages and Disadvantages of the Three Approaches

42. **AIEC Approach.** This method not only arrives at the least-cost option but also clearly indicates the long-run marginal cost (LRMC) in economic prices, an essential core information for tariff design. The methodology, however, needs explaining why discounting the water quantity is to be done to arrive at the unit price of water.

43. **PVEC Approach.** This method is easiest to apply as straightforward discounting is needed at one fixed rate of discount. However, information available is limited. It does not indicate the per unit cost of water, nor does it indicate which option will be the least-cost if the discount rate is different from what has been used for calculation.

44. **EDR Approach.** Unlike the other two methods, this approach gives a clear indication as to which option is the least-cost at different discount rates rather than at a fixed discount rate. However, the calculations needed are more than in the other two methods and it requires understanding that EDR is also the IRR of the incremental cash flow of one option over the other.

Results

45. The results show that the EDR is 13.66 percent. In other words, the additional capital costs involved in choosing option 1 (ground water scheme) as against option 2 (surface water scheme) has a return of 13.66 percent, which is above the acceptable rate of return of 12 percent. Therefore, the lowest life-cycle cost option is option 1 (ground water scheme).

4.6 Outputs from the Alternatives are not the same

46. In principle, the LCA is applied to mutually exclusive options, which generate identical benefits. If those benefits are not the same, a normalization procedure can be applied to allow for comparison

4.6.1 Normalization Procedure

47. Where one alternative has a larger but identical output than another, the costs of the smaller project should be increased to allow for its smaller output. This can be done by adding the value of the foregone benefits to the cost of the smaller alternative. Box 4.7 shows an example of the normalizing method, applied to the data of two alternatives considered (ground water and surface water supply schemes) for the Viet Nam town. It is assumed that while the ground water supply scheme is able to meet the full demand of the town (30,000 m^3/day), the surface water scheme is only able to supply 25,000 m^3/day. The surface water source is limited due to shortage of availability of water resources.

Box 4.7 **Normalizing Procedure**

Present Value of Outputs		
Ground water scheme	=	48.858 m^3 (in millions)
Surface water scheme	=	44.127 m^3 (in millions)
Present Value of Costs		
Ground water scheme	=	VND123,858.00 (in millions)
Surface water scheme	=	VND101,578.00 (in millions)

Output of the surface water scheme is lower than that of ground water scheme by

$$= \left[\frac{48.858 = 44.127}{48.858} \right] = 9.68\%$$

The marginal cost of supply or AIEC of surface water scheme

$$= \frac{101,578.26}{44.127} = \text{VND2,301.95 per } m^3$$

The normalized cost of surface water should be increased by 9.68 percent to ensure equivalence.

Normalized cost of surface water = 2,301.95 x 1.0968 = VND2,524.78 per m^3

This normalized cost (not the un-normalized AIEC of the surface water VND2,301.95 per m^3) should be compared with the AIEC of the ground water scheme.

ANNEX 4.A.

Opportunity Cost of Water Calculation : Case Study

1. Introduction

The opportunity cost of water (OCW) can be calculated in numerous ways which are indicative of the foregone benefit of utilizing the water for a water supply project (WSP)[1] as compared to its next best alternative. In particular, the foregone benefit in irrigation and in hydropower generation are common methods of estimating the opportunity cost of water. In the former case, the value is based on the highest value irrigation crop being displaced when water is diverted from irrigation purposes for water supply schemes. In the latter, it is based on the reduced value of electricity production caused by water being diverted for water supply purposes upstream of the hydropower station. (i.e., less water is available for electricity generation). In either case, the OCW value in economic terms gets charged as a cost in the economic analysis of the WSP.

This annex proceeds with an example of how the opportunity cost of water based on foregone irrigation benefits may be calculated. The basis for the example is a case study in the Philippines undertaken during preparation of the *Handbook for the Economic Analysis of Water Supply Projects*.

2. Economic Assumptions

Through comparison of cropping patterns, intensities and yields, rice was demonstrated to be the highest value irrigation crop in the project affected area. The case study country is a net importer of rice. Consequently, the basis for the estimation of the opportunity cost of water is the import parity price of rice.

Economic costs and benefits were denominated in terms of the domestic price numeraire and are expressed in constant 1996 dollar prices. For purposes of illustration all prices and costs are presented in foreign currency costs, the $ being the foreign currency unit selected. Traded components were adjusted to economic prices using a shadow exchange rate factor (SERF) of 1.11 and non-traded components were valued at domestic market prices. Labor was adjusted using the Shadow Wage Rate Factor (SWRF) for unskilled labor in the country of .9.

The without-project scenario has one rainfed crop wheras the with-project scenario has one dry season irrigated crop and one wet season irrigated crop.

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[1] A water supply project is defined as non-irrigation water supply for purposes of this example.

The estimate of OCW is calculated for an indicative production year when full yields have been achieved from the irrigation scheme.

3. Import Parity Price of Rice

The calculation of the opportunity cost of water is presented in Table 4.A. For ease of presentation the reference to line numbers are all with respect to Table 4.A.

The calculation begins with the calculation of the **import parity price of rice** for the rainfed, dry season irrigated and wet season irrigated crop scenarios. The **benchmark world price of rice** used for analysis purposes is Thai (5 percent broken). This benchmark price may be obtained from the World Bank's quarterly publication *Commodity Markets and the Developing Countries*.[2] This benchmark price is equivalent for the without-project and with-project scenarios. It is shown in line 2.

The quality of the rainfed and the wet season irrigated crop are equivalent and are 10 percent lower quality than Thai (5 percent broken). The wet season crop is of the same quality as Thai (5 percent broken). The **quality adjustment factors** for the without-project and the with-project scenarios are presented in line 3.

To calculate the **quality adjusted price FOB Bangkok** shown in line 4, the benchmark price presented in line 2 is multiplied by the quality adjustment factor given in line 3 for each scenario.

It is now necessary to estimate the economic price at the port of importer (i.e., border price). This is done by adding the costs of shipping and handling from the port in Bangkok to the port of destination (say, Manila). These costs are based on weight or volume and are assumed identical for the with-project and the without-project scenarios. They are estimated at $33 as shown in line 5. By adding the quality adjusted price FOB Bangkok (line 4) and the shipping and handling costs (line 5) the CIF Port of Destination, or in this case CIF Manila, price is calculated. This is given in line 6.

As the domestic price numeraire has been selected for purposes of economic analysis it is now necessary to convert the CIF Manila price from a financial price to an economic price by applying the shadow wage rate factor (SERF). The CIF Manila price (line 6) is muliplied by the SERF (line 7) to derive the quality adjusted economic price at the border, as shown in line 8. All costs are traded to this point and must be adjusted by the SERF.

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[2] The prices used in the example may not be identical to those presented in the World Bank Commodity Markets and the Developing Country Reports.

It is also necessary to determine the economic farmgate price by calculating the costs incurred in transporting and handling the rice from the port to the farmgate. In practice, this typically includes consideration of dealer's margins, milling costs and other costs associated with the transportation and handling from the port to the farmgate. It is necessary to apportion these costs on the basis of being traded and nontraded and further separate labor costs. The SERF is to be applied to the traded components and the shadow wage rate factor (SWRF) to the labor component. For ease of illustration, all costs are considered under the category local shipping and handling in line 9 and are considered to be nontraded. The farmgate price can be calculated by adding the CIF Manila price (line 8) and the local shipping and handling costs (line 9). The farmgate prices for the rainfed, dry season irrigated and wet season irrigated crops are presented in line 10. This represents the import parity price of rice at the farmgate. It is not necessary to calculate an average farmgate price for the incremental analysis. It will be accomodated in the comparison of the with-project and the without-project analysis of crop production and farm inputs.

4. Crop Production Analysis

The next step is to perform a simplified crop production analysis. In practice, this requires knowledge of the cropping patterns, cropping intensities, yields, dry paddy to milled rice conversion factors and other factors impacting on the quality and quantity of rice yields without-project and with-project. In this illustration, the analysis of alternative crop production models indicated that paddy production had the highest value both without the project and for both the wet and dry season cropping pattern with the project. The paddy yields in tons per hectare for the rainfed, wet season irrigation and dry season irrigation are shown in line 12. The paddy yields represent dry paddy. The production of rice from dried paddy is calculated by applying the processing factor (0.59) shown in line 13 to the paddy yields in line 12. Rice production in tons per hectare are given in line 14. The gross returns in dollars per hectare given in line 16 are then calculated by multiplying the rice production estimates shown in line 14 by the farmgate price shown in line 15 (i.e., identical to the farmgate price calculated in line 10). The incremental gross margin is the difference in the with-project and the without-project scenarios calculated by taking the sum of the gross margins for irrigated crops and deducting the gross margin from rainfed crops.

5. Farm Inputs

Farm inputs represent the input costs required for crop production including labor, draught animals or machinery, seed, fertilizer, irrigation and other input factors. In practice, the market price of each input are shadow priced to derive economic values on a dollar-per-hectare basis. For purposes of this illustration farm inputs are shown as non-labor and labor inputs only. Non-labor inputs are assumed to be non-traded, requiring no further shadow pricing and are shown in line 18. Labor requires adjustment by the shadow wage rate factor (SWRF). The economic price of labor shown in line 21 is calculated by multiplying the price of labor shown in line 19 by the SWRF given in line 20. Total farm inputs shown in line 22 are the sum of non-labor inputs (line 18) and economic labor costs (line 21). Incremental farm inputs from the project are calculated by taking the sum of the wet season and dry season farm inputs (i.e., with-project production) and deducting the rainfed farm inputs (i.e., without-project production) as given in line 22.

6. Net Return

The net return for each scenario given in line 26 is the difference between the gross returns (line 24) and farm inputs (line 25), where the values of gross returns and farm inputs are equivalent to the values calculated in lines 16 and 22 respectively. Incremental net returns from the project are calculated by taking the sum of the wet season and dry season net returns (i.e., with-project production) and deducting the rainfed net returns (i.e., without-project production) as shown in line 26.

7. Water Requirements

Water requirements for irrigation purposes are now introduced into the calculation. As shown in line 28 in the rainfed scenario, there is no additional water requirement, and dry season irrigation requirements are less than wet season irrigation requirements. This is because during the wet season, rainfall provides much of the water requirement and irrigation provides the additional requirement to increase productivity. During the dry season, irrigation water accounts for the entire crop requirement. As shown in line 29, there are also losses from evaporation, transpiration and non-technical reasons incurred in the supply of irrigation water. The total irrigation water requirements for the wet and dry season are shown in line 30 and is equivalent to the sum of lines 28 and 29 . The incremental water requirement is equal to the sum of the wet and dry season irrigation water requirement.

8. Opportunity Cost of Water

It is now possible to calculate the opportunity cost of water (OCW). It is calculated by taking the incremental net return shown in line 32 which is derived from line 26 and dividing by the incremental gross water requirement shown in line 33, which is derived from line 30. In this example, as shown in line 34, the opportunity cost of water is approximately \$0.02 per m^3. This OCW can now be used as an input cost in the economic cost estimate for the WSP.

Opportunity Cost of Water based on Irrigation Benefits Foregone (Based on Import Parity Price of Rice						
Line No.	Item	Units	Rainfed Crop	Dry Season	Wet Season	Incre-mental
1	**a) Import Parity Price of Rice Calculation**					
2	Rice FOB Bangkok	$/ton	323	323	323	
3	Quality Adjustment		0.9	0.9	1.0	
4	Quality Adjusted Price FOB Bangkok	$/ton	290.7	290.7	323	
5	Shipping and Handling	$/ton	33	33	33	
6	Landed Price(CIF Port of Entry)	$/ton	323.7	323.7	356	
7	Shadow Exchange Rate Factor (SERF)		1.11	1.11	1.11	
8	Quality Adjusted Economic Border Price	$/ton	359.3	359.3	395.2	
9	Local Shipping and Handling	$/ton	5	5	5	
10	Farmgate Price	$/ton	364.3	364.3	400.2	
11	**b) Crop Production Analysis**					
12	Paddy Yields	tons/ha	1.5	3.7	2.6	
13	Processing Factor		0.59	0.59	0.59	
14	Processed Rice Production	tons/ha	0.9	2.2	1.5	
15	Farmgate Price	$/ton	364.3	364.3	400.2	
16	Gross Returns	$/ha	322.4	795.3	613.8	1,086.7
17	**c) Farm Inputs**					
18	Non-labor Farm Inputs	$/ha	66	226	150	
19	Labor Inputs	$/ha	66	155	119	
20	Shadow Wage Rate Factor (SWRF)		0.9	0.9	0.9	
21	Economic Price of Labor	$/ha	59.4	139.5	107.1	
22	Farm Inputs in Econ. Prices	$/ha	125.4	365.5	257.1	497.2
23	**d) Net Return**	$/ha				
24	Gross Returns	$/ha	322.4	795.3	613.8	1,086.7
25	Farm Inputs in Econ. Prices	$/ha	125.4	365.5	257.1	497.2
26	Net Return	$/ha	197.0	429.8	356.7	589.5
27	**e) Water Requirements**					
28	Water Required at Farm	m^3/ha	0	13,500	9,500	23,000
29	Water Losses Reservoir to Farm	m^3/ha	0	3,500	2,500	6,000
30	Gross Water Requirement	m^3/ha	0	17,000	12,000	29,000
31	**f) Opportunity Cost of Water**					
32	Net Return	$/ha				589.5
33	Gross Water Requirement	m^3/ha				29,000.0
34	Opportunity Cost of Water	$/$m^3$				0.0203

ANNEX 4.B

Data for the Illustrated Case of a Viet Nam Town Water Supply

1. Water Demand Forecast

The quantity of water demanded per day in the town is estimated at 23,077 m^3 in year 0 and it is expected to grow at the rate of 7.2 percent per year. Thus it is projected that the demand will amount to 46,145 m^3 per day in year 10.

Even though the demand will continue to grow beyond year 10, the proposed water supply project (WSP) will have a maximum output so as to meet the growing demand for only ten years from year 0.

It is expected that the new project will supply the incremental quantity of water demanded from year 1 up to the end of the life of the project, which is assumed to be 25 years.

As the non-revenue water in the system is approximately 30 percent, the quantity to be produced to meet the required revenue demand will vary from 30,000 m^3 per day (= 23,077 x 1.3) in year 0 to 60,000 m^3 per day (= 46,165 x 1.3) in year 10. Columns 1 to 5 of Table 4.B.1 show the quantity to be produced by the WSP.

Table 4.B.1 **Discounted Value of Quantity of Water Supplied**

Column 6 of this table shows the discounted value when the water quantities are discounted at the rate of 12%.

Col 1 Year	*Col 2* Sale Quantity per day (m^3)	*Col 3* Quantity to be produced per day (sale quantity x 1.3*) (m^3)	*Col 4* Incremental quantity to be produced/day by the project (m^3)	*Col 5* Quantity to be produced by the project in a year (Mm^3)	*Col 6* Discounted value @ 12% discount rate (Mm^3)
0	23,077	30,000	-	-	-
1	24,738	32,160	2,160	0.79	0.705
2	26,520	34,476	4,476	1.63	1.299
3	28,428	36,957	6,957	2.54	1.808
4	30,475	39,618	9,618	3.51	2.231
5	32,670	42,471	12,471	4.55	2.582
6	35,022	45,528	15,528	5.67	2.872
7	37,544	48,807	18,807	6.86	3.103
8	40,246	52,320	22,320	8.14	3.288
9	43,145	56,088	26,088	9.52	3.329
10	46,154	60,000	30,000	10.95	
11	46,154	60,000	30,000	10.95	
12	46,154	60,000	30,000	10.95	
13	46,154	60,000	30,000	10.95	
14	46,154	60,000	30,000	10.95	
15	46,154	60,000	30,000	10.95	
16	46,154	60,000	30,000	10.95	
17	46,154	60,000	30,000	10.95	
18	46,154	60,000	30,000	10.95	=27.537
19	46,154	60,000	30,000	10.95	
20	46,154	60,000	30,000	10.95	
21	46,154	60,000	30,000	10.95	
22	46,154	60,000	30,000	10.95	
23	46,154	60,000	30,000	10.95	
24	46,154	60,000	30,000	10.95	
25	46,154	60,000	30,000	10.95	
					48.858

**UFW is assumed to be 30 percent.*

2. Supply of Water from the Two Alternatives of the Project

Whereas alternative 1 (ground water scheme) will be supplying the annual water requirements of the town from year 1 to year 25 (see Column 5 of Table 4.B.1), alternative 2 (surface water scheme) will be supplying the project from year 1 to year 8; but from year 9 to year 25, the project water supply will be confined to 25,000 m^3 per day. The remaining quantity of 1,088 m^3/day (= 26,088 m^3 – 25,000 m^3) in year 9 and

5,000 m^3/day (= 30,000 m^3 – 25,000 m^3) from year 10 to year 25 will be met by water diverted from agricultural use. This is shown in Table 4.B.2.

Table 4.B.2 **Quantity of Water to be Produced for the Ground water and Surface Water Alternative**

Year	Alternative 1 (ground water)	Alternative 2 (surface water)	
	from the project (Mm^3)	from the project (Mm^3)	diverted from agricultural use
0	-	-	-
1	0.79	0.79	-
2	1.63	1.63	-
3	2.54	2.54	-
4	3.51	3.51	-
5	4.55	4.55	-
6	5.67	5.67	-
7	6.86	6.86	-
8	8.14	8.14	-
9	9.52	9.125	0.395
10	10.95	9.125	1.825
11	10.95	9.125	1.825
12	10.95	9.125	1.825
13	10.95	9.125	1.825
14	10.95	9.125	1.825
15	10.95	9.125	1.825
16	10.95	9.125	1.825
17	10.95	9.125	1.825
18	10.95	9.125	1.825
19	10.95	9.125	1.825
20	10.95	9.125	1.825
21	10.95	9.125	1.825
22	10.95	9.125	1.825
23	10.95	9.125	1.825
24	10.95	9.125	1.825
25	10.95	9.125	1.825

3. Construction Period

The project construction period is expected to be four years. The physical progress determining the financial expenditure during the construction period will be as follows:

Year	Physical Progress
0	5%
1	30%
2	45%
3	20%
	100%

4. Depletion Premium for Alternative 1 (Ground Water Supply)

The depletion premium worked out in section 4.3.2.2 is to be added as "other costs" in the case of alternative 1 (see data in Table 4.5).

5. Opportunity Cost of Water for Alternative 2 (Surface Water Supply)

The opportunity cost of water diverted from agricultural use (0.395 million m^3 in year 9 and 1.825 million m^3 in years 10 to 25) are to be added as "other costs" (see data in Table 4.4).

6. Capital Costs (Ground Water Supply) and (Surface Water Supply)

They are given in Tables 4.1 and 4.2.

7. Operation and Maintenance Costs

They are given in Table 4.3.

LEAST-COST SOLUTION OF THE CASE

1. Capital Costs:

A. Alternative 1 (ground water scheme)

The total economic cost of the scheme for a daily supply of 60,000 m^3 is estimated at VND229,779 million (from section 3.A below). The maximum water supply of the project will be only half of 60,000 m^3 per day i.e. 30,000 m^3 per day. The cost function of capital and O&M cost of the water supply scheme shows that the economics of scale factor is 0.7 as ascertained in the Viet Nam Town by the RETA 5608 Study.

The cost function of water supply with the use of scale factor is as follows:

$$C = k\,(Q)^{\alpha}$$

Where C = Cost
k = constant
Q = Quantity
α = Scale factor

Applying this for 60,000 m^3 water per day, the cost function is:

$$C_{60000} = k\,(60{,}000)^{0.7}$$

To arrive at the cost for 30,000m^3/day, the following relationship can be used:

$$\frac{C_{30000}}{C_{60000}} = \frac{k\,(30{,}000)^{0.7}}{k\,(60{,}000)^{0.7}}$$

or

$$\begin{aligned} C_{30000} &= C_{60000}\ (1/2)^{0.7} \\ &= (229{,}779)\ \times (1/2)^{0.7} \\ &= 229{,}779\ \times\ 0.61557 \\ &= \text{VND141,445 million.} \end{aligned}$$

This cost is expected to be distributed as follows during the construction period.

(Year)	(%)	VND Million
0	5%	7,072
1	30%	42,434
2	45%	63,651
3	20%	28,289
	100%	141,446

B. Alternative 2 (surface water scheme)

The maximum amount of water which can be drawn from the canal is 25,000 m^3 per day. The remaining 5,000 m^3 per day will be met by diverting water from existing agricultural use. The capital economic cost for supply of 60,000m^3/day has been worked out to be VND208,710 million (from Section 3A below). Hence, the capital cost for a supply of 25,000m^3/day from the surface water scheme

$$= (208{,}710) \times \left[\frac{25{,}000}{60{,}000}\right]^{0.7} = (208{,}710) \times (0.54182) = \text{VND}113{,}083 \text{ million}$$

The distribution of this cost over the construction period is as follows:

(Year)	(%)	VND million
0	5%	5,654
1	30%	33,925
2	45%	50,887
3	20%	22,617
	100%	113,083

2. Operating and Maintenance Costs

A. For Alternative 1 (ground water scheme)

The economic O&M costs per year for supply of 60,000 m^3/day was worked out to be VND2,596 million (from Section 3.B below). The supply in year 1 is 2,160 m^3/day and it is expected to rise up to 30,000 m^3/day in year 10. The scale factor is expected to be the same 0.7 as O&M is proportional to the size of the plant. Hence, the O&M costs will be:

In year 1: (2,596) x $\left[\frac{2,160}{60,000}\right]^{0.7}$ = VND253.35 million

In year 10: (2,596) x $\left[\frac{30,000}{60,000}\right]^{0.7}$ = VND1,598.03 million

B. Alternative 2 (surface water scheme)

The economic O&M costs per year for supply of 60,000 m^3/day was worked out to be VND3,095 million (from section 3.A below). Hence the O&M costs will be:

In year 1: (3,095) x $\left[\frac{2,160}{60,000}\right]^{0.7}$ = VND 302.05 million

In year 10: (3,095) x $\left[\frac{25,000}{60,000}\right]^{0.7}$ = VND 1,676.92 million

3. Economic Costs of the Two Options

They can now be arrived at:

(A) Capital Costs for 60,000 m^3/day Supply

Alternative 1 (ground water supply)
Economic Costs = [Market Costs] x CF_I
Economic costs = [VND210,806.5 mn] x [1.09] = VND229,779 mn
(Note: CF_I = 1.09 from Table 4.6; Market costs are taken from Table 4.1.)

Alternative 2 (surface water supply)
Economic Costs = [Market Costs] x CF_2
Economic Costs = [VND201,262.92 mn] x [1.037] = VND208,709 mn.
(Note: CF_2 = 1.037 from Table 4.7; Market costs are taken from Table 4.2.)

(B) O&M Costs for 60,000m^3/day Supply

Alternative 1 (ground water supply)
Economic Costs = [Market Costs] x CF_I
Economic Costs = [VND2,392.67mn] x [1.085] = VND2,596.05 mn
(Note: CF_I = 1.085 from Table 4.6; Market costs are taken from Table 4.3.)

Alternative 2 (Surface Water Supply)
Economic Costs = [Market Costs] x CF_2
Economic Costs = [VND2,882.09mn] x [1.074] = VND3,095.36 mn
(Note: CF_2 = 1.074 from Table 4.7; Market costs are taken from Table 4.3.)

Table 4.B.3 **Life Cycle Costs Stream of Alternative 1**
(Ground Water Supply)

(A) Without Depletion Premium

Year	Capital costs (VND10⁶)	O&M Costs (VND10⁶)	Total Costs (VND10⁶)	Discount Factor for 12% discount rate	Discounted value (VND10⁶)
0	7,072	-	7,072.00	1.0000	7,072.00
1	42,434	253.35	42,687.25	0.8929	38,115.54
2	63,651	421.91	64,072.91	0.7972	51,078.04
3	28,289	574.50	28,863.50	0.7118	20,545.04
4		720.71	720.71	0.6355	458.01
5		864.43	864.43	0.5674	490.48
6		1,007.81	1,007.81	0.5066	510.56
7		1,152.45	1,152.45	0.4523	521.25
8		1,299.23	1,299.23	0.4039	524.76
9		1,499.13	1,499.13	0.3606	522.55
10		1,598.03	1,598.03	0.3220	514.57
11-25		1,598.03	1,598.03	2.1929[a/]	3,504.31
					123,858.00

[a/] Discount factor 2.1929 = 7.8431 – 5.6502 where 5.6502 is the sum of discount factors for the first ten years.
PVEC = VND123,858.00 million.
The discounted value of water = 48,858 million m^3 (from Table 4.B.1).

$$AIEC = \frac{123,858}{48.858} = VND2,535 \text{ per } m^3$$

(B) With Depletion Premium

Total PVEC = Total Discounted Costs
= [Discounted cost without D.P.]
+ [Discounted value of depletion premium (from Table 4.4)]
= (123,858) + (517.54) = VND124,375.54million.

Therefore, the $$AIEC = \frac{124,375.54}{48.858} = VND2,545 \text{ per } m^3$$

Table 4.B.4 **Life Cycle Cost Stream for Alternative 2**
(*Surface Water)*

Year	Capital Costs (VNDmn)	O&M costs (VNDmn)	Other costs *from Table4.5* (VNDmn)	Total (VND mn)	D.F. for 12% D.R.	Discounted Cost (VNDmn)
0	5,654	-		5,654.00	1.0000	5,654.00
1	33,925	302.05		34,227.00	0.8929	30,561.29
2	50,887	503.01		51,390.00	0.7972	40,968.11
3	22,617	684.94		23,302.00	0.7118	16,586.36
4		859.24		859.24	0.6355	546.00
5		1,030.59		1,030.59	0.5674	584.80
6		1,201.53		1,201.53	0.5066	608.70
7		1,373.97		1,373.96	0.4523	621.40
8		1,548.96		1,548.96	0.4039	625.60
9		1,676.92	2,202	3,878.92	0.3606	1,398.70
10		1,676.92	10,118	11,794.92	0.3220	3,798.00
11-25		1,696.72	10,118	11,794.92	2.1929[a/]	25,865.10
						127,818.06

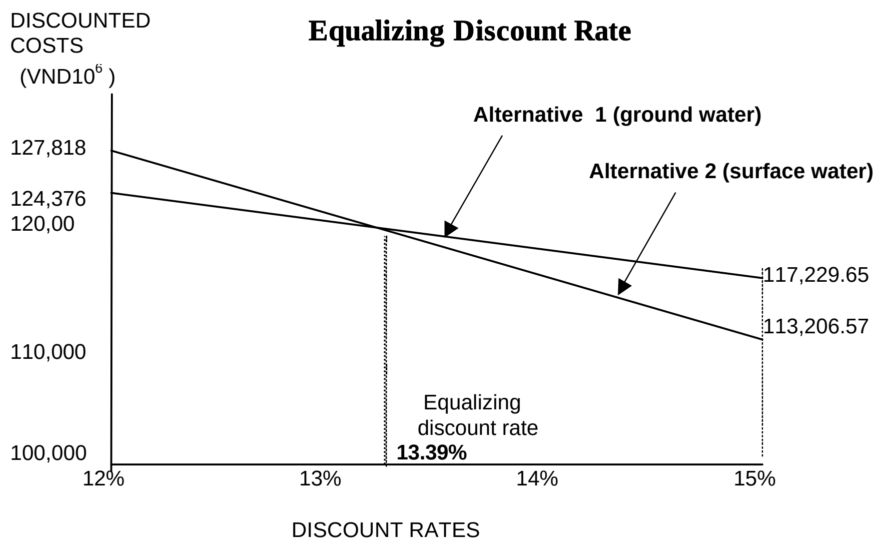
[a/] 2.1929 = 7.8431 – 5.6502

PVEC = VND 127818.06 million, and AIEC = $\frac{127,818.06}{48.858}$ = VND2,616.11 per m^3

PVEC (without other costs) = VND101,578.26 million (in column 4)

Table 4.B.5 **Equalizing Discount Rate**

Year	ALTERNATIVE I (Ground Water Supply)			ALTERNATIVE II (Surface Water Supply)		
	Cost Stream (excluding depletion premium) VND(10^6)	*Discounted Costs* (VND10^6) at 12% rate of discount	*Discounted Costs* (VND10^6) at 15% rate of discount	*Cost Stream* (excluding depletion premium) (VND10^6)	*Discounted Costs* (VND10^6) at 12% rate of discount	*Discounted Costs* (VND10^6) at 15% rate of discount
0	7,072.00	7,072.00	7,072.00	5,654.00	5,654.00	5,654.00
1	42,687.25	38,115.54	37,120.80	34,227.00	30,561.29	29,763.80
2	64,072.91	51,078.04	48,445.50	51,390.00	40,968.11	38,856.00
3	28,863.50	20,545.04	18,977.80	23,302.00	16,586.36	15,321.07
4	720.71	458.01	412.10	859.24	546.00	491.30
5	864.43	490.48	429.80	1,030.59	584.80	512.40
6	1,007.81	510.56	435.70	1,201.53	608.70	519.40
7	1,152.45	521.25	433.20	1,373.96	621.40	516.50
8	1,299.23	524.76	424.70	1,548.96	625.60	506.40
9	1,499.13	522.55	426.20	3,878.92	1,398.70	1,102.80
10	1,598.03	514.57	395.00	11,794.92	3,798.00	2,915.70
11-25	1,598.03	3,504.31	2,309.60	11,794.92	25,865.10	17,047.20
		123,858.00	116,882.40		127,818.06	113,206.57
Add discounted value of depletion premium (from Table 4.5)		517.54	347.25			
		124,375.54	117,229.65			



DISCOUNTED
COSTS
(VND10^6)
Equalizing Discount Rate
Alternative 1 (ground water)
Alternative 2 (surface water)
127,818
124,376
120,00
110,000
100,000
117,229.65
113,206.57
Equalizing
discount rate
13.39%
12%
13%
14%
15%
DISCOUNT RATES

Table 4.B.6 **IRR of the Incremental Cash Flow** *(Alternative 1 - Alternative 2)*

Year	Alternative 1 (Ground water) Cost stream (VND10^6)	Alternative 2 (Surface Water) Cost stream (VND10^6)	Difference in cost streams (Alt 2 - Alt 1) (VND10^6)	Discount factor for 15% DR	Discounted value of cost stream differences (VND10^6)	Discount factors for 12% DR	Discounted value of cost-stream differences (VND10^6)
0	7,072.00	5,654.00	-1,418.00	10000	-1,418.00	1.0000	-1,418.00
1	42,687.25	34,227.00	-8,460.25	0.8696	-7,357.74	0.8929	-7,553.79
2	64,072.91	51,390.00	-12,682.90	0.7561	-9,590.09	0.7972	-10,110.70
3	28,863.50	23,302.00	-5,561.5	0.6575	-3,656.78	0.7118	-3,958.57
4	720.71	859.24	+138.53	0.5718	+79.20	0.6355	+88.04
5	864.43	1,030.59	+166.16	0.4972	+82.61	0.5674	+94.28
6	1,007.81	1,201.53	+193.72	0.4323	+83.75	0.5066	+98.14
7	1,152.45	1,373.96	+221.51	0.3759	+83.27	0.4523	+100.20
8	1,299.23	1,548.96	+249.73	0.3269	+81.64	0.4039	+100.86
9	1,449.13	3,878.92	+2,429.79	0.2843	+690.79	0.3606	+876.21
10	1,598.03	11,794.92	+10,196.89	0.2472	+2,520.52	0.3220	+3,283.13
11-25	1,598.03	11,794.92	+10,196.89	1.4453[a/]	+14,738.39	2.1929[b/]	+22,360.92
					-3,661.53		+3,960.69

[a/] 1.4453 = 6.4641 – 5.0188

[b/] 2.1929 = 7.8431 – 5.6502

Notes for Table 4.B.6:

(1) Without depletion premium in Alternative 1:

IRR of the incremental cash flow $= 12 + (15 - 12) \times \dfrac{3,960.69}{3,960.69 + 3,661.53}$

$= 12 + 1.56 = 13.56\%$

(2) With depletion premium in Alternative 1:

Discounted value of depletion premium (refer to Table 4.5 in para. 4.3.2.2)

(i) at 12% Rate of Discount = VDN517.54 million

(ii) at 15% Rate of Discount = VND347.25 million

Discounted cost stream differential:

(i) at 12% Rate of Discount = 3,960.69 – 517.54

= 3,443.15

(ii) at 15% Rate of Discount = –3,661.53 – 347.25

= –4,008.78

IRR of the incremental cash flow $= 12 + (15 - 12) \times \dfrac{3,443.15}{3,443.15 + 4,008.78}$

$= 12 + 1.39 = 13.39\%$

CHAPTER 5

FINANCIAL BENEFIT-COST ANALYSIS

CONTENTS

Tables

5.1 Introduction

1. The purpose of the financial benefit-cost analysis is to assess the financial viability of the proposed project, i.e., if the proposed project is financially attractive or not from the entity's viewpoint. This analysis is done for the chosen least-cost alternative which is identified following methodology described in Chapter 4.

2. In the financial benefit-cost analysis, the unit of analysis is the *project* and not the entire economy nor the entire water utility. Therefore, a focus on the *additional* financial benefits and costs to the water utility, attributable to the project, is maintained. In contrast, the economic benefit-cost analysis evaluates the project from the viewpoint of the entire economy whereas the financial analysis evaluates the entire water utility by providing projected balance, income, and sources and applications of fund statements. Financial analysis is the subject of the *ADB Guidelines on the Financial Analysis of Projects*.

3. The financial benefit-cost analysis includes the following eight steps:

(i) determine annual project revenues;
(ii) determine project costs;
(iii) calculate annual project net benefits;
(iv) determine the appropriate discount rate (i.e., weighted average cost of capital serving as proxy for the financial opportunity cost of capital);
(v) calculate the average incremental financial cost;
(vi) calculate the financial net present value;
(vii) calculate the financial internal rate of return; and
(viii) risk and sensitivity analysis.

4. Project revenues, costs and net benefits are determined on a with-project and without-project basis. They are estimated in constant prices for a selected year (e.g., constant 1998 prices), typically using the official exchange rate at appraisal. The revenues of the project comprise of entirely user charges, that is, no government subsidies are included.

5.2 Financial Revenues

5. The focus of the financial benefit-cost analysis is on the financial benefits and costs of the project intervention. Hence, the project's water sales revenues are determined on a with-project and without-project basis. In this way, the contribution of the project to the total revenues of the utility is estimated.

6. The project revenues are usually determined for different groups of users, such as households, government institutions and private commercial/industrial establishments. Each may have a different consumption pattern, may be charged a different tariff and may respond differently to tariff increases. These price-quantity relationships are part of the demand forecast presented in Chapter 3.

7. Table 5.1 illustrates the calculation of project revenues. In the example, the existing water supply system has reached its maximum supply capacity. It has been assumed that, without the project, the system will be properly maintained and operated so that the present volume and quality of water supply can be maintained in the future. With the project, the water supply system will be extended to supply (increased quantities of) water to existing as well as new consumers. The project water supply and revenues are determined as the difference between the with-project and the without-project situations.

Table 5.1 **Estimation of Project Revenues** *(1996 prices)*

		unit	1996	1997	1998	1999	2000	2005
1	**Domestic consumers**							
2	Water supplied with-project	‘000 m³	1,239	1,518	1,864	2,289	2,819	3,954
3	Water supplied without-project	‘000 m³	1,239	1,239	1,239	1,239	1,239	1,239
4	Project water supply	‘000 m³	0	279	625	1,050	1,580	2,715
5	Average tariff	VND/m³	2,220	2,394	2,581	2,782	3,000	4,500
6	Project revenues	VND mn	0	668	1,613	2,922	4,740	12,217
7	**Government establishments**							
8	Water supplied with-project	‘000 m³	293	300	308	315	324	454
9	Water supplied without-project	‘000 m³	293	293	293	293	293	293
10	Project water supply	‘000 m³	0	7	15	22	31	161
11	Average tariff	VND/m³	2,800	3,061	3,347	3,659	4,000	4,500
12	Project revenues	VND mn	0	21	50	80	124	726
13	**Private establishments**							
14	Water supplied with-project	‘000 m³	332	339	348	356	366	513
15	Water supplied without-project	‘000 m³	332	332	332	332	332	332
16	Project water supply	‘000 m³	0	7	16	24	34	181
17	Average tariff	VND/m³	4,500	4,620	4,743	4,870	5,000	5,500
18	Project revenues	VND mn	0	32	76	117	170	997
19	**Subtotal water revenues**							
20	Total project water revenues	VND mn	0	722	1,739	3,119	5,034	13,940
21	Total project water supply	‘000 m³	0	293	656	1,096	1,645	3,058
22	**Connection fees**							
23	Average connection fee	‘000 VND	1,500	1,500	1,500	1,500	1,500	1,500
24	New connections with-project	number	0	1,701	2,045	2,459	2,957	0
25	New connections without-project	number	0	0	0	0	0	0
26	Additional connections	number	0	1,701	2,045	2,459	2,957	0
27	Project connection fees	VND mn	0	2,552	3,068	3,689	4,436	0
28	Total project revenues	VND mn	0	3,273	4,807	6,807	9,470	13,940

Note: Years 2001-2004 are not shown in this example.

8. The average tariff presented in constant 1996 prices as shown in Table 5.1, was projected to increase significantly with the implementation of the project, to achieve a higher level of cost recovery, as follows (VND/m³):

	Year		
consumers	1996	2000	2005
domestic	2,220	3,000	4,500
government	2,800	4,000	4,500
private	4,500	5,000	5,500

9. This tariff proposal took into account the ability to pay of domestic consumers and involves some degree of cross-subsidization between domestic and non-domestic consumers.

10. The water demand forecast used for illustrative purposes includes the effect of price as well as real per capita income increases on demand. Overall increase in water demand will mainly result from new domestic consumers connected to the new water system project, as shown in Table 5.1.

5.3 Project Costs

11. Once the least-cost alternative has been selected, the preliminary project cost estimates are typically worked out in greater detail by the engineer. The following main categories are distinguished:

(i) investments;
(ii) operation and maintenance; and
(iii) re-investments during the life cycle.

12. Again, the costs should be attributed to the project on a with-project and without- project basis. Only the additional costs due to the project should be taken into account. The basis to attribute costs to the project should be the formulated with-project and without-project scenarios. In Section 5.2 for example, it was assumed that without the project, the existing water supply would be properly maintained and operated, and that the present level of services would continue if the project were not implemented. The project costs should be calculated on an annual basis and should be equal to the with-project costs less the without-project costs. It should also be noted that in many cases the system would deteriorate further in the without-project scenario.

5.3.1 Investments

13. The breakdown of an investment cost estimate of total US$83.00 million (including IDC) is shown in Table 5.2 where foreign and local currency components were distinguished to establish the foreign exchange implications of the project and counterpart financing requirements. Following the general principles of discounting according to which costs and benefits are entered in the analysis in the year in which they occur, interest during construction (IDC) is excluded from the costs used in the financial benefit-cost analysis.

Table 5.2 **Project Cost Estimates** a/ ($ million)

Component	Foreign Currency	Local b/	Total
A. WATER SUPPLY			
1. Land	-	1.17	1.17
2. Civil Works			
- Drilling of Wells by Contractors	0.92	1.85	2.77
- Civil Works by Contractors	12.75	19.94	32.69
- Civil Works by WDs	1.85	10.15	12.00
3. Procurement of Equipment			
- Pipes and Fittings	4.16	0.46	4.62
- Pumps and Motors	1.39	0.15	1.54
- Water Meters	2.78	0.30	3.08
- Office Equipment	0.28	0.03	0.31
- Stored Materials	1.60	0.47	2.07
4. Studies and Construction Management by Administration	-	1.54	1.54
Subtotal (A)	25.73	36.06	61.79
B. HEALTH EDUC & WATER TESTING			
1. Health and Hygiene Education Program	-	0.08	0.08
2. Water Quality Testing Program			
a. Training for Staff and Conduct of Testing	-	0.02	0.02
b. Civil Works	-	0.18	0.18
c. Procurement of Equipment			
- Equipment for Water Analysis Laboratories	0.56	0.06	0.62
- Chemicals and Reagents	0.07	0.01	0.08
- Portable Water Analysis Kits	0.41	0.05	0.46
d. Land	-	0.16	0.16
Subtotal (B)	1.04	0.56	1.60
C. INSTITUTIONAL DEVELOPMENT			
1. Capacity-Building Program			
- Training of Water Districts' Staff	-	0.96	0.96
- LWUA's Project Management Staff	0.06	0.03	0.09
2. Benefit Monitoring and Evaluation	-	0.07	0.07
3. Consulting Services	1.60	3.25	4.85
Subtotal (C)	1.66	4.31	5.97
D. INTEREST DURING CONSTRUCTION	6.68	6.96	13.64
TOTAL	35.11	47.89	83.00
PERCENT	42.3	57.7	100.00

a/ August 1996 price level

b/ Local cost includes duties and taxes estimated at $6.4 million equivalent or 10% of civil works, equipment, materials and consulting services.

5.3.2 Operation and maintenance

14. Estimates of operation and maintenance (O&M) costs are usually provided to the economist by the engineer or financial analyst. In practice, different ways of estimating O&M costs are used. One approach is to estimate the O&M costs as a percentage of (accumulated) investment costs. Another approach might be to analyze the utility's past performance and to relate the total O&M costs to the volume of water produced and/or distributed. And a third approach relates specific costs items to specific outputs and totals them in a second step. For example, costs of electricity and chemicals could be calculated on the basis of a specific requirement per m^3 produced and the labor requirements could be calculated on the basis of the number of employees per connection.

15. The elements of O&M costs may include:

- labor;
- electricity;
- chemicals;
- materials;
- overhead;
- raw water charges;
- insurance;
- other.

5.3.3 Reinvestments

16. Different project investment assets have different lifetimes and need replacement within the project lifetime. The cost of those reinvestments needs to be included in the project's benefit-cost calculation.

5.3.4 Residual values

17. The residual value of project assets at the end of the project life should be included in the benefit-cost analysis as a negative cost (or benefit).

5.4 Net Financial Benefits

18. The project net benefit is the difference between the project revenues and project costs. Sometimes, the net benefit stream is called the (net) cash flow.

19. An example of a net benefit calculation is shown in Table 5.3. Here, the project revenues are drawn from Table 5.1. The project costs comprise of (i) phased investment costs during 1996-1999; (ii) operation and maintenance costs (VND1,400 per m³ water sold); (iii) sales taxes (1 percent on water sales, 3 percent on connection fees); (iv) business and land taxes (lump sum of VND100 mn per year); and (iv) connection costs (VND1.425 mn per connection).

Table 5.3 **Net Financial Benefits** *(1996 VND mn)*

		1996	1997	1998	1999	2000	2005 2026
1	**Project revenues**						
2	Water sales revenues						
3	Domestic consumers	0	668	1,613	2,922	4,740	12,217
4	Government establishments	0	21	50	80	124	726
5	Private establishments	0	32	76	117	170	997
6	Subtotal	0	722	1,739	3,119	5,034	13,940
7	Connection fees	0	2,552	3,068	3,689	4,436	0
8	Total project revenues	0	3,273	4,807	6,807	9,470	13,940
9	**Project costs**						
10	Investments	7,184	43,107	64,660	28,738	0	0
11	Operation and maintenance	0	410	918	1,534	2,303	4,281
12	Sales taxes	0	84	109	142	183	139
13	Business/land tax	0	100	100	100	100	100
14	Connection costs	0	2,424	2,914	3,504	4,214	0
15	Total project costs	7,184	46,125	68,702	34,018	6,800	4,520
16	**Net financial benefit**	-7,184	-42,852	-63,895	-27,211	2,669	9,420

Note: Years 2001-2004 are no shown in this example.

20. Discounted at FOCC, the net benefit stream during the lifetime of the project (30 years) shows the project's worth. An internal rate of return calculated on the net benefit stream shows the project's profitability. Both profitability measures will be further discussed in section 5.6. after the discount rate to be used is determined.

5.5 Financial Opportunity Cost of Capital

and Weighted Average Cost of Capital

21. For water supply projects (WSPs), the weighted average cost of capital (WACC) is typically used as the benchmark to assess the financial viability of the project. Although it is an accepted benchmark, it is important to understand that the WACC may not fully reflect the financial opportunity cost of capital (FOCC) in the market. Although a project may generate sufficient returns to allow full recovery of all investment and O&M costs while still yielding a small return on investment, this return may not be sufficient incentive for the owner to make the original investment or to maintain the investment.

22. Private foreign investors will be looking for returns on equity that also includes an allowance for risks, such as political and economic. Private domestic investors will also have alternative investments, whether they be in financial assets, other productive activities or areas such as real estate. Government investment may be guided by whether the funds are fungible, by the real cost of investment funds and the economic benefits of the project. If funds are fungible, they may be more interested in investing in projects with higher returns, economic and/or financial.

23. Finally, projects with low returns are riskier to implement and strain the financial sustainability of the corporate entity (public or private) charged with its operation and maintenance. Consequently, it is important to keep these issues in mind when comparing the FIRR of a project against a benchmark such as the WACC. These issues become particularly important as the role of government in the supply and operation and maintenance of infrastructure services changes and private sector participation becomes more prevalent.

5.6 Calculating the Weighted Average Cost of Capital

24. The discount rate to be used in financial benefit-cost analysis is the weighted average cost of capital (WACC). This WACC represents the cost incurred by the *entity* in raising the capital necessary to implement the project. Since most projects use several sources to raise capital and each of these sources may seek a different return, the WACC represents a weighted average of the different returns paid to these sources. The WACC is calculated first by estimating the nominal cost of the different

sources of capital. In Table 5.4, the nominal cost after corporate tax is shown. In a second step, the WACC in nominal terms is corrected for inflation to form the WACC in real terms, as shown in Table 5.4.

Table 5.4 **Sample Calculation of Weighted Average Cost of Capital**

	Weight	Nominal Cost	After Tax (Tax 40%)
ADB loan	40%	6.70%	4.02%
Commercial loan	20%	12.00%	7.20%
Grant	5%	0.00%	0.00%
Equity participation	35%	10.00%	10.00%
Total	100%		
WACC,nominal			6.55%
Inflation rate			4.00%
WACC,real[(1+0.0655)/(1+0.0400)]-1			2.45%

25. In this example, the project provides its own equity capital (35 percent) and raises additional capital from local banks (20 percent), from the ADB (40 percent), and obtains a grant from the government (5 percent). The project entity pays a different nominal return to each source of capital, including the expected return of 10 percent on its equity to its shareholders.

26. Interest payments to the ADB and to the commercial bank are deductible from pretax income, with corporate taxes of 40 percent (60 percent of interest payments to the ADB and to the commercial bank remains as the actual cost of capital to the project). Dividend paid to shareholders (if any) is not subject to corporate tax; it might be subject to personal income tax, which does not impose a cost to the utility.

27. The weighted average cost of capital in nominal terms is obtained by multiplying the nominal cost of each source of capital after tax with its respective weight. In Table 5.4, it is calculated as 6.55 percent. To obtain the WACC in real terms, the nominal WACC is corrected for inflation of 4 percent as follows:

$$\text{WACC real} = \{(1+\text{WACC nominal})/(1+\text{inflation})\} - 1$$

28. In the example, the WACC in real terms amounts to 2.45 percent. This is the discount rate to be used in the financial benefit-cost analysis of this particular project as a proxy for the financial opportunity cost of capital (FOCC).

29. The sample calculation in Table 5.3 has been done "after tax". For the purpose of distribution analysis, however, the NPV is calculated "before tax", using a discount rate of 12 percent in both financial and economic analysis.

5.7 Financial IRR and NPV

30. The profitability of a project to the entity is indicated by the project's financial internal rate of return (FIRR). The FIRR is also the discount rate at which the present value of the net benefit stream in financial terms becomes zero.

31. In Table 5.5, project revenues, project costs and project net benefits have been presented for the full project period (i.e., 30 years) where, for the purpose of the illustration, it has been assumed that revenues and costs will remain constant from year 2006 onwards.

Table 5.5 **Estimation of FIRR and FNP**
(1996 prices)

Year	Project Water (*'000 m³*)	Project Cost (*VND mn.*)	Project Revenues (*VND mn.*)	Project Net Benefit (*VND mn.*)
1996	0	7,184	0	-7,184
1997	293	46,125	3,273	-42,852
1998	656	68,702	4,807	-63,895
1999	1,096	34,018	6,807	-27,211
2000	1,645	6,800	9,470	2,669
2001	1,891	2,810	6,306	3,496
2002	2,153	3,193	7,795	4,602
2003	2,435	3,604	9,535	5,931
2004	2,736	4,045	11,568	7,522
2005	3,058	4,520	13,940	9,420
2006	3,058	4,520	13,940	9,420
2007	3,058	4,520	13,940	9,420
2008	3,058	4,520	13,940	9,420
2009	3,058	4,520	13,940	9,420
2010	3,058	4,520	13,940	9,420
2011	3,058	4,520	13,940	9,420
2012	3,058	4,520	13,940	9,420
2013	3,058	4,520	13,940	9,420
2014	3,058	4,520	13,940	9,420
2015	3,058	4,520	13,940	9,420
2016	3,058	4,520	13,940	9,420
2017	3,058	4,520	13,940	9,420
2018	3,058	4,520	13,940	9,420
2019	3,058	4,520	13,940	9,420
2020	3,058	4,520	13,940	9,420
2021	3,058	4,520	13,940	9,420
2022	3,058	4,520	13,940	9,420
2023	3,058	4,520	13,940	9,420
2024	3,058	4,520	13,940	9,420
2025	3,058	4,520	13,940	9,420
2026	3,058	4,520	13,940	9,420
PV@2.45%	52,440	224,359	240,285	15,925
Per m³		4,278	4,582	304
FIRR				3.24%
FNPV @ 2.45%				VNDmn 15,925
FNPV @ 3.24%				VNDmn 0
FNPV @ 12.00%				VNDmn –66,903

32. The discount rate at which the present value of the net benefits becomes zero works out to be 3.24 percent. This is the FIRR, which should be compared to the WACC. If the FIRR exceeds the WACC, the project is considered to be financially viable. If the FIRR is below the WACC, the project would only be financially viable if subsidized by the government. In the example, the FIRR of 3.24 percent is above the WACC of 2.45 percent, and hence the project is financially viable.

33. The financial net present value (FNPV) shows the present value of the net benefit stream, or the projects' worth today. The discount rate to be used here is the WACC. A positive FNPV indicates a profitable project, i.e. the project generates sufficient funds to cover its cost, including loan repayments and interest payments. If the FNPV, discounted at the WACC of 2.45 percent, turns out to be positive, the project is earning an interest of at least the required 2.45 percent. In the example, as the FIRR is 3.24 percent, the project earns an interest of 3.24 percent. The project, thus, earns more than the required 2.45 percent interest, recovers all investment and recurrent costs, and yields a very small profit.

34. A negative FNPV points to a project that does not generate sufficient returns to recover its costs, to repay its loan and to pay interest. Note that, as a general principle of discounting cash flows for the purpose of IRR calculations, loan repayments and interest payments are not considered part of the economic cost.

35. Discounted at the WACC of 2.45 percent, the FNPV of the project is positive VND1.59 billion. The project is thus financially profitable. If a discount rate of 3.24 percent is used (equal to the FIRR), the FNPV equals (by definition) zero.

36. The example shows that if the discount rate used (2.45 percent) is below the FIRR (3.24 percent), the FNPV is positive; vice versa, if the discount rate used (5, 10, 12 percent) is above the FIRR (3.24 percent), the FNPV is negative.

37. The last line of Table 5.4 has included the discounted volume of project water and the discounted values of project costs, revenues and net benefits. The AIFC is VND4,278 per m^3 calculated as the present value of project costs divided by the present value of the quantity of project water. Similarly the present value of project revenues divided by the present value of project water represents the average financial revenue per m^3, in the example VND4,582 per m^3; and the present value of project net benefits divided by the present value of project water indicates the profit (loss) per m^3, in the example VND304 per m^3.

CHAPTER 6

ECONOMIC BENEFIT-COST ANALYSIS

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Figures

Boxes

Tables

6.1 Identification of Economic Benefits and Costs

6.1.1 Basic Principles

1. After choosing the best among project alternatives and verifying the financial viability of the selected option, the next step is to test the economic viability of that option. The initial step in testing the economic viability of a project is to identify, quantify and value the economic costs and benefits. Two important principles to be followed are:

(i) Comparison between with- and without-project situations; and

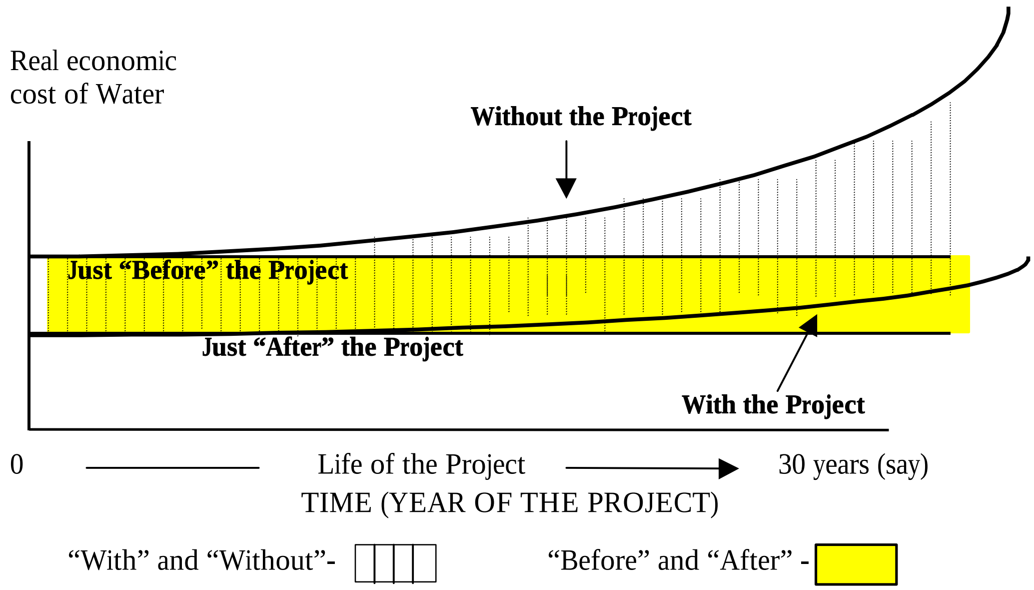
(ii) Distinction between nonincremental and incremental inputs (costs) and outputs (benefits).

6.1.2 With- and Without-cases: Comparison

2. The comparison between “with” and “without” the project is often different from the comparison between “before” and “after” the project. The without-project situation is that which would prevail if the project is not undertaken. For example, population in the project area will grow leading to an increase in the use of water; and water sources will become increasingly scarce and remote, contributing to a higher cost of water to the consumers. The situation, therefore, will not remain static at the level just “before” the project.

3. The project inputs and outputs should be identified, quantified and valued by comparing the without-project situation with that of the with-project to cover the relevant project benefits and costs. Figure 6.1 shows the differences of the real economic cost of water in the with- and without-project and the before- and after-project situations. A similar diagram could also be used to show the differences in the benefits between the various project situations.

Figure 6.1 **"With" and "Without" Project vs. "Before" and "After" Project**



6.1.3 Nonincremental and Incremental Inputs and Outputs

6.1.3.1 Introduction

4. In identifying project benefits and costs, a distinction is to be made between nonincremental and incremental inputs (costs), and between nonincremental and incremental outputs (benefits). This distinction is important because nonincremental and incremental effects are valued in different ways. Nonincremental inputs are project demands that are met by existing supplies while incremental inputs are project demands that are met by an increase in the total supply of the input. Nonincremental outputs are project outputs that replace existing outputs while incremental outputs expand supply to meet new or additional demands.

5. Inputs (either nonincremental or incremental) to a water supply project (WSP) may include expenditure categories such as water, electricity, labor, equipment and materials, etc., while outputs (either nonincremental or incremental) may include water supply and/or sanitation services.

6.1.3.2 Nonincremental Inputs

6. In some cases, water supply to a user of water, say an industrial plant, is to be met (partly or fully) by an existing stock of available water without expansion of overall supply. For example, such supply is met by withdrawing water from existing users in, say, agriculture. Such water is defined as nonincremental water input.

6.1.3.3 Incremental Inputs

7. If a water demand is to be met by an expansion of the water supply system, the water supply input should be considered as incremental supply of water.

6.1.3.4 Nonincremental Output

8. If the output of a WSP replaces the existing supply to the users, that output is defined as nonincremental output. For example, if the present source of water to the consumers is from vendors or from wells, a canal and or a river (with time and effort spent on such use of water), the supply of water from the project which replaces this is to be considered nonincremental.

6.1.3.5 Incremental Output

9. The supply of water from a project that meets additional or induced demand (possibly as a result of availability of higher quality of water at lower cost) is to be considered as incremental output.

6.1.4 Demand and Supply Prices

10. In economic analysis, the market prices of inputs and outputs are adjusted to consider the effects of government intervention and market failures. Shadow prices based either on the supply price or the demand price, or a weighted average of the two, are used. Different shadow prices are used for incremental output, nonincremental output, incremental input and nonincremental input. Incremental outputs and nonincremental inputs are valued in the same manner, i.e., in terms of their adjusted demand price or willingness to pay. Nonincremental outputs and incremental inputs are valued in terms of their adjusted supply price or opportunity costs. This is shown in Table 6.1.

Table 6.1 **Shadow Prices of Project Outputs and Inputs**

	Incremental	**Nonincremental**
Outputs	Adjusted demand price or willingness to pay	Adjusted supply price or opportunity cost
Inputs	Adjusted supply price or opportunity cost	Adjusted demand price or willingness to pay

6.2 Quantification of Economic Costs

11. In estimating the economic costs, some items of the financial costs are to be excluded while some items not considered in the financial costs are to be included. This is to reflect costs from the viewpoint of the economy as a whole rather than from the viewpoint of the individual entity. They are summarized below:

6.2.1 Taxes, Duties, and Subsidies

12. Taxes, duties, and subsidies are called transfer payments because they transfer command over resources from one party (taxpayers and subsidy receivers) to another (government, the tax receivers and subsidy givers) without reducing or increasing the amount of real resources available to the economy as a whole. Hence, such transfer payments are not economic costs.

13. However, these transfer payments are to be included in the economic costs in certain circumstances, including:

(i) if the government is correcting environmental costs through a tax or a pollution charge;

(ii) if the water supply input is nonincremental (refer to para. 6.1.3 above). For example, the volume of water withdrawn from existing agricultural use which is supplied to a newly established industrial plant is to be considered as water. Its economic cost is based on the demand price of agricultural water and as such, the transfer element (tax or subsidy) is a part of the demand price.

6.2.2 External Effects

14. These refer to such effects of a WSP on the activities of individuals/entities outside the project that affect their costs and benefits but which are not directly reflected in the financial cash flow of the project. For example, environmental effects of a WSP, such as river water pollution due to discharge of untreated wastewater effluent, affect activities like fishing and washing downstream.

15. Other examples include the following:

(i) a WSP uses ground water from an aquifer and the natural rate of recharge of that aquifer is less than the withdrawal rate of water. This results in a "depletion" of the resource for which a premium is to be imposed as an economic cost to the project.

(ii) a WSP uses scarce or limited water resources and there is competition among the users of raw water. This may lead to withdrawing water from existing users (e.g., irrigation) to provide water to a new industrial estate, thus imposing a disbenefit to the existing agriculture users. This case is referred to as (nonincremental) water inputs in paragraph 6.1.3 above.

6.2.3 Working Capital

16. A certain amount of working capital is normally required to run a WSP. This working capital includes inventories and spare parts which must be available to facilitate smooth day-to-day operations. Items of working capital reflect not only inventories but also loan receipts, repayment flows, etc. However, for the purpose of economic analysis, only inventories that constitute real claims on a nation's resources should be included.

6.3 Quantification of Economic Benefits

6.3.1 Benefits from a Water Supply Project

17. Gross benefits from a WSP can be estimated conveniently by apportioning the supply of water into nonincremental output and incremental output.

These were explained in para. 6.1.3.

18. The following example, with calculation and diagram, explains the concepts of valuing incremental and nonincremental demand.

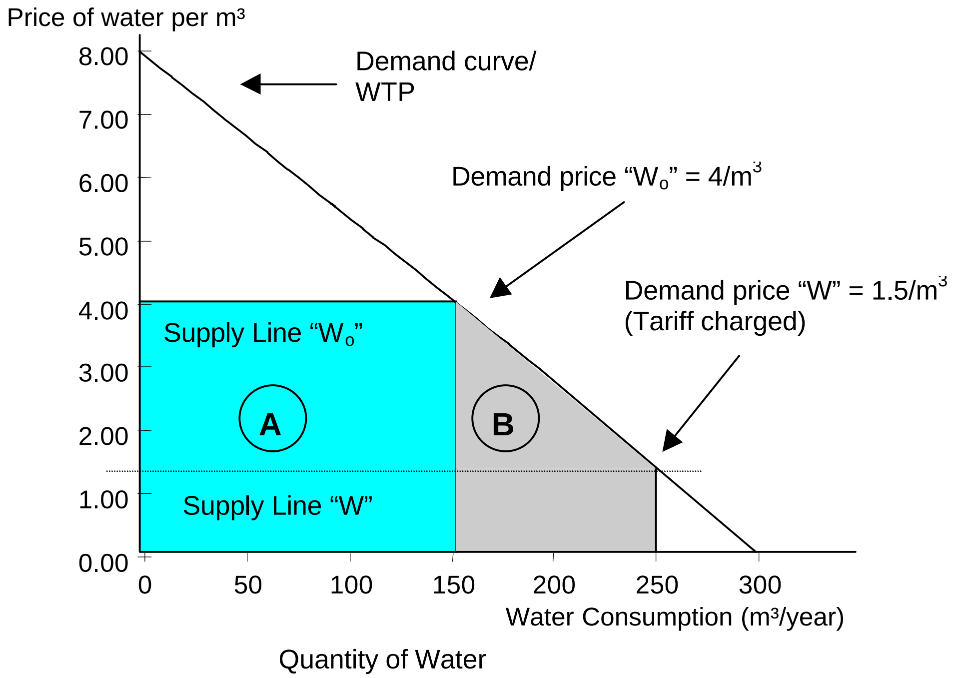
Data:

A piped WSP is proposed to meet a growing demand for an area from its existing level of 150 m^3 per year to 250 m^3 per year. The present supply of 150 m^3 per year is met as follows: 25 percent from vendors and 75 percent from household wells, at the following financial prices which include the cost of home processing of water to a quality closer to that of piped supply.

Sources	Proportion	Annual Quantity	Cost/m^3
Private vendors	25%	37.5 m^3	5L
Household wells	75%	112.5 m^3	3L
Average of supply price			**4L/m^3**

This is a public water supply scheme and the price of piped water supply is only 1.5 liters per m^3, which is lower than the present cost of supply. Due to the higher quality and lower price of piped supplies, the existing supply of water by vendors and household wells will be fully replaced. The concept of gross benefits is illustrated in Figure 6.2.

Figure 6.2 **Concept of Gross Benefits**



Quantity consumed:

Q_{wo}	$=150\ m^3/yr$	=	water from vendors and wells
Q_w	$=250\ m^3/yr$	=	water from the project

Prices:

P_{wo}	$=4L/m^3$	=	cost of water (existing)without-project
P_w	$=1.5L/m^3$	=	tariff with-project

Non-incremental benefit due to full replacement of existing supply
(based on average supply price) = AREA A
= (Qwo) x (Pwo)
= 150 x 4
= 600 L

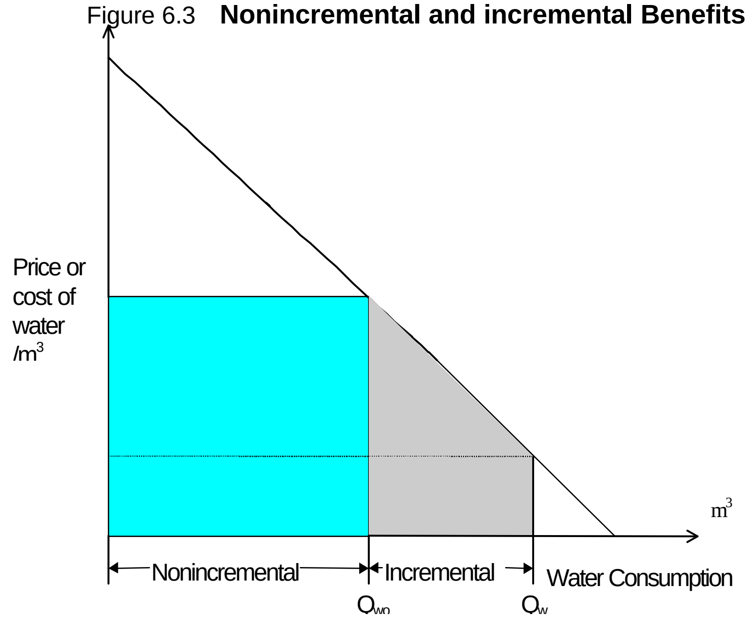
Incremental benefit due to future increase of water use
(based on average demand price) = AREA B
= 1/2 (Pwo + Pw) x (Qw - Qwo)
= 1/2 (4 + 1.5) x (250 - 150)
= 275 L

Total gross benefit = Area A + Area B
= 600 + 275
= 875 L

The prices used in this example are in financial terms. They are to be expressed in economic terms by applying economic valuation methodology described in Section 6.4.

19. From the example, it can be seen that the nonincremental part of the gross benefit is based on the average supply price of water in the without-project situation whereas the incremental part is based on the average demand price of water. In the example, the demand curve is taken to be a straight line. But if the demand curve is arrived at by some other method including the contingency valuation method, the actual demand curve (which may not be a straight line) can be used to arrive at the gross benefit of incremental water by calculating the area below the demand curve, as shown in Figure 6.3.

Figure 6.3 **Nonincremental and incremental Benefits**



6.3.2 Measuring Other Benefits of a Water Supply Project

6.3.2.1 Health Benefits

20. WSPs have been justified on the basis of expected public and private health benefits, which are likely to occur with the project due to the overall improvement in the quality of drinking water. Such benefits are likely to occur provided the adverse health impacts of an increased volume of wastewater can be eliminated or minimized.

21. Drinking unsafe water may cause water-related diseases, such as Diarrhoea, Roundworm, Guinea Worm and Schistosomiasis. People affected by these diseases may have to purchase medicines, consult a doctor or lose a day's wage. Accordingly, health benefits due to the provision of safe water have two dimensions: avoided private/public health expenditures; and economic value of days of sickness saved.

22. Whether for the existing use of water (nonincremental) or its future extended use (incremental), it is often difficult to estimate the health benefits in monetary terms. The reasons include:

(i) improved health due to safe water and sanitation alone is difficult to arrive at. For example, public health programs may promote boiling or chemical treatment of water and improve the overall health conditions. Such improvement could not be attributed to the provision of safe water.

(ii) the supply of safe water alone may not improve health unless complementary actions are taken, such as hygienic use of water through hygiene education, nutritional measures, etc.

(iii) The ultimate effect of health benefit is the increased labor productivity due to the "healthy life days" (HLDs) saved, which may possibly be estimated in quantitative terms; but to arrive at the value of increased productivity in monetary terms is difficult and complicated as appropriate data is rarely available.

23. Because of these reasons, it is customary to confine the health benefit-related analysis to cost effectiveness analysis and arrive at HLDs saved per unit of money spent. In the case of projects with a low EIRR or where the EIRR cannot be calculated, the alternative with the highest HLDs per unit of money spent should be selected.

24. In practice, health benefits are often not valued but treated as non-quantifiable benefits. If health benefits are expected to be significant, the EIRR analysis should then be supplemented with a qualitative, if possible quantitative, assessment of the importance of such benefits. There may be cases where a valuation of health benefits can be done.

6.3.2.2 Time Cost Saving Benefit

25. In the without-project situation, time spent in collecting water from the nearest source of water supply (e.g., wells, tank, river, standposts on the road) may be considerable, especially during the dry season. An important benefit from a piped water supply and provision of public taps is that it brings the source of water very near to the households. Time saved in with- and without-project situations can be estimated. What is difficult, however, is how to value time in monetary terms. Different approaches have been used by different agencies and authorities. Box 6.1 shows three such examples.

Box 6.1 **Value of Time Spent on Water Collection**

There are different approaches to value time savings:

- The Inter-American Development Bank assumes that time savings should be valued at 50 percent of the market wage rate for unskilled labor;
- Whittington, et al (1990) conclude that the value of time might be near- or even above-the-market wage rate for unskilled labor;
- A 1996 WB SAR on the Rural Water Supply and Sanitation Project in Nepal, has taken (i) 30 percent of time saved, devoted to economic activities, at the full rural market wage; (ii) 16 percent of time saved, devoted to household activities, at 50 percent of the rural market wage; and the remainder 54 percent at 25 percent of the rural market wage. This comes to a weighted average of 51.5 percent of the rural market wage.

26. It is, however, difficult to find out the precise value of time without a considerable amount of research and data. As an approximation, it is suggested that the value of time saved is calculated on the basis of the local minimum wage rate for casual unskilled labor.

6.3.2.3 Demand Curve Analysis and Other Benefits

27. It is suggested in para. 6.3.1 that a demand curve be estimated by establishing the user's behavior in the without-project situation (such as vendor's charges paid or costs of well's operation) as one point on the demand curve and the water charges levied by the government or water authorities as a second point on the demand curve. Water charges for piped water are the basis for the future water use with-project.

Alternatively, a surrogate demand curve may be derived using the contingency valuation method to derive gross economic benefits. If such demand curves are well established and reflect the user's marginal willingness to pay, then again bringing in health benefits and time saving benefits separately will lead to double counting.

28. Costs due to ill-health (arising out of unsafe water) and costs of time spent in collecting water in the existing without-project situation (if at all it can be valued in monetary terms) may, however, be used to arrive at the point in the demand curve in the without-project situation.

6.4 Valuation of Economic Benefits and Costs

6.4.1 General

29. Once the costs and benefits, including external effects, have been identified and quantified, they should be valued. Decisions by the producers and users of project output are based on financial prices. To appraise the consequences of their decisions on the national economy, benefits and costs are to be valued at economic prices. Therefore, the (financial) market prices are to be adjusted to account for the effects of government interventions and market structures.

(i) transfer payments - taxes, duties and subsidies incorporated in market prices of goods and services;

(ii) official price of foreign exchange where government controls foreign exchange markets;

(iii) wage rates of labor where minimum wage legislation affects wage rates; and,

(iv) commercial cost of capital where government controls the capital market.

30. Hence, as market rates in those cases are poor indicators of the economic worth of resources concerned, they need to be converted into their shadow prices for economic analysis.

6.4.2 Principle of Shadow Pricing (Economic Pricing)

6.4.2.1 Opportunity Cost

31. Opportunity cost is the benefit foregone from not using a good or a resource in its next best alternative use. To value the benefits (outputs) and costs, the opportunity cost measured in economic prices is the appropriate value to be used in project economic analyses.

32. Opportunity Cost of Labor. Assuming that surplus labor is available in the project area, the economic cost of labor employed in a new project will approximate the economic value of net output lost elsewhere, which is reflected in the rural labor wage of casual labor (say 40 taka per day). The labor rate used in the financial analysis of the project is the government controlled minimum wage rate of 60 taka per day. The ratio of the economic opportunity cost of labor to the project wage rate will be 40/60 = 0.67. This means that the true economic cost of labor is two-thirds of the wages paid in financial prices.

33. Opportunity Cost of Land. The economic value of land in a project is best determined through its opportunity cost. For example, for new projects in a rural area, the opportunity cost of land will typically be the net agricultural output foregone, measured at economic prices.

34. Opportunity Cost of Water. Depending on the source of water, the opportunity cost of water may vary from zero to a very high figure. If the water in the area is abundant, the opportunity cost of using such water is zero; but if, on the contrary, the water is scarce and an urban water supply scheme has to use some water by taking it away from existing agriculture or industrial use, the opportunity cost of water will be equal to the value of net agricultural or industrial production lost by diverting water from these alternative uses. Box 6.2 shows a typical calculation.

Box 6.2 **Calculating Opportunity Cost of Water**

Water for drinking purposes is required to be diverted from present agricultural use.

(1)	Annual net income from 1 ha. of paddy is		
	from (existing) irrigated land	=	Tk11,600
	annual net income from rainfed land	=	Tk7,100
	(in future when irrigation water is not available)		----------------
	Benefit from irrigation	=	Tk4,500
(2)	Farmers' need of water for irrigation at present	=	8,000m^3 per ha.
(3)	Incremental net benefit from irrigation	=	Tk4,500/8,000m^3
		=	Tk0.56 / m^3
(4)	Opportunity cost of diverted water	=	Tk0.56 / m^3

Note: Net income = total production output (sales) - total production costs

6.4.3 Conversion Factors and Numeraire

6.4.3.1 Numeraire

35. Economic pricing can be done in two different currencies and at two different price levels. The choice of currency and the price level specifies the numeraire or unit in which the project effects are measured, such as:

(i) Domestic price level numeraire, when all economic prices are expressed in their equivalent domestic price level values; and

(ii) World Price level numeraire, when all economic prices are expressed in their equivalent world price levels.

Table 6.2 **Unit of Account**

Price Level	Currency	
	National	Foreign
Domestic Prices	Domestic, taka	Domestic, dollars
World Prices	World, taka	World, dollars

36. As the *Guidelines for the Economic Analysis of Projects* makes clear, provided equivalent assumptions are made in the analyses, the choice of the numeraire (whether the world price or the domestic price level numeraire) will not alter the decision on a project. However, in some special cases, especially in WSPs, it is convenient to conduct the economic analysis of a project in units of domestic prices. These cases relate to projects where distributional effects and the question of a subsidy to users below the poverty line are important policy issues.

37. The example in section 6.5 shows the relevant calculation using both numeraires.

6.4.3.2 Border Price

38. The world price mentioned in Table 6.2 is represented by the country's price of imported or exported goods at the border.

(i) for imported items, the border price is the c.i.f. value (cost, insurance and freight) expressed in domestic currency by using the official exchange rate (OER).

Example: The c.i.f. value of an imported water supply pump is $20,000.00 and the OER is P40 = $1. The economic border price of the pump expressed in domestic currency is 20,000 X 40 = P800,000.

(ii) for exported items the border price is the f.o.b. value (free on board) expressed in domestic currency using the OER.

6.4.3.3 Traded and Nontraded Goods and Services

39. Goods and services which are imported or exported are known as traded items and their production and consumption affect a country's level of exports or imports. Using the world price numeraire in economic valuation (c.i.f. for imports and f.o.b. for exports expressed in domestic currency by using OER), there is no need for any further conversion. If, however, the domestic price level numeraire is used in economic valuation, the c.i.f. and f.o.b. values are to be converted to their domestic price equivalent by using the relevant conversion factor (e.g., shadow exchange rate factor, SERF) which is the reciprocal value of the standard conversion factor (SCF).

40. The link between the domestic and world price numeraire is provided by a parameter reflecting the average ratio of world to domestic prices for an economy. If

the analysis is done in world price or border price equivalent, this parameter is the standard conversion factor (SCF) which compares world prices with domestic prices. In a domestic price system, its reciprocal – the ratio of the shadow to the official exchange rate (SER/OER), sometimes termed the foreign exchange conversion factor – is used. In either system, the relative valuation of traded to nontraded goods is provided by the average ratio of world to domestic prices.

41. Box 6.3 shows the commonly used equation for calculating the SCF.

Box 6.3 **SCF and SERF**

$$SCF = \frac{\text{Border price}}{\text{Domestic price}} \approx \frac{\text{Official exchange rate (OER)}}{\text{Shadow exchange rate (SER)}}$$

$$= \frac{M + X}{\{M(1 + t_m - s_m)\} + \{X(1 - t_x + s_x)\}}$$

Where:

M & X - are total imports and exports, respectively, in a particular year at world prices and converted into local currency at the OER.

t_m & t_x - are the average rate of taxes on imports and exports, respectively, calculated as the ratio of tax collected to M and X.

s_m & s_x - are the average rate of subsidy on imports and exports, respectively, calculated as the ratio of subsidy paid to M and X.

Illustration: Philippines 1994

M = 495,134 million pesos
X = 202,698 million pesos

Tax on imports	= 88,278 m pesos	$t_m = 88{,}278 / 495{,}134 = 0.178$
Subsidy on imports	= 0	$s_m = 0$
Tax on exports	= 17 million peso	$t_x = 17 / 202{,}698 = 0.00008$
Subsidy on exports	= 0	$s_x = 0$

$$\text{Hence, } SCF = \frac{(495{,}134) + (202{,}698)}{\{495{,}134 \times (1 + 0.178)\} + \{202{,}698 \times (1 - .00008)\}}$$

$$= 0.888$$

Also, SERF = SER/OER = 1/SCF = 1 / 0.888 = 1.126 – 1.13 (Rounded).
In other words a SCF = .888 results in a 13 percent premium on foreign exchange.

6.4.3.4 Conversion Factors

42. To remove the market distortions in financial prices of goods and services and to arrive at the economic prices, a set of ratios between the economic price value and the financial price value for project inputs and outputs is used to convert the constant price financial values of project benefits and costs into their corresponding economic values. The general equation is as follows:

$$CF_i = EP_i / FP_i$$

where CF_i = conversion factor for i
EP_i = economic value of i
FP_i = financial value of i

43. Conversion factors can be used for groups of similar items like engineering, construction, transport, energy and water resources used in a particular project, or for the economy as a whole as in the SCF or SERF. The former are referred to as project specific conversion factors for inputs while the latter refer to national parameters. These are briefly discussed hereafter.

National parameters:

44. Several nontraded inputs occur in nearly all projects. These include construction, transport, water, power and distribution. It is useful to calculate specific conversion factors for these commonly occurring inputs on a country basis so that consistent values are used across different projects in a country. These are known as national parameters. Their determination is normally the work of national institutions, such as the Ministry of Finance and/or an Economic Development Unit or Central Planning Organization, if any. In countries where national parameters are not available, international financial institutions (World Bank, regional development banks like ADB) attempt to use conversion factors (e.g., SWR, SER and SCF) derived from recent consultant reports or research studies available in the country concerned and try to update them periodically.

Project specific conversion factors for inputs:

45. Where the supply of nontraded inputs is being expanded, specific conversion factors can be calculated through a cost breakdown at financial prices. The following calculations show an illustration of electricity charges in a WSP.

National conversion factors:

SCF	=	0.885
SERF	=	1.13
Labor (unskilled)	=	0.7 in domestic price(=SWR)
Labor (skilled)	=	1.0 in domestic price

Cost breakdown of electricity supply per kWh:

Fuel (traded)	=	P 0.900
Skilled labor	=	P 0.015
Unskilled labor	=	P 0.025
Capital charges		
Traded element	=	P 0.300
Nontraded element	=	P 0.340
Domestic materials (nontraded)	=	P 0.120

Subtotal	=	P1.700
Government tax	=	P0.170

Total	=	**P1.870**

Table 6.3 **Economic Price of Electricity (per kWh)**

		World Price Numeraire		Domestic Price Numeraire	
	Financial Cost	Conversion Factor	Economic Value (P)	Conversion Factor	Economic Value (P)
Fuel (traded)	0.900	1.0	0.900	1.13	1.017
Skilled labor	0.015	1.0 x 0.885	0.013	1.00	0.015
Unskilled labor	0.025	0.7 x 0.885	0.015	0.70	0.018
Capital charge					
Traded	0.300	1.0	0.300	1.13	0.339
Nontraded	0.340	0.885	0.301	1.00	0.340
Domestic Materials (nontraded)	0.120	0.885	0.106	1.00	0.120
Government tax	0.170	0	0.000	0.00	0.000
	1.870		**1.635**		**1.849**

C.F. in world price numeraire = 1.635 / 1.87 = 0.874

C.F. in domestic price numeraire = 1.849 / 1.87 = 0.989

The financial price of electricity has to be adjusted to its economic price by multiplying with this project specific conversion factor.

6.5 Valuation of Economic Benefits and Costs *of Water Supply Projects*

6.5.1 Economic Benefits of Water Supply Projects

46. This can be best explained by an illustration. The benefit evaluation in financial terms of the nonincremental and incremental components of demand discussed in Section 6.3.1 will be used for this purpose.

47. The data are again shown below:

Q_{wo}	=	quantity without-project	=	150 m^3/yr
Q_w	=	quantity with-project	=	250 m^3/yr
P_{wo}	=	financial cost/price of existing water supply	=	4 P/m^3
P_w	=	(financial) tariff with project	=	1.5 P/m^3

Nonincremental benefit based on average supply price	=	600 P
Incremental benefit based on average demand price	=	275 P

Total gross benefit per year in financial terms	=	875 P

Letter P may refer to any other local currency unit.

For economic valuation purposes, the breakdown of the items into traded, nontraded, labor and transfer payments (if any) is needed. The numerical values of the national parameters, i.e.: SCF/SERF, SWRF, etc. should also be known.

Demand and supply:

48. The existing annual demand is met partly (25 percent) by the supply from private vendors and partly (75 percent) by the operation of household wells at the following financial prices, which include the costs of home processing of water to a quality close to that of piped supplies:

Sources	Proportion	Yearly Quantity	Cost(P)/m^3
Private vendors	25%	37.5 m^3	8.61
Household wells	75%	112.5 m^3	2.46
Total	**100%**	**150.0** m^3	**4.00** (weighted average)

Breakdown of costs

1. Private vendors' supply price (8.61 P/m^3)

Unskilled labor	=	4.31 P/m^3	=	50%
Nontraded materials	=	3.44 P/m^3	=	40%
Traded element	=	0.86 P/m^3	=	10%
Total	**=**	**8.61 P/m^3**	**=**	**100%**

2. Household wells' price (2.46L/m^3)

Traded element	=	1.72 P/m^3	=	70%
Unskilled Labor	=	0.37 P/m^3	=	15%
Nontraded materials	=	0.37 P/m^3	=	15%
Total	**=**	**2.46 P/m^3**	**=**	**100%**

The steps followed in calculating the economic benefit are shown in Box 6.4 (using domestic price numeraire) and in Box 6.5 (using world price numeraire).

Box 6.4 **Calculation of Economic Benefits**
(Using Domestic Price Numeraire)

SWRF	=	0.7
SERF	=	1.2
Premium	=	.2

A. Economic Valuation of Nonincremental Benefits

Source of Water	Cost Components	Amount	Conversion Factor	Economic Price (P)
Private Vendors	Traded	0.86	1.20	1.03
	Unskilled labor	4.31	0.70	3.02
	Nontraded materials	3.44	1.00	3.44
	Total	**8.61**		**7.49**
Household wells	Traded	1.72	1.20	2.06
	Unskilled labor	0.37	0.70	0.26
	Nontraded materials	0.37	1.00	0.37
	Total	**2.46**		**2.69**

Weighted average economic value of nonincremental water
= (0.25 x 7.49) + (0.75 x 2.69)
= 1.87 + 2.02 = 3.89 P/m^3

B. Economic Valuation of Incremental Benefits

Average cost/price of water without-project = 4 P/m^3
Tariff of water with-project = 1.5 P/m^3

Average demand price with- and without-project (using domestic price numeraire) = (4 + 1.5) / 2
= 2.75 P/m^3

C. Economic Value of Water Supply Project (using domestic price numeraire)

Gross economic benefits of water supply project
= (Economic value of nonincremental water) + (Economic value of incremental water)
= (150 x 3.89) + (250 – 150) x 2.75
= 858.5 P

Box 6.5 **Calculation of Economic Benefits**
(Using World Price Numeraire)

SCF = 1/SERF = 1/1.2 = 0.83
SWRF = 0.7 x SCF = 0.58

A. Economic Value of Nonincremental Benefits

Source of Water	Cost Components	Amount	Conversion Factor	Economic Price (P)
Private Vendors	Traded	0.86	1.00	0.86
	Unskilled labor	4.31	0.58	2.50
	Nontraded materials	3.44	0.83	2.86
	Total	**8.61**		**6.22**
Household wells	Traded	1.72	1.00	1.72
	Unskilled labor	0.37	0.58	0.21
	Nontraded materials	0.37	0.83	0.31
	Total	**2.46**		**2.24**

Weighted average economic value of nonincremental water
= (0.25 x 6.22) + (0.75 x 2.24)
= 3.235 P/m^3 = 3.24 P/m^3 (rounded)

B. Economic Valuation of Incremental Benefits
Average cost/price of water without-project = 4 P/m^3
Tariff of water with-project = 1.5 P/m^3

Average demand price with and without the Project (in financial prices) = (4 + 1.5)/2
= 2.75 P/m^3

World price equivalent of average demand price = 2.75 x SCF
= 2.75 x 0.83
= 2.28 P/m^3

C. Economic Value of Water Supply Project (in world price numeraire)
Gross economic benefits of water supply project
= (Economic value of nonincremental water) + (Economic value of incremental water)
= (150 x 3.24) + (250 – 150) x 2.28
= 714.00 P

6.5.2 Economic Value of Water Supply Input

49. This can best be illustrated by an example. A newly established industrial plant needs a large quantity of water from the public water supply. Two thirds of the total requirement of the industrial plant (180,000 m^3 per year) will be met from an expansion of the existing water supply. To meet the remaining one third of the supply to the industrial plant, it will be necessary for the public water supply organization to withdraw this water from existing agricultural use as there is a strict limitation to the water resource. Hence, the water supply to the industrial plant will be as follows:

Nonincremental water input	=	1/3 of 180,000
(diverted from agricultural use)	=	60,000 m^3
Incremental water input	=	2/3 of 180,000
(to be met from expansion)	=	120,000 m^3

Data:

The financial cost breakdown of the incremental water input is as follows:

		Taka/10m^3
Tradable inputs	=	37.5
Power	=	90.0
Capital charges		
Construction (nontraded)	=	31.3
Equipment (traded)	=	8.7
Unskilled labor	=	92.5
Nontraded domestic materials	=	16.3
Subtotal	=	276.3
Taxes and duties	=	27.6
Total	**=**	**303.9 per 10 m^3**

Therefore, the financial cost per cubic meter is 30.39 taka.

The economic valuation of water supply input is illustrated in Box 6.6.

Box 6.6 **Economic Valuation of Inputs** (Using Domestic Price Numeraire)

Conversion factors (national parameters):
SERF = 1.25
SWRF = 0.68

A. Economic Price of Incremental Water input (120,000 m^3) in domestic price numeraire

Items	Financial Cost Breakdown (Taka/10 m^3)	Conversion Factor	Breakdown of Economic Price (Taka/10m^3)
Tradable inputs	37.5	1.25	46.88
Power	90.0	0.989 */	89.01
Capital Charges			
Construction (nontraded)	31.3	1.00	31.30
Equipment (traded)	8.70	1.25	10.88
Labor	92.5	0.68	62.90
Nontraded domestic materials	16.3	1.00	16.30
Taxes and duties	27.6	0	-
Total	**303.9**		**257.27**

*/ - worked out separately. This shows there is a heavy subsidy in power supply.
The economic price per cubic meter is 25.73 taka.

B. Economic Price of nonincremental water input (60,000m^3)

Water diverted from agricultural use to meet the industrial demand is estimated through the marginal loss of net agricultural output, at shadow prices per unit of water diverted to the new users.

Opportunity cost of water in financial price diverted from agricultural use is 0.56 taka per m^3 of water. The data used here is taken from paragraph 6.4.2.1 in Box 6.2.

C. Conversion factor for the agricultural product lost by withdrawing water from agriculture

Agricultural prices for the crops grown in the area are regulated and some of the inputs like ‘energy’ and ‘water’ are subsidized. The net effect is expressed in a conversion factor relative to the financial cost of a unit of water. The conversion factor is calculated as 2.55 in domestic price numeraire.

Economic price of nonincremental water input for industrial use (diverting from agricultural use) can now be worked out: 0.56 x 2.55 = 1.428 Taka per m^3.

Total value of the water input for industrial use
= (Economic price of incremental water) + (Economic price of nonincremental water)
= (120,000 x 3.03) + (60,000 x 1.428)
= 363,600 + 65,520
= 429,120.00 Taka

6.5.3 Summary of Basic Criteria Used In Economic Valuation of the Project Outputs and Inputs

50. The basic criteria used in the economic valuation of incremental and nonincremental outputs and inputs are summarized in Table 6.4.

Table 6.4 **Economic Valuation of Project Outputs and Inputs**

	Incremental		Nonincremental	
	Basic Criteria	Illustration (refer to..)	Basic Criteria	Illustration (refer to..)
Outputs	Adjusted demand price or WTP	Example in para. 6.5.1.1 (B)	Adjusted supply price or opportunity cost	Example in para 6.5.1.1 (A)
Inputs	Adjusted supply price or opportunity cost	Example in para. 6.5.2 (A)	Adjusted demand price or WTP	Example in para. 6.5 (B)

6.6 Economic Benefit-Cost Analysis: *An Illustration*

51. This section shows a simple illustration of an economic benefit cost analysis. The example starts with the financial benefit-cost analysis, so that the links and differences between both analyses can be brought out.

6.6.1 Financial and Economic Statement of a WSP

52. Table 6.5 shows the financial statement of a WSP providing 1.00 Mm^3 of water per year. The quantity of water sold is assumed to build up annually by batches of 200,000 m^3, from year 1998 to reach full project supply by 2002. At an average tariff of Rs2.00 per m^3, the financial revenues of this project will eventually reach Rs2 mn per year.

Table 6.5 **Financial statement**

Year	Water Sold	Financial revenues	Financial costs			Net Financial Benefit
			Investment	O&M	Total	
	'000 m³	Rs '000	Rs '000	Rs '000	Rs '000	Rs '000
A	B	D	E	F	G=E+F	H=D-G
1997	0	0	11,000	0	11,000	-11,000
1998	200	400		440	440	-40
1999	400	800		440	440	360
2000	600	1,200		440	440	760
2001	800	1,600		440	440	1,160
2002	1,000	2,000		440	440	1,560
2003	1,000	2,000		440	440	1,560
2004	1,000	2,000		440	440	1,560
2005	1,000	2,000		440	440	1,560
2006	1,000	2,000		440	440	1,560
2007	1,000	2,000		440	440	1,560
2008	1,000	2,000		440	440	1,560
2009	1,000	2,000		440	440	1,560
2010	1,000	2,000		440	440	1,560
2011	1,000	2,000		440	440	1,560
2012	1,000	2,000		440	440	1,560
NPV @7%	**6,876**	13,752	10,280	3,745	14,026	-274
Per m³ sold		2.00	1.50	0.54	2.04	-0.04
					AIFC	FIRR = 6.5%

53. The investment cost of the project amounts to Rs11.00 million and the annual operation and maintenance cost is estimated to be 4 percent of the investment. The weighted average cost of capital (WACC) is 7 percent. The calculation of the WACC is not shown in this example. The financial net present value of the project, discounted at 7 percent, is negative (Rs274,000). The FIRR is 6.5 percent, which is below the WACC of 7 percent. The AIFC at 7 percent is Rs2.04 per m³.

54. The economic benefit-cost analysis of the project involves the conversion of financial into economic values and introduces a new cost element: the opportunity cost of water. In this example, the domestic price numeraire is used. The economic statement is given in Table 6.6.

Table 6.6 **Economic Project Resource Statement**

Year	Water sold			UFW[a]			Total water prod.	Total water cons.	Gross benefits				Resource costs				Net economic benefit
	Non-incr.	Incr.	Total	NTL[b]	TL[c]	Total			Non-incr.	Incr.	NTL	Total Benefit	Investment	O&M	OCW	Total cost	
	'000m³	'000m³	'000m³	'000m³	'000m³	'000m³	'000m³	'000m³	Rs'000	Rs'000	Rs'000	Rs'000	Rs'000	Rs'000	Rs'000	Rs'000	Rs'000
A	B	C	D=B+C	E	F	G=E+F	H=D+G	I=D+E	J	K	L	M=J+K+L	N	O	P	Q=N+O+P	R=M-Q
1997	0	0	0	0	0	0	0	0	0	0	0	0	12,100	0	0	12,100	-12,100
1998	80	120	200	29	57	86	286	229	400	360	109	869		447	57	504	365
1999	160	240	400	57	114	171	571	457	800	720	217	1,737		447	114	561	1,176
2000	240	360	600	86	171	257	857	686	1,200	1,080	326	2,606		447	171	618	1,988
2001	320	480	800	114	229	343	1,143	914	1,600	1,440	434	3,474		447	229	675	2,799
2002	400	600	1,000	143	286	429	1,429	1,143	2,000	1,800	543	4,343		447	286	732	3,611
2003	400	600	1,000	143	286	429	1,429	1,143	2,000	1,800	543	4,343		447	286	732	3,611
2004	400	600	1,000	143	286	429	1,429	1,143	2,000	1,800	543	4,343		447	286	732	3,611
2005	400	600	1,000	143	286	429	1,429	1,143	2,000	1,800	543	4,343		447	286	732	3,611
2006	400	600	1,000	143	286	429	1,429	1,143	2,000	1,800	543	4,343		447	286	732	3,611
2007	400	600	1,000	143	286	429	1,429	1,143	2,000	1,800	543	4,343		447	286	732	3,611
2008	400	600	1,000	143	286	429	1,429	1,143	2,000	1,800	543	4,343		447	286	732	3,611
2009	400	600	1,000	143	286	429	1,429	1,143	2,000	1,800	543	4,343		447	286	732	3,611
2010	400	600	1,000	143	286	429	1,429	1,143	2,000	1,800	543	4,343		447	286	732	3,611
2011	400	600	1,000	143	286	429	1,429	1,143	2,000	1,800	543	4,343		447	286	732	3,611
2012	400	600	1,000	143	286	429	1,429	1,143	2,000	1,800	543	4,343		447	286	732	3,611
NPV @ 12%	1,859	2,789	4,649	664	1,328	1,992	6,641	5,313	9,297	8,368	2,524	20,188	10,804	2,716	1,328	14,848	5,341
Per m³ consumed									1.75	1.58	0.48	3.80	2.03	0.51	0.25	AIEC= 2.79	1.01
																	EIRR 19.0%

[a] Unaccounted for water
[b] Non-technical losses
[c] Technical losses

6.6.2 Economic Benefits

6.6.2.1 Water Sold

55. The economic benefit-cost analysis distinguishes between nonincremental and incremental water. Forty percent of the total annual volume of water sold (column D) displaces water previously obtained from other sources (i.e. nonincremental water, column B). The remaining 60 percent is an addition to total water demand (i.e. incremental water, column C).

56. The methodology for valuing nonincremental and incremental water is different. Nonincremental water is valued on the basis of resource cost savings. This proxy for the economic supply price of water without the project is estimated to be Rs5.00 per m^3. Incremental water is valued on the basis of willingness to pay as proxy for the average demand price with (Rs2.00/m^3) and without (assumed at Rs4.00/m^3) the project. It is estimated to be Rs3.00 per m^3. All these prices are in economic terms. Columns J and K give the total economic values of nonincremental and incremental water sold, derived by multiplying the quantity of non-incremental and incremental water by their respective values.

6.6.2.2 Unaccounted-for-Water

57. Thirty percent of the volume of water produced will not generate any financial revenue; this unaccounted-for-water (column G) is lost during the distribution process. The concept of unaccounted-for-water (UFW) is used by the engineer to estimate the required volume of water production (column H) and production capacity.

58. A portion of UFW may, in practice, be consumed. The reason why it is administratively lost is that it is either consumed illegally or that its consumption has not been metered. This portion of UFW is called nontechnical losses. In the example, it has been estimated to be 10 percent (column E) of the total water production. The remaining 20 percent of UFW is leakage, known as technical losses (column F).

59. The economic benefit-cost analysis is concerned with all participants in the economy and the benefits are the benefits to the entire society. As such, the focus is on water consumed instead of water sold; this is why the value of nontechnical losses should be taken into account. In the example, it is assumed that nontechnical losses occur for both nonincremental and incremental water. Therefore, the value of nontechnical losses per m^3 is determined as the weighted average of the economic value of incremental and nonincremental water per m^3; in the example this would be Rs3.80 per m^3 (40% x Rs5.00 + 60% x Rs3.00). Such weighing is not necessary if nontechnical

losses would only occur for nonincremental water. The economic value of NTL would then be Rs5/m^3.

6.6.3 Economic Costs

60. In this example, the domestic price numeraire is used. The SERF is 1.25 and the SWRF 0.80. Nontraded inputs have been valued at the domestic price, using a conversion factor equivalent to 1.0. The breakdown of the investment cost into different components and the conversion to economic cost are shown in Table 6.7.

Table 6.7 **Conversion of Financial into Economic Costs**

	Financial Rs'000	CF	Economic Rs'000
Traded	6,000	1.25	7,500
Non-traded			
Unskilled labor	2,000	0.80	1,600
Local Materials	3,000	1.00	3,000
Total	11,000		12,100

61. The economic cost of the investment is Rs12.1 million. The financial annual operation and maintenance cost of the project (i.e., 4 percent of the investment) has been shadow-priced in Table 6.8. The conversion factor for electricity is 1.10 which indicates that electricity is a subsidized input.

Table 6.8 **Conversion of financial operation and maintenance cost**

	Financial %	CF	Economic %
Traded	30.0%	1.25	37.5%
Non-traded			
Unskilled labor	40.0%	0.80	32.0%
Electricity	20.0%	1.10	22.0%
Local Materials	10.0%	1.00	10.0%
Total	100%		101.5%
CF = (101.5/100) =		1.015	

62. The average weighing of conversion factors for the O&M costs results in a CF of 1.015. The annual O&M cost is calculated as 11,000 x 4% x 1.015 = 447. The third cost component considered in this example is the opportunity cost of water,estimated as Rs0.20 per m³ of water produced. This estimate is arrived at as a separate exercise not shown in this example. In year 2001, the OCW is equal to 1,143 x .2 = 229.

6.6.4 Results

63. Table 6.6 shows that project is viable from the economic viewpoint: the ENPV at 12 percent discount rate is positive Rs5.3 million and the EIRR 19.0 percent. The AIEC at 12 percent is Rs2.79 per m³ while the economic benefit per m³ is Rs3.80. The net economic benefit per m³ is Rs1.01.

6.6.5 Basic Differences between Financial and Economic Benefit-cost Analyses

64. The examples show the basic differences between financial benefit cost analysis and economic benefit-cost analysis:

(i) the financial benefit-cost analysis is concerned with the project entity whereas the economic benefit-cost analysis is concerned with the entire economy;

(ii) in financial benefit-cost analysis, discounting is done at the FOCC (approximated by the WACC) whereas in economic benefit-cost analysis, discounting is done at the EOCC of 12 percent. The Bank's *Guidelines for the Economic Analysis of Projects* provide an explanation of the chosen discount rate.

(iii) in financial benefit-cost analysis, benefits are valued on the basis of water sold whereas the economic benefit-cost analysis values its benefits on the basis of water consumed. The difference is the nontechnical loss;

(iv) the average incremental financial cost (AIFC) is based on the present value (at the FOCC) of water sold (6.876 Mm³ in Table 6.5) and the average incremental economic cost of water (AIEC) on the present value (at the EOCC) of water consumed (5.313 Mm³);

(v) the valuation of economic benefits differentiates between incremental and nonincremental demand for water in the calculation of financial revenues. This distinction is not necessary;

(vi) in economic analysis, project inputs are shadow-priced to show their true value to the society. Some inputs may not have a financial cost and are not shown in the financial benefit-cost analysis (e.g., if raw water at the intake is available to the water supply utility for free). However, they should be shown in the economic benefit-cost analysis if the input has a scarcity value (e.g., if raw water is diverted from another alternative use such as irrigation or hydropower);

(vii) in financial benefit-cost analysis, the FIRR should be compared with the FOCC, and in economic benefit-cost analysis, the EIRR should be compared with the EOCC, to assess the project's viability in financial or economic terms, respectively.

CHAPTER 7

SENSITIVITY AND RISK ANALYSES

CONTENTS

Tables

Boxes

7.1 Introduction

1. The financial and economic benefit-cost analysis of water supply projects (WSPs) is based on forecasts of quantifiable variables such as demand, costs, water availability and benefits. The values of these variables are estimated based on the **most probable** forecasts, which cover a long period of time. The values of these variables for the most probable outcome scenario are influenced by a great number of factors, and the actual values may differ considerably from the forecasted values, depending on future developments. It is therefore useful to consider the effects of likely changes in the key variables on the viability (EIRR and FIRR) of a project. Performing sensitivity and risk analysis does this.

Box 7.1 **Definitions**

Sensitivity Analysis shows to what extent the viability of a project is influenced by variations in major quantifiable variables.

Risk Analysis considers the probability that changes in major quantifiable variables will actually occur.

2. The viability of projects is evaluated based on a comparison of its internal rate of return (FIRR and EIRR) to the financial or economic opportunity cost of capital. Alternatively, the project is considered to be viable when the Net Present Value (NPV) is positive, using the selected EOCC or FOCC as discount rate. Sensitivity and risk analyses, therefore, focus on analyzing the effects of changes in key variables on the project's IRR or NPV, the two most widely used measures of project worth.

3. In the economic analysis of WSPSs, there are also other aspects of project feasibility which may require sensitivity and risk analysis. These include:

(i) Demand Analysis: to assess the sensitivity of the demand forecast to changes in population growth, per capita consumption, water tariffs, etc.

(ii) Least Cost Analysis: to verify whether the selected least-cost alternative remains the preferred option under adverse conditions;

(iii) Sustainability Analysis: to assess possible threats to the sustainability of the project.

(iv) Distributional Analysis: to analyze whether the project will actually benefit the poor.

This chapter aims at explaining the general concept of sensitivity and risk analysis.

4. Sensitivity and risk analyses are particularly concerned with factors, and combinations of factors, that may lead to unfavorable consequences. These factors would normally have been identified in the project (logical) framework as “project risks” or “project assumptions”. Sensitivity analysis tries to estimate the effect on achieving project objectives if certain assumptions do not, or only partly, materialize. Risk analysis assesses the actual risk that certain assumptions do not, or only partly, occur.

7.2 The Purpose of Sensitivity Analysis

5. Sensitivity analysis is a technique for investigating the impact of changes in project variables on the base-case (most probable outcome scenario). Typically, only adverse changes are considered in sensitivity analysis. The purpose of sensitivity analysis is:

(i) to help identify the key variables which influence the project cost and benefit streams. In WSPs, key variables to be normally included in sensitivity analysis include water demand, investment cost, O&M cost, financial revenues, economic benefits, financial benefits, water tariffs, availability of raw water and discount rates.

(ii) to investigate the consequences of likely adverse changes in these key variables;

(iii) to assess whether project decisions are likely to be affected by such changes; and,

(iv) to identify actions that could mitigate possible adverse effects on the project.

7.3 Performance of Sensitivity Analysis

6. Sensitivity analysis needs to be carried out in a systematic manner. To meet the above purposes, the following steps are suggested:

(i) identify key variables to which the project decision may be sensitive;

(ii) calculate the effect of likely changes in these variables on the base-case IRR or NPV, and calculate a sensitivity indicator and/or switching value;
(iii) consider possible combinations of variables that may change simultaneously in an adverse direction;
(iv) analyze the direction and scale of likely changes for the key variables identified, involving identification of the sources of change.

The information generated can be presented in a tabular form with an accompanying commentary and set of recommendations, such as the example shown in 7.2. The different steps are described in the following paragraphs:

Step 1: Identifying the Key Variables

7. The base case project economic analysis incorporates many variables: quantities and their inter-relationships, prices or economic values and the timing of project effects. Some of these variables will be predictable or relatively small in value in the project context. It is not necessary to investigate the sensitivity of the measures of project worth to such variables. Other variables may be less predictable or larger in value. Variables related to sectoral policy and capacity building may also be important. As they are more difficult to quantify, they are not further considered hereafter but should be assessed in a qualitative manner.

8. As a result of previous experience (from post-evaluation studies) and analysis of the project context, a preliminary set of likely key variables can be chosen on the following basis:

(i) Variables which are numerically large. For example: investment cost, projected water demand;
(ii) Essential variables, which may be small, but the value of which is very important for the design of the project. For example: assumed population growth and water tariffs;
(iii) Variables occurring early in the project life. For example: investment costs and initial fixed operating costs, which will be relatively unaffected by discounting;
(iv) Variables affected by economic changes, such as, changes in real income.

Important variables to be considered in WSPs include :

Box 7.2 **Variables in Water Supply Projects to be considered in Sensitivity Analysis**

Possible Key Variables	Quantifiable Variables	Underlying Variables
Water Demand	• Population growth Achieved coverage Household Consumption • Non Domestic Consumption • Unaccounted for Water	• Price Elasticity • Income Elasticity
Investment Costs (Economic & Financial)	• Water Demand • Construction Period • Real Prices • Conversion Factors	
O&M Costs	• Personnel Costs (wages/No. of staff, etc.) • Cost of Energy • Cost of Maintenance • Efficiency of Utility	
Financial Revenues	• Quantity of water consumed • Service level • Income from connection fees	• Water Tariffs • UFW (bad debts)
Economic Benefits	• Water Demand • Resource Costs Savings	• Willingness to Pay
Cost Recovery	• Water Tariffs • Subsidies	

Step 2 and 3: Calculation of Effects of Changing Variables

9. The values of the basic indicators of project viability (EIRR and ENPV should be recalculated for different values of key variables. This is preferably done by calculating "sensitivity indicators" and "switching values". The meaning of these concepts is presented in Box 7.3 and a sample calculation immediately follows. Sensitivity indicators and switching values can be calculated for the IRR and NPV, see Box 7.3.

Box 7.3 **Use of Sensitivity Indicators and Switching Values**		
	Sensitivity Indicator	Switching Value
Definition	**1. Towards the Net Present Value** Compares percentage change in NPV with percentage change in a variable or combination of variables. **2. Towards the Internal Rate of Return** Compares percentage change in IRR above the cut-off rate with percentage change in a variable or combination of variables.	**1. Towards the Net Present Value** The percentage change in a variable or combination of variables to reduce the NPV to zero (0). **2. Towards the Internal Rate of Return** The percentage change in a variable or combination of variables to reduce the IRR to the cut-off rate (=discount rate).
Expression	**1. Towards the Net Present Value** $SI = \frac{(NPV_b - NPV_1) / NPV_b}{(X_b - X_1) / X_b}$ where: X_b - value of variable in the base case X_1 - value of the variable in the sensitivity test NPV_b - value of NPV in the base case NPV_1 - value of the variable in the sensitivity test **2. Towards the Internal Rate of Return** $SI = \frac{(IRR_b - IRR_1) / (IRR_b - d)}{(X_b - X_1) / X_b}$ where: X_b - value of variable in the base case X_1 - value of the variable in the sensitivity test IRR_b - value of IRR in the base case IRR_1Value of the variable in the sensitivity test d - discount rate	**1. Towards the Net Present Value** $SV = \frac{(100 \times NPV_b)}{(NPV_b - NPV_1)} \times \frac{(X_b - X_1)}{X_b}$ where: X_b - value of variable in the base case X_1 - value of the variable in the sensitivity test NPV_b – value of NPV in the base case NPV_1 – value of the variable in the sensitivity test **2. Towards the Internal Rate of Return** $SV = \frac{(100 \times (IRR_b - d)}{(IRR_b - IRR_1)} \times \frac{(X_b - X_1)}{X_b}$ where: X_b - value of variable in the base case X_1 - value of the variable in the sensitivity test IRR_b - value of IRR in the base case IRR_1 – value of the variable in the sensitivity test d - discount rate

Box 7.3 **Use of Sensitivity Indicators and Switching Values**

	Sensitivity Indicator	Switching Value
Calculation example	**1. Towards the Net Present Value** Base Case: Price = P_b = 300 NPV_b = 20,912 Scenario 1: P_1 = 270 (10% change) NPV_1 = 6,895 $SI = \frac{(20,912 - 6,895) \,/\, 20,912}{(300 - 270) \,/\, 300} = 6.70$ **2. Towards the Internal Rate of Return** Base Case: Price = P_b = 300 IRR_b = 15.87% Scenario 1: P_1 = 270 (10% change) IRR_1 = 13.31% d = 12% $SI = \frac{(0.1587 - 0.1331) \,/\, (0.1587 - 0.12)}{(300 - 270) \,/\, 300}$ = 6.61	**1. Towards the Net Present Value** Base Case: Price = P_b = 300 NPV_b = 20,912 Scenario 1 P_1 = 270 (10% change) NPV_1 = 6,895 $SV = \frac{(100 \times 20,912)}{(20,912 - 6,895)} \times \frac{(300-270)}{300} = 14.9\%$ **2. Towards the Internal Rate of Return** Base Case: Price = P_b = 300 IRR_b = 15.87% Scenario 1: P_1 = 270 (10% change) IRR_1 = 13.31% d = 12% $SV = \frac{(100 \times (0.1587-0.12))}{(0.1587 - 0.1331)} \times \frac{(300-270)}{300}$ = 15.1%
Interpretation	(i) percentage change in NPV respectively (ii) percentage change in IRR above the cut-off rate (12%)is larger than percentage change in variable: price is a key variable for the project.	A change of approximately 15 % in the price variable is necessary before the NPV becomes zero or before the IRR equals the cut-off rate.
Characteristic	Indicates to which variables the project result is or is not sensitive. Suggests further examination of change in variable.	Measures extent of change for a variable which will leave the project decision unchanged.

10. The switching value is, by definition, the reciprocal of the sensitivity indicator. Sensitivity indicators and switching values calculated towards the IRR yield slightly different results if compared to SIs and SVs calculated towards the NPV. This is because the

IRR approach discounts all future net benefits at the IRR value and the NPV approach at the discount rate d.

Table 7.1 **Base Case of a Water Supply Project**

Economic statement	PV @12%	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Benefits:											
- Non-incremental water	1,674	0	225	270	315	360	405	450	450	450	450
- Incremental water	167	0	23	27	32	36	41	45	45	45	45
- Non-technical losses	263	0	35	42	50	57	64	71	71	71	71
Total	2,104	0	283	339	396	453	509	566	566	566	566
Costs:											
- Investment	1,687	1,889	0	0	0	0	0	0	0	0	0
- O&M	291	0	61	61	61	61	61	61	61	61	61
Total	1,978	1,889	61	61	61	61	61	61	61	61	61
Net cash flow	126	-1,889	222	278	335	391	448	505	505	505	505

11. In the base case, the ENPV is 126 and the EIRR is 13.7 percent. The sensitivity of the base case ENPV has been analyzed for (adverse) changes in several key variables, as follows:

(i) An increase in investment cost by 20 percent;

(ii) A decrease in economic benefits by 20 percent;

(iii) An increase in costs of operation and maintenance by 20 percent.

(iv) A delay in the period of construction, causing a delay in revenue generation by one year.

Proposed changes in key variables should be well explained. The sensitivity analysis should be based on the most likely changes. The effects of the above changes are summarized in Table 7.2 below.

Table 7.2 **Sensitivity Analysis: A Numerical Example**

Item	Change	NPV	IRR %	SI (NPV)	SV (NPV)
Base Case		126	13.7		
Investment	+ 20%	- 211	9.6	13.3	7.5%
Benefits	- 20%	-294	7.8	16.6	6%
O&M Costs	+ 20%	68	12.9	2.3	43.4%
Construction delays	one year	-99	10.8	NPV 178% lower	

SI = Sensitivity Indicator, SV = Switching Value

Source: Based on the data in Table 7.1.

12. Combinations of variables can also be considered. For example, the effect on the ENPV or EIRR of a simultaneous decline in economic benefits and an increase in investment cost can be computed. In specifying the combinations to be included, the project analyst should state the rationale for any particular combination to ensure it is plausible.

Step 4: Analysis of Effects of Changes in Key Variables

13. In the case of an increase in investment costs of 20 percent, the sensitivity indicator is 13.34. This means that the change of 20 percent in the variable (investment cost) results in a change of (13.3 x 20 percent) = 266 percent in the ENPV. It follows that the higher the SI, the more sensitive the NPV is to the change in the concerned variable.

14. In the same example, the switching value is 7.5 percent which is the reciprocal value of the SI x 100. This means that a change (increase) of 7.5 percent in the key variable (investment cost) will cause the ENPV to become zero. The lower the SV, the more sensitive the NPV is to the change in the variable concerned and the higher the risk with the project.

15. At this point the results of the sensitivity analysis should be reviewed. It should be asked: (I) which are the variables with high sensitivity indicators; and (ii) how likely are the (adverse) changes (as indicated by the switching value) in the values of the variables that would alter the project decision?

7.4 Risk Analysis

7.4.1 Qualitative Risk Analysis

16. In cases where project results are expected to be particularly sensitive to certain variables, it has to be assessed how likely it is that such changes would occur. This likelihood can be assessed by studying experiences in earlier, comparable projects and by investigating the situation in the sector as a whole.

17. Steps should be taken to reduce the extent of uncertainty surrounding those variables where possible. This may require remedial actions at the project, sector or national level. Examples of actions are:

(i) At the project level,

(a) make specific agreements to ensure contractor performance and project quality during construction works to reduce the likelihood of delays;

(b) enter into an agreement of long term supply contracts at specified quality and prices to reduce uncertainty of operating costs;

(c) formulate capacity building activities to ensure appropriate technical and financial management of water supply systems;

(d) conduct information or awareness building/educational programs to ensure the involvement of customers and to improve the hygienic use of water;

(e) incorporate the cost of sanitation or wastewater collection and treatment into project economic costs to ensure that environmental effects can be mitigated;

(f) implement a pilot phase to test technical assumptions and observe user's reactions, in case there is considerable uncertainty in a large project or program;

(g) set certain criteria which have to be met by subprojects before approval; for example, in rural WSPs, villages would have to fulfill certain criteria (e.g., community involvement) to be included in the program. This is especially important in sector loans where most (small) subprojects will be prepared after loan approval.

(ii) At the sector level,

(a) make price and tariff adjustments to ensure sufficient revenues for utilities and to ensure their financial liquidity and sustainability;

(b) conduct technical assistance programs to develop appropriate project and operational management skills for staff in water enterprises;

(c) implement loan covenants to prompt necessary (policy) institutional and legal reforms.

(iii) At the national or macro level,

(a) implement changes in tax and credit policy to influence incentives and simplify procedures for the import of goods;

(b) reformulate incentives (e.g. corporate taxes for utilities) to encourage higher levels of investment;

(c) implement legislative reform and regulation to provide an enabling environment for productive activities.

18. The results of the sensitivity analysis should be stated along with the associated mitigating actions being recommended, and the remaining areas of uncertainty that they do not address. Sensitivity analysis is useful at all stages of project processing: at the design stage to incorporate appropriate changes; at the appraisal stage to establish a basis for monitoring; and, during project implementation to take corrective measures. The uncertainty surrounding the results of the economic and financial analysis is expected to decrease as the project moves into the operational phase.

19. For the key variables and combinations of such variables, a statement can be presented including: the source of variation for the key variables; the likelihood that variation will occur; the measures that could be taken to mitigate or reduce the likelihood of an adverse change; and the switching values and/or sensitivity indicators.

7.4.2 Quantitative Risk Analysis

20. The purpose of quantitative risk analysis is to estimate the probability that the project EIRR will fall below the opportunity cost of capital; or that the NPV, using the EIRR as the discount rate, will fall below zero. A statement of such an estimate means that decisions can be based not just on the single base-case EIRR but also on the probability that the project will prove unacceptable. Projects with smaller base-case EIRRs may involve less uncertainty and have a higher probability of being acceptable in implementation. Projects with higher base-case EIRRs may be less certain and involve greater risk. Risk analysis can be applied also to projects without measurable benefits, for example to assess the probability that unit costs will be greater than a standard figure.

21. Undertaking a risk analysis requires more information than for sensitivity analysis. It should be applied to selected projects that are large or marginal, or where a key variable is subject to a considerable range of uncertainty. A large project is one which takes a high proportion of government or the country's investment resources, for example a project using more than 5 percent of the government’s investment budget in the peak project investment years. A marginal project is one where the base-case EIRR is only marginally higher than the opportunity cost of capital. A decision should be taken at an early stage of analysis whether to include a risk analysis in the appraisal or not.

CHAPTER 8

FINANCIAL SUSTAINABILITY ANALYSIS

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Boxes

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8.1 Introduction

1. Sustainable development is development that lasts. Economic viability of a water supply project (WSP) depends on its financial viability, i.e., sustainability of the project's financial returns. The economic analysis of projects should include an analysis of the financial viability of project agencies and environmental sustainability of project inputs and outputs. Unless such factors are taken into account, economic benefits may not be sustained at the level necessary to generate an acceptable EIRR over the useful life of the project.

2. This chapter focuses on the relationship between financial sustainability and economic viability of WSPs. Environmental sustainability is not explicitly defined or discussed in this handbook; to the extent possible, environmental costs and benefits should be internalized into the economic cost and benefit estimation of the WSP per se.

3. There are other dimensions of sustainability—institutional sustainability and technical sustainability. With regard to institutional sustainability, the financial impact of the project on the concerned institutions needs to be evaluated and the question to be asked is whether or not these institutions are able to pay the financial subsidies that may be needed for the WSP to survive. Economic analysis may also suggest institutional changes or policy measures needed to sustain the financial and economic benefits generated by the project. Technical sustainability is looked after as part of the analysis of alternatives and determination of the least-cost option, which is done in the early project preparation or feasibility stage.

8.2 Financial Sustainability

4. There are mainly three aspects of financial sustainability in connection with a given WSP:

(i) First, project funding and fiscal impact on government budget. WSPs are frequently funded by the government and full cost recovery especially from poor water users may not be possible even for their basic minimum needs.

(ii) Second, full or partial cost recovery of project costs from project beneficiaries. WSPs, like projects in other sectors, can hardly be sustained on government subsidy alone, without the revenue generation from the sector itself. Cost recovery and proper design of water tariff based on the costs of supply are required.

(iii) Third, financial incentives are necessary to ensure participation in the project of all stakeholders. In the context of a WSP, the participants include:

- lenders who lend money for capital investment;
- guarantors who guarantee the loan (In public projects like WSPs, the government is often the guarantor.);
- suppliers of inputs to the project;
- users of project output (households/industries); and
- the organization which sponsors and runs the project (water enterprise).

5. Each of these participants must have sufficient incentives to participate, i.e., must have sufficient returns from the project.

- lenders must have their original loan amount and interests paid back in time as per the debt-repayment schedule agreed between the project entity and the lenders;
- the guarantor should have profit-tax paid by the project especially when the project is run by a corporate entity so that there is an incentive to guarantee;
- suppliers of project inputs should have their payments in time by the project entity;
- users must be willing to pay and pay on time the charges levied for their use of water outputs.

6. The above items are dealt with in two financial statements—income statement and cash flow statement which are an essential part of the financial analysis of the project. The incentive for the project entity to participate is reflected by the “return to equity”, which has to be worked out from the cash flow statement of the financial

analysis of the project. Equity funding also includes the shareholders who contribute to the project. An example is shown in section 8.6.

8.2.1 Project Funding and Fiscal Impact

7. A financial plan at constant prices is necessary to assess the need for funds to finance project expenditures, both during the construction or implementation phase and the period of operation. If the project does not generate sufficient funds to cover all operating expenditures, then steps should be taken to ensure that the utility or government commits adequate funds for operational purposes (fiscal impact).

8. Similarly, through tax revenues and concession fees, projects can impact positively on the utility or government budget. Consequently, a fiscal impact assessment is an important consideration when structuring user charges, operator fees and taxes.

9. Where the funds required to operate the project are not covered through budgetary reallocation or efficiency improvements, they will have to be met through extra taxation or from borrowing. The economic effects of extra taxes and borrowing by government can be assessed at the national level. In either case, it is important to consider the effects of extra taxation or borrowing on the groups who are the principal project beneficiaries, especially the poor.

10. Assessing the fiscal impact is particularly important for projects where subsidies are involved and for undertakings (e.g., rural WSPs) where the government is the main project sponsor.

8.2.2 Cost Recovery from Beneficiaries

11. User charges from the beneficiaries to finance operational expenditures involve several issues, such as:

(i) economic effect of water charges;

(ii) charges for existing and new users in the case of expansion of the supply network;

(iii) affordability of tariff by different users; and

(iv) cost recovery.

8.2.3 User Charges

8.2.3.1 Economic Effect of Charges

12. The basic principle behind user charges is that users should pay the economic cost of the water services as the economic price of water should ensure the optimum "economic efficiency" of water charges. Theoretically, this ensures the optimum use of water—neither over-use (i.e., waste) nor under-use (below the minimum quantity to sustain adequate health and other criteria).

13. The appropriate cost for users to pay is the "Long-Run Marginal Economic Cost" (LRMEC) which includes both the investment and O&M costs. This is approximated by the Average Incremental Economic Cost (AIEC) derived from the least-cost method of supplying the water. This cost should be taken as the appropriate target for charging water users where a project stands alone.

8.2.3.2 Case of Expansion of Supply Network

14. Where a project extends an existing network, the tariff should be related to the AIEC of the water supply but spread over existing as well as new users.

8.3 Issue of Subsidy

15. Financial "adequacy" will be achieved only if the average financial cost can be recovered from users. As mentioned in paragraph 13, AIEC should be the appropriate target for charging water users. AIEC can, however, be more than or less than AIFC. First, if the AIEC is less than the AIFC, charges based on AIEC will create financial deficiency and financial sustainability will not be achieved based on user's charges alone. Second case, if AIEC is more than the AIFC, which may happen especially in the later years of the project, there is no difficulty in achieving the financial sustainability if water charges are based on AIEC. The first case requires governmental intervention in the form of "subsidy".

16. The difference between the average financial price of water charged and the AIFC is referred to as the AFS (average financial subsidy). Similarly, the difference

between the AIEC and the economic price of water charged is referred to as the AES (average economic subsidy). AFS and AES may not coincide due to market distortions, magnitude of nontechnical losses in the water supply system and externalities like environmental costs and benefits. Bank's policy is to eliminate "subsidy" over time where they are not justified. However, in projects like WSPs particularly in the rural areas, the subsidy arises in most cases.

8.3.1 Subsidy and its Justification

17. Generally, subsidies should be progressively reduced or phased out to the extent feasible because they may lead to macro-economic pressures via the budget and inefficient resource allocation. However, in certain conditions, subsidies may be justified. The ADB's document "Criteria for Subsidies" identifies conditions under which subsidies could be justified.

(i) Situations exist in which positive externalities occur where social returns from a project exceed private returns, like when health benefits to beneficiaries or environmental improvements due to the water supply projects are not reflected in the flow of financial benefits.

(ii) In industries with decreasing costs (due to e.g. economies of scale), say water industries, the cost of producing the marginal unit of output does not cover the full average costs. This would entail a loss for producers. Producers need to be subsidized to attain the economically (and socially) optimal levels of output.

(iii) There may be a need to compensate for the effects of market distortions which may have to be offset through subsidies. For example, a government may have a very high tax on imported machinery but may consider it appropriate to provide a general subsidy for the purchase of equipment for water supply.

(iv) A fourth situation is the case of redistribution, where subsidies are targeted at the poor; it is often considered desirable to provide subsidies for basic minimum water consumption to these groups.

(v) In case of positive environmental effects generated by the project which would not directly benefit the users, it may be justifiable to subsidize at least part of the costs made to generate these benefits.

(vi) There are special considerations that may require subsidies, such as in the context of transitional economies where the market institutions are yet to develop fully.

8.4 Affordability and Income Transfers

18. Although subsidies may be justifiable on the basis of the above considerations, it will be preferable as a first step to take recourse to "income transfer". For example, a cross-subsidy from the rich household users to poor household users is built into the water tariff structure. This may eliminate the need for subsidizing the water supply operations as a whole.

19. Tariff structures can be designed to ensure that those who use more water per capita (high income group) pay more than the single average tariff for all the groups and compensate for the lower than average tariff paid by the low income and poor households.

20. Subsidy from the central exchequer should be avoided as much as possible in an effort to avoid transfers from other sectors to water supply sector as this hampers the self-sufficiency of the water supply sector, which is needed to ensure financial sustainability of WSPs.

8.4.1 Affordability of Charges Paid by Users at Different Levels of Income

21. For any project to be financially sustainable, consumers must be able to afford to pay the price charged and the total monthly or annual bill. Affordability analysis typically compares the household cost of water consumption with a measure of household income.

22. Household consumption varies with several factors as discussed in Chapter 3. These factors may include household size, income, quantities used for basic uses such as drinking, cooking, and cleaning associated with the low-income group and non-basic uses such as watering lawn or washing cars etc. associated with the middle or high-income groups.

23. Affordability analyses are mainly meant for the low-income group in the project area and the poor households, i.e., those below the poverty line. A monthly bill based on the designed water tariff and projected average water consumption is worked out for an average household of the low-income group and compared with the average monthly income of the household in that group. A typical analysis of affordability for the town of Mysore in India is shown in Table 8.1 on the next page.

Table 8.1 **Mysore Water Supply and Sanitation Component Affordability Analysis**

Item	**Estimated**						**Projected**						
	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Tariffs and Monthly Bill													
Domestic Water and Sewerage Tariff(Rs/m^3)	0.76	1.23	1.47	1.99	3.36	4.20	4.62	5.08	7.62	8.38	9.22	10.14	11.16
Monthly Water Consumption - LIG Household (m^3)	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
Monthly Bill - LIG Household (Rs)	14	22	26	36	60	76	83	91	137	151	166	183	201
Monthly Water Consumption - EWS Household (m^3)	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Monthly Bill - EWS Household (Rs)	11	18	22	30	50	63	69	76	114	126	138	152	167
Household Incomes													
Upper Limit of LIG (Rs/month)	2,650	2,891	3,153	3,439	3,752	4,092	4,464	4,869	5,311	5,794	6,320	6,894	7,519
Upper Limit of EWS (Rs/month)	1,250	1,364	1,487	1,622	1,770	1,930	2,106	2,297	2,505	2,733	2,981	3,252	3,547
Percent of Household Income Devoted to Water and Sewerage													
Upper Limit of LIG	0.5	0.8	0.8	1	1.6	1.8	1.9	1.9	2.6	2.6	2.6	2.6	2.7
Upper Limit of EWS	0.9	1.4	1.5	1.8	2.8	3.3	3.3	3.3	4.6	4.6	4.6	4.7	4.7

LIG - Low-income Group
EWS – Economically weaker section

24. It can be seen from the Box that a household at the upper limit of the low-income group with only Rs2,650/month in 1993 would pay approximately 2.7 percent of income (i.e., a monthly bill of Rs201 as a percentage of a household income of Rs7,519) for water and sanitation upon the full implementation of tariff (increased from Rs0.76/m^3 to Rs11.16/m^3) in ten years' time in 2005. Even the household earning as low as only Rs1,250/month in 1993 would pay only 4.7 percent of income for water and sanitation in the year 2005. Cost recovery was thus justified for the project loan as the household expenditure on water supply and sanitation facilities did not exceed 5 percent of the household income, which is generally accepted as norm by international development banks and financial institutions.

25. However, affordability indicators of this nature are somewhat arbitrary and crude and, therefore, must be used with great care allowing for variation of circumstances in different locations and different countries. The Box 8.1 below shows an example where households from some Moroccan towns were willing to pay more than 5 percent of their income if house connections were given.

Box 8.1 **The "Five Percent Rule" for Improved Water Services:**
Can Households Afford More?

Results of a household-willingness-to-pay survey in five small Moroccan cities revealed that respondents would pay 7 to 10 percent of total household income for individual water connections, and subsequent commodity charges despite already having a reliable and free standpost service.

Source: McPhail, Alexander A. 1993. Quoted from: *The "Five Percent Rule" For Improved Water Service: Can Households Afford More?* The World Bank, World Development, Vol. 21, No 6, pp. 963-973.

26. If the result of the affordability analysis is that the low-income households would have to spend a relatively high proportion of their income to cover their basic needs for water, the following actions may be appropriate:

- comparison is to be made between the predicted expenditures on water with-project and expenditures without-project. If users are actually paying the same or higher costs without-project, they may be expected to spend at least a similar portion of their income for future water consumption provided by the project.

- consideration should be given as to whether or not users will still be interested to obtain lower service levels in which case cost to households can be reduced and brought within the affordable level; and

- consideration is to be given as to whether cross-subsidization from higher income groups to the low-income group can be incorporated in the tariff design so that the average cost recovery is almost equal to AIFC.

8.4.2 Cost Recovery and Tariff Design *(based on Affordability Considerations and Cross-subsidization)*

27. The annex to this chapter has an illustration of a tariff design for a town in India showing an increasing water consumption from low (with 40 liters per capita per day, lcd) to middle (80 lcd) to high income groups (150 lcd), incorporating cross subsidization from the higher income groups to lower income groups. The AIFC is Rs6.96/m^3 and the AIEC is Rs6.71/m^3,using domestic price numeraire for arriving at economic costs. The AIEC is lower because of the high value of non-technical losses (water consumed but not paid for) which represent a benefit in the economic analysis. The charges are, therefore, based on AIFC for ensuring financial sustainability.

8.5 Demand Management

28. The economic cost of subsidies to the water industry may be quite large. The sustainability of WSPs may be adversely affected if the subsidy required is very large. In such a situation, successful demand management can yield economic savings which may be greater than economic benefits from supply expansions. Depending on the price elasticity of demand, the result of an increase in the price of water may be:

- a decrease in the quantity of water demanded;
- an increase in sales revenue; and
- a reduction in capital costs.

29. This is best explained through the following illustration relating to a WSP in India, the Channapatna/Ramanagaran WSP. Tables 8.2 and 8.3 –Water Supply Expansion with Financial Price below AIFC and Water Supply Expansion with Demand

Management Option with Financial Price equal to AIFC – contain the data and calculations for two cases. The results are summarized as follows:

A. Supply expansion with Financial Price below AIFC: (See Table 8.2)

AIFC = Rs6.96 per m^3
Financial Price = Rs5.00 per m^3
Present Value at 12% Discount Rate

- Financial Benefit = Rs151.25 x 10^6
- Quantity Demanded = 30250 m3
- Financial Costs = Rs210.4 x 10^6
- Net Financial Cost = Rs.59.15 x 10^6
  = Rs (210.4-151.25) x 10^6

B. Supply expansion and Demand Management with Financial Price equal to AIFC: (See Table 8.3)

AIFC = Rs6.96/m^3
Financial Price = Rs.6.96/m^3
Present Values @ 12% Discount Rate:

- Financial Benefit = Rs184.4 x 10^6
- Quantity Demanded with application of price
  = 26529.25 m^3
- Price Elasticity of demand = -0.4
- Value of Financial Costs = Rs184.5 x 10^6
- Net Financial Costs = 0

30. Without demand management, the financial subsidy (the difference between the average price and the AIFC) is equal to Rs1.96/m^3 (= Rs6.96 – Rs5.0). This subsidy represents 28.16 percent of the costs. With demand management, higher charge for water and lower demand (but also lower investment costs), the final subsidy is reduced to zero as the full financial cost is being met.

Table 8.2 **Supply Expansion with Financial Price Below AIFC**

Year	Financial Price (Rs/m³) (A)	Quantity Demanded (000m³) (B)	Financial Benefit (Rs 10^6) (AxB = C)	Financial Costs (Rs 10^6) (D1)	Financial Costs (Rs 10^6) (D2)	Total Financial Costs (Rs 10^6) (D= D1+D2)	Net Financial Benefits (Rs 10^6) (E=C-D)
0		0	0	39.4	0	39.4	-39.4
1	5	82	0.41	90.0	0	90.0	(89.59)
2	5	130	0.65	73.1	0	73.1	(72.45)
3	5	179	0.895	22.5	0	22.5	(21.61)
4	5	3,500	17.50		3.7	3.7	13.80
5	5	4,885	24.43		2.7	2.7	21.73
6	5	5,204	28.02		2.9	2.9	25.12
7	5	5,807	26.54		2.9	2.9	23.64
8	5	5,412	27.06		3.5	3.5	23.56
9	5	5,896	29.48		7.8	7.8	21.68
10	5	6,059	30.30		8.1	8.1	22.20
11	5	6,226	31.13		8.3	8.3	22.83
12	5	6,397	31.98		8.5	8.5	23.48
13	5	6,812	34.06		9.0	9.0	25.06
14	5	6,948	34.76		9.3	9.3	25.46
15	5	7,086	35.43		9.5	9.5	25.93
16	5	7,112	35.56		10.0	10.0	25.56
17	5	7,112	35.56		10.0	10.0	25.56
18	5	7,112	35.56		10.0	10.0	25.56
19	5	7,112	35.56	33.7	10.0	10.0	(8.14)
20-34	5	7,112	35.56		10.0	10.0	25.56
Present value @12%		30,250	151.25			210.4	(59.15)
Average cost in Rs. Per m³			5			AIFC=6.955	(1.96)

Table 8.3 **Supply Expansion and Demand Management**
with Financial Price Equal to AIEC

Year	**Financial Price** *(Rs/m³)* (A)	**Quantity Demanded** *('000m³)* (B)	**Financial Benefit** *(Rs 10^6)* (C = AxB)	**Financial Costs** *(Rs 10^6)* (D1)	**O&M Costs** *(Rs 10^6)* (D2)	**Financial Costs** *(Rs 10^6)* (D= D1+D2)	**Net Financial Costs** *(Rs 10^6)* (E=C-D)
0	-	0	0	34.55	0	34.55	(34.55)
1	6.96	71.91	0.500	78.9	0	78.93	(78.93)
2	6.96	114.01	0.794	64.11	0	64.11	(64.11)
3	6.96	156.98	1.092	19.73	0	19.73	(19.73)
4	6.96	3,069.50	21.36		3.25	3.25	18.11
5	6.96	4,284.15	29.82		2.37	2.37	27.45
6	6.96	4,563.91	31.76		2.54	2.54	29.22
7	6.96	4,654.24	32.39		2.54	2.54	29.85
8	6.96	4,746.32	33.03		3.07	3.07	29.96
9	6.96	5,170.79	35.99		6.84	6.84	29.15
10	6.96	5,313.74	36.98		7.10	7.10	29.88
11	6.96	5,460.20	38.00		7.28	7.28	30.72
12	6.96	5,610.17	39.05		7.45	7.45	31.60
13	6.96	5,974.12	41.58		7.89	7.89	33.69
14	6.96	6,093.40	42.41		8.16	8.16	34.25
15	6.96	6,214.42	43.25		8.33	8.33	34.92
16	6.96	6,237.22	43.41		8.77	8.77	34.64
17	6.96	6,237.22	43.41		8.77	8.77	34.64
18	6.96	6,237.22	43.41		8.77	8.77	34.64
19	6.96	6,237.22	43.41	29.55	8.77	8.77	34.64
20	6.96	6,237.22	43.41		8.77	8.77	34.64
21	6.96	6,237.22	43.41		8.77	8.77	34.64
22	6.96	6,237.22	43.41		8.77	8.77	34.64
23	6.96	6,237.22	43.41		8.77	8.77	34.64
24	6.96	6,237.22	43.41		8.86	8.86	34.55
25-33	6.96	6,237.22	43.41		9.91	9.91	33.50
34	6.96	6,237.22	43.41		10.00	10.00	33.41
Present value @12%		26,529.25	184.40			184.5	-0.1
Average cost in Rs. per m³			6.96			AIFC = 6.96	

Notes:

$Q_2 = Q_1 \times \{ (1 + e \times A/2) / (1 - e \times A/2) \}$

Where: Q_2 = Quantity demanded as a result of price increase to Rs 6.95/m^3 = P_2

Q_1 = Quantity demanded at the original price of Rs 5.00/m^3 = P_1

e = Price elasticity of demand = -0.4 assumed

and $A = \frac{(P_2 - P_1)/(P_2 + P_1)}{2} = \frac{(6.95 - 5.0)/(6.96 + 5.0)}{2} = 0.3278$

Hence, $Q_2 = Q_1 \times \frac{\{1 + (-.4) \times 0.3278/2\}}{\{1 - (-.4) \times 0.3278/2\}} = Q_1 \times 0.877$

8.6 Financial Returns to the Project Participants

31. In cases where the main project participant is a corporation, either public or private, the income statement and cash flow statement built up in the project's financial analysis show the net income generated by the project investment after allowing for loan flows, loan payments and taxation of profit. After meeting all these financial obligations and financing the need for working capital where applicable, the residual money is the return to the project sponsor's own contribution and contribution to shareholders who have also a stake in the project investment. This return to equity is to be worked out and it should be high enough to attract their participation in the project.

8.6.1 Return to Equity

32. The following illustration relates to the Channapatna/Ramanagaran WSP in Karnataka State of India which is to be implemented through a corporate entity. The income and cash flow statements of the project have been worked out based on the following basic features:

1) Initial investment is spread over four years.

2) The loan from the Bank which covers 80 percent of the total investment has a grace period of 5 years and is then repayable over a 20-year period at an interest rate of 6.9 percent. However, consistent with government policy, this is re-lent to the water entity by the government at a nominal interest of 12 percent. The anticipated inflation is 3.2 percent per annum. Thus, the real rate of interest amounts to 8.5 percent. The calculation is shown in Box 8.2 below.

Box 8.2 **Real Rate of Interest Calculation**

The relationship between inflation, nominal interest rate and real interest rate is stated in the following equation:

$$(1 + i)(1 + r_r) = (1 + r_n)$$

or $$r_r = \{(1 + r_n)/(1 + i)\} - 1$$

where i = annual rate of inflation
r_r = real rate of interest
r_n = nominal rate of interest

In this case,
$i = 0.032$
$r_n = 0.12$

hence,

$$(1 + .032)(1 + r_r) = (1 + 0.12)$$

or r_r = 8.5 percent

3) The remaining 20 percent of the investment comes from a government grant to the water entity for which no payment of interest or principal is to be made.

4) Project assets are operated for 31 years, after which there is no residual value.

5) O&M costs increase gradually with increasing supply of water.

6) The average price of water rises over the 35-year project period from Rs1.72 per m^3 to Rs6.18 per m^3 in real terms.

7) Water sales on the basis of project supplies increase over the first 12 years of the project, then remain at a constant level.

8) Twenty percent of UFW are nontechnical losses and do not generate any revenue.

9) The water entity would become liable for profit tax (remuneration

to the guarantor—the government) at the rate of 46 percent of gross profit from the year onward when accumulated profit is no more negative.

33. The cash flow statement is shown in Annex 3 (Table 8.3) of this chapter. The “return to equity” works out to be 4.3 percent.

8.6.2 Assessment of “Return to Equity” of 4.3 percent

34. The return to equity of 4.3 percent is generally considered to be low. The following key questions are:

(i) will this low return induce foreign investment funds, or private domestic investment, or even government investment?

(ii) does a 4.3 percent return to equity provide sufficient incentive to the project owner to undertake and maintain the investment?

(iii) is the return to equity as low as 4.3 percent sufficient to justify an operation of the water supply project on a corporate basis?

Case of Foreign Investment

35. Most private foreign investors in many countries would be looking for returns of 16 to 20 percent in real financial prices. Hence, a return of only 4.3 percent per annum would not appear to be acceptable to foreign investors.

Case of Private Domestic Investment

36. Private domestic investors are likely to have alternative investment opportunities that yield much higher than 4.3 percent in real terms. They will, therefore, also be excluded in such an investment with low return to equity.

Case of Government Investment

37. Government investment, again, depends on the cost of investment funds. What is the opportunity cost of investment funds for most of the member countries? Combining estimates of returns to savers and investors and allowing for the elasticity of demand and supply of investment funds suggest that the cost of investment in real financial prices is between 10 percent and 12 percent. Government may wish to

achieve these rates of interest in project investments in financial terms. Hence, it is unlikely that government funds will be available for a WSP generating a low return of 4.3 percent. However, governments may still support this WSP, considering the economic and environmental benefits not captured in the financial benefit calculation.

Project Implementation Risk

38. A return of 4.3 percent to equity is too low to justify the project. The risk is high as the small return may quickly become zero, or negative in case there is a high cost-overrun in implementing the project and/or if the projected level of demand for water does not materialize. This will then require an undesirable level of subsidy to be sustained over the life of the project.

39. However, if instead of relending the loan (with Bank's rate of 6.9 percent) to the domestic water entity at a high rate of 12 percent (resulting in a real rate of 8.6 percent, see Box 8.3) , the government sets the relending equal to the Bank's terms (such as, five years of grace period at 6.9 percent interest rate), the return to equity improves considerably and becomes 11.9 percent. This rate of return would then be sufficient for a water authority to be set up on a corporate basis.

40. A change in onlending rate (refer to para. 39 above) raises the issue of who carries the foreign exchange risk. The issues of foreign exchange movements and risk sharing are important in cases where the water enterprise uses external finance but gets its main revenue from the domestic household and industrial/commercial sector. In the example presented in section 8.6.2, the lowering of the relending rate from 12 percent to 6.9 percent means that the government has to shoulder the foreign exchange risk. Any adverse foreign exchange movements may then have an impact on fiscal sustainability .

Table 8.4 **Cash Flow Statement**

Items	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Cash Inflows																		
Water Sales	0.0	0.1	0.2	0.6	11.8	25.1	27.2	28.3	29.4	32.2	33.3	34.3	35.5	37.9	38.9	39.8	40.2	40.4
Loan	31.5	72.1	58.5	18.0														
Total Cash Inflows	31.5	72.2	58.7	18.6	11.8	25.1	27.2	28.3	29.4	32.2	33.3	34.3	35.5	37.9	38.9	39.8	40.2	40.4
Cash Outflows																		
Capital Costs	39.4	89.9	72.9	21.9														
O&M Costs					2.2	4.6	5.1	5.3	5.9	6.2	6.4	6.6	6.8	7.2	7.4	8.0	8.0	8.0
Loan Repayments						5.0	5.4	5.9	6.4	6.9	7.5	8.2	8.9	9.6	10.5	11.4	12.4	13.4
Interest Payments						21.0	20.5	20.1	19.6	19.0	18.4	17.8	17.1	16.3	15.5	14.6	13.6	12.5
Tax Payments																5.4	6.1	6.8
Total Cash Outflows	39.4	89.9	72.9	21.9	2.2	30.6	31.1	31.3	31.9	32.2	32.4	32.6	32.8	33.2	33.4	39.4	40.1	40.8
Net Cash Flows	-7.9	- 17 .7	-14.2	-3.3	9.6	-5.5	-3.9	-3.0	-2.5	0.0	0.9	1.7	2.7	4.7	5.5	0.4	0.1	-0.4

Note: Loan inflow is calculated as 80 percent of capital investment cost over the four years of project implementation.

Table 8.4 Cash Flow Statement (continuation)

Items	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Cash Inflows																	
Water Sales	40.6	40.8	41.0	41.2	41.5	41.6	41.9	42.1	42.2	42.5	42.7	42.9	43.1	43.3	43.6	43.8	44.0
Loan																	
Total Cash Inflows	40.6	40.8	41.0	41.2	41.5	41.6	41.9	42.1	42.2	42.5	42.7	42.9	43.1	43.3	43.6	43.8	44.0
Cash Outflows																	
Capital Costs		33.6															
O&M Costs	8.0	8.0	8.1	8.1	8.1	8.1	8.1	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Loan Repayments	14.6	15.9	17.2	18.7	20.3	22.1	24.0										
Interest Payments	11.4	10.1	8.8	7.3	5.7	3.9	2.1										
Tax Payments	7.5	8.2	9.0	9.8	10.7	11.7	12.7	13.4	13.6	13.7	13.8	14.0	14.1	14.3	14.4	14.6	14.7
Total Cash Outflows	41.5	75.8	43.0	43.9	44.8	45.8	46.9	22.4	22.6	22.7	22.8	23.0	23.1	23.3	23.4	23.6	23.7
Net Cash Flows	-0.9	-35.0	-2.0	-2.7	-3.3	-4.2	-5.0	19.7	19.6	19.8	19.9	19.9	20.0	20.0	20.2	20.2	20.3
IRR = 4.3% ≈ return to equity																	

8.7 Financial Analysis at the Enterprise Level

41. Project sustainability is also contingent upon the overall financial performance of the enterprise, either public or private, undertaking the project and the enterprise's incentive to invest in the project. That is, in addition to the project generating sufficient incentive (i.e., profitability and/or return to investment) to the project sponsor undertaking and maintaining the investment, the financial performance of the enterprise must also be sufficient to attract capital to the project and the forecasted cash flow of the enterprise must be sufficient to finance the project.

42. The financial performance of the enterprise prior to the project investment must be sound in order to attract capital to the project. This analysis is undertaken as part of the financial analysis for each project in accordance with the Bank's *Guidelines for the Financial Analysis of Projects,* in three financial statements—income statement, cash flow statement and balance sheet.

43. Assuming that requisite financial analysis has been performed and the project has been found to be financially viable, an analysis of the projected financial statements of the enterprise will identify any cash flow implications on the financial sustainability at both the project and the enterprise level.

Annex
Tariff Design for Financial Sustainability
(an Illustration)
Based on data from Karnataka Urban Infrastructure Development Project

(1) Population in year 5 of the project = 80,000

(2) Household size = 4

(3) No. of households = 20,000

(4) High income group = 0.15 x 20,000 = 3,000 nos. households
(Rs5,000 to Rs7,000 per month)

(5) Middle income group = 0.65 x 20,000 = 13,000 nos. households
(Rs2,400 to Rs5,000 per month)

(6) Low income group households = 0.20 x 20,000 = 4,000 nos.
(Rs1,250.00 per month to Rs2,400 per month)

(7) Consumption per capita per day: (liters per capita per day = lcd)
- one connection outside house = 40.00 lcd (for low income group)
- one connection inside house = 80.0 lcd (for middle income group)
- two connections inside house = 150.0 lcd (for high income group)

(8) Total consumption per day: (in m^3)

$$\frac{1}{1000}(3,000 \times 4 \times 150) + (13,000 \times 4 \times 80) + (4,000 \times 4 \times 40) = 6,600 m^3$$

(9) Consumption per day by commercial and small industrial plants
= ten percent of total consumption = 660m^3

(10) Quantity of water sold per day = (6,600 + 660) m^3 = 7,260 m^3

(11) AIFC = Rs6.96/m^3
AIEC = Rs.6.71/m^3 (using domestic price numeraire)

(12) Total financial cost to be met per day
= 7260 x 6.96 = Rs50,529.60

(13) Provision for uncollected water charges = six percent of total water sales.

(14) Charges for commercial businesses and industrial plants = Rs10.00/m^3
As AIFC < Rs10/m^3, the commercial/industrial sector cross-subsidizes the household sector.

(15) Payments (per day) by commercial houses and industrial plants
= (660) x (10) = Rs6,600.00

(16) Remaining financial costs (per day) are to be met by the households
= Rs50,529.6 – Rs660.00
= Rs43,929.60

(17) Charges for different income groups

- low income group = Rs5.00/m^3 < AIFC (40 for lcd)
- middle income group
  first 40 Lcd = Rs5.00/m^3 < AIFC
  next 40 Lcd = Rs8.00/m^3 > AIFC
- high income group
  first 40 Lcd = Rs5.00/m^3 < AIFC
  next 40 Lcd = Rs8.00/m^3 > AIFC
  next 70 Lcd = Rs13.00/m^3 > AIFC

(18) Total charges from households per day:

from low income group

$$= 4,000 \times \frac{(4 \times 40 \times 5)}{1,000} = \text{Rs}3,200.00$$

from middle income group

$$= 13,000 \times \frac{(4 \times 40 \times 5) + (4 \times 40 \times 8)}{1,000} = \text{Rs}27,040$$

for high income group

$$= 3,000 \times \frac{(4 \times 40 \times 5) + (4 \times 40 \times 8.0) + (70 \times 4 \times 13.00)}{1,000}$$

= Rs17,160.00

TOTAL CHARGES FROM ALL HOUSEHOLDS (PER DAY)
= Rs3,200.00 + Rs27,040 + Rs17,160 = Rs47,400.00

Total water sales (per day) from commercial/industrial sector and households
= Rs47,400.00 + Rs6,600.00 = Rs54,000.00

(19) Provision for uncollected water sales value (per day) as a percentage of total sales

$$= 100 \text{ x } \frac{(54{,}000.00 - 50{,}529.60)}{(54{,}000.00)} = 6.4\%$$

(20) Test for "affordability":

Lowest income group

Monthly payment from each household = (3,200.00/4,000) x 30 = Rs24.00

Lowest monthly income of low income group = Rs1,250.00

Water charges as a percentage of monthly income $= \frac{24.00}{1{,}250.00} \text{ x } 100 = 1.92\%$

Middle income group

Monthly payment from each household = (27,040/13,000) x 30 = Rs62.4

Lowest monthly income of middle income group = Rs2,400.00

Water charges as a percentage of monthly income $= \frac{62.4}{2{,}400} \text{ x } 100 = 2.6\%$

High income group

Monthly payments from each household = (17,160/3,000) x 30 = Rs171.60

Lowest monthly income of high income group = Rs5,000.00

Water charges as a percentage of monthly income $= \frac{171.60}{5{,}000} \text{ x } 100 = 3.43\%$

Remarks:

Key questions to be asked for the tariff design are:

- Have we got adequate finance to ensure financial sustainability?
- Are the water charges "affordable" to the consumers, especially to the poorer section of the community?
- Is the economic price covered by the water charges?

The answers to these questions are "yes".

- Is there any "subsidy" involved?
  There is no general subsidy, either financial or economic. However, there is cross-subsidy from the high-income group to the low-income group, as can be seen below:

  Low-income group: -
  (100% @ Rs5.00/m^3)
  This is less than AIFC = Rs6.96/m^3
  Middle income group : -
  (50% @ Rs5.00/m^3 and 50% @ 8.00/m^3)
  Weighted average rate = 0.5 x 5 + 0.5 x 8 = Rs6.5/m^3
  This is slightly less than AIFC = Rs6.96/m^3
  High-income group: -
  (0.267 @ Rs5.00/m^3, 0.267 @ Rs8.0/m^3 and 0.466 @ Rs 13.0/m^3)
  Weighted average rate = 0.267 x 5.0 + 0.267 x 8 + 0.466 x 13
  = Rs9.53
  This is higher than AIFC = Rs6.96/m^3

- Weighted average price of water

$$= \left[\frac{660}{7,260} \times 10\right] + \left[\frac{640}{7,260} \times 5\right] + \left[\frac{4,160}{7,260} \times 6.5\right] + \left[\frac{1,800}{7,260} \times 9.53\right]$$

= Rs7.44/m^3

CHAPTER 9
DISTRIBUTION ANALYSIS
AND IMPACT ON POVERTY

CONTENTS

Tables

9.1 Concept and Rationale

1. The cost and benefits of a water supply project (WSP) are shared among different groups. Based on the results from the financial and economic benefit-cost analysis, an assessment of the distribution of project benefits and costs can be given to show which participant will gain from the project or incur a loss.

2. For example, consumers might gain due to the project if they can obtain water with the project at a lower price than without the project. Meanwhile, farmers might loose with the project when less irrigation water is available, and the government might loose when it subsidises the utility if it does not generate sufficient financial funds.

3. In general, distribution analysis is useful:

i) to assess whether the expected distribution of project effects corresponds with the objectives of the project (e.g., increased well-being) ;

ii) to assess the likely impact of policy changes on the distribution of project benefits (e.g., pricing and exchange rate policy); and

iii) to provide the basis for the poverty impact assessment (Section 9.5). This assessment evaluates which portion of the net gains of the project will ultimately benefit the poor.

4. The distribution analysis depends on data from both the financial and economic benefit-cost analyses. As financial benefit-cost analysis is done using the domestic price level numeraire, the latter will be used in the examples throughout this chapter.

9.2 Distribution of Project Benefits and Costs

5. The following is an example of a statement on the distribution of project benefits and costs in a WSP. The assumptions used to derive the economic benefits and costs are presented in Table 9.1.

Table 9.1 **Basic data**

Demand without-project		200	‘000m³/year
Price of water without-project		2.50	Rs/m³
Price of water with-project (tariff)		1.50	Rs/m³
Price elasticity of demand		-0.5	
	Demand with-project	240	‘000m³/year
	Incremental water	40	‘000m³/year
	Nonincremental water	200	‘000m³/year
	Average demand price with-& without- project	2.00	Rs/m³
Economic supply price of water without-project		2.25	Rs/m³
Unaccounted for water		30%	
	non-technical losses	10%	
	and technical losses	20%	
Investment costs (financial)			
Equipment		1,37	Rs‘000
		1	
Installation (labor)		171	Rs‘000
Operation and Maintenance			
Operating labor (% investment)		1.0%	
Electricity (% investment)		1.5%	
Other operating costs (% investment)		0.5%	
Conversion factors (domestic price numeraire)			
Equipment (traded component)		1.11	SERF
Installation (labor)		0.90	SWR
Operating (labor)		0.90	SWR
Electricity (subsidized)		1.20	CF
Other operating costs		1.00	CF
Opportunity cost of water			
Opportunity cost of water		0.10	Rs/m³ prod.

6. The with-project demand forecast for year 2002, the time horizon for this project, has been assessed on the basis of the following assumptions:

(i) the project is expected to replace a demand from alternative sources of 200,000 m³/year (nonincremental demand);

(ii) the average financial price of water without the project is Rs2.50 per m³;

(iii) the average financial price or tariff with the project will be Rs1.50 per m³;

(iv) the price elasticity of demand is -0.50.

7. As a result of a 40 percent price decrease [(2.50-1.50)/2.50] x 100, the demand with the project is expected to increase by 20 percent [(-0.50 x -0.40) x 100], from 200,000 m³ to 240,000 m³ per year.

8. This demand would build up during five years, from 50 percent of the ultimate demand forecast in 1997, 60 percent in 1998 until full supply capacity is reached in 2002. On the basis of an unaccounted-for-water (UFW) of 30 percent, the project water production would be [240,000/(1 - 0.30)] or 343,000 m³ (rounded). The demand and production of piped water with the project is shown in the table below.

Table 9.2 **Piped Water Demand and Production**

Piped Water Demand and Production	**Unit**	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
- Demand/Capacity build- up with-project			50%	60%	70%	80%	90%	100%	100%	100%	100%
- Piped water demand	‘000 m³		120	144	168	192	216	240	240	240	240
-UFW (30% of production)	‘000 m³		51	62	72	82	93	103	103	103	103
Piped water production	‘000 m³		171	206	240	274	309	343	343	343	343

9. The financial cash flow statement of the project during the project life is presented in Table 9.3. The project lifetime is for presentational purposes, assumed to be ten years.

10. The revenues are calculated on the basis of the forecasted demand and tariffs. For example, in 1997, revenues are equal to (50% x 240,000 x 1.5) or Rs180,000. The investment cost of the project is Rs1,371,000 for equipment and Rs171,000 for installation labor. Operating labor is estimated at 1 percent of the total investment of Rs1.543 mn, electricity at 1.5 percent and other O&M at 0.5 percent. At the projected tariff level, the water utility will not recover the full incremental cost of the project at financial prices, discounted at 12 percent which is the assumed WACC. At this rate, the utility will have a loss of Rs259,000 in present value. So, the project is only viable if subsidized.

Table 9.3 **Project Financial Benefits and Costs**
(Rs'000, 1996 prices)

Financial statement	**PV @12%**	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Benefits:											
- Revenue	1,339		180	216	252	288	324	360	360	360	360
Total	1,339		180	216	252	288	324	360	360	360	360
Costs:											
- Equipment	1,224	1,371									
- Installation (labor)	153	171									
- Operating labor	73		15	15	15	15	15	15	15	15	15
- Electricity	110		23	23	23	23	23	23	23	23	23
- Other operating costs	37		8	8	8	8	8	8	8	8	8
Total	1,598	1,543	46	46	46	46	46	46	46	46	46
Net cash flow	-259	-1,543	134	170	206	242	278	314	314	314	314

11. The economic analysis of the project introduces the following considerations:

(i) with the project, increased quantities of water will be available at a lower cost, representing an economic benefit to the user. Nonincremental water (200,000 m^3/year) has been valued by its economic supply price without the project of Rs2.25 per m^3 and incremental water (40,000 m^3/year) by its average demand price of Rs2.00 per m^3 [(1.50 + 2.50)/2].

(ii) water consumed but not sold (non-technical losses) does not generate revenues for the utility. It, however, does benefit the consumer. At full capacity, the volume of the non-technical losses is 10 percent of water produced, or 34,300 m^3 per year (10% of 343,000). Valued at the weighted average economic value of incremental and nonincremental water of Rs2.21 per m^3 (5/6 x 2.25 + 1/6 x 2), the worth of NTL is Rs76,000 (rounded) per annum, as of year 2002. From Table 9.4, it can be seen that the weights 5/6 and 1/6 are constant during 1997-2005.

Volumes of incremental and nonincremental water demand, and of nontechnical losses are shown in the table below. The economic benefits derived from this water consumed are comprised in Table 9.5.

Table 9.4 **Volumes of Water from which Economic Benefits are Derived**

	Unit	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Demand/Capacity build- up with-project			50%	60%	70%	80%	90%	100%	100%	100%	100%
Water demand with-project [1/]	‘000 m^3		120	144	168	192	216	240	240	240	240
Water demand without-project [2/]	‘000 m^3		100	120	140	160	180	200	200	200	200
Nonincremental water	‘000 m^3		100	120	140	160	180	200	200	200	200
Incremental water	‘000 m^3		20	24	28	32	36	40	40	40	40
Nontechnical losses (10% of production)	‘000 m^3		17	21	24	27	31	34	34	34	34

[1/] Piped water demand, ultimately reaching 240,000 m^3 per year, building up according to percentages given.

[2/] Water from alternative sources, to be replaced by the project, ultimately reaching 200,000 m^3, building up according to percentages given.

(iii) there is a difference between the economic price of foreign exchange and the official exchange rate. A SERF of 1.11 has been estimated for the country, implying that foreign exchange components have a higher economic than financial cost to the country. All equipment has to be imported;

(iv) the economic cost of labor is below the financial cost. The SWRF has been estimated at 0.90 and is applied to the installation labor and to operating labor;

(v) electricity is subsidized by the government. The economic cost of electricity is 20 percent higher than the financial cost;

(vi) the benefit foregone in agricultural production (opportunity cost of water) has been estimated at Rs0.10 per m^3 of water produced (343,000 m^3 at full capacity).

12. The financial project statement has been adjusted taking into account the above considerations to arrive at the project economic statement, as given in Table 9.5. This Table also shows the annual flow of benefits, other than revenue. The discounted economic benefits are now larger than the discounted economic costs. The economy will benefit as the project has a positive present value of Rs392,000. The project is economically justified.

Table 9.5 **Project Economic Benefits and Costs**
(Rs'000, 1995 prices)

Economic statement	**PV@ 12%**	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Benefits:											
- Nonincremental water	1,674		225	270	315	360	405	450	450	450	450
- Incremental water	298		40	48	56	64	72	80	80	80	80
- Non-technical losses	282		38	45	53	61	68	76	76	76	76
Total	2,253		303	363	424	485	545	606	606	606	606
Costs:											
- Equipment	1,361	1,524									
- Installation	138	154									
- Operating labor	66		14	14	14	14	14	14	14	14	14
- Electricity	132		28	28	28	28	28	28	28	28	28
- Other operating costs	37		8	8	8	8	8	8	8	8	8
-Opportunity cost of water	128		17	21	24	27	31	34	34	34	34
Total	1,861	1,678	67	70	73	77	80	84	84	84	84
Net cash flow	392	-1,678	236	293	351	408	465	522	522	522	522

9.3 Analysis of Beneficiaries

13. In the example, the following beneficiaries of the project have been identified:

(i) Consumers. These will benefit from the project because of the lower cost of water and the accompanied induced increase in consumption. They also reap economic benefits because of the economic value of non-technical losses;

(ii) Government/economy. Because of the overvaluation of the domestic currency at the official exchange rate, the economic cost of the equipment exceeds its financial cost by the extent of the SERF. The loss is borne by the government and economy; the government is providing a subsidy on electricity, this represents a cost (loss) to the government.

14. The diverted water is assumed to result in a lower agricultural production value, as expressed by the opportunity cost of water. This loss is borne by the government or by the farmers who are treated as a part of the economy.

(i) Labor. The financial cost of labor exceeds its opportunity cost; the difference accrues as a gain to the laborers;

(ii) Utility. There is a loss to the utility because not all of the full financial costs including capital costs, are recovered.

9.4 Distribution Analysis

15. The financial and economic statements are shown in Table 9.6. The gains and losses to different participants in the project (distribution of project effects) are also indicated. The gains and losses to the different participants are determined by the difference between financial and economic benefits and costs.

16. The overall results are a negative financial net present value (FNPV) of Rs 259,000 and a positive economic net present value (ENPV) of Rs392,000. The ENPV exceeds the FNPV by Rs651,000.

17. Two participants lose from the project. The utility will suffer a loss of Rs259,000. The rest of the economy will suffer a loss of:

(i) Rs136,000, because foreign exchange is available at a price lower than its economic price;

(ii) Rs22,000, because the financial price of electricity is below the economic cost; and

(iii) Rs128,000, because water previously used in irrigated agriculture will be diverted to household use.

The result is a total loss of Rs286,000.

18. On the other hand, two participants are expected to gain. Labor will gain by Rs23,000 at the projected wages, and consumers will gain by Rs914,000. These gains and losses in part compensate for each other; the net gain is positive and equal to the ENPV of Rs392,000.

Table 9.6 **Distribution of Net Economic Benefits**

(Rs'000, present values at 12% discount rate)

				Difference	**Distribution of Project Effects**				
	Financial Present Values	Conversion Factor	Economic Present Values	Economic minus Financial	Utility	Gov't/ Economy	Labor	Consumers	Total
Benefits:									
Total benefits	1,339		2,253	914				914	914
Costs:									
- Equipment	1,224	1.11	1,361	136		-136			-136
- Installation (labor)	153	0.90	138	-15			15		15
- Operating labor	73	0.90	66	-7			7		7
- Electricity	110	1.20	132	22		-22			-22
- Other operating costs	37	1.00	37	0					0
- Opportunity cost of water			128	128		-128			-128
Total costs	1,598		1,861	263					
Net benefits	-259		392	651	-259				-259
Gains and Losses					-259	-286	23	914	392

9.5 Poverty Impact Analysis

19. The initial step required to trace the poverty reduction impact of a project is to evaluate the expected distribution of net economic benefits to different groups as summarized in Table 9.6. The next step is to assign the economic benefits to the poor and to the non-poor. The **poor** are defined as those living below the country specific poverty line. An example of a calculation of a poverty impact ratio is given in Table 9.7 and discussed below.

20. The first line in Table 9.7 repeats the gains and losses for the government/economy, consumers and laborers from the last line in Table 9.6. In the second line, it has been assumed that the negative financial return to the utility of Rs259,000 is subsidized by the government, resulting in an additional loss to the government. This represents a loss of potential fiscal resources which could be used, for instance, in poverty alleviation programs.

21. The proportion of benefits accruing to the poor are estimated as follows for losses and gains to:

(i) Government/economy. An assessment of the targeting of government expenditures shows that on average, 50 percent of all government expenditures reach the poor. Losses/gains to the government/economy are decreasing/increasing the available government funds, therewith decreasing/increasing government expenditures directly targeted to the needs of the poor;

(ii) Labor. Thirty-three percent of the operating and installation labor needed for the project is carried out by poor people;

(iii) Consumers. A socioeconomic survey has been conducted in the project service area and it was found that 40 percent of the new consumers are below the poverty line.

22. A poverty impact ratio (PIR), expressing the proportion of net economic benefits accruing to the poor, can be calculated by comparing net economic benefits to the poor with the net economic benefits to the economy as a whole. In this case, as shown in Table 9.7, the PIR is 0.26 (= 101/392), which indicates that 26 percent of the economic benefits (present value) of the project will reach the poor.

Definition of Poverty Impact Ratio (PIR)

$$\text{PIR} = \frac{\text{Benefits to the poor}}{\text{Total economic benefits}}$$

23. The PIR should be assessed in relation to the population, which is poor in the project area. For example, if 20 percent of the population in the area is poor, and the PIR amounts to 0.26, the project would have a positive poverty reducing impact.

Table 9.7 **Poverty Impact Ratio**

(Rs'000, present values at 12% discount rate)

	Gov't/ Economy	Labor	Consumers	Total
Gains and Losses (NEB-NFB)	-286	23	914	651
Financial return utility	-259			-259
Benefits	-544	23	914	392
Proportion of poor	0.50	0.33	0.40	
Benefits to poor	-272	7	366	101

Poverty impact ratio: 101 / 392 = 0.26

9.6 Limitations of the PIR

24. The distribution analysis and PIR calculation consider the economic benefits of the project. A part of this benefit is the economic cost of water replaced by the project, such as the cost of water sold by vendors, households' wells and kerosene. The PIR does not take into account the question whether this replacement affects poor or non-poor people. For example, if vendors will loose their jobs as a result of the project, the expressed PIR does not take this into account.

25. The proportion of benefits going to the poor is difficult to estimate. For the consumer benefits, the estimate is usually based on survey data. The portion of the economic benefits to the economy affecting the poor, or cost that the project imposes on the government or economy, can be estimated on the basis of the existing budgetary policy of the government. The portion of project labor that is

carried out by poor people has to be based on some broad assumptions but may be easier to estimate.

26. Note that the distribution analysis and the PIR calculation can only be done if the same discount rate is used in both financial and economic benefit-costs analysis. In the example a discount rate of 12 percent has been used in both the economic and financial analysis. Sensitivity analysis using other discount rates might be appropriate. Such an analysis is presented in Table 9.8.

Table 9.8 **Sensitivity of the PIR**
(at different discount rates)

Discount rate	PIR
12%	0.26
10%	0.32
7%	0.37

27. Different discount rates result in different PIRs. In this example, it appears that the higher the discount rate, the lower the PIR and vice versa. A relative high discount rate (e.g., 12 percent) gives relatively high weight to costs and benefits in the early project years, and relatively low weight to costs and benefits that accrue in later years. On the other hand, a relatively low discount rate (e.g., 7 percent) gives relatively low weight to costs and benefits in the early project years, and relatively high weight to costs and benefits that accrue in later years.

APPENDIX A

DATA COLLECTION

A.1 METHODS OF DATA COLLECTION

A.1.1 Collection of Secondary Data

1. When preparing new projects, examination of seconday data will always have to take place, whereas gathering of primary data is only needed when secondary data are considered insufficient or unreliable. The sources of secondary data are given in the box below.

Box 1 **Sources of Secondary Data**

1. Water enterprises: Financial and Technical Reports, Customer Information, reports of utilities in similar areas;
2. Local government agencies: Urban and Regional Development Plans, Demographic Data, Socioeconomic Reports, Statistical Reports, etc.
3. Non-governmental organizations: Survey Reports, Publications, etc.
4. Universities: Research Publications, scientific work;
5. Public health authorities: Data on Public Health, Waterborne Diseases.

2. Data on population projections are often available from secondary sources. Information on current water consumption, income and current water sources can also be collected from secondary data in many cases. Estimating consumption through analysis of time series data can be applied when data are available on water consumption level and on explanatory variables such as income, service levels, alternative sources, water tariffs and weather conditions. A prerequisite for this type of analysis is that the data are applicable to the new project situation. Econometric analysis can be carried out for projects in larger urban areas where piped water has been available for a longer period of time, where alternative resources are limited and where existing water tariffs are close enough to the expected future tariffs in the with project scenario.

A.1.2 Reconnaissance Survey

3. During a reconnaissance survey, secondary and primary data are collected. Such surveys are useful to obtain a more detailed picture of the project area. During the survey, technical and non-technical data may be collected from local organizations, or data may be based on own observations.

4. To stimulate integrated formulation of the project scope, the composition of the survey team should include technical experts (water supply engineers) as well as economists. The viability of different service levels or technical options should be investigated at this early stage.

5. During the reconnaissance survey, it is also useful to consult with certain key actors in the project area such as government officials and community leaders, and to carry out a

small number of representative interviews with community members to obtain a good picture of the local situation and conditions (situational analysis).

A.1.3 Collection of Primary Data

6. Primary data can be collected through field observations or, more importantly, by conducting surveys among selected households and/or industries and institutions. These surveys should be undertaken if insufficient secondary data are available on one or more of the following items: existing water use patterns; present expenditures for water (financial and non-financial); preferred service levels; willingness to pay for water and connection fees; and income.

7. It would be carrying it too far to include in this Handbook an extensive guide on how to conduct these surveys. A sample questionnaire is given in Appendix A.3. Lessons learned in carrying out the four case studies under RETA 5608 are as follows:

(i) **Local Research Organizations.** During the field studies it was found that in all countries, there exists sufficient capability and capacity to carry out surveys for primary data collection and processing. These sources may include universities, research institutes, consultancy firms, community organizations, etc. It was also found that it is of the utmost importance that the surveyor be closely involved in the preparation and implementation of customer surveys.

(ii) **In-depth surveys versus larger surveys.** The researcher should consider the usefulness of obtaining data by means of either a larger household survey or a smaller in-depth survey. In the case of Rawalpindi, e.g., where the persons interviewed were mostly the (male) heads of the household and where no water meters were installed, it appeared impossible to obtain reliable data about existing water consumption from the larger household survey. Instead, it was necessary to carry out a smaller in-depth survey involving the women in the households to obtain more reliable estimates.

(iii) **Timeframe and preparation.** It is often thought that the implementation of household surveys requires extensive resources and a long period of time. In the case studies carried out under RETA 5608, the experience has been that when working with an experienced domestic team, surveys can be carried out rather swiftly. The cost of carrying out the household survey in the four case studies in Bangladesh, Indonesia, Pakistan and Viet Nam was between $5,000 to $8,500 per survey among, on average, 300 households. The survey included preparation of questionnaire and field survey, implementation of the survey, processing, and analysis of data and report writing. A typical timeframe for carrying out a household survey is shown in Box 3.7.

Box 2. Timeframe for Conducting Household Survey

Before start of the survey
- Preparation of questionnaire
- Preparation of survey team
- Analysis of secondary data
- Inform relevant authorities
- Preliminary stratification

day 1:
- Discussions with survey team
- Field testing of questionnaire
- Visit relevant authorities and obtain introductory letter

day 2:
- Adapt and finalize questionnaire
- Training of surveyors including further field tests

day 3:
- Finalize training of surveyors
- Start of the survey

day 4-5:
- Monitoring of first results
- Adapt/change questions where needed

The actual survey may need between five to ten days, depending on the number of surveyors and the number of interviews to be conducted. Normally, one surveyor is able to conduct between five and ten interviews per day and therefore, a survey team consisting of five persons would be able to conduct between 125 and 250 interviews per week.

Source: RETA 5608: Economic Evaluation of WSPs

(iv) **Length of the questionnaire.** In this context, it is useful to note that most questionnaires contain questions which are later not used in the analysis. An important reason is that different actors are involved in the design of the questionnaires and that each of these actors has his/her own wishes. It is recommended to carefully assess the usefulness of each question and to keep the questionnaire (which should be in local language) as short as possible. An example of a household questionnaire is attached as Appendix A.3.

(v) **Defining the new water service level.** In many cases, it may be difficult to clearly and realistically define the new product (improved water supply) to be used as a basis for the willingness-to-pay questions. In the case of the Rawalpindi water supply project (WSP) for example, it was not considered feasible to achieve 24 hours water supply at good pressure within a foreseeable period of time. Instead, project engineers expected that they would be able to achieve ten hours per day of clean water supply at good pressures.

8. It is also important to present alternative options, where these exist. In urban areas, these may include public taps. In the case of rural water supply, potential customers may not always have a clear idea of different technical options, and it may be necessary to bring pictures or drawings of the new faciltities required for each option.

A.2 CONTINGENT VALUATION METHOD (CVM)

A.2.1 Introduction

9. This section draws on the 1988 WASH *Guidelines for Conducting Willingness-to-Pay Studies for Improved Water Services in Developing Countries*. This very useful *Guidelines* contains detailed examples on how to design and conduct a willingness-to-pay (WSP) survey.

A.2.2 Concept of CVM and Advantages

10. The CVM is a direct means of estimating the economic benefits of an improved water supply. One simply asks how much the consumer is willing to pay for a given level of service. The method is called "contingent valuation" because the respondent is asked about what he or she would do in a hypothetical (or contingent) situation in which the level of service is expected to be improved.

11. This approach has the following advantages:

(i) one can observe the current water situation of the households, inquire about the level of service people want and how much they are willing to pay for it;

(ii) the consumer can value services for which indirect approaches would be imperfect (e.g., what are the benefits of increased reliability, higher water quality, etc.);

(iii) the analyst can estimate the reactions of households to prices or technologies beyond the range of past experience;

(iv) the answers of respondents to WTP questions are easily understood by non-economists and decision-makers;

(v) CVM can be used to easily derive estimates of economic benefits without the use of econometric techniques;

(vi) the CVM could also be used to assess the benefits of improved water services to industries and commercial establishments.

12. One possible drawback of the CVM approach is that the full economic benefits (e.g. health improvements) of an improved level of water service may not be well perceived by the beneficiaries and that answers may be unreliable and give biased estimates of WTPs for a number of reasons discussed further below.

A.2.3 Use of WTP data

13. Both policy makers and water resource planners in developing countries are becoming increasingly interested in conducting WTP studies to learn more about households' preferences for improved water supplies and their willingness and ability to contribute to the costs of operation, maintenance and construction. Water sector professionals now consider it necessary to incorporate communities' preferences regarding proposed water supply systems in the design of the project. WTP studies can provide useful information to assist policy makers, planners and project analysts in making four types of decisions:

- **Setting Priorities**. If a water agency or donor has a limited budget and must choose between villages or towns to receive a piped water supply, WTP surveys can assist in prioritizing investments or site selection. For example, villages which show high WTP for improved water supplies are likely to benefit considerably from a new piped water system, and the potential for cost recovery of the operation and maintenance costs is likely to be high. Similarly, if a village has many high-quality traditional water sources nearby, WTP for a piped water supply system is likely to be low.

- **Choice of service level**. Planners in developing countries have often assumed that a community should be provided with the highest level of service possible, as long as the cost for households to obtain the water does not exceed 5 percent of the household income. It has also been assumed that as long as this 5 percent is not exceeded, households would abandon their existing water supply in favor of the improved system. These assumptions have proven to be incorrect in many cases. WTP surveys can assist in defining the appropriate technology and service level;

- **Tariff design**. Water utilities are under increasing pressure to be financially viable and to raise the prices they charge for water to reflect better the cost of the service. However, few water utilities in developing countries have adequate information on which to base decisions regarding tariff design. If prices are set too low, revenues will not be sufficient to cover the costs of supplying water. If prices are set too high, households may not be able to afford connecting to a piped water supply, and again revenues will be low. With WTP information, the relationship between the price of water, the number of households connected and revenues can be estimated;

- **Project design and benefit-cost analysis**. Provided that households understand all the changes and perceive all the benefits which will result from an improved water supply, the WTP bids can serve as a measure of the economic benefits of the project.

A.2.4 Design of WTP Questions

14. In general, WTP surveys are based on either of two types of questions:

(i) respondents may be asked a direct, open-ended question such as: "*What is the maximum amount of money you would be willing to pay (for a specified good or service)?*" or,

(ii) respondents are presented with a specific choice which requires a yes/no answer, like "*Suppose a water distribution line were installed in front of your house, and assuming the connection fee was x (in local currency), and that the monthly tariff was y (flat charge or per m³) would you choose to connect to the new water distribution system?*"

Different questions can be combined and bidding games can be developed.

Box 1 **Bidding Game**
(Tariff per month)

When the new project starts, and assuming (i) if piped water quantity is increased to 12 hours supply per day at adequate pressure so that you can get the additional supply of water of good quality and (ii) the tariffs are re-fixed at Tk …. per month, would you want a connection and pay for the bill? [go to the bidding game]

1.	(a) No, I do not want a connection. (b) Yes, I want a connection; if 1(b), then go to 2.	
2.	Tk400	If "Yes", then stop; if "No", go to 3
3.	Tk350	If "Yes", then stop; if "No", go to 4
4.	Tk300	If "Yes", then stop; if "No", go to 5
5.	Tk250	If "Yes", then stop; if "No", go to 6
6.	Tk200	If "Yes", then stop; if "No", go to 7
7.	Tk150	If "Yes", then stop; if "No", go to 8
8.	Tk100	If "Yes", then stop; if "No", go to 9
9.	Tk75	If "Yes", then stop; if "No", go to 10
10.	Tk50	If "Yes", then stop; if "No", go to 11
11	Tk25	If "Yes", then stop; if "No", explain.

15. In Box 6.7, the bidding game starts at the higher amount of Tk400. The selection of the initial amount is important and should reflect realism; e.g., the initial amount should generally not be higher than two times the unit cost of the enhanced level of service.

A.2.5 Reliability of WTP Data

16. Professionals are often concerned about the validity and reliability of respondents' answers to hypothetical WTP questions. Two main concerns are at issue here. The first is whether respondents will answer WTP questions honestly and accurately. The second is whether WTP responses are reliable measures of economic benefits.

17. Systematic (non-random) differences between respondents' answers to WTP questions and their true WTP can arise for many reasons:

Strategic bias

18. Strategic biases may occur when the respondent believes he or she can influence a decision or plan by not answering the enumerator's question honestly.

Box 2 **Strategic Bias**

A research team from the University of Karachi was conducting a WTP study for the World Bank and went into a poor peri-urban area of Karachi to pre-test an early version of their WTP questionnaire. A neighborhood was selected and a community leader was informed about the purpose of the research team's visit.

The team went to the first house on the block to conduct the first interview and within five minutes after starting the interview, a truck rolled by. The driver leaned out his window and shouted that the water situation in the neighborhood was terrible and that the research team should arrange for the ***government*** to provide a water distribution line immediately.

In such an environment, there is clearly a risk that misinformation and rumors about a WTP study will affect the answers respondents give and possibly encourage them to attempt to influence the results of the study by giving biased responses to the WTP questions. In this example, WTP would probably be an underestimate of the economic benefits because the respondent might believe that not he but the government should pay for the water service.

Source: Wash, 1988

19. Strategic biases occur when respondents **understate** their true willingness to pay for an improved level of water service while others pay for the provision of the good or service. On the other hand, if the price to be charged for the improved water service is not tied to an individual's WTP and the respondent is aware of this, he may **overstate** his true WTP to ensure its provision.

20. The problem of strategic biases can be reduced by carefully stressing the importance of a truthful answer. The questionnaire used in Phan Thiet (Viet Nam) started with the following opening statement, which the enumerator was asked to read exactly as it was given and not paraphrase it.

Box 3 **Opening Statement**

As you are aware, the present water supply system in Phan Thiet town has been unreliable and it has not been possible to improve the service level due to lack of financial funds. Now, the Water Supply and Drainage Company of Binh Thuan Province intends to improve and extend the water supply system in the town. The intended improvements of the system will be better water quality and higher pressure 24 hours a day. To do this, the company has planned to borrow the money from the Asian Development Bank. Repayments of the loan and operation and maintenance expenditures will have to be covered by the revenues from all water users.

Now, I'm going to ask you some questions to learn whether your household is interested in having a connection and would be willing to pay to make use of the water supply system (non-connected households) or improve the reliability of the water supply scheme serving this town (already connected households). It is important that you answer the questions as truthfully as you can so that we can really know whether you wish to have a better quality of service or not, and which amount you can afford and are willing to pay for it. If you and the other people we interview say that you cannot pay anything or anything more than you are currently paying, even if these statements are not true, then perhaps it is not possible to improve and extend the water supply system. If what you say is that what you can pay is actually too much, then you might not be able to pay your monthly water bill. It is therefore important to answer the questions honestly.

Source: RETA 5608 Case Study on the Provincial Towns Water Supply and Sanitation Project, Phan Thiet, Viet Nam

21. According to Hanley and Spash (1993), the available empirical evidence suggests that contingent valuation studies are less prone to strategic bias than was once believed. If strategic biases do occur, the use of WTP bids to measure the economic benefits of a water supply, becomes a doubtful operation.

Design Bias

22. The design of a WTP study includes the way information is presented to individuals, the order in which it is presented, the question format and the amount and type of information presented. The following items can affect the response:

- *Choice of the bid question.* Open-ended questions or bidding games may influence the average WTP;

- *Starting point bias.* In bidding games, the starting point given to respondents can influence the final bid offered. This can be caused by impatience of the respondent or can happen because a starting point may suggest what size of a bid is appropriate;

- *Nature of information provided.* The amount of effort enumerators spent on describing the positive features (pressure, availability, quality) of a (improved) piped water supply might influence the WTP of respondents.

23. Empirical research indicates that a bidding game with a higher starting point is less prone to biases than that with a low starting point; it is recommended to start the bidding game with the highest bid and come down until the respondent indicates that he/she is willing to pay the indicated amount. An appropriate starting point might be two to three times the estimated cost of the service. If field testing of the questionnaire indicates that large proportions of the sample have chosen the highest bid, then the top bid should be increased.

Hypothetical Bias

24. A respondent who does not know his willingness to pay and does not wish to exert the mental energy to think about his preferences may simply guess at an answer to a WTP question. The enumerator should pay particular attention if this situation occurs and endeavor to reduce the bias through careful explanation about the benefits of the project.

Compliance Bias

25. Respondents in a particular cultural context may feel it appropriate to answer some kinds of questions in specific ways or may attempt to give answers that they think will please the enumerator. This compliance bias can result in substantial differences between reported and true WTP values.

26. WASH (1988) experience indicates the importance of using enumerators with close ties to the community in which the surveys are to be conducted. The enumerators may be local school teachers, secondary school graduates or government employees; but, whatever their occupation, they should be respected within the community and have a good understanding of the local economy, social traditions, the design and benefits of the proposed project.

Existing tariffs

27. In situations where a piped water supply exists, individuals with and without a piped water supply may feel that the existing (subsidized) tariff constitutes a fair WTP bid. An improved level of water service should normally result in an expressed WTP which is higher than the existing tariff, assuming there are no biases in the answer and the respondent is fully aware about the full economic benefits.

Gender bias

28. The point of concern here is that in many cultures, fetching water is a job for women and often children. Thus, the provision of improved water supplies may have important implications for traditional social roles of men and women. If a woman whose time would be saved is married, her husband might consider the change in his wife's traditional role improper. He might disapprove not merely because of the potential change of power relations in the family, but also because the new "modern" roles and lifestyles may seem to him to depart from a right and customary way of life. The husband's valuation of the consequences of the improved water supply might thus be negative, or diminished. Consequently, WTP by male respondents might be less than WTP by female respondents.

29. Therefore, the survey should attempt to cover an equal number of men and women. This might implicate that a part of the survey is conducted during the day, and another part during the evening. In some cultures, especially Islamic, female surveyors might have a better access to the women in the household.

Health

30. Willingness to pay measures the economic benefits correctly only to the extent that all health and non-health related benefits are fully perceived by the beneficiaries. This may not always be the case at the time of the survey, especially when respondents have low educational status. Health education campaigns may enhance the people's WTP over time.

A.3 SAMPLE SOCIOECONOMIC SURVEY QUESTIONNAIRE

Part 1
General Information
ALL HOUSEHOLDS [1]

Identification:
Location : ________________________________
Serial No.: ________________________________

Household Head

A.1 Interviewee is head of the household ________
(1) Yes (2) No

A.2 Head of the household ________
(1) Male (2) Female

A.3 Education of the head of the household ________
(1) No Schooling
(2) Primary Education (1-5 years)
(3) Secondary Education (6-12 years)
(4) Higher Education (> 12 years)

A.4 Occupation of the head of the household ________
(1) Agriculture or fishing
(2) Own business
(3) (Semi-)Government employee/Retired
(4) Private employee
(5) Housewife
(6) Others

A.5 Number of persons living in the household
No. of adults (> 16 years) ________
No. of minors (< 16 years) ________

A.6 Mode of Transport: ________
(1) Bicycle
(2) Motorbike
(3) Own Car
(4) Public Transport
(5) By foot
(6) Others

Housing Characteristics

A.7 Tenurial status of the house _______
(1) Owned (2) Rented (3) Others

A.8 Type of Dwelling _______
(1) Concrete
(2) Wood
(3) Tin-shed
(4) Others

A.9 Rental value of the dwelling per month _______

Source of Water

A.10 Primary Source of Water _______
(1) House connection
(2) Public street hydrant
(3) Neighbor
(4) Private tubewell
(5) Dugwell
(6) Pond
(7) River
(8) Others

Note: If source is 1, go to Schedule B
If source is 2, go to Schedule C
If source is 3 through 8, go to Schedule D

Part 2
FOR HOUSEHOLDS WITH IN-HOUSE CONNECTIONS

B.1 Two most important reasons for having a connection ________ & ________ (1) Convenience
(2) Health
(3) Reliability
(4) Modernization
(5) Alternative source is not sufficient
(6) Cheaper
(7) Others

B.2 Last monthly bill ________
Consumption per month (m^3) ________

B.3 Do you sell piped water to others, e.g. neighbors? ________
(1) Yes (2) No
If yes, how many cubic meters per month? ________

B.4 How many persons outside your household use water delivered through your connection? ________

B.5 Water availability ________
(1) Sufficient all year
(2) Insufficient during dry season
(3) Sometimes insufficient
(4) Insufficient mostly

B.6 How many hours per day do you receive water from the piped system? ________

How many days per week do you receive water from piped system? ________

In summer/dry season, how many days do you receive water from piped system? ________

In winter/rainy season, how many days do you receive water from piped system? ________

B.7 What do you think of the quality of the water delivered?
a. Taste ________
(1) Good (2) Average (3) Bad
b. Smell
(1) Good (2) Average (3) Bad ________

c. Color
(1) Good (2) Average (3) Bad ________

B.8 Is there any relation between the quality of water and the illnesses in your household?
(1) Yes (2) No ________

B.9 How many persons in your household were ill during the last year due to the consumption of unsafe water? ________

How many days of sickness per person? ________

If the sick person got treatment, how much was the medical cost? ________

B.10 Which of the following diseases occurred in your household during the last year in your area? ________
(insert a list of waterborne diseases)

B.11 Water pressure: ________
(1) Strong (3) Generally strong
(2) Weak (4) Sometimes weak

B.12 How do you treat water? ________
(1) Boil and filter
(2) Boil
(3) Filter
(4) Others
(5) None

B.13 What type of storage do you have; what is the total volume of your storage and how much was the installation cost?

Type	Liters or Gallons	Installation Cost
(1) Overhead tank		
(2) Underground tank		
(3) Drum		
(4) Bucket/vessel		
(5) Others		
(6) None		

B.14 Water from secondary source, if any:

Secondary Sources	Distance from Source	If source is used		Use of source		Monthly Exps.[a]	Inst Cost[b]
	(meter)	Consumption(litre/day)	Collecting Time (min./day)	Days/ Mo.	Mos./yr	LC/ month	LC
Neighbor							
Public Street Hydrant							
Private Tubewell							
Dugwell							
Pond							
River							
Water Vendors							
Others							

a/ Include Operations and Maintenance costs, payments made to the delivery person or the tanker, cost of electricity, etc.
b/ Include construction cost of well, cost of pump and its installation etc.

B.15 How many additional hours per day of water supply will be required to meet all your needs? ________

B.16 Do you prefer a: ________
(1) Fixed Charge (2) Metered Bill

Bidding Game
(Tariff per month)

B.17 When the new project will start, and if piped water quantity is sufficiently increased to 24 hours supply per day at adequate pressure so that you can get the additional supply of water needed with a good quality, and if the tariff rates are re-fixed at ______(local currency) per month, would you pay for the bill? (Go to the Bidding Game.)

(1)	> 400 LC/month	(6)	150 LC/month
(2)	350 LC/month	(7)	100 LC/month
(3)	300 LC/month	(8)	75 LC/month
(4)	250 LC/month	(9)	50 LC/month
(5)	200 LC/month	(10)	25 LC/month (existing tariff)

Part 3
FOR HOUSEHOLDS WITH PRIMARY SOURCE OF PUBLIC STREET HYDRANT

C.1 Distance from the public street hydrant: ________

C.2 Consumption (liter/day) ________

C.3 Collecting time (min/day) ________

C.4 Monthly charges, if any. ________

C.5 Water availability ________
(1) Sufficient all year
(2) Insufficient during dry season
(3) Sometimes insufficient
(4) Insufficient mostly

C.6 How many hours per day do you receive water from the public street hydrant? ________

How many days per week do you receive water from the public street hydrant? ________

In summer/dry season, how many days do you receive water from the public street hydrant? ________

In winter/rainy season, how many days do you receive water from the public street hydrant? ________

C.7 What do you think of the quality of the water delivered?
a. Taste ________
(1) Good (2) Average (3) Bad
b. Smell
(1) Good (2) Average (3) Bad ________
c. Color
(1) Good (2) Average (3) Bad ________

C.8 Is there any relation between the quality of water and illnesses in your household? ________
(1) Yes (2) No

C.9 How many persons in your household were ill during the last year due to the consumption of unsafe water? ________

How many days of sickness per person? ________

If the sick person got treatment, how much was the medical cost? ________

C.10 Which of the following diseases occurred in your household during the last year? ________
(insert a list of waterborne diseases)

C.11 Water flow: ________
(1) Strong (3) Generally strong
(2) Weak (4) Sometimes weak

C.12 How do you treat water? ________
(1) Boil and filter
(2) Boil
(3) Filter
(4) Others
(5) None

C.13 What type of storage do you have, what is the total volume of your storage and how much was the installation cost?

Type	Liters or Gallons	Installation Cost
(1) Overhead tank		
(2) Underground tank		
(3) Drum		
(4) Bucket/vessel		
(5) Others		
(6) None		

C.14 Water from secondary source, if any:

Secondary Sources	**Distance from Source**	**If source is used**		**Use of source**		**Monthly Exps.**[a]	**Inst Cost**[b]
	(meter)	**Consumption (litre/day)**	**Collecting Time (min./day)**	**Days/ Mo.**	**Mos./ yr**	**LC/ month**	**LC**
House Connection							
Neighbor							
Private Tubewell							
Dugwell							
Pond							
River							
Water Vendors							
Others							

a/ Include Operations and Maintenance costs, payments made to the delivery person or the tanker, cost of electricity, etc.
b/ Include construction cost of well, cost of pump and its installation etc.

C.15 Reasons for not having in-house connection: ___________
(1) Connection fee too high
(2) Monthly charges too high
(3) Connection is not available
(4) Present arrangement satisfactory
(5) Rented house
(6) Waiting list
(7) Others, specify: ___________

Bidding Game
(Tariff per month)

C.16 If piped water quantity is sufficiently supplied 24 hours per day at adequate pressure so that you can get sufficient piped water with a good quality, and the tariff rates are re-fixed at LC .. per month, would you want a connection and pay for the bill? [Go to the Bidding Game.]
(1) Yes (2) No ________

C.17 If yes, how much you are willing to spend for the connection fee and material and labor?
(1) > 400 LC/month
(2) 350 LC/month
(3) 300 LC/month
(4) 250 LC/month
(5) 200 LC/month
(6) 150 LC/month
(7) 100 LC/month
(8) 75 LC/month
(9) 50 LC/month
(10) 25 LC/month
(11) < 25 LC/month; Explain

C.18 Do you prefer a: ________
(1) Fixed Charge (2) Metered Bill

Part 4
FOR HOUSEHOLDS WHOSE PRIMARY WATER SOURCE IS NON-PIPED WATER

D.1 Sources of Water

Secondary Sources	Distance from Source	If source is used		Use of source		Monthly Exps.[a]	Inst Cost[b]
	(meter)	Consumption (litre/day)	Collecting Time (min./day)	Days/ Mo.	Mos./yr	LC/ month	LC
House Connection							
Neighbor							
Private Tubewell							
Dugwell							
Pond							
River							
Water Vendors							
Others							

a/ Include Operations and Maintenance costs, payments made to the delivery person or the tanker, cost of electricity, etc.
b/ Include construction cost of well, cost of pump and its installation etc.

D.2 Water availability ________
(1) Sufficient all year
(2) Insufficient during dry season
(3) Sometimes insufficient
(4) Insufficient mostly

D.3 What do you think of the quality of the water delivered?
a. Taste ________
(1) Good (2) Average (3) Bad
b. Smell
(1) Good (2) Average (3) Bad ________
c. Color
(1) Good (2) Average (3) Bad ________

D.4 Is there any relation between the quality of water and illnesses in your household? ________
(1) Yes (2) No

D.5 How many persons in your household were ill during the last year due to the consumption of unsafe water? ________

How many days of sickness per person? ________

If the sick person got treatment, how much was the medical cost? ________

D.6 Which of the following diseases occurred in your household during the last year? ________
(insert a list of waterborne diseases)

D.7 How do you treat water? ________
(1) Boil and filter
(2) Boil
(3) Filter
(4) Others
(5) None

D.8 What type of storage do you have, what is the total volume of your storage and how much was the installation cost?

Type	Liters or Gallons	Installation Cost
(1) Overhead tank		
(2) Underground tank		
(3) Drum		
(4) Bucket/vessel		
(5) Others		
(6) None		

D.9 Reasons for not having in-house connection: ___________

(1) Connection fee too high
(2) Monthly charges too high
(3) Connection is not available
(4) Present arrangement satisfactory
(5) Rented house
(6) Waiting list
(7) Others, specify: ___________

D.10 Reasons for not having a public street hydrant as main source: __________
(1) Charges too high
(2) Not available
(3) Too far away
(4) Present arrangement satisfactory
(5) Others, specify ………………………………

Bidding Game
(Tariff per month)

D.11 When the new project starts, and if piped water quantity is supplied 24 hours per day at adequate pressure so that you can get sufficient water with a good quality, and the tariff rates are re-fixed at LC .. per month, would you want a connection and pay for the bill?
(1) Yes (2) No

If yes, go to the Bidding Game.
(1) > 400 LC/month
(2) 350 LC/month
(3) 3400 LC/month
(4) 250 LC/month
(5) 200 LC/month
(6) 150 LC/month
(7) 100 LC/month
(8) 75 LC/month
(9) 50 LC/month
(10) 25 LC/month; Explain

D.12 Do you prefer a: _______
(1) Fixed Charge (2) Metered Bill

D.13 If you want an in-house connection, how much you are willing to spend to have it (for the connection fee and material and labor)? _______

D.14 If you do not want to have a house connection, would you like to use a public street hydrant?
(1) Yes (2) No

If Yes, what is the maximum distance the hydrant should be located from your house? ________ (meters)

If Yes, how much LC per bucket of 20 liters are you prepared to pay? [Go to a bidding game]

1. 5 LC/bucket
2. 4 LC/bucket
3. 3 LC/bucket
4. 2 LC/bucket
5. 1 LC/bucket
6. 0.75 LC/bucket
7. 0.50 LC/bucket
8. 0.25LC/bucket

Part 5
Sanitation Services
ALL HOUSEHOLDS

How do you dispose off your wastewater?

E.1 Human waste water (Excreta/Urina) _______
(1) Sewerage system (2) Septic tank
(3) Open drainage canals (4) Into the street/road
(5) Into the open field/river (6) In the garden/compound
(7) Other, specify.......

E.2 Grey waste water (washing/bathing/kitchen) _______
(1) Sewerage system (2) Septic tank
(3) Open drainage canals (4) Into the street/road
(5) Into the open field/river (6) In the garden/compound
(7) Others, specify.......

E.3 Are you satisfied with the current disposal of your wastewater? _______
(1) Yes
(2) Moderately
(3) Not at all

E.4 Would you prefer to have an improved wastewater disposal system? _______
(1) Yes (2) No

ONLY CONTINUE IF ANSWER TO E.4 IS YES

E.5 Which improved wastewater disposal system do you prefer? _______
(1) Septic tank/soak pit in compound
(2) Open drains
(3) Others, specify ....

E.6 The project plans to provide a credit scheme to provide funds for low cost sanitation by means of a revolving fund. Are you interested to obtain a loan from this fund to improve your sanitation facilities and if yes, how much are you willing to pay back per month?.
(1) > 200 LC per month (5) 50 LC per month
(2) 150 LC per month (6) 25 LC per month
(3) 100 LC per month (7) 0 LC per month
(4) 75 LC per month

Part 6
EXPENSES AND INCOME
ALL HOUSEHOLDS

Monthly Expenses on:

F.1 Food ________

F.2 Clothing ________

F.2 Housing(rent, repair etc. ________

F.3 Transport ________

F.4 Utilities ________

F.5 Education ________

F.6 Health ________

F.7 Others ________

F.8 How many persons contribute to household income? ________

F.9 How much income savings per year, if any, can you make? ________

F.9 Total household income per month ________
(Direct estimate, do not calculate from above)

Interviewer's Name: ________________________
Signature: ________________________
Date: ________________________

APPENDIX B

CASE STUDY FOR URBAN WATER SUPPLY PROJECT

CONTENTS

Tables

Annexes

B.1 INTRODUCTION

B.1.1 General

1. This Appendix provides the reader with an example of several steps which are conducted in the process of economic benefit-cost analysis. The concepts which are used have been discussed in (previous) chapters of the Handbook. The example is simplified. It is based on case studies conducted in Viet Nam. The focus is on one consumer-group: households using house connections. In this example, the following will be discussed:

(i) analysis of present water consumption;
(ii) forecast of water demand, with- and without-project;
(iii) financial benefit-cost analysis;
(iv) economic benefit-cost analysis;
(v) sensitivity analysis of the ENPV;
(vi) sustainability;
(vii) distribution analysis and poverty impact reduction.

2. Preceding the case study, a least-cost analysis, including and based on water demand forecasting, has identified the preferable option. The least-cost analysis itself is not presented. The text and tables will refer to the case studies as “the Project”. These tables will show the benefits and costs for selected years. Tables presenting each year of the project life are given in Annexes to Appendix B.

B.1.2 Description of the Project

3. The population of the town, living within the service area in 1996, is estimated at 100,000. The population is increasing at 3 percent per year due to natural growth and immigration from rural areas.

4. The project’s objective is to increase piped water supply to households within the service area from its present coverage of 45 percent to 70 percent by year 2000, and 80 percent by 2005. Household surveys have indicated that this is a realistic goal (85 percent of the population stated a clear preference for piped water services).

5. The data above form the basis of the demand forecast as shown in the annexes. The forecast is used to further formulate and design the project. For phase 1 investments, the supply capacity is designed to meet the year 2005 project demand forecast of 2.6 Mm^3 per year. To meet increased demand beyond 2006, a phase 2 project is required. Phase 2 is not included in the analysis. The utility will supply water of good quality at adequate pressure 24 hours per day. It is expected that the first new households will benefit from the project in year 1997. The lifetime of phase 1 investments is 30 years.

B.1.3 With- and Without-Project Cases

6. At present, 45,000 persons are supplied with piped water services through 7,500 connections. The quality of water obtained from the existing supply system is adequate, but the quantity of water is mostly insufficient (i.e., water is supplied less than 24 hours a day). The proposed project includes a reinforcement and extension of the existing supply system. However, no major rehabilitation of the system is foreseen in the project. It has therefore been considered that rehabilitation, if required, will take place outside of the project. The water supply company can maintain its existing level of service in the without-project situation. Consequently, the without-project piped water supply is assumed to remain constant in the without-project situation.

B.1.4 Prices and Currency

7. Throughout the analysis, the domestic price numeraire will be used. All prices are expressed in constant values of the base year, 1996. The currency is Viet Nam Dong, VND. The exchange rate used is $1 = VND11,000.

B.1.5 Project Lifetime

8. The project lifetime is 30 years (1996-2026), including an implementation period of four years. Year 2026 is the last year when benefits and costs due to the project are expected to occur. The project is designed to meet demand through 2005. In the tables in this Appendix, the main project variables remain constant in the period 2006-2026.

B.2 ANALYSIS OF VOLUME and COST OF PRESENT DEMAND

9. As part of the study, a household survey of 200 nonconnected households and 100 connected households has been conducted.

B.2.1 Present Water Consumption

10. **Nonconnected households.** Detailed data on the present consumption of nonconnected households are presented in Annex B.1. The consumption per nonconnected household per month was estimated on the basis of daily quantities of water collected from a specific source. In a second step, this estimate was corrected for the number of days and months that the source is not used. The estimated demand is 13.5 m^3 per household per month. The average household size is 5.7 persons. The present per capita consumption is approximately 78 liters per day.

11. **Connected households.** The average piped water consumption for a connected household is currently 85 lcd, which is not sufficient to satisfy demand. The collected data show that an additional 15 lcd is collected from secondary sources, mainly from open wells.

B.2.2 Present Supply Cost of Water

12. **Nonconnected households.** Nonconnected households obtain water from alternative sources. According to the survey, water is obtained mainly from neighbors, wells with electric pumps, open wells and vendors, as shown in column H of Annex B.1. The costs involved relate to collecting time, cash expenditures for water and investments.

13. The average collecting time per household is 36 minutes per day and the average consumption per household is 445 liters per day (5.7 x 7.8). It thus takes a household about one hour and 20 minutes to collect 1 m^3 of water (36/0.445 = 81 minutes). The value of time is estimated on the basis of the observed wage rate for unskilled labor in construction work of VND3,000 per hour in the project area.

14. The cash expenditures for water obtained from neighbors and vendors constitute a major part of the supply cost. In the project area, some households sell (from piped and non-piped sources) water to their neighbors at prices close to the prices of vendors (VND10,000 - 13,000 per m^3).

15. The investment costs in alternative sources range from VND250,000 for tankers to VND1.3 million for wells with electric pumps. These have been converted to a per m^3 equivalent by using a capital recovery factor, with a 12 percent interest and an assumed lifetime of 15 years.

16. This approach has also been applied to the cost of storage facilities (on average VND450,000 per household). The average cost of storage facilities comes therewith on approximately VND500 per m^3.

17. Table B.1 depicts the supply cost of water from the four most important alternative sources as they are used by nonconnected households. Also shown is the proportion of water obtained from that source as a percentage of total of water consumed. The data are rounded off, and are based on the detailed data in Annex B.1.

Table B.1 **Financial and Economic Cost of Water from Various Sources**								
	% of water consumed	financial demand price (VND/m^3)			cost break down (%)			economic supply cost [a/] (VND/m^3)
		source	storage	total	traded	Non-traded Labor	Non-traded Equipment	
CF [b/]					1.11	0.65	1.00	
Neighbor	10%	18,100	500	18,600	20%	40%	40%	16,409
Electric well	10%	3,300	500	3,800	30%	60%	10%	3,129
Open well	70%	3,200	500	3,700	10%	80%	10%	2,705
Vendor	10%	18,500	500	19,000	20%	50%	30%	16,097
Total/Ave	100%	6,230	500	6,730	20%	49%	31%	5,457

a/ using domestic price numeraire

b/ Conversion factor for traded items is the SERF of 1.11, for (unskilled) labor 0.65 and for other non-traded 1.00

18. The financial demand price of water obtained from neighbors and vendors is approximately VND19,000 per m^3; and of water obtained from open wells or from electric wells, VND3,700 - 3,800 per m^3. The (weighted) average financial demand price is VND6,730 per m^3.

19. This financial price has been apportioned into a traded component, a (unskilled) labor component and a nontraded equipment component. To estimate the economic supply cost of water, the traded component has been shadow-priced with the SERF of 1.11, the unskilled labor component with the SWRF of 0.65 and the nontraded component with a conversion factor of 1.00. The average economic supply cost of water obtained from alternative sources is VND5,457 per m^3.

20. **Connected households.** Connected households use approximately 15 lcd of water from alternative sources, mainly from open wells. The survey indicated that the costs involved are comparable to the cost for nonconnected households. The financial demand price of water from alternative sources has therefore been taken at VND3,700 per m^3, and the economic supply cost at VND2,705 per m^3.

B.3 WATER DEMAND FORECAST

21. The population and demand forecast for the project in years 1996-2005 are given in Tables B.2 to B.5. The project supply capacity of 3.6 Mm^3 is designed to meet the year

2005 demand, the time horizon of the project. The lifetime of the project is 30 years. Constant benefits and costs will occur from 2006 until year 2026. It is necessary to look at the demand for water with the project and without the project because economic benefits of the project occur as a result of a change in cost of water and the induced change in demand. The focus is consequently on incremental and nonincremental water, used by existing and new consumers.

B.3.1 Population and Coverage

22. A summary of the data is presented in Table B.2 (lines 1-5). As shown in this Table, the population in the service area (100,000 in 1996) is expected to grow at an annual rate of 3 percent, slightly above the national average, due to natural growth and immigration from rural areas. The population increases to 130,000 by the year 2005. The project aims at a gradual increase in coverage, from the present 45 percent of the population to 70 percent in 2000 and 80 percent in 2005. The population served with the project increases by almost 60,000 consumers, from 45,000 consumers in 1996 to 104,000 persons by the year 2005.

Table B.2 **Population and Coverage**

		Unit	1996	1997	2000	2005	2006 2026
1	**Population and coverage**						
2	Population growth	%	3.0%	3.0%	3.0%	3.0%	
3	Population in service area	person	100,000	103,000	112,551	130,478	130,478
4	Coverage (present/target)	%	45%	51%	70%	80%	80%
5	Population served with project	person	45,000	52,530	78,786	104,382	104,382

B.3.2 Demand Without-Project

B.3.2.1 Existing Consumers

23. Relevant data are presented in Table B.3, lines 6-17. The water supply system is maintained and operated at a level that is required to continue providing the existing level of services to 45,000 consumers through 7,500 existing connections. Without the project, no further service extension (in terms of volume, connections, quality) will occur.

24. The total per capita demand of water of 100 lcd in 1996 grows by 0.5 percent annually to 105 lcd in 2005. Since the existing water supply system operates at its maximum capacity, this demand will meet only 85 lcd of piped water (i.e., the present level of piped water supplied). The remaining 15 to 20 lcd would have to be obtained from other sources. The total piped water consumption is 1.4 Mm^3 per year. Water obtained from other sources would increase from 246,000 m^3 in 1996 to 322,000 m^3 by 2005.

B.3.2.2 Consumers of Water from other Sources

25. Relevant data are presented in Table B.3, lines 19-23. In the without-project water demand projection, the focus is on the without-project demand for water obtained from other (than piped water) sources for the portion of the population which will be connected *with and as a result of the project*. It is the consumption of water from other sources that will be displaced as a result of the project. The number of new consumers is obtained by deducting the existing population served (line 10) from the target population to be served (line 5). Ultimately, 59,000 additional consumers will benefit from the project. Their existing 1996 water demand from other sources of 78 lcd is assumed to grow at 0.5 percent annually to reach 82 lcd by 2005 and to total 1.8 Mm^3 by 2005.

Table B.3 **Demand for water, without-project**

		unit	1996	1997	2000	2005	2006 2026
6	**WITHOUT-PROJECT**						
7	**Existing consumers**						
8	Number of connections	no	7,500	7,500	7,500	7,500	7,500
9	Person per connection	person	6.00	6.00	6.00	6.00	6.00
10	Persons served	person	45,000	45,000	45,000	45,000	45,000
11	Increase in per capita demand	%		0.5%	0.5%	0.5%	
12	Total per capita demand	lcd	100	101	102	105	105
13	Per capita piped water consumption	lcd	85	85	85	85	85
14	Per capita water consumption other source	lcd	15	16	17	20	20
15	Total piped water consumption	'000 m³	1,396	1,396	1,396	1,396	1,396
16	Total water consumption other source	'000 m³	246	255	279	322	322
17	Total water demand	'000 m³	1,643	1,651	1,676	1,718	1,718
18							
19	**Consumers of water from other sources**						
20	Number of persons	person	0	7,530	33,786	59,382	59,382
21	Increase in per capita demand	%		0.5%	0.5%	0.5%	
22	Per capita demand other sources	lcd	78	78	80	82	82
23	Total water demand other sources	'000 m³	0	215	981	1,768	1,768

B.3.3 Demand with the Project

Data on demand are presented in Table B.4.

B.3.3.1 Per Capita Consumption

26. The per capita demand forecast, which is assumed equal for existing and new consumers, is built around the assumptions of a price elasticity of -0.35 (i.e., based on survey data) and an income elasticity of 0.50 (literature) [lines 25-34]. The forecast considers that:

(i) financial analysis at the enterprise level shows that the tariff should be increased to meet the financial targets set in the loan covenant of the project. An annual increase of 2 percent (in real terms) is proposed. As a result, the existing tariff of VND2,800 per m^3 will increase to VND3,346 per m^3 by the year 2005. This price increase is, *ceteris paribus*, expected to cause a 0.7 percent annual demand reduction (0.02 x -0.35); and

(ii) macro-economic forecasts for the country estimate a 2.5 percent real per capita income increase. This income increase is, *ceteris paribus*, expected to cause a 1.25 percent annual demand increase (0.025 x 0.50).

27. The net effect is a 0.55 percent annual increase in per capita demand. The per capita piped water demand increases moderately from 100 lcd in 1996 to 105 lcd by the year 2005. After 2005, no further increase in the per capita demand has been assumed.

B.3.3.2 Existing consumers

28. Since the financial demand price of water from other sources including open wells is above the price of piped water, and since supplies of piped water are no longer constrained, the project is expected to replace all water previously obtained from other sources [lines 36-41]. The per capita piped water demand increases from 85 lcd in 1996 to 101 lcd in 1997, as a result of replacement and as a result of price and income effects. The total piped water demand will reach 1.7 Mm^3 per year by 2005.

B.3.3.3 New Consumers

29. The number of persons to be served is a result of the set targets. The number of new connections is determined by the average household size of 5.70 persons [lines 43-48]. The project water is expected to fully displace water obtained from alternative sources. The new consumers will develop a similar consumption pattern as that of old consumers. The total piped water demand will reach 2.3 Mm^3 per year by 2005.

B.3.3.4 Total Demand and Required Capacity

30. The total piped water demand with the project will reach 4.0 Mm^3 annually by the year 2005 [lines 50-55]. Unaccounted for water with the project is expected to decrease from its present 35 percent to 25 percent by the year 2000 due to the purchase of leakage detection equipment and monitoring systems. As a result, a part of the additional demand can be met by the existing supply capacity. The total piped water production will reach 5.3 Mm^3 by the year 2005 (4.0/(1-0.25). The total required supply capacity is calculated on basis of a peak factor of 1.15 and increases from the present 2.5 Mm^3 per year to 6.1 Mm^3 (5.3 x 1.15) per year by the year 2005.

B.3.3.5 Project Water Supply

31. This section indicates the additional volumes of water sold and produced as a result of the project [lines 56-60]. The volume of project water sold is determined on a with- and without-project basis. For example, without the project, 1.4 Mm^3 is sold in the year 2005 (line 15) while with the project, 4.0 Mm^3 (line 51). Hence, the Project has increased the volume of water sold by 2.6 Mm^3.

32. The volume of project water produced is determined by the increase in water production as compared to the base year 1996 (line 53). In 2005, it reaches 3.2 Mm^3 per year (i.e., 5.3 Mm^3 - 2.1 Mm^3). The project should add an additional supply capacity of 3.6 Mm^3 per year for the 2005 horizon (i.e., 6.1 Mm^3 - 2.5 Mm^3, lines 55 and 59).

Table B.4 **Demand for Water, with the Project**

		unit	1996	1997	2000	2005	2006 2026
24	**WITH-PROJECT**						
25	**Per capita consumption**						
26	Tariff increase	%		2.00%	2.00%	2.00%	
27	Tariff	VND/m³	2,800	2,856	3,031	3,346	3,346
28	Price elasticity			-0.35	-0.35	-0.35	-0.35
29	Price effect on demand	%		-0.70%	-0.70%	-0.70%	0.00%
30	Income elasticity			0.50	0.50	0.50	0.50
31	Per capita income increase	%		2.50%	2.50%	2.50%	
32	Income effect on demand	%		1.25%	1.25%	1.25%	0.00%
33	Total effect	%		0.55%	0.55%	0.55%	0.00%
34	Per capita piped water demand	lcd	100	101	102	105	105
35							
36	**Existing consumers**						
37	Number of connections	no	7,500	7,500	7,500	7,500	7,500
38	Person per connection	person	6.00	6.00	6.00	6.00	6.00
39	Persons served	person	45,000	45,000	45,000	45,000	45,000
40	Per capita piped water demand	lcd	85	101	102	105	105
41	Total piped water demand	'000 m³	1,396	1,652	1,679	1,726	1,726
42							
43	**New consumers**						
44	Persons to be served	person	0	7,530	33,786	59,382	59,382
45	Person per connection	person	na	5.70	5.70	5.70	5.70
46	Number of connections	no	na	1,321	5,927	10,418	10,418
47	Per capita piped water demand	lcd	na	101	102	105	105
48	Total piped water demand	'000 m³	na	276	1,261	2,277	2,277
49							
50	**Total**						
51	Total piped water demand	'000 m³	1,396	1,928	2,939	4,003	4,003
52	Unaccounted for water	%	35.0%	32.5%	25.0%	25.0%	25.0%
53	Total piped water production	'000 m³	2,148	2,856	3,919	5,337	5,337
54	Peak factor		1.15	1.15	1.15	1.15	1.15
55	Required capacity	'000 m³	2,470	3,285	4,507	6,138	6,138
56	**PROJECT WATER SUPPLY**						
57	Project water sold	'000 m³	0	532	1,543	2,607	2,607
58	Project water produced	'000 m³	0	708	1,771	3,189	3,189
59	Existing supply capacity	'000 m³	2,500	2,500	2,500	2,500	2,500
60	Required proj. supply capacity	'000 m³	0	785	2,007	3,638	3,638

B.3.3.6 Project Water Consumption

33. The data are presented in Table B.5, lines 61-70. This section separates the total project water demand into incremental and nonincremental demand. The distinction is important when valuing water in economic terms.

34. The demand forecast has assumed that all water from other than piped sources will be replaced; this is the non-incremental water and is shown in lines 16 and 23. The remainder of the project water delivered is incremental water. which is the difference between the with- and without-project consumption (i.e., line 41-line 17, line 48-line 23). The Table shows that the most of the project water sold (i.e., 2005: 0.3+2.3=2.6 Mm^3) displaces water from other sources (2005: 0.3+1.8=2.1 Mm^3). The remainder adds to the total water consumption (2005: 0.5 Mm^3).

Table B.5 **Project Water Consumption**

		unit	1996	1997	2000	2005	2006 2006
61	**PROJECT WATER CONSUMPTION**						
62	**Existing consumers**						
63	Nonincremental water	'000 m^3		255	279	322	322
64	Incremental water	'000 m^3		1	3	8	8
65	Project water sold	'000 m^3		255	283	329	329
66							
67	**New consumers**						
68	Nonincremental water	'000 m^3		215	981	1,768	1,768
69	Incremental water	'000 m^3		61	279	509	509
70	Project water sold	'000 m^3		276	1,261	2,277	2,277

B.4 FINANCIAL BENEFIT-COST ANALYSIS

B.4.1 Project Revenues

35. The data are presented in Table B.6, lines 71-79. The financial revenues of the project are made up of revenues on project water sold and connection fees. The connection fee is VND0.5 m per connection. All other data needed to calculate the financial revenues (i.e. the project water sold, tariffs and connections) stem from previous sections (lines 57; 27 and 46). From year 2006 and onwards, no new connections due to the project have been projected and

hence, no additional connection fees are received. The financial revenues will remain constant at VND8.7 billion per annum in years 2006 to 2026.

Table B.6 **Project Financial Revenues**

		unit	1996	1997	2000	2005	2006 2026
71	**Project water sold**						
72	Project water sold	'000 m³	0	532	1,543	2,607	2,607
73	Tariff	VND/m³	2,800	2,856	3,031	3,346	3,346
74	Project revenues from sales	VND m.	0	1,519	4,678	8,722	8,722
75	**Connection fees**						
76	New connections per year	no.	0	1,321	1,745	978	0
77	Connection fee	VND m.	0.50	0.50	0.50	0.50	0.50
78	Project revenues from connections	VND m.	0	661	872	489	0
79	**Total Project Revenues**	VND m.	0	2,179	5,550	9,211	8,722

B.4.2 Project Costs

The data on project costs are presented in Table B.8.

B.4.2.1 Investments

36. For selecting the project, a least-cost analysis on the basis of preliminary economic cost estimates was carried out among the different project alternatives [lines 80-92]. The economic analysis given in this Appendix is for the project selected through the least-cost analysis. The cost of the chosen least-cost alternative includes the development of a new source, water treatment plant, ground and elevated storage, pump station, distribution system, sanitation and drainage, consulting services, investigations and institutional support. Including physical contingencies calculated at 8 percent of the project cost subtotal, the total project cost is estimated to be VND64.5 billion. The investment costs are scheduled for disbursement during 1996-1999. Details are given in Table B.7.

Table B.7 **Project Investment and Disbursement Profile**

	Total	Disbursement in project years (%)			
	VND m.	1996	1997	1998	1999
Source development	18,000	40%	40%	20%	0%
Water treatment	2,475	40%	30%	30%	0%
Ground storage	360	20%	50%	30%	0%
Elevated storage	1,620	20%	50%	30%	0%
Pump station	675	40%	50%	10%	0%
Distribution system	18,000	20%	60%	10%	10%
Sanitation and drainage	3,150	30%	30%	20%	20%
Consulting services	9,900	50%	40%	10%	0%
Investigations	180	50%	40%	10%	0%
Institutional support	5,400	20%	30%	30%	20%
Subtotal	59,760				
Physical contingencies @ 8%	4,781				
Total investment	64,541				

B.4.2.2 Operation and Maintenance

37. The operation and maintenance costs, expressed as a percentage of the total project investment, comprise of: labor (0.5percent); electricity (1.0percent); chemicals (0.7percent); and other O&M (0.9percent) [lines 93-98]. An adjustment for a real increase of the price of labor has been made. The wages have been assumed to increase by the percentage real growth in per capita income of 2.5 percent per annum. The cost of operating and maintenance are expected to reach some VND2.1 billion per annum in project year 2005.

B.4.2.3 Raw Water Tax

38. The proposed project diverts water from a water reservoir which is located just outside the town [lines 89-93]. The reservoir is also used for a medium sized irrigation scheme of 3,000 hectares. The local irrigation authority, which is responsible for the management and operation of the reservoir, has imposed a raw water tax. The water supply utility pays VND200 per m^3 of water diverted from the reservoir. The additional raw water taxes due to the project are applied to all water produced by the project (line 100 = line 58). The utility will pay an additional VND638 million per year to the authority once the Project reaches its full capacity.

Table B.8 **Project Costs**							
		Unit	1996	1997	1998	1999	2006 2026
80	**Investments**						
81	Source development	VND m.	7,200	7,200	3,600	0	0
82	Water treatment	VND m.	990	743	743	0	0
83	Ground storage	VND m.	72	180	108	0	0
84	Elevated storage	VND m.	324	810	486	0	0
85	Pump station	VND m.	270	338	68	0	0
86	Distribution system	VND m.	3,600	10,800	1,800	1,800	0
87	Sanitation and drainage	VND m.	945	945	630	630	0
88	Consulting services	VND m.	4,950	3,960	990	0	0
89	Investigations	VND m.	90	72	18	0	0
90	Institutional support	VND m.	1,080	1,620	1,620	1,080	0
91	Physical contingencies @ 8%	VND m.	1,562	2,133	805	281	0
92	Total investment	VND m.	21,083	28,800	10,867	3,791	0
93	**Operation and maintenance**						
94	Labor	VND m.	0	256	319	348	403
95	Electricity	VND m.	0	499	608	645	645
96	Chemicals	VND m.	0	349	425	452	452
97	Other O&M	VND m.	0	449	547	581	581
98	Total O&M	VND m.	0	1,553	1,899	2,026	2,081
99	**Raw water tax**						
100	Project water produced	'000 m^3	0	708	1,040	1,375	3,189
101	Raw water tax/m^3	VND/m^3	200	200	200	200	200
102	Project raw water tax	VND m.	0	142	208	275	638
103	**Total project costs**	VND m.	21,083	30,495	12,974	6,091	2,719

B.4.3 FNPV and FIRR

39. The data for calculating FNPV and FIRR are presented in Table B.9 lines 104-108. The project costs are deducted from the project revenues on an annual basis to estimate the net cash flow of the project (line 108). The FIRR of 6.26 percent is just below the (assumed) WACC of 7 percent. The FNPV at 7 percent is negative VND4.8 billion. (The cash flow for all project years 1996-2026 is appended as Annex B.2.)

Table B.9 **FNPV and FIRR**

		Unit	PV @ 7%	1996	1997	2000	2005	2006 2026
104	Revenues project water sold	VND m.	77,387	0	1,519	4,678	8,722	8,722
105	Revenues connection fees	VND m.	3,633	0	661	872	489	0
106	Total project revenues	VND m.	81,020	0	2,179	5,550	9,211	8,722
107	Total project costs	VND m.	85,773	21,083	30,495	2,389	2,719	2,719
108	**Net cash flow**	VND m.	-4,753	-21,083	-28,315	3,161	6,492	6,004
109								
110	FIRR		6.26%					
111	FNPV @ 7%	VNDm.	-4,753					

B.5 ECONOMIC BENEFIT-COST ANALYSIS

B.5.1 Economic Benefits

40. The demand and supply prices of water obtained from alternative sources differ significantly for existing and for new consumers as shown in Table B.10. Therefore, incremental and nonincremental project water has been valued separately for new and existing consumers.

B.5.1.1 Existing Consumers

41. The value of nonincremental water is based on the economic supply cost of water (i.e., resource savings) displaced by the project [lines 112-115]. In the case of existing consumers, this is the cost of water obtained from open wells, estimated at VND2,705 per m³ (1996). The cost involves a high labor component (80 percent), which is mainly for collecting water. On the basis of a 2.5 percent annually per capita real income growth, the economic supply cost has been increased by 2 percent (80% x 2.5%) each year, from VND2,705 per m³ in 1996 to VND3,233 in 2005. The value of nonincremental water increases to VND10 billion by the year 2005 and remains constant in years 2006-2026.

42. The value of incremental water is based on the average willingness to pay as a proxy for the demand price of water for the project [lines 117-121]. The demand price of water without the project is the financial demand price of water from open wells, VND3,700 per m³ in 1996 (refer Table 1). The average demand price of water with the project is equal to the tariff, VND2,800 per m³ in 1996. Both prices are increasing at 2 percent annually. The total value of incremental water reaches VND30 million by the year 2005 and remains constant in the years 2006-2026.

B.5.1.2 New consumers

43. In the case of new consumers, the weighted average of the economic supply cost of water from alternative sources of VND5,457 per m^3 in 1996 (Table 1) is used to value nonincremental water [lines 122-125]. This supply cost is based on the cost of water obtained from wells, vendors and neighbors. It comprises approximately 50 percent labor. On the basis of a 2.5 percent annual per capita income growth, this cost has been increased by 1.25 percent annually (50% x 2.5%). By the year 2005, the total value of nonincremental water amounts to VND10.9 billion.

44. The average demand price with and without the project determines the value of incremental project water [lines 127-131]. The financial demand price of water without the project is VND6,730 per m^3 (Table 1) and with the project, it is equal to the tariff of VND2,800 per m^3 in 1996. Again, the tariff increases by 2 percent annually, and the demand price of water without the project by 1.25 percent. The value of incremental water reaches VND2.8 billion by the year 2005.

B.5.1.3 Total Value of Project Water

45. The total value of incremental and nonincremental water to old and new consumers make up the total gross economic benefit of the project as summarized in Table B.10 [lines 132-135]. The largest portion of project water will displace water previously obtained from other sources. The value of nonincremental water reaches VND11.8 billion by 2005; the value of incremental water, VND2.8 billion; and the total value of project water, VND 14.6 billion.

Table B.10 **Gross Economic Benefits**

		unit	1996	1997	2000	2005	2006 2026
112	**Existing consumers**						
113	Nonincremental water	'000 m³	0	255	279	322	322
114	Economic supply price n.i. water	VND/m³	2,705	2,759	2,928	3,233	3,233
115	Value of nonincremental water	VND m.	0	702	818	1,040	1,040
116							
117	Incremental water	'000 m³	0	1	3	8	8
118	Demand price w/o project	VND/m³	3,700	3,774	4,005	4,422	4,422
119	Demand price with project (tariff)	VND/m³	2,800	2,856	3,031	3,346	3,346
120	Average demand price	'000 m³	3,250	3,315	3,518	3,884	3,884
121	Value of incremental water	VND m.	0	3	12	30	30
122	**New consumers**						
123	Nonincremental water	'000 m³	0	215	981	1,768	1,768
124	Economic supply price n.i. water	VND/m³	5,457	5,522	5,724	6,075	6,075
125	Value of nonincremental water	VND m.	0	1,190	5,616	10,743	10,743
126							
127	Incremental water	'000 m³	0	61	279	509	509
128	Demand price w/o project	VND/m³	6,730	6,811	7,059	7,493	7,493
129	Demand price with project (tariff)	VND/m³	2,800	2,856	3,031	3,346	3,346
130	Average demand price	VND/m³	4,765	4,833	5,045	5,419	5,419
131	Value of incremental water	VND m.	0	294	1,409	2,758	2,758
132	**Total value project water**						
133	Value nonincremental water	VND m.	0	1,892	6,435	11,783	11,783
134	Value incremental water	VND m.	0	297	1,421	2,788	2,788
135	**Total value project water (gross benefit)**	VND m.	0	2,189	7,855	14,571	14,571

B.5.2 Calculation of Economic Project Costs

B.5.2.1 Investment

46. The investment cost of the project has been apportioned into: (i) traded; (ii) unskilled labor (non-traded); and (iii) other non-traded components as summarized in Table B.11 [lines 136-148].

Table B.11 **Conversion of (Financial) Investment Cost** ***(1996 VND m.)***

	Financial cost	breakdown % Trad	Unsk. Lab	Other	Economic a/
Conversion factor		1.11	0.65	1.00	
Source development	18,000	70%	15%	15%	18,455
Water treatment	2,475	60%	20%	20%	2,467
Ground storage	360	40%	20%	40%	351
Elevated storage	1,620	40%	20%	40%	1,579
Pump station	675	70%	20%	10%	680
Distribution system	18,000	40%	20%	40%	17,540
Sanitation and drainage	3,150	50%	20%	30%	3,105
Consulting services	9,900	70%	0%	30%	10,670
Investigations	180	25%	0%	75%	185
Institutional support	5,400	50%	0%	50%	5,700
Subtotal	59,760				60,731
Physical contingencies @ 8%	4,781				4,858
Grand total	64,541				65,589

Note: a/ using domestic price level numeraire
Conversion factor tradable component is SERF of 1.11
Conversion factor unskilled labor is SWRF of 0.65

47. The SERF of 1.11 is used to shadow price the tradable component while the SWRF of 0.65, to shadow price the unskilled labor component. Since the domestic price numeraire is being used, non-tradables do not need further adjustment. The disbursement profile shown in Table B.7 has been used to calculate the investment in economic prices per year in Table B.12.

B.5.2.2 Operation and Maintenance

48. The operation and maintenance costs in financial terms (lines 93-98) have been converted to economic values as follows [lines 149-154]:

(i) **Labor**. Approximately 10 percent of the operating labor cost is unskilled labor (conversion factor 0.65) and the other 50 percent, skilled labor (conversion factor 1.00). The financial labor cost has been converted to economic by 0.965 (10% x 0.65 + 90% x 1.00);

(ii) **Electricity**. The national conversion factor for electricity based on the domestic price numeraire is 1.1;

(iii) **Chemicals**. Chemicals, such as chlorine and lime, used by the utility to treat water are traded internationally. It is assumed that 90 percent of the cost to the utility would represent the traded component, which is converted to economic by the SERF. The other 10 percent would represent the non-traded component, such as local transport and storage, which requires no adjustment. The financial cost of chemicals has been converted to economic by 1.1 (90% x 1.11 + 10% x 1);.

(iv) **Other**. Other operation costs, such as overhead, office utensils, small materials, has been assumed as half traded (CF 1.11) and half non-traded (CF 1.0). The financial cost has been converted to economic by 1.056 (50% x 1.11 +50% x 1.00).

B.5.2.3 Opportunity Cost of Water

49. The raw water tax of VND200 per m^3 paid to the irrigation authority underestimates the economic value of additional raw water used as an input for drinking water supply [lines 155-159]. It has been concluded that the expansion of the drinking water supply for the town prohibits the planned expansion of the irrigation scheme by 200 hectares. An assessment of the opportunity cost of water indicates that the economic value of raw water used for irrigation is approximately VND400 per m^3. The total economic benefit foregone in irrigation would be VND1.3 billion in 2005, when the water supply project demands an additional volume of 3.2 Mm^3 raw water.

Table B.12 **Project Cost in Economic Prices**							
		unit	1996	1997	1998	1999	2006 2026
136	**Investments**						
137	Source development	VND mn	7,382	7,382	3,691	0	0
138	Water treatment	VND mn	987	740	740	0	0
139	Ground storage	VND mn	70	175	105	0	0
140	Elevated storage	VND mn	316	789	474	0	0
141	Pump station	VND mn	272	340	68	0	0
142	Distribution system	VND mn	3,508	10,524	1,754	1,754	0
143	Sanitation and drainage	VND mn	931	931	621	621	0
144	Consulting services	VND mn	5,335	4,268	1,067	0	0
145	Investigations	VND mn	93	74	19	0	0
146	Institutional support	VND mn	1,140	1,710	1,710	1,140	0
147	Physical contingencies @ 8%	VND mn	1,603	2,155	820	281	0
148	Total investment	VND mn	21,636	29,089	11,068	3,796	0
149	**Operation & maintenance**						
150	Labor	VND mn	0	247	308	335	389
151	Electricity	VND mn	0	549	668	710	710
152	Chemicals	VND mn	0	384	468	497	497
153	Other O&M	VND mn	0	474	577	613	613
154	Total O&M	VND mn	0	1,653	2,021	2,155	2,209
155	**Opportunity cost of water**						
156	Project water produced	'000 m^3	0	708	1,040	1,375	3,189
157	Opportunity cost of water	VND/m^3	400	400	400	400	400
158	Opportunity cost of water	VND mn	0	283	416	550	1,276
159	**Project economic cost**	VND mn	21,636	31,026	13,505	6,502	3,485

B.5.3 ENPV and EIRR

50. Table B.13 presents a summary of the economic benefits and costs for the Project, used to estimate the ENPV and EIRR. [lines 160-164]. The non-technical losses (10 percent of water produced) are added to the volume of project water sold to form the total project water consumed. The total volume of project water consumed is 2.9 Mm^3 in 2005.

51. The first two lines (lines 166 and 167) recapture the value of incremental and nonincremental water [lines 166-169]. The value of non-technical losses per m³ is the weighted average of the value of incremental and non-incremental water per m³. In 2005, the total value of non-technical losses amounts to VND1.8 billion (319,000 m³ x [(VND11.78 mn + VND2.79 mn)/2.697 Mm³]).

52. The net cash flow of the project is the difference between the economic benefits and costs [lines 170-175]. Discounted at 12 percent, the ENPV is positive VND5.5 billion. The EIRR is 13.1 percent, which exceeds the EOCC of 12 percent by 1.1 percent. The project is economically viable albeit marginally. A table which shows the cash flow for the entire 1996-2026 period is appended as Annex B.2.

Table B.13 **EIRR and ENPV**

		Unit	PV @ 12%	1996	1997	2000	2005	2006 2026
160	Project water sold	'000 m³	13,295	0	532	1,543	2,607	2,607
161	Project water produced	'000 m³	16,120	0	708	1,771	3,189	3,189
162	Non-technical losses	%		10%	10%	10%	10%	10%
163	Non-technical losses	'000 m³	1,612	0	71	177	319	319
164	Project water consumed	'000 m³	14,907	0	603	1,720	2,926	2,926
165	**Gross benefits**							
166	Value nonincremental water	VND mn	58,037	0	1,892	6,435	11,783	11,783
167	Value incremental water	VND mn	13,268	0	297	1,421	2,788	2,788
168	Value of non-technical losses	VND mn	8,643	0	292	902	1,783	1,783
169	Project economic benefits	VND mn	79,948	0	2,481	8,757	16,354	16,354
170	Project economic benefits	VND mn	79,948	0	2,481	8,757	16,354	16,354
171	Project economic cost	VND mn	74,455	21,636	31,026	2,872	3,485	3,485
172	Project net cash flow	VND mn	5,493	-21,636	-28,545	5,885	12,869	12,869
173								
174	EIRR		13.1%					
175	ENPV @ 12%	VNDmn	5,493					

B.5.4 Sensitivity Analysis

53. The EIRR of 13.1 percent is marginally sufficient to justify the project. Sensitivity analysis is important to test the robustness of the project under unforeseen circumstances. Table 14 assesses the impact of a change in selected parameters on the EIRR. For each parameter, the value in the base-case and two sensitivity tests are given.

54. Switching values are also calculated. A switching values is the percentage change in the parameter required to reduce the EIRR to the cut-off rate of 12 percent (i.e., EOCC).

Table B.14 **Results of Sensitivity Analysis**

Parameter	Unit	Base Value	Scenario Values 1	Scenario Values 2	Switching Values (SVs)
SERF		1.11	1.25	1.00	23%
EIRR		13.1%	12.5%	13.6%	
SWRF		0.65	0.50	0.80	20%
EIRR		13.1%	11.8%	14.2%	
Operating life	years	30	25	20	
EIRR		13.1%	12.6%	11.7%	
Economic benefits minus		0%	10%	20%	7%
EIRR		13.1%	11.5%	9.8%	
Investment cost plus		0%	10%	20%	36%
EIRR		13.1%	12.8%	12.5%	
Water demand (1996)	lcd	100	90	85	6%
EIRR		13.1%	11.2%	10.2%	
Coverage 2000 (2005 + 10%)	% pop	70%	65%	60%	5%
EIRR		13.1%	11.5%	9.8%	
Real income growth per caput	% per year	2.5%	1.5%	0.5%	36%
EIRR		13.1%	11.9%	10.7%	
Income elasticity		0.50	0.40	0.30	62%
EIRR		13.1%	12.7%	12.4%	
Price elasticity		-0.35	-0.50	-0.60	111%
EIRR		13.1%	12.7%	12.4%	
Population growth	% per year	3.0%	2.0%	0.0%	21%
EIRR		13.1%	11.3%	7.6%	
Delay in benefits	years	0	1	2	
EIRR		13.1%	12.7%	12.1%	

55. As summarized in Table B.14, the switching values demonstrate that the project's EIRR would fall from 13.1 percent to 12 percent if:

(i) the SERF was 23 percent higher (i.e., 1.37 compared to 1.11). A higher SERF increases the economic price of traded materials used in the project;

(ii) the SWRF was 20 percent lower (i.e., .52 compared to .65). A lower SWRF reduces the economic supply cost of water replaced by the project (a benefit to the project), and reduces the economic opportunity cost of unskilled labor inputs (a cost to the project). The first effect is stronger than the second;

(iii) economic benefits fell by 7 percent;

(iv) the economic value of project assets increased by 36 percent;

(v) the existing per capita demand for piped water of 100 lcd was overestimated by 6 percent and resources to connect additional consumers were not available;

(vi) the achieved coverage in the year 2000 was 5 percent below target, so that the population coverage in 2000 would be 67 percent (95% x 70%) and in 2005, 77 percent (67% + 10%);

(vii) the real income growth per capita was reduced by 36 percent, from 2.5 percent to 1.6 percent (64% x 2.5%). A lower per capital income growth leads to a lower than expected demand, causes the economic supply cost of water displaced by the project to be lower in later years of the analysis, and reduces the value of operating labor. The first two effects affect the EIRR negatively, the third positively. The net effect is negative;

(viii) the income elasticity of demand fell by 62 percent, from .50 to 0.19 (38% x 0.50). A lower income elasticity implies that the expected increase in incomes will translate into lower additional demand than projected, and hence an oversized project;

(ix) the price elasticity of demand increased by 111 percent, from -0.35 to -0.74 (111% x -0.35). The higher (absolute) value of the price elasticity, in combination with an annual 2 percent tariff increase, would lead to a lower demand than initially foreseen;

(x) population growth was 21 percent lower than projected at 2.4 percent per annum (79% x 3%). This would cause the total demand to be less than anticipated;

(xi) and all other parameters do not change. If the lifetime of the project assets is reduced to 25 or to 20 years, the EIRR would decrease to 12.6 percent and 11.7

percent, respectively. If the project benefits were deferred by one or two years, the EIRR would decrease to 12.7 percent and 12.1 percent respectively.

B.6 SUSTAINABILITY

56. Sustainability has different dimensions, including financial, economic, environmental and institutional. A simplified test of financial sustainability of the project is assessed by comparing the average tariff with the AIFC, which is a test of the ability of the project to cover all costs, including financing charges, and make an adequate return on investment. The difference is the financial subsidy. The ADB expects that if financial subsidies are required, a justification is provided and an assessment of the ability of the government to subsidize the project is made. Sustainability analysis also involves financial analysis at the entity level. However, for purposes of this example, it is not included.

57. Most of these steps are not discussed in this section. It is limited to the calculation of the AIC and subsidies of the urban case study discussed throughout this Annex. The calculation is shown in Table 15 and Table 16. (The flows of water, costs and benefits are shown for all project years in Annex B.2.)

B.6.1 Average Incremental Financial Cost and Financial Subsidy

58. [lines 176-182] The average incremental financial cost of water is calculated by dividing the present value of the project cost at financial values by the present value of project water sold. The average tariff is calculated by dividing the present value of financial revenues by the present value of project water sold. Discounting is done at the WACC of 7 percent, which is used as a proxy of the FOCC. The flows of project water, costs and revenue have been calculated in the previous tables and are repeated here (line 176 = line 103, line 177 = line 79 and line 178 = line 57).

59. The AIFC in the example is VND3,617 per m^3 (VND85.7 billion/23.7 Mm^3 x 1,000). The average tariff is VND3,416 per m^3 (VND81.0 billion/23.7 Mm^3 x 1,000). The financial subsidy amounts to VND200 per m^3 (3,617 - 3,416). With the proposed tariffs, 94 percent (3,416/3,617) of all costs will be recovered through user charges.

Table B.15 **AIFC and Financial Subsidy**

		unit	PV @ 7%	1996	1997	2000	2005	2006 2026
176	Total project costs	VND m.	85,773	21,083	30,495	2,389	2,719	2,719
177	Total project revenues	VND m.	81,020	0	2,179	5,550	9,211	8,722
178	Project water sold	'000 m³	23,717	0	532	1,543	2,607	2,607
179	AIFC @ 7%	VND/m³	3,617					
180	Average tariff @ 7% (incl. connection fees)	VND/m³	3,416					
181	Financial subsidy	VND/m³	200					
182	Financial cost recovery %	VND/m³	94%					

B.6.2 Average Incremental Economic Cost and Economic Subsidy

60. The average incremental economic cost of water is calculated by dividing the present value of the project cost at economic values by the present value of project water consumed [lines 183-188]. The average tariff is calculated by dividing the present value of financial revenues by the present value of project water consumed. The quantity of water consumed includes non-technical losses. Discounting is done at the EOCC of 12 percent. The flows of project water, costs and revenues have been calculated in the previous tables and are repeated here (line 183 = line 159; line 184 = line 117 and line 185 = line 164).

61. The AIEC in the example is VND4,995 per m³ and the average tariff is VND3,073 per m³. The economic subsidy amounts to VND1,922 per m³. The most important reason for the AIEC to exceed the AIFC is the discount rate of 12 percent used.

Table B.16 **AIEC and Economic Subsidy**

		unit	PV @ 12%	1996	1997	2000	2005	2006 2026
183	Project economic cost	VND m.	74,455	21,636	31,026	2,872	3,485	3,485
184	Total project revenues	VND m.	45,802	0	2,179	5,550	9,211	8,722
185	Project water consumed	'000 m³	14,907	0	603	1,720	2,926	2,926
186	AIEC @ 12%	VND/m³	4,995					
187	Average tariff @ 12% (incl. connection fees)	VND/m³	3,073					
188	Economic subsidy	VND/m³	1,922					

B.7 DISTRIBUTION ANALYSIS and POVERTY IMPACT

62. In Annex B.3, a summary of the financial and economic statement of the Project is shown. For purposes of distribution analysis, the discount rate used in both statements is 12 percent. Table B.17 summarizes the present values and shows the distribution of project effects among the different participants.

63. As a result of the project, some participants loose and others gain. At a discount rate of 12 percent, the utility will suffer a loss of VND23.6 billion. The economy will suffer a loss because the overvaluation of the currency causes the financial values of traded goods to be below the economic costs by VND4.3 billion. The farming community will loose by VND3.2 billion because it is unable to extend irrigated agricultural land due to the diversion of water to the water supply project.

64. Laborers gain by VND2.5 billion because the project pays wages in excess of the economic opportunity cost of labor. The consumers will gain by VND34.1 billion because they can avail of increased quantities of water at a lower cost than without the project.

65. The distribution analysis indicates that the largest share of the gains to consumers and labor (total VND36.6 billion) are in fact paid for by the government/economy and by farmers (total VND31.1 billion). The net gain to the economy is much less than the net gain to the consumers, which is VND5.5 billion.

Poverty Impact Indicator.

66. Nationwide, 50 percent of the population is living in poverty. Poverty is more evident in rural than in urban areas; approximately 60 percent of the rural and 30 percent of the urban population are classified as poor. The socio-economic survey showed that the project town and its surrounding area show similar poverty characteristics.

Table B.17 **Distribution of project effects** (VND m., PVs @ 12 percent discount rate)

			Difference	Distribution of Project Effects				
	Financial Present Values	Economic Present Values	Economic minus Financial	Utility	Gov't/ Economy	Farmers	Labor	Consumers
Benefits:								
Total project benefits	45,802	79,948	34,146					34,146
Costs:								
Project investment								
Traded element	29,523	32,803	3,280		-3,280			
Unskilled labor	6,884	4,475	-2,409				2,409	
Non-traded equipment	15,520	15,520	0		0			
Operation and maintenance								
Labor	2,616	2,524	-92				92	
Electricity	4,498	4,948	450		-450			
Chemicals	3,149	3,463	315		-315			
Other O&M	4,048	4,273	225		-225			
Opportunity cost of water	3,224	6,448	3,224			-3,224		
Total project costs	69,462	74,455						
Net benefits	-23,660	5,493	29,153	-23,660				
Gains and losses				-23,660	-4,270	-3,224	2,501	34,146

Source: Present values @ 12 percent in Annex 3.

67. For each class of beneficiary, the Project's benefits have been distributed to the poor as follows:

(i) *government/economy*: the loss of VND27.9 billion will reduce the available government funds. A budgetary assessment estimates that 40 percent of the government expenditures are targeted to the poor;
(ii) *farmers*: the loss in total of VND3.2 billion due to the downsized planned extension of the medium sized irrigation scheme by 200 hectares may be counterproductive in terms of alleviating rural poverty. Sixty percent of the beneficiaries from the existing and proposed irrigation are poor farmers.
(iii) *labor*: the gain of VND2.5 billion is a result of the project wages for unskilled labor, which are above the opportunity cost of unskilled labor. Sixty percent of unskilled labor are considered as poor;
(iv) *consumers*: the gain to the consumers is VND34.1 billion. Approximately 40 percent of the new consumers are estimated to be poor.

The poverty impact ratio for the project is calculated in Table B.18.

Table B.18 **Poverty impact ratio** (VND m., PVs @ 12 percent discount rate)

	Gov't/ Economy	Farmers	Labor	Consumers	Total
Gains and losses (NEB-NFB)	-4,270	-3,224	2,501	34,146	29,153
Financial return utility	-23,660				-23,660
Benefits	-27,930	-3,224	2,501	34,146	5,493
Proportion of poor	0.40	0.60	0.60	0.40	
Benefits to poor	-11,172	-1,934	1,501	13,658	2,053
Poverty impact ratio: 2,053 / 5,493 = 0.37					

68. The poverty impact ratio, which is calculated as the benefits to the poor divided by the total benefits, is 0.37 (VND2,053 m / VND5,493 m.). Compared to an urban population living in poverty of 30 percent, it is concluded that the project has a moderate poverty reducing impact for the town.

B.8 RECOMMENDATIONS

69. The project is a beneficial project, although marginally, as the EIRR is 13.1 percent. This EIRR is particularly prone to variations in assumptions underlying the total demand forecast. These assumptions include forecasts on population coverage, per capita piped water demand, income changes, income elasticity and price elasticity. The lowest switching values occur for changes in per capita water demand and population coverage. Six percent overestimated per capita demand (94 instead of 100 lcd) and a 5 percent lower than planned coverage by year 2000 (from 70 to 67 percent) reduces the EIRR to 12 percent.

70. Considering that: (i) the substantial and constrained piped water demand of 85 lcd by existing consumers, supplemented with 15 lcd of water from alternative sources against a cost which is above the cost of water form the project; and (ii) a consumption of non-piped water of 78 lcd by nonconnected households at a cost which is more than twice the cost of water with the project, a piped water demand estimate of 100 lcd is considered a reasonable and conservative estimate.

71. The population coverage target of 70 percent by 2000 (and 80 percent by 2005) is below the 85 percent of the population which stated a clear preference for piped water supply. The stated coverage targets are supply constrained and actions at the entity level could be taken to increase efficiency.

72. The project is marginally financially sustainable. The estimated costs are covered by user charges (94 percent). Operating losses, if any, might be covered by the local community. The entity could pay 6.26 percent interest on its loans, while it is estimated that 7 percent is required.

Annex B.4 **Economic Benefit-Cost Analysis**

		unit	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006 2026
1	**Population and coverage**												
2	Population growth	%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	
3	Population in service area	person	100,000	103,000	106,090	109,273	112,551	115,928	119,406	122,988	126,678	130,478	130,478
4	Coverage (present/target)	%	45%	51%	57%	63%	70%	72%	74%	76%	78%	80%	80%
5	Population served with project	person	45,000	52,530	60,471	68,842	78,786	83,468	88,360	93,471	98,809	104,382	104,382

		unit	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006 2026
6	**WITHOUT-PROJECT**												
7	**Existing consumers**												
8	Number of connections	no	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500
9	Person per connection	person	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
10	Persons served	person	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000
11	Increase in per capita demand	%		0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	
12	Total per capita demand	lcd	100	101	101	102	102	103	103	104	104	105	105
13	Per capita piped water consumption	lcd	85	85	85	85	85	85	85	85	85	85	85
14	Per capita water consumption other source	lcd	15	16	16	17	17	18	18	19	19	20	20
15	Total piped water consumption	'000 m³	1,396	1,396	1,396	1,396	1,396	1,396	1,396	1,396	1,396	1,396	1,396
16	Total water consumption other source	'000 m³	246	255	263	271	279	288	296	305	313	322	322
17	Total water demand	'000 m³	1,643	1,651	1,659	1,667	1,676	1,684	1,692	1,701	1,709	1,718	1,718
18													
19	**Consumers of water from other sources**												
20	Number of persons	person	0	7,530	15,471	23,842	33,786	38,468	43,360	48,471	53,809	59,382	59,382
21	Increase in per capita demand	%		0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	
22	Per capita demand other sources	lcd	78	78	79	79	80	80	80	81	81	82	82
23	Total water demand other sources	'000 m³	0	215	445	689	981	1,123	1,272	1,429	1,594	1,768	1,768

Annex B.4 **Economic Benefit-Cost Analysis**

		unit	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006 2026
24	**WITH-PROJECT**												
25	**Per capita consumption**												
26	Tariff increase	%		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	
27	Tariff	VND/m³	2,800	2,856	2,913	2,971	3,031	3,091	3,153	3,216	3,281	3,346	3,346
28	Price elasticity			-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35
29	Price effect on demand	%		-0.70%	-0.70%	-0.70%	-0.70%	-0.70%	-0.70%	-0.70%	-0.70%	-0.70%	0.00%
30	Income elasticity			0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
31	Per capita income increase	%		2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	
32	Income effect on demand	%		1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	0.00%
33	Total effect	%		0.55%	0.55%	0.55%	0.55%	0.55%	0.55%	0.55%	0.55%	0.55%	0.00%
34	Per capita piped water demand	lcd	100	101	101	102	102	103	103	104	104	105	105
35													
36	**Existing consumers**												
37	Number of connections	no	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500
38	Person per connection	person	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
39	Persons served	peson	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000
40	Per capita piped water demand	lcd	85	101	101	102	102	103	103	104	104	105	105
41	Total piped water demand	'000 m³	1,396	1,652	1,661	1,670	1,679	1,688	1,697	1,707	1,716	1,726	1,726
42													
43	**New consumers**												
44	Persons to be served	person	0	7,530	15,471	23,842	33,786	38,468	43,360	48,471	53,809	59,382	59,382
45	Person per connection	person	na	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70
46	Number of connections	no	na	1,321	2,714	4,183	5,927	6,749	7,607	8,504	9,440	10,418	10,418
47	Per capita piped water demand	lcd	na	101	101	102	102	103	103	104	104	105	105
48	Total piped water demand	'000 m³	na	276	571	885	1,261	1,443	1,636	1,838	2,052	2,277	2,277
49													
50	**Total**												
51	Total piped water demand	'000 m³	1,396	1,928	2,232	2,554	2,939	3,131	3,333	3,545	3,768	4,003	4,003
52	Unaccounted for water	%	35.0%	32.5%	30.0%	27.5%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%
53	Total piped water production	'000 m³	2,148	2,856	3,188	3,523	3,919	4,175	4,444	4,727	5,024	5,337	5,337
54	Peak factor		1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
55	Required capacity	'000 m³	2,470	3,285	3,666	4,052	4,507	4,801	5,111	5,436	5,778	6,138	6,138
56	**PROJECT WATER SUPPLY**												
57	Project water sold	'000 m³	0	532	835	1,158	1,543	1,735	1,937	2,149	2,372	2,607	2,607
58	Project water produced	'000 m³	0	708	1,040	1,375	1,771	2,027	2,296	2,579	2,877	3,189	3,189
59	Existing supply capacity	'000 m³	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
60	Required project supply capacity	'000 m³	0	785	1,166	1,552	2,007	2,301	2,611	2,936	3,278	3,638	3,638

Annex B.4 **Economic Benefit-Cost Analysis**

		unit	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006 2026
61	**PROJECT WATER CONSUMPTION**												
62	**Existing consumers**												
63	Nonincremental water	'000 m³		255	263	271	279	288	296	305	313	322	322
64	Incremental water	'000 m³		1	2	2	3	4	5	6	7	8	8
65	Project water sold	'000 m³		255	264	274	283	292	301	311	320	329	329
66													
67	**New consumers**												
68	Nonincremental water	'000 m³		215	445	689	981	1,123	1,272	1,429	1,594	1,768	1,768
69	Incremental water	'000 m³		61	126	196	279	320	364	409	458	509	509
70	Project water sold	'000 m³		276	571	885	1,261	1,443	1,636	1,838	2,052	2,277	2,277

		unit	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006 2026
71	**Project water sold**												
72	Project water sold	'000 m³	0	532	835	1,158	1,543	1,735	1,937	2,149	2,372	2,607	2,607
73	Tariff	VND/m³	2,800	2,856	2,913	2,971	3,031	3,091	3,153	3,216	3,281	3,346	3,346
74	Project revenues	VND mn	0	1,519	2,434	3,442	4,678	5,364	6,108	6,912	7,782	8,722	8,722
75	**Connection fees**												
76	Incremental connections in year	no.	0	1,321	1,393	1,469	1,745	821	858	897	936	978	0
77	Connection fee	VND mn	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
78	Project revenues	VND mn	0	661	697	734	872	411	429	448	468	489	0
79	**Total project revenues**	VND mn	0	2,179	3,130	4,176	5,550	5,775	6,537	7,360	8,251	9,211	8,722

Annex B.4 **Economic Benefit-Cost Analysis**

		unit	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006 2026
80	**Investments**												
81	Source development	VND mn	7,200	7,200	3,600	0	0	0	0	0	0	0	0
82	Water treatment	VND mn	990	743	743	0	0	0	0	0	0	0	0
83	Ground storage	VND mn	72	180	108	0	0	0	0	0	0	0	0
84	Elevated storage	VND mn	324	810	486	0	0	0	0	0	0	0	0
85	Pump station	VND mn	270	338	68	0	0	0	0	0	0	0	0
86	Distribution system	VND mn	3,600	10,800	1,800	1,800	0	0	0	0	0	0	0
87	Sanitation and drainage	VND mn	945	945	630	630	0	0	0	0	0	0	0
88	Consulting services	VND mn	4,950	3,960	990	0	0	0	0	0	0	0	0
89	Investigations	VND mn	90	72	18	0	0	0	0	0	0	0	0
90	Institutional support	VND mn	1,080	1,620	1,620	1,080	0	0	0	0	0	0	0
91	Physical contingencies @ 8%	VND mn	1,562	2,133	805	281	0	0	0	0	0	0	0
92	Total investment	VND mn	21,083	28,800	10,867	3,791	0	0	0	0	0	0	0
93	**Operation and maintenance**												
94	Labour	VND mn	0	256	319	348	356	365	374	384	393	403	403
95	Electricity	VND mn	0	499	608	645	645	645	645	645	645	645	645
96	Chemicals	VND mn	0	349	425	452	452	452	452	452	452	452	452
97	Other O&M	VND mn	0	449	547	581	581	581	581	581	581	581	581
98	Total O&M	VND mn	0	1,553	1,899	2,026	2,034	2,043	2,052	2,062	2,071	2,081	2,081
99	**Raw water tax**												
100	Project water produced	'000 m³	0	708	1,040	1,375	1,771	2,027	2,296	2,579	2,877	3,189	3,189
101	Raw water tax/m³	VND/m³	200	200	200	200	200	200	200	200	200	200	200
102	Project raw water tax	VND mn	0	142	208	275	354	405	459	516	575	638	638
103	**Total project costs**	VND mn	21,083	30,495	12,974	6,091	2,389	2,449	2,512	2,577	2,647	2,719	2,719

Annex B.4 **Economic Benefit-Cost Analysis**

		unit	PV @ 7%	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006 2026
104	Revenues project water sold	VND mn	77,387	0	1,519	2,434	3,442	4,678	5,364	6,108	6,912	7,782	8,722	8,722
105	Revenues connection fees	VND mn	3,633	0	661	697	734	872	411	429	448	468	489	0
106	Total project revenues	VND mn	81,020	0	2,179	3,130	4,176	5,550	5,775	6,537	7,360	8,251	9,211	8,722
107	Total project costs	VND mn	85,773	21,083	30,495	12,974	6,091	2,389	2,449	2,512	2,577	2,647	2,719	2,719
108	**Net cash flow**	VND mn	-4,753	-21,083	-28,315	-9,843	-1,915	3,161	3,326	4,025	4,783	5,604	6,492	6,004
109														
110	FIRR		6.26%											
111	FNPV @ 7%	VND mn	-4,753											
			-4,753	-21,083	-28,315	-9,843	-1,915	3,161	3,326	4,025	4,783	5,604	6,492	6,004

		unit	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006 2026
112	**Existing consumers**												
113	Nonincremental water	'000 m³	0	255	263	271	279	288	296	305	313	322	322
114	Economic supply price n.i. water	VND/m³	2,705	2,759	2,814	2,871	2,928	2,987	3,046	3,107	3,169	3,233	3,233
115	Value of nonincremental water	VND mn	0	702	740	778	818	860	903	947	993	1,040	1,040
116													
117	Incremental water	'000 m³	0	1	2	2	3	4	5	6	7	8	8
118	Demand price w/o project	VND/m³	3,700	3,774	3,849	3,926	4,005	4,085	4,167	4,250	4,335	4,422	4,422
119	Demand price with project (tariff)	VND/m³	2,800	2,856	2,913	2,971	3,031	3,091	3,153	3,216	3,281	3,346	3,346
120	Average demand price	'000 m³	3,250	3,315	3,381	3,449	3,518	3,588	3,660	3,733	3,808	3,884	3,884
121	Value of incremental water	VND mn	0	3	6	9	12	15	19	22	26	30	30
122	**New consumers**												
123	Nonincremental water	'000 m³	0	215	445	689	981	1,123	1,272	1,429	1,594	1,768	1,768
124	Economic supply price n.i. water	VND/m³	5,457	5,522	5,589	5,656	5,724	5,792	5,862	5,932	6,003	6,075	6,075
125	Value of nonincremental water	VND mn	0	1,190	2,486	3,897	5,616	6,504	7,456	8,477	9,571	10,743	10,743
126													
127	Incremental water	'000 m³	0	61	126	196	279	320	364	409	458	509	509
128	Demand price w/o project	VND/m³	6,730	6,811	6,892	6,975	7,059	7,144	7,229	7,316	7,404	7,493	7,493
129	Demand price with project (tariff)	VND/m³	2,800	2,856	2,913	2,971	3,031	3,091	3,153	3,216	3,281	3,346	3,346
130	Average demand price	VND/m³	4,765	4,833	4,903	4,973	5,045	5,118	5,191	5,266	5,342	5,419	5,419
131	Value of incremental water	VND mn	0	294	618	973	1,409	1,639	1,888	2,156	2,446	2,758	2,758
132	**Total value project water**												
133	Value nonincremental water	VND mn	0	1,892	3,226	4,675	6,435	7,364	8,359	9,424	10,564	11,783	11,783
134	Value incremental water	VND mn	0	297	624	982	1,421	1,654	1,906	2,178	2,472	2,788	2,788
135	**Total value project water (gross benefit)**	VND mn	0	2,189	3,850	5,657	7,855	9,018	10,265	11,602	13,036	14,571	14,571

		unit	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006 2026
136	**Investments**												
137	Source development	VND mn	7,382	7,382	3,691	0	0	0	0	0	0	0	0
138	Water treatment	VND mn	987	740	740	0	0	0	0	0	0	0	0
139	Ground storage	VND mn	70	175	105	0	0	0	0	0	0	0	0
140	Elevated storage	VND mn	316	789	474	0	0	0	0	0	0	0	0
141	Pump station	VND mn	272	340	68	0	0	0	0	0	0	0	0
142	Distribution system	VND mn	3,508	10,524	1,754	1,754	0	0	0	0	0	0	0
143	Sanitation and drainage	VND mn	931	931	621	621	0	0	0	0	0	0	0
144	Consulting services	VND mn	5,335	4,268	1,067	0	0	0	0	0	0	0	0
145	Investigations	VND mn	93	74	19	0	0	0	0	0	0	0	0
146	Institutional support	VND mn	1,140	1,710	1,710	1,140	0	0	0	0	0	0	0
147	Physical contingencies @ 8%	VND mn	1,603	2,155	820	281	0	0	0	0	0	0	0
148	Total investment	VND mn	21,636	29,089	11,068	3,796	0	0	0	0	0	0	0
149	**Operation and maintenance**												
150	Labour	VND mn	0	247	308	335	344	352	361	370	379	389	389
151	Electricity	VND mn	0	549	668	710	710	710	710	710	710	710	710
152	Chemicals	VND mn	0	384	468	497	497	497	497	497	497	497	497
153	Other O&M	VND mn	0	474	577	613	613	613	613	613	613	613	613
154	Total O&M	VND mn	0	1,653	2,021	2,155	2,164	2,172	2,181	2,190	2,199	2,209	2,209
155	**Opportunity cost of water**												
156	Project water produced	'000 m³	0	708	1,040	1,375	1,771	2,027	2,296	2,579	2,877	3,189	3,189
157	Opportunity cost of water	VND/m³	400	400	400	400	400	400	400	400	400	400	400
158	Opportunity cost of water	VND mn	0	283	416	550	709	811	918	1,032	1,151	1,276	1,276
159	**Project economic cost**	VND mn	21,636	31,026	13,505	6,502	2,872	2,983	3,100	3,222	3,350	3,485	3,485

Annex B.4 **Economic Benefit-Cost Analysis**

		unit	PV @ 12%	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006 2026
160	Project water sold	'000 m³	13,295	0	532	835	1,158	1,543	1,735	1,937	2,149	2,372	2,607	2,607
161	Project water produced	'000 m³	16,120	0	708	1,040	1,375	1,771	2,027	2,296	2,579	2,877	3,189	3,189
162	Non-technical losses	%		10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
163	Non-technical losses	'000 m³	1,612	0	71	104	138	177	203	230	258	288	319	319
164	Project water consumed	'000 m³	14,907	0	603	939	1,296	1,720	1,938	2,167	2,407	2,660	2,926	2,926
165	**Gross benefits**													
166	Value nonincremental water	VND mn	58,037	0	1,892	3,226	4,675	6,435	7,364	8,359	9,424	10,564	11,783	11,783
167	Value incremental water	VND mn	13,268	0	297	624	982	1,421	1,654	1,906	2,178	2,472	2,788	2,788
168	Value of non-technical losses	VND mn	8,643	0	292	479	672	902	1,054	1,217	1,392	1,581	1,783	1,783
169	Project economic benefits	VND mn	79,948	0	2,481	4,329	6,329	8,757	10,071	11,482	12,995	14,616	16,354	16,354
170	Project economic benefits	VND mn	79,948	0	2,481	4,329	6,329	8,757	10,071	11,482	12,995	14,616	16,354	16,354
171	Project economic cost	VND mn	74,455	21,636	31,026	13,505	6,502	2,872	2,983	3,100	3,222	3,350	3,485	3,485
172	Project net cash flow	VND mn	5,493	-21,636	-28,545	-9,176	-173	5,885	7,088	8,382	9,773	11,266	12,869	12,869
173														
174	EIRR		13.1%											
175	ENPV @ 12%	VND mn	5,493											

Annex B.4 **Economic Benefit-Cost Analysis**

Financial sustainability

		unit	PV @ 7%	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006 2026
176	Total project costs	VND mn	85,773	21,083	30,495	12,974	6,091	2,389	2,449	2,512	2,577	2,647	2,719	2,719
177	Total project revenues	VND mn	81,020	0	2,179	3,130	4,176	5,550	5,775	6,537	7,360	8,251	9,211	8,722
178	Project water sold	'000 m³	23,717	0	532	835	1,158	1,543	1,735	1,937	2,149	2,372	2,607	2,607
179	AIFC @ 7%	VND/m³	3,617											
180	Average tariff @ 7% (incl. connection fees)	VND/m³	3,416											
181	Financial subsidy	VND/m³	200											
182	Financial cost recovery %	VND/m³	94%											

Economic sustainability

		unit	PV @ 12%	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006 2026
183	Project economic cost	VND mn	74,455	21,636	31,026	13,505	6,502	2,872	2,983	3,100	3,222	3,350	3,485	3,485
184	Total project revenues	VND mn	45,802	0	2,179	3,130	4,176	5,550	5,775	6,537	7,360	8,251	9,211	8,722
185	Project water consumed	'000 m³	14,907	0	603	939	1,296	1,720	1,938	2,167	2,407	2,660	2,926	2,926
186	AIEC @ 12%	VND/m³	4,995											
187	Average tariff @ 12% (incl. connection fees)	VND/m³	3,073											
188	Economic subsidy	VND/m³	1,922											

APPENDIX C

CASE STUDY
FOR RURAL WATER SUPPLY PROJECT

CONTENTS

Tables

ANNEX

C.1 INTRODUCTION

1. To obtain an insight into the applicability of the economic evaluation of water supply projects (WSPs) in a true rural setting, one small village named Loa Lepu in a remote area in Kalimantan, Indonesia was selected for purposes of this case study. For this village, the following steps in the economic analysis were carried out:

(i) Determination of Scope and Objectives
(ii) Assessment of Demand
(iii) Least-Cost Analysis
(iv) Economic Benefit-Cost Analysis
(v) Financial Benefit-Cost Analysis
(vi) Sustainability Analysis
(vii) Distributional Analysis
(viii) Analysis of Untangible Effects
(ix) Analysis of Uncertainty

2. In this case study, each of the different steps in economic evaluation is dealt with in a separate section. The last paragraph summarizes the conclusions and recommendations.

3. The activities planned for Loa Lepu are part of the Rural Water Supply and Sanitation Sector Project in Indonesia, which supports the governments' policy to promote water supply and sanitation services in less developed villages and rural growth centers and focuses on the low-income population. The project aims at:

(i) providing safe, adequate and reliable water supply and sanitation services to selected low-income rural communities through community-based arrangements; and,

(ii) to support hygiene and sanitation education, water quality surveillance and community management activities in the project area. The project area covers 12 provinces and consists of 3,000 rural communities.

C.2 The Village LOA LEPU

4. In order to obtain a first impression of the area to be studied, a reconnaissance visit was carried out in February 1996. Subsequently, a household survey was carried out in the village in March 1996. The results of both surveys form the basis for the economic analysis.

5. During the reconnaissance survey, basic data on the village was collected. These concerned population, rainfall, water resources, present water supply and sanitation facilities and the socio-economic situation. Based on these data, preliminary design options were formulated

and the questionnaire to be used in the household survey was adapted to fit the local situation. An overview of basic data for Loa Lepu is provided in Table C.1.

6. The selected village, Loa Lepu, is located in the Kabupaten Kutai in the province East Kalimantan. Suitable water sources in the area are limited. Ground water is available at a depth of about four meters, but the quality is often bad and dugwells run dry in the dry season. River water is becoming increasingly polluted. Rainfall is abundant in the rainy season but less regular in the dry season, which lasts from June to November. Periods without rain, however, are seldom very long.

Table C.1 **Basic Data for Loa Lepu**

Indicator	**Unit**	**Loa Lepu**
Population	Number	594
Average HH Size in sample	Number	5.1
Existing Water Supply		
Unprotected Wells	%	20
Untreated River Water	%	80
Existing Sanitation		latrines
Profession		
Farmers	%	80
Entrepreneur	%	4
Fixed employment	%	12
Informal sector	%	4
Average Quantity of water carried home per HH		
rainy season	l/day	137
dry season	l/day	149
Average distance from source		
rainy season	meter	58
dry season	meter	62
Preferred alternative source		
Rainwater collector	%	4
Hand pump	%	52
Public Tap	%	40
No reply	%	4
Average Income	Rp/month	221,280
Average Rainfall	mm/year	1962

7. The total population in the village is 594, with an average household size of 5.1 persons. A large part of the population is occupied in agricultural activities from which they derive an average income of Rp221,280 per month.

8. The local public health unit (Puskesmas) in the area reported that a total of 3,718 persons or 4 percent of a total service population of 91,197 visited the unit with complaints about water-related diseases in 1994.

9. Approximately 70 percent of the population of Loa Lepu is concentrated near the Makaram river while the remaining 30 percent is living scattered at distances up to 10 km from the river. Potential water sources for water supply are: shallow ground water, the Makaram river and rainwater. The population is making use of unprotected water sources such as open dug wells and the river. The water in the dug wells is two to four meters below ground level but the quality is poor. In the dry season, the dug wells run dry. The average distance from the water source is approximately 60 meters. The average annual rainfall in the area is 1,962 mm.

10. People were asked how many buckets of water they carried on average to their homes per day. From this, an average water use of 143 liters per HH, or 28 liters per capita per day (lcd), could be derived. People also use water from wells and the river, which they do not carry home. This water is used for washing, bathing and sanitation purposes. For defecation purposes, simple latrines, mostly without septic tanks, are used. Domestic wastewater flows through small drainage canals into the fields or rivers. There is a clear interest in alternative water supply and sanitation facilities. There also exists a remarkable interest and willingness to pay for the upgrading of sanitary facilities.

C.3 PROJECT FRAMEWORK

11. A detailed description of the project framework is provided in Annex C.1 of this chapter. A short explanation follows.

C.3.1 Government Policies

12. The provision of water supply and sanitation has been a central issue in government policy over the past 30 years, with priority on low-income communities and underdeveloped areas with poor water resources and a high incidence of waterborne diseases. The government has provided safe water supply to 14,000 villages during the fifth Five-Year Plan and aims to provide access to clean water to another 20,600 villages or 16.5 million people during the sixth Five-Year Plan (Repelita VI).

13. Based on experience from earlier RWSS programs, government activities in this field are now guided by the following policies:

(i) increased community participation in planning, implementation, operation and rehabilitation of RWSS facilities;

(ii) special attention on drinking water quality surveillance and sanitation;

(iii) target communities in water scarce areas, coastal or transmigration areas or communities facing endemic diarrhoea and other waterborne diseases;

(iv) flexible planning and channelling of funds;

(v) decentralized project implementation and local accountability for delivery;

(vi) an important role for women in program design and implementation;

(vii) recovery of O&M costs and in addition, contribution in kind (labor) to capital costs.

C.3.2 Sector Objective

14. The Rural Water Supply and Sanitation Project as a whole, of which the activities in Loa Lepu form a part, has set the following objectives:

(i) providing safe, adequate and reliable water supply and sanitation services to selected low-income rural communities through community-based arrangements; and,

ii) supporting hygiene and sanitation education, water quality surveillance and community management activities in the project area.

C.3.3 Case Study Objective

15. Based on the results of both the reconnaissance and the household surveys, it was decided to formulate these objectives for improved water supply and sanitation facilities in Loa Lepu:

(i) to provide safe and low-cost water supply alternatives to the population, which presently has no access to protected water sources;

(ii) to provide latrines to that part of the population which is not satisfied with existing facilities and which expresses a willingness to pay for those facilities.

C.3.4 Project Components

16. In order to achieve the project objectives mentioned above, the project includes three components:

(i) the construction of simple low-cost piped and non-piped water supply systems and/or the rehabilitation of existing water supply systems;

(ii) provision of sanitation sub-projects in the project area through the construction of sanitary public and private latrines;

(iii) the provision of a) implementation support to the local offices of the Ministry of Public Works; b) a hygiene and sanitation education and water quality surveillance program to be implemented by the Ministry of Health; and c) community management and WSS institutional development programs to be implemented by the Ministry of Home Affairs.

C.3.5 Project Resources

17. The resources to be allocated to the project will be utilized for land acquisition, civil works, equipment and materials, incremental Operation and Maintenance (O&M) costs and for consultancy services for feasibility studies, detailed design, supervision and for institutional support.

C.4 DEMAND FORECAST

C.4.1 Current Water Consumption

18. Current water consumption must be separated into two parts:

(i) water carried to and consumed in the house;

(ii) water used at the sites of the river and wells respectively.

19. The first component, water carried and used in the house, has been estimated at 143 liters per HH per day, or an average use of 28 lcd. In addition, it has been estimated that households use an additional 50 percent of that volume of water (14 lcd) outside the house for washing in the river or near the well, bathing in the river, etc. The total current water consumption is, therefore, estimated at 42 lcd.

20. Current annual water consumption in Loa Lepu is, therefore, estimated as follows:

In-house consumption: (594 x 28 x 365)/1,000 = 6,071 m^3/year.

Outside the house: (594 x 14 x 365)/1,000 = 3,036 m^3/year

C.4.2 Future Water Demand

21. During the household survey, people were offered three technical alternatives for water supply to chose from, being:

Alternative 1: Communal hand pumps (one hand pump for ten families);

Alternative 2: A small piped system in the center of town with public taps (ten families per PT) and the remaining part of the village with communal hand pumps;

Alternative 3: Rainwater collectors (one rainwater collector per four families)

In the remaining text of this case study, alternative 1 will be indicated as HP, alternative 2 as HP/PT and alternative 3 as RWC.

22. The data collected during the reconnaissance survey and the household survey provide the expressed preference of the communities for the different types of water supply facilities offered to them. This preference is based on the consumers' perception of water, quality, reliability and convenience, which they relate to the different types of supply. The outcome of the survey is presented in columns 2 and 3 of Table C.2. It is assumed that water from the above facilities will be used for 'in house water consumption'.

23. Based on national standards and in line with figures observed in similar situations, the average consumption per person per day for the use of hand pumps and public taps is estimated at 50 lcd whereas the average use for rainwater collectors is estimated at 33 lcd (this figure is based on an average use of 50 lcd in the rainy season but only 16 lcd in the dry season).

24. If the different types of water supply facilities would be installed in accordance with the expressed preference of the community, and if the average water consumption per type of facility (based on national standards) is multiplied with the number of users, the quantity of water demanded by the community can be calculated at 10,715 m^3/year.

Table C.2 **Demand for Water Supply and Sanitation Facilities**

Type of facility	Number of HH interested	in %	Avg. Water Consumption (lcd)[1]	Calculated demand (m^3/year)
Rainwater Collector	5	4	33	286
Communal Hand pumps	61	52	50	5,637
Public Tap	47	40	50	4,336
No Reply	5	4	49[2]	456
Sanitation	107	92	-	-
Total Demand				10,715

[1] Based on national standards and field observations.
[2]A weighed average of the other users.

25. It is likely that some households will also continue to use water from other sources than the above. In particular, households which choose rainwater collectors would have to rely on secondary sources in the dry season.

C.4.3 Incremental vs. Nonincremental Water Demand

26. A distinction is made between nonincremental water and incremental water provided by the project. Nonincremental water will be water provided by the project which displaces water already used from existing sources and would be used in the without-project situation. Incremental water is water provided by the project, which will add to the existing and future water consumption without the project. For purposes of analysis, the future without-project scenario is assumed to remain at existing levels.

27. The volume of incremental water will depend on the technical option which will be selected. Table C.3 below shows the average incremental and nonincremental water demand, which is supplied for by the project.

Table C.3 **Average Nonincremental Demand for Water**

	Total Water Demand Without the Project			Total Water Demand With the Project			Water Supplied by the Project		
Alternative	In house	Outside house	Total	In house	Outside house	Total	Non Incremental	Incremental	Total
HP	28	14	42	50	5	55	42	8	50
HP/PT	28	14	42	50	5	55	42	8	50
RWC	28	14	42	33	12	45	33	0	33

28. Total water demand without the project is estimated at an average 42 lcd. Depending on the alternative chosen, in-house water consumption will increase to 33 lcd (RWC) or 50 lcd (HP and PT).

29. In the case of alternatives 1 and 2, the 50 lcd of water supplied by the project will fully replace the old sources (42 lcd = non incremental) and add an additional 8 lcd (which refers to incremental water). In addition, households are assumed to still use some water (5 lcd) outside the house. In the case of alternative 3 (RWC), the average of 33 lcd supplied by the project will be fully used to replace old sources and therefore the total volume of water supplied by the project is non-incremental (even though total demand of these customers increases).

C.5 LEAST-COST ANALYSIS

C.5.1 Technical Options at Project Level

30. The purpose of the Least-Cost Analysis is to identify the least-cost alternative option for water supply and sanitation, which will adequately achieve the project objective. For the project, standard low-cost water supply and sanitation options were developed by the Department of Public Works, including communal hand pumps (HP), rainwater collectors (RWC), small piped systems with public taps (PT), public and school latrines and private latrines, as follows:

(i) Water Supply Options

(a) Rainwater Collector:

Volume	-	10 m³
Number of users	-	20 persons/RWC
Unit Price	-	Rp1,725,000
Annual O&M costs	-	approximately 0.5% of investment
Avg. consumption	-	33 lcd

(b) Hand pump small bore wells:

Number of users	-	50 persons/HP
Unit Price	-	Rp2,025,000
Annual O&M Costs	-	approximately 2.5% of investment
Avg. consumption	-	50 lcd

(c) Hand pump small bore wells with upflow filter units:

Number of users	-	50 persons/HP
Unit Price	-	Rp2,625,000
Annual O&M Costs	-	approximately 4% of investment
Avg. consumption	-	50 lcd

(d) Piped system + PT:

Number of users per PT	-	50 persons
Investment Cost	-	Rp40,000,000
Annual O&M Costs	-	approximately 7% of investment
Avg. consumption	-	50 lcd

(ii) Sanitation Options

(a) Private latrine:

Number of users	-	10 persons
Unit Price	-	Rp91,700
Annual O&M costs	-	approximately 2.5% of investment

(b) Public latrine:

Number of users	-	600 persons
Unit Price	-	Rp2,500,000
Annual O&M costs	-	approximately 2.5% of investment

31. The project approached the sanitation component by providing one public latrine to the village, to be located at a central location (school, market, etc). Furthermore, private latrines would be installed in accordance with demand from the population. The project support should be seen as promotion of improved hygiene behavior of the community.

C.5.2 Technical Options for LOA LEPU

32. During the reconnaissance survey, the technical options for the village were determined. During the household survey, the interest of the population in each of the options was measured. Based on this, the following technical alternatives were formulated for Loa Lepu:

Alternative 1: 100 percent coverage through hand pump wells provided with small upflow filtration units per well. Ground water is sufficiently available in the area, but the water quality is, in some cases, effected by high contents of iron. Therefore, these wells will be equipped with simple filtration units.

Alternative 2: 70 percent covered by a small piped scheme with pumped/treated water from the Makaram river. The remaining 30 percent of the population will be covered with hand pump wells since this part of the population is living at a great distance from the river.

Alternative 3: 100 percent coverage through rainwater collectors by using 10 m³ ferro-cement reservoirs serving approximately 20 persons per collector.

Sanitation: Based on the Household Survey, it is assumed that the 92 percent of households who expressed interest will obtain a new latrine. Furthermore, one school latrine will be installed.

33. Table C.4 summarizes the size of the investment for each of the alternatives. For example, 20 people make use of one rainwater collector, which means that in order to cover the total population with RWC's, a total of 30 RWC's would have to be installed.

Table C.4 **Determination of Size of Investment for Different Alternatives**

Item	Unit	Alternative1 HP	Alternative2 PT/HP	Alternative3 RWC
COVERAGE				
Hand pump Wells	% of pop	100	33	0
Rainwater Collectors	% of pop	0	0	100
Piped Water Public Taps	% of pop	0	67	0
Total Coverage	% of pop	100	100	100
NO. OF FACILITIES				
New. RWC's needed[1]	Number	0	0	30
New HP Wells needed[2]	Number	12	4	0
PT's needed	Number	0	8	0
Number of private latrines	Number	107	107	107
Number of School Latrines	Number	1	1	1

[1] Average number of users per RWC is 4 families or 20 persons

[2] Average number of users per PT/HP is 10 families or 50 persons

C.5.3 Capital and O&M Costs

34. The capital costs of the different alternatives, as well as the number of users per unit, are based on the standard designs as developed by the MPW. With proper maintenance, it is expected that these facilities will have a lifetime of 20 years. The O&M costs of the facilities differ per type of facility. Because the project will provide water supply and sanitation facilities to 3,000 small villages scattered over different provinces in Indonesia, it has been assumed that project funds will not be used for future investments, which will be necessary as a result of population growth. Therefore, only the initial investment and the related O&M costs have been taken into account.

35. Based on the cost estimates of the project loan, it has been assumed that overhead costs for project management, community development and water quality monitoring activities amount to 10 percent of the physical investment costs. The financial cost estimates for investment costs and O&M costs for the different alternatives are presented in Table C.5.

Table C.5 **Investment Costs and annual O&M Costs, including 10% sales tax**
(in Rp'000)

	HP	HP/PT	RWC	Sanitation
Investment Cost				
Equipment	23,148	36,155	36,750	7,387
Labor	8,352	14,345	15,000	4,925
Sub Total	31,500	50,500	51,750	12,312
Overhead Cost (10%)	3,150	5,050	5,175	1,231
Grand Total	*34,650*	*55,550*	*56,925*	*13,543*
Annual O&M Cost				
Equipment	1,095	2,161	184	160
Labor	209	209	75	148
Total	*1,304*	*2,370*	*259*	*308*

C.5.4 Economic vs. Financial Prices

36. Least-Cost Analysis is carried out in economic prices and, in this case, using domestic price numeraire. First, the 10 percent sales tax included in the investment and O&M costs is deducted from the financial costs. The cost estimates are then apportioned into traded and nontraded components and (unskilled) labor. Finally, financial prices are multiplied with the respective conversion factors to arrive at economic prices.

37. The shadow exchange rate factor for foreign exchange has been estimated at 1.06. The figure was obtained from an ADB regional study on Shadow Pricing in 1993. The conversion factor for unskilled labor has been estimated at 0.65, reflecting the fact that the real market price of labor is lower than the official wage rates which are used in the financial cost estimates.

38. An example of the calculation of the economic prices for alternative 1 (communal hand pumps) is given in Table C.5 below, whereas the calculation for the other options is attached as Annex C.2 to this Appendix.

Table C.6 **Calculation of Economic Price of the Communal Hand pumps Option**
(Rp'000)

	Financial Costs including taxes	Financial costs excluding sales tax	Conversion Factor	Economic Value
Investment Cost				
Traded (60%)	13,889	12,500	1.06	13,250
Non Traded (40%)	9,259	8,333	1.00	8,333
Labor	8,352	7,517	0.65	4,886
Overhead Cost (10%)	3,150	3,150	1.00	3,150
Grand Total	*34,650*	*31,500*		*29,619*
Annual O&M Cost				
Traded (60%)	657	591	1.06	627
Non Traded (40%)	438	394	1.00	394
Labor	209	188	0.65	122
Total	*1,304*	*1,174*		*1,143*

39. In the area, no shortage of water is expected in the foreseeable future; therefore, the opportunity costs of water are considered to be zero. The environmental impact of the project is considered negligible; therefore, the environmental costs have not been valued. The costs of draining the additional volume of water supplied are assumed to be covered by the costs for additional sanitation facilities.

C.5.5 Costs for the Household

40. Besides the investment and direct O&M costs, the future users of the facilities will also make costs. These costs differ per selected alternative and will have to be taken into account in the Least-Cost Analysis. The costs per household are presented in Table C.7.

Table C.7 **Average Costs per Household for Different Options**

Option	Quantity of Water Used l/day per HH	Average distance to source meters	Avg. Time needed for Collection hrs/month	Collection Costs per HH rp/month	Other Costs per HH rp/month	Average Costs per HH rp/ month	Total Costs per HH rp/year
No. Column	1	2	3	4	5	6	7
RWC	168	15	3	436	50	486	5,832
HP	255	30	6	871	50	921	11,052
PT	255	30	6	871	50	921	11,052

Explanation:

Column 1: The average household size is 5.1, which is multiplied by the average consumption per capita per day for each of the alternatives (e.g. for RWC: 5.1 x 33 = 168.3 liters per day);

Column 2: With regard to distance, it has been assumed that the average distance for RWC is less than for PT and HP because only four houses make use of one RWC and ten households use one PT or HP.

Column 3: At present, the average time needed for water collection is 12 hours per HH per month. It has been estimated that households with RWC's will save 75 percent collection time as compared to the situation before the project; and households with HP/PT will save 50 percent collection time.

Column 4: The costs of time used for collecting water has been estimated at 65 percent of the minimum wage rate of Rp343.75 per hour. This is subsequently multiplied with the shadow wage rate of 0.65, resulting in a cost of Rp145 per hour, which is multiplied by the number of hours needed per month.

Column 5: The column of other costs include the costs for storage which has been assumed at 50 percent of the current storage costs of Rp50 per month. These costs are considered to be nontraded costs and therefore, no conversion factor has been applied. No costs for chemicals will be needed after the introduction of the new facilities. Boiling of water for drinking and cooking will still be needed; but as no data were available, these costs have not been included in the calculations.

Columns 6 & 7: The costs per HH per month and per year are calculated by adding columns 4 and 5 and multiplying by 12.

C.5.6 LEAST-COST ANALYSIS for LOA LEPU

41. For each of the alternatives, the investment costs and the annual O&M costs have been calculated, as well as the annual costs made by the households (see Annex C.3 to this Appendix). The figures are now used to calculate the present values of the costs for each of the alternatives. Subsequently, the present values of the costs are related to the volume of water supplied for each of the options in order to calculate the AIEC. The calculations are presented in Table C.8. The economic costs have been discounted at the EOCC of 12 percent. The calculations lead to the following results:

Table C.8 **Calculation of Present Values and AIEC for Alternative Technical Options**

Number	Investments	Unit	Alt.1 HP	Alt. 2 HP/PT	Alt.3 RWC
1	Investment Cost Water Supply Yr 1	Rp'000	29,619	47,153	48,216
2	Investment Costs for Sanitation Yr 1	Rp'000	10,920	10,920	10,920
3	PV Investment Costs Water Supply and Sanitation	Rp'000	36,196	51,851	52,800
4	PV of O&M and HH Costs for WS&S Year 1-20	Rp'000	17,571	23,948	7,446
5	Total Present Value	Rp'000	53,767	75,799	60,246
6	PV of Water Supplied Year 1-20	'000 m^3	71,290	71,290	47,054
7	AIEC of Water Supply	Rp/m^3	754	1,063	1,280

Lines 1 & 2: present the estimated costs of investment of water supply and sanitation works in year 1.

Line 3: gives the Present Value of the total investment costs in year 0 using a discount rate of 12 percent.

Line 4: gives the Present Value of the annual O&M costs plus the annual costs made by households over the project life using a discount rate of 12 percent.

Line 5: gives the Total Present Value for each of the alternatives.

Line 6: gives the discounted value of the annual volumes of water supplied by each of the project alternatives over the project life.

Line 7: divides the present value of total costs by the present value of the volume of water supplied to calculate an AIEC for each of the options.

42. Based on the Least-Cost Analysis, it is concluded that the quantity of water demanded is most efficiently supplied by means of communal hand pumps with an AIEC of water of Rp774 per m^3. Therefore, this alternative is selected as the preferred option.

43. It could be argued that the three alternatives provide different benefits to the consumers. However, besides the costs of investment and O&M, also the costs to the household in terms of time needed for water collection has been taken into account; and these costs have been related to the quantity of water provided. Therefore, it is considered that the choice between the alternatives in this case can be made based on the Least-Cost Analysis.

C.6 ECONOMIC BENEFIT-COST ANALYSIS

C.6.1 Introduction

44. The economic benefit-cost analysis will show whether economic benefits exceed economic costs and whether the project is economically viable.

C.6.2 Methodology to Estimate Economic Benefits

45. The economic benefits of the project consist of two components:

(i) Cost savings on nonincremental supply

(ii) The Willingness-to-Pay based on average demand price for incremental water supplies

46. Table C.9 shows how incremental demand is calculated. The existing supply without the project can be divided into two components being in-house consumption and consumption outside the house. In-house consumption is estimated at 28 lcd which would amount to 6,071 m^3 per year; whereas water used outside the house (14 lcd) is estimated at 3,035 m^3/year. As the future without-project supply is maintained at the existing supply level, the incremental demand is equal to the difference in the water supplied by the project and existing supplies evaluated annually.

C.6.3 Cost Savings Method for Estimating Nonincremental Water Benefits

Table C.9 **Water supply for Different Technical Options**

Technical Option	Supplied by the Project (lcd)	Total Supply with-project (m^3/year)	Existing Supply without-project (m^3/year)	Incremental Demand (m^3/year)
100% HP	50	10,840	9,106	1,734

47. When the new supply facilities will be introduced, it is predicted that households will shift from the old sources of water to the new sources of water. The old sources of water will be displaced with the new water source and the costs related to the 'old' sources will therefore be saved.

48. Nonincremental water consists of water carried to the house for in-house consumption and water used outside the house. The estimated cost components related to these different uses are explained below:

(i) Water for in-house consumption:

(a) **Time needed to collect water.** Time has been valued at Rp145/hour — which is 65% of the official minimum wage rate of Rp2750 per day divided by 8 hours per day and subsequently multiplied by the shadow wage rate factor (SWRF) of 0.65. Based on past economic growth figures, it has been assumed that the minimum wage rate will show a real increase of 3 percent per annum;

(b) **Chemicals to clean the water will no longer be needed.** Villagers used calcium hypochlorite to disinfect water used from unprotected sources. One family uses about 100 grams per month, which cost Rp250. These costs will be saved when new water supply facilities are introduced. Chemicals and filters in this case are considered nontraded goods. Boiling will still be needed, but these costs have not been included in the calculations.

(c) **Costs of storage.** All households store water in drums with an average value of Rp13,200. The related construction works are considered nontraded. Assuming a 10-year lifetime for these drums, the average costs amount to Rp100 per month.

The costs related to the in-house water consumption differ between the dry season and the rainy season. The results of the HH survey are presented in Table C.10. From the table it can be seen that the weighted average costs per household for the existing in house water supply is Rp1,738 per HH per month. With an average consumption of 143 liters per HH per day, this amounts to a weighted average of Rp472 per m^3(see Table C.2.2, Annex C below). The total costs per year for the in-house water supply in Loa Lepu will then be 6,071 m^3 x Rp472 = Rp2,865,512 (rounded off to Rp2,866,000) per year. These costs will be saved by switching to an alternative source of water.

Table C.10 **Economic Costs of Nonincremental Water** (results from HH survey)

Source	No of HH	Average Quantity liters per HH	Average distance to source (meters)	Average Collect. Time hours per month	Collect. Costs in Rp per month per HH	Other Costs in Rp per month	Average Costs per HH/ Month	Month/ Year	Total Cost per HH per season in Rp
Rainy Season									
Dugwell	3	138	89	16.59	2,410	350	2,760	6	16,560
River/ Waterpond	19	147	58	11.52	1,673	350	2,023	6	12,138
Neighbors	3	69	23	2.14	311	350	661	6	3,968
Average Rainy Season		137	58	11	1,598	350	1,948	6	11,689
Dry Season									
Dugwell	1	92	92	11.44	1,661	350	2,011	6	12,065
River/ Waterpond	21	163	66	14.54	2,111	350	2,461	6	14,766
Neighbors	3	69	23	2.14	311	350	661	6	3,968
Average dry season		149	62	13	1,877	350	2,227	6	13,362
Average/ Total		143	60	12	1,738	350	2,088	12	25,056

Source: Table C.2.2 in Annex C

(ii) Water used outside the house:

Water outside the house is used for washing, bathing and sanitation purposes. Users will have to walk to the source and maybe carry clothes to the river/well. The water used outside the house is not treated or cleaned in any way. The value of nonincremental water used outside the house is estimated at half the value of the water used in the house. The total costs per year for the water used outside the house is 3,035 m^3 x Rp236 = Rp716,260 per year.

C.6.4 Valuation of Incremental Demand for Water

49. Incremental water is valued at the average demand price, which is approximated by the average between the current and future costs of water supply in financial prices. The future supply costs of water with the project to the consumers are as follows:

(i) In accordance with government policies, users will have to pay for the costs of O&M. Construction works will be carried out by local contractors and therefore, users will not contribute to the costs of investment. The financial costs of O&M of water supply are estimated at Rp1,304,000 per year.

(ii) Furthermore, households themselves still make costs which are calculated in financial prices. These costs are calculated in the same manner as was demonstrated in Table C.10 above; but in this case, the costs of time of collecting the water is calculated at its financial value of 0.65 x 2750/8 = Rp223/hour. This adds up to Rp1,294,000 per year.

50. The future supply costs to the household per m^3 of water supplied with the project are (Rp1,304,000 + Rp1,294,000)/ 10840 = Rp239/m^3.

51. The supply costs of water without the project in economic prices have been calculated in Table C.10, applying the SWRF of 0.65 to the value of time needed for water collection. The resulting weighed average supply costs of water without the project are then calculated as Rp679 per m^3.

52. The average demand price is approximated by the average between future and current costs of water supply to the consumer which is (Rp697 + Rp239.7)/2 = Rp468/m^3. The value of incremental water is thus estimated at 1734 m^3 x Rp468/m^3 = Rp811,512.

C.6.5 Valuation of Sanitation Benefits

53. For sanitation, no data are available with regard to current resource cost savings in the without-project situation. Using the contingency valuation methodology, an average WTP was expressed by the users of Rp1,641 per month. This WTP is taken as an approximation of the benefits which can be attributed from the sanitation component provided by the project. The total annual value of benefits derived from the sanitation component is thus calculated is follows:

No. of HH x monthly WTP x 12 = 107 x 1641 x 12 = Rp2,107,044 per year.

C.6.6 Economic Gross Benefits

54. Gross benefits are defined as the cost savings on nonincremental water and the average demand price for incremental water as calculated in the previous sections. As investments for sanitation are also included in the project, the WTP for sanitation facilities is also added to this, which results in the following:

Table C.11 **Annual Gross Project Benefits** (in Rp'1000 per year)

Component	Gross Annual Benefits
Nonincremental Water used in the house	2,866
Nonincremental Water used outside the house	716
Incremental Water	812
Sanitation	2,107
Total Gross Benefits per annum	6,501

C.6.7 Economic Benefit-Cost Analysis

55. Based on the estimates of costs and benefits, the EIRR can now be calculated as is shown in Table C.12. Detailed calculations are presented in Annex C.4.

Table C.12 **Economic Benefit Cost Analysis**

Present Value of Investment Cost Rp'000	Present Value of O&M Costs Year 1-20 Rp'000	Present Value of Benefits Year 1-20 Rp'000	Net Present Value Rp'000	EIRR
36,196	17,571	53,767	-568	12 %

56. Based on the EIRR rates as shown above, the project would be viable with an EIRR of 12 percent and a NPV of Rp-568,000.

C.6.8 Sensitivity Analysis

57. The sensitivity analysis appraises the impact of changes in key parameters on the EIRR as calculated in the previous section. The following changes have been investigated:

(i) An increase in the investment cost;

(ii) A reduction in the economic benefits;

(iii) A reduction in the lifetime of the investments.

58. For variations in each of the above parameters, the sensitivity indicators and the switching values have been determined. The **sensitivity indicator** is the ratio of percentage change in the ENPV divided by the percentage change in the parameter. A **switching value** indicates the percentage change in a certain parameter required to reduce the EIRR equal to the opportunity cost of capital, or the ENPV equal to zero. The calculations show the following results:

Table C.13 **Switching Values (SV) and Sensitivity Indicators (SI)**

Parameter	% change	NPV before change (Rp'000)	NPV after change (Rp'000)	SV	SI
Increase in Investment Cost	+ 10%	-568	-5,947	1.05%	95
Reduction in Benefits	- 10%	- 568	-5,890	1.06%	94
Reduction in assets lifetime	- 10%	- 568	-2,868	2.46 %	41

E.g. the Switching Value in the first row is calculated as follows:

$SV = 100 \times (NPV_b / NPV_b – NPV_1) \times (X_b – X / X_b) = 100 \times [-568 / (-568 + 5,947)] \times (.10) = 1.06\%$

and the Sensitivity Indicator as follows:

$SI = [(NPV_b - NPV_1) / NPV_b] / [(X_b - X_1) / X_b] = [(-568 + 5,947) / -568] / 0.10 = 95$

59. From Table C.13, it can be seen that an increase in the investment costs of 1.05 percent will result in an ENPV of zero. The same result will be reached if benefits differ 1.06 percent from the estimated values, or if the lifetime of assets will vary with 2.46 percent. The percentages are very low, which is not surprising, because the value of the calculated EIRR is 12 percent, which is equivalent to the cut-off rate.

60. The Sensitivity Indicator shows that the project results are most sensitive to both changes in the estimated benefits and costs. The factor is larger than one, indicating that the relative change in ENPV is larger than the relative change in the parameter, which means that these parameters are important for the project result.

C.7 FINANCIAL BENEFIT-COST ANALYSIS

C.7.1 Financial Costs

61. The cost estimates for the project, as presented in Table C.14, are expressed in financial prices, including taxes.

Table C.14 **Calculation of Present Values in Financial Prices and AIFC**

No.	INVESTMENTS	Unit	PV in Rp'000
1	Investment Cost Water Supply and Sanitation Yr 1	Rp'000	48,330
2	PV Investment Costs Water Supply and Sanitation	Rp'000	43,152
3	PV of O&M Costs for WS&S Year 1-20	Rp'000	10,601
4	Total Present Value	Rp'000	53,753
5	PV of Water Supplied Year 1-20	'000 m^3	71,290
6	AIFC of Water Supply	Rp/m^3	754

The AIFC for the project is estimated at Rp754/m^3 (which happens to be equal to AIEC).

C.7.2 Financial Benefits

62. In the project under consideration, there are no fixed financial revenues. The recovery of O&M costs is the responsibility of the households and, where applicable, local village organizations. For this reason, no attempt was made to carry out a financial benefit-cost analysis.

C.8. SUSTAINABILITY ANALYSIS

C.8.1 Introduction

63. Economic analysis encompasses testing for project sustainability. For a project to be sustainable, it must be both financially and economically viable and have sufficient annual cash flow to meet O&M and financing costs at a minimum. Unless the project is financially viable, economic benefits will not materialize. If the project's EIRR is above the cut-off rate, the project is economically viable to society. However, if its FIRR is below the cut-off rate, the project does not provide sufficient incentives for the project sponsors to invest and will only be sustainable if subsidized by the government.

64. In urban piped water supply projects, calculations for financial and economic sustainability make use of the average incremental cost formula, which equals the present value of the stream of future capital and O&M costs (at either financial or economic costs), divided by the present value of future quantities of water. The value of the AIC is subsequently compared with the average tariff.

65. The AIC calculations mentioned above can also be used in the case of rural water supply and sanitation projects, but because the future quantity of water is unknown (or

uncertain) and because there is no formal tariff structure to compare with, the figures will only be indicative.

C.8.2 Comparison between AIC and Average Tariff

66. The AIFC as well as the AIEC have been both calculated at Rp754 per m^3. The average tariff or revenues could be calculated as the estimated O&M costs per m^3 which is covered by the users themselves. The annual O&M costs for WS&S have been estimated at Rp1,612,000 per year. The average 'tariff' in this case would be Rp1,612,000/10,840 m^3 = Rp149 per m^3. The financial subsidy amounts to Rp754 - Rp149 = Rp605 per m^3 or (10,840 m^3 x Rp605) = Rp6.6 million per year.

C.8.3 Sustainability Analysis

67. The policy of the Government of Indonesia for water supply and sanitation in rural areas is that the O&M costs for the project will be covered by the community and that the investment costs will be financed by the Government. Where possible, the community may also contribute to the investment cost of the project by providing labor.

68. The large amounts needed for financial subsidies are due to the fact that the consumers do not contribute to the investment related costs of the project. As the investment costs will be financed up front by the Government, the sustainability of the project will depend on whether or not the users will cover the expenditures for Operation and Maintenance.

69. The O&M costs for the type of facilities installed in the villages under consideration (hand pumps), will partly consist of (own) labor, and partly of buying replacements for parts of the equipment. The responsibility for this is put upon the village authorities or the user groups.

70. For water supply, a system to collect monthly fees apparently does not exist. For sanitation, there is the possibility to create a revolving fund from which the population can obtain a credit and pay back on a monthly basis.

71. For the above reasons, it can be assumed that O&M will take place on an ad hoc basis, where labor will be provided in kind by the communities and where money will be collected from the users to pay for replacement of items of equipment at the time when this is needed.

72. As the average expressed willingness to pay for water and sanitation exceeds by far the required O&M costs, it can be concluded that the schemes in principle are sustainable. It is strongly recommended that the village authorities or user groups establish some kind of collection system on a regular basis to ensure that sufficient funds are available when breakdowns occur. It is also recommended that simple organizational arrangements be made at village level to take care of regular O&M facilities.

C.9 DISTRIBUTIONAL ANALYSIS

C.9.1 Introduction

73. The poverty reducing impact of a project is traced by evaluating the expected distribution of net economic benefits to different groups. As the financial prices determine which participating group controls the net economic benefits, the first step would be to estimate the present value of net financial benefits per participating group. Next, the difference between net benefits by group at economic and financial prices is added to net financial benefits by group, to give the distribution of net economic benefits per group. Finally, the net economic benefits are allocated in proportion to each group. A Poverty Impact Ratio (PIR) expressing the proportion of net economic benefits accruing to the poor can be calculated by comparing which part of net economic benefits accrues to the poor as compared to the economic benefits of the project as a whole.

74. In this case, no attempt has been made to calculate the net financial benefits and therefore, the above procedure will not be fully applied. However, a qualitative assessment will be attempted below.

C.9.2 Participating Groups

75. For the purpose of poverty impact analysis, project beneficiaries are divided into three groups: the poor, the non-poor and the government. Net economic benefits by group are distributed between these three groups in accordance with the extent that they benefit from the project. In the case that net economic benefits are allocated to the government, it is assumed that 50 percent of these amounts will benefit the poor. For Loa Lepu, it is has been assumed that 80 percent of the population consists of poor households with an income of less than Rp300,000 ($128) per month. With regard to the group ‘labor’, it has been assumed that 80 percent of this group is poor.

76. The benefits for each of the groups are briefly explained in the following table:

Table C.15 **Benefits of the Participating Groups**

Group	Financial vs. Economic Benefits
Consumers (80percent poor)	Consumers will benefit from the fact that they derive gross benefits estimated at Rp53.8 million. For this they will 'pay' only Rp17.6 million, which is the present value of the annual O&M costs and other costs made by the households. Consumers will therefore have a net benefit of about Rp36.2 million, which is mainly caused by the fact that the government will cover the costs of investments.
Government	The government will cover the costs of investments made in the project. Ten percent of these costs will be refunded to the government as sales tax. Furthermore, the economic costs of investments differ from the financial costs. The economic costs of traded goods are higher than the financial costs and these extra costs are paid by the economy as a whole. The economic costs of labor are lower as compared to the financial costs. These costs can be considered as a kind of subsidy to the labor force.
Labor (80percent poor)	Labor benefits from the project, in the assumption that they are willing to work at lower wages than they actually receive. The difference between the official wage rates and the actual market rates are considered as a benefit to labor.

As 80 percent of both consumers and the labor force are considered poor, and because most of the benefits of the project can be allocated to these groups, it can be concluded that the project will benefit the poor groups in society.

C.10 NONQUANTIFIABLE EFFECTS

77. Below, some nonquantifiable effects of the project are presented. These effects, which are beneficial to the communities concerned, can be considered as benefits derived from the project. The calculated EIRR is therefore most likely underestimated. The positive health impact must especially be considered as a major positive effect of the project.

C.10.1 Social and Gender Effects

78. The provision of water supply facilities which are closer to the families' homes and are of better quality will save resources of (in general) poor families which have previously been devoted to collecting and treating water. These family resources can now be spent on other activities such as education, income generating activities and leisure time.

79. Improved water supply will most likely be particularly beneficial for women because of their role in managing the households. The improved water supply situation will allow them more time for other activities.

80. Women, in general, also have the primary responsibility for the health and hygiene education of their children. Improved water supply and sanitation facilities may facilitate their role in this respect.

C.10.2 Health Effects

81. The provision of water supply and sanitation facilities may be considered as a major health intervention which is expected to decrease health care expenditures and the total number of healthy days lost. This may especially apply to those people who are presently making use of river water.

82. From the data of the district health office in the project area, it appears that in 1994, 4 percent of the population visited the office with a water-related disease. Considering that only those persons who have a more serious form of disease are likely to visit the health office, the actual occurrence of water-related diseases is probably much higher. It is expected that the occurrence of water-related diseases will decrease as a result of the project. These cost-savings, however, could not be quantified and have therefore not been included in the calculated cost savings.

C.11 TREATMENT of UNCERTAINTY

C.11.1 Introduction

83. The purpose of Risk Analysis is to estimate the probability that the project EIRR will fall below the opportunity cost of capital or that the NPV will fall below zero. In this particular case study, no quantitative Risk Analysis has been attempted because the case study only dealt with one small village out of a total of 3,000 villages to be covered by the project. Instead, the focus has been on a qualitative analysis of the main risks involved and on proposing mitigative measures which can be taken to reduce the risks involved in project implementation.

C.11.2 Key Assumptions to Achieve Project Targets and Possible Mitigative Actions

84. Some general risks and/or assumptions made for the project have been described in Chapter 2 and include political and economic stability as well as the non-occurrence of natural disasters. These risks are difficult to assess but, certainly in the long run, they cannot be neglected. (For example, in 1996 the above risks were not considered as large whereas in 1998, both economic and political situations have undergone considerable changes and enormous forest fires have destroyed large parts of the project area).

85. Aside from the more general risks described above, the effects of changes in certain specific variables have been calculated in paragraph 6.6 of this Handbook. These changes involve:
(i) an increase in investment costs; (ii) a decrease in project benefits; and, (iii) a reduced lifetime

of the installations. The chances that these variables may actually occur and possible mitigative actions are discussed below:

(i) **Increases in Investment Costs.** The risk that investment costs will actually increase is not considered very likely because the project is dealing with a large number of relatively small investments which are produced on a large scale. It is, however, recommended that the costs of the project are closely monitored during the lifetime of the project.

(ii) **Decreases in Project Benefits.** From section 6.6, it can be seen that the EIRR is most sensitive to variations in project benefits. The risk that project benefits are substantially below the results in the three villages can, however, be substantially reduced by a careful selection of the villages to be included in the project. In general, it can be said that in villages where water resources are of poor quality or far from the demand point, WTP and cost savings will be higher as compared to villages with adequate water resources. If the distance from the households to the water sources in the village in this case study is increased to an average of 150 meters, the EIRR would double.

(iii) **Reduced Lifetime of Installations.** The effect of a reduced lifetime of project installations is considered a major threat to the success of the Project. In many villages in Indonesia, the remnants of on site water supply and sanitation facilities, which were installed in previous water supply and sanitation projects, can be found. Reduced lifetime of facilities is mainly due to a lack of O&M which, in turn, is caused by a lack of commitment and involvement of the communities. This issue may be addressed by: a) ensuring that the facilities meet a real need in the villages where they are installed; and b) that the communities are closely involved and made responsible in the planning and operation. The project design, to some extent, includes provisions to enable sufficient community involvement; but it is recommended that this issue is closely monitored during project implementation.

86. From the above it can be concluded that the most important mitigative measures to reduce the risk for the project lie in a careful selection of the villages to be included in the project and a close involvement of the communities in the planning, implementation and O&M of water supply and sanitation facilities.

Annex C.1 **Urban Water Supply and Sanitation Project Framework** Page 1/2

Design Summary	Project Targets	Project Monitoring Mecha-	Risks/Assumptions
1. Sector/Area Goals 1.1 Improved Health Situation 1.2 Improved Living Conditions and reduced poverty 1.3 Improved Productivity	- Prevalence of water-related diseases among target population reduced by 15% by 1999; - 75% of people below poverty line have access to safe W&S facilities by 1999; - time spent on collection of water in target area reduced by 50%; - number of sick days in the project area has been reduced by 20%	- Yearly epidemiological reports of the district Health Office - Progress reports - End of project report - Special reports	- no political instability - no natural disaster in project area - macro-economic development continues
2. Project Objective/Purpose 2.1 Provide safe and reliable water supply and sanitation facilities to the population in the project area. 2.2 Carry out a hygiene and sanitation campaign and water quality monitoring program.	- Access to safe water supply and sanitation facilities for 75% of the target population by December 1999. - Improved capacity to carry out hygiene and sanitation campaigns and water quality monitoring programs	- Water Enterprise Reports - Progress reports - Epidemiological/ Health Surveys - Reports of the Ministries of Home Affairs and Health - Project Progress Reports	- current water tables will not decrease dramatically because of drought. - loan effectiveness by first of January 1996.

Annex C.1 **Urban Water Supply and Sanitation Project Framework** Page 2/2

3. Project Components/Outputs 3.1 Carry out construction / rehabilitation of water supply facilities. 3.2 Carry out construction & rehabilitation of sanitation facilities. 3.3 Implement project, carry out water quality surveillance program and hygiene and sanitation campaign.	- Water supply facilities for 75% of target population installed & operational. - Sanitation facilities for 75% of target population installed & operational. - water surveillance program carried out on regular basis. - hygiene and sanitation programs carried out on regular basis	- Progress Reports - Water Enterprise Reports - Reports of MOPW, MOHA, MOH	- no delays in contracting (building) contractors and delivery of materials; - WS&S facilities properly installed; - adequate O&M systems established.
4. Activities 4.1 Develop Physical Infrastructure for Water Supply and Sanitation Facilities - Surveys - acquire Land - Procurement - Construction - Supervision - Comm. Mgt. 4.2 Set up and carry out Water Surveillance, Sanitation and Hygiene campaigns	**5. Inputs** 5.1 Water Supply: Land, Civil Works, Equipment and Materials, Studies and DED, Construction, Supervision and O&M: $104,6 million; 5.2 Sanitation: Civil Works, equipment and materials, incremental O&M: $12,0 million 5.3 Institutional Support: implementation assistance, hyg. ed. program, water surv. program, inst. devt. progr, comm. mgt. program, project administration: $15,6 million	- Progress Reports and Review missions - Special Reports	-loan approval -government funds approved

Annex C.2

Financial Prices vs. Economic Prices

Table C.2.1 **Conversion of Financial Prices into Economic Prices**

	Financial Prices Rp'000	Conversion Factor	Economic
Communal Hand Pumps			
Investment Cost (excl. tax)			
Traded goods	12,500	1.06	13,250
Non-traded goods	8,333	1.00	8,333
Labor	7,517	0.65	4,886
Project Overhead	3,150	1.00	3,150
Total Investment Cost	31,500		29,619
Annual O&M Costs (excl.tax)			
Traded goods	591	1.06	627
Non-traded goods	394	1.00	394
Labor	188	0.65	122
	1,174		1143
Hand pumps and Public Taps			
Investment Cost (excl. tax)			
Traded goods	19,524	1.06	20,695
Non-traded goods	13,016	1.00	13,016
Labor	12,911	0.65	8,392
Project Overhead	5,050	1.00	5,050
Total Investment Cost	50,500		47,153
Annual O&M Costs (excl.tax)			
Traded goods	1,129	1.06	1,197
Non-traded goods	753	1.00	753
Labor	251	0.65	163
	2,133		2,113

Table C.2.1 **Conversion of Financial prices into Economic Prices**

Rainwater Collectors			
Investment Cost (excl. tax)			
Traded goods	19,845	1.06	21,036
Non-traded goods	13,230	1.00	13,230
Labor	13,500	0.65	8,775
Project Overhead	5,175	1.00	5,175
Total Investment Cost	51,750		48,216
Annual O&M Costs (excl.tax)			
Traded goods	99	1.06	105
Non-traded goods	66	1.00	66
Labor	68	0.65	44
	233		215
Sanitation			
Investment Cost (excl. tax)			
Traded goods	2,659	1.06	2,819
Non-traded goods	3,989	1.00	3,989
Labor	4,433	0.65	2,881
Project Overhead	1,231	1.00	1,231
Total Investment Cost	12,312		10,920
Annual O&M Costs (excl.tax)			
Traded goods	72	1.06	76
Non-traded goods	72	1.00	72
Labor	133	0.65	87
	277		235

Table C.2.2 **Economic Costs of Households**

Source	No. of HH	Average Quantity per day (liters)	Average distance to source (meters)	Average Collect. Time hours/m	Coll. Costs /month per HH	Other Costs	Average Costs per HH per month	Month/Year	Total Costs per HH per season or yr.	Average Costs Rp/m^3
EXISTING FACILITIES										
RAINY SEASON										
Cost of Collecting Water (Rp/hr)				145						
Dugwell	3	138	89	16.59	2,410	350	2,760	6	16,560	658
Hand pump	0	0	0	0.00	0	0	0	6	0	0
Electric Pump	0	0	0	0.00	0	0	0	6	0	0
Rainwater Collector	0	0	0	0.00	0	0	0	6	0	0
River/Waterpond	19	147	58	11.52	1,673	350	2,023	6	12,138	452
Watervendor	0	0	0	0.00	0	0	0	6	0	0
Neighbor	3	69	23	2.14	311	350	661	6	3,968	315
Public tap	0	0	0	0.00	0	0	0	6	0	0
Average Rainy Season		137	58	11	1,598	350	1,948	6	11,689	461

Table C.2.2 **Economic Costs of Households**

DRY SEASON										
Dugwell	1	92	92	11.44	1,661	350	2,011	6	12,065	719
Hand pump	0	0	0	0.00	0	0	0	6	0	0
Electric Pump	0	0	0	0.00	0	0	0	6	0	0
Rainwater Collector	0	0	0	0.00	0	0	0	6	0	0
River/Waterpond	21	163	66	14.54	2,111	350	2,461	6	14,766	496
Water vendor	0	0	0	0.00	0	0	0	6	0	0
Neighbor	3	69	23	2.14	311	350	661	6	3,968	315
Public tap	0	0	0	0.00	0	0	0	6	0	0
Average dry season		149	62	13	1,877	350	2,227	6	13,362	484
Average		143	60	12	1,738	350	2,088	12	25,051	472
NEW FACILITIES (Costs for HH)										
RWC	117	168	15	3.00	436	50	486	12	5,828	95
HP	117	255	30	6.00	871	50	921	12	11,057	119
PT	117	255	30	6.00	871	50	921	12	11,057	119

Annex C.3 **LEAST-COST ANALYSIS**

Table C.3.1 **Basic Data**

Item	Unit	Quantity	Existing	Alt 1	Alt 2	Alt 3
WATER SUPPLY COVERAGE						
Total Population	no.		594	594	594	594
Household size	no.		5.1	5.1	5.1	5.1
covered by						
Unprotected Wells	% of pop		20	0	0	0
Untreated River Water	% of pop		80	0	0	0
Hand pump Wells	% of pop		0	100	33	0
Rainwater Collectors	% of pop		0	0	0	100
Piped Water Public Taps	% of pop		0	0	67	0
Total Coverage	% of pop		100	100	100	100
ALTERNATIVE FACILITIES						
Source development	no.					
No. of benef. per RWC	no.	20				
No. of benef. per HP/PT	no.	50				
Number of incr. RWC	no.			0	0	30
Number of incr. HP Wells	no.			12	4	0
Number of PT	no.			0	8	0
Number of private latrines	no.			107	107	107
No. of School Latrines	no.			1	1	1
INVESTMENTS WS&S						
Sanitation Financial Prices	Rp'000			13,680	13,680	13,680
Sanitation Ec.Prices	Rp'000			10,920	10,920	10,920
Water Supply Fin Pr	Rp'000			34,650	55,550	56,925
Water Supply Ec.Pr.	Rp'000			29,619	47,153	48,216
WS&S Financial Prices	Rp'000			48,330	69,230	70,605
WS&S Economic Prices	Rp'000			40,539	58,073	59,136
NUMBER OF BENEFICIARIES						
WS through RWC	no.			0	0	594
WS through HP Well	no.			594	196	0
WS through piped scheme	no.			0	398	0
Total beneficiaries WS	no.			594	594	594

Table C.3.1 **Basic Data**

ANNUAL COSTS WS				
Water Supply Fin Prices	Rp'000	1,304	2,370	259
Sanitation Fin Prices	Rp'000	308	308	308
Water Supply Econ Prices	Rp'000	1,143	2,113	215
Sanitation Econ Prices	Rp'000	235	235	235
HH Financial Prices	Rp'000	1,952	1,952	1,952
HH Economic Prices	Rp'000	1,294	1,294	682
Total Financial Prices	Rp'000	3,564	4,630	2,519
Total Economic Prices	Rp'000	2,672	3,641	1,132
PROJECT BENEFITS				
NI In-House Water	m^3/year	6,071	6,071	6,071
NI Out-house water	m^3/year	3,035	3,035	1,084
Incremental Water	m^3/year	1,734	1,734	0
Supply Costs NIW (inside)	Rp/m^3	472	472	472
Supply Costs NIW (outside)	Rp/m^3	236	236	236
Future Supply Cost WS	Rp/mo./	2,319	3,078	1,575
Water Demand	m^3/mo./	8	8	5
Future WS&S Cost	Rp/m^3	299	397	308
Current Supply Cost WS	Rp/m^3	679	679	679
Annual Benefits NIW-in	Rp'000	2,866	2,866	2,866
Annual Benefits NIW-out	Rp'000	716	716	256
Annual Benefits IW	Rp'000	848	933	0
Annual Benefits Sanitation	Rp'000	2,107	2,107	2,107
Total Annual Benefits	Rp'000	6,537	6,622	5,229

Table C.3.2 **Comparison of Costs Among Alternatives**

Year	Alternative 1			Alternative 2			Alternative 3		
	Capital Cost (Rp'000)	Oper. Cost (Rp'000)	Total Cost (Rp'000)	Capital Cost (Rp'000)	Oper. Cost (Rp'000)	Total Cost (Rp'000)	Capital Cost (Rp'000)	Oper. Cost (Rp'000)	Total Cost (Rp'000)
1996	40,539	0	40,539	58,073	0	58,073	59,136	0	59,136
1997		2,672	2,672		3,641	3,641		1,132	1,132
1998		2,672	2,672		3,641	3,641		1,132	1,132
1999		2,672	2,672		3,641	3,641		1,132	1,132
2000		2,672	2,672		3,641	3,641		1,132	1,132
2001		2,672	2,672		3,641	3,641		1,132	1,132
2002		2,672	2,672		3,641	3,641		1,132	1,132
2003		2,672	2,672		3,641	3,641		1,132	1,132
2004		2,672	2,672		3,641	3,641		1,132	1,132
2005		2,672	2,672		3,641	3,641		1,132	1,132
2006		2,672	2,672		3,641	3,641		1,132	1,132
2007		2,672	2,672		3,641	3,641		1,132	1,132
2008		2,672	2,672		3,641	3,641		1,132	1,132
2009		2,672	2,672		3,641	3,641		1,132	1,132
2010		2,672	2,672		3,641	3,641		1,132	1,132
2011		2,672	2,672		3,641	3,641		1,132	1,132
2012		2,672	2,672		3,641	3,641		1,132	1,132
2013		2,672	2,672		3,641	3,641		1,132	1,132
2014		2,672	2,672		3,641	3,641		1,132	1,132
2015		2,672	2,672		3,641	3,641		1,132	1,132
Discounted Value	36,196	17,571	53,767	51,851	23,948	75,799	52,800	7,446	60,246

Table C.3.2 **Comparison of Costs Among Alternatives**

Supply	Supply in m^3	Supply in m^3	Supply in m^3
1996	0	0	0
1997	10,840	10,840	7,155
1998	10,840	10,840	7,155
1999	10,840	10,840	7,155
2000	10,840	10,840	7,155
2001	10,840	10,840	7,155
2002	10,840	10,840	7,155
2003	10,840	10,840	7,155
2004	10,840	10,840	7,155
2005	10,840	10,840	7,155
2006	10,840	10,840	7,155
2007	10,840	10,840	7,155
2008	10,840	10,840	7,155
2009	10,840	10,840	7,155
2010	10,840	10,840	7,155
2011	10,840	10,840	7,155
2012	10,840	10,840	7,155
2013	10,840	10,840	7,155
2014	10,840	10,840	7,155
2015	10,840	10,840	7,155
Discounted Value	71,290	71,290	47,054
AIEC(incl. Sanitation)	754	1,063	1,280

Annex C.4 **Economic Benefit-Cost Analysis**

Year	Alternative 1					Alternative 2					Alternative 3				
	Capital Cost Rp'000	Oper. Cost Rp'000	Total Cost Rp'000	Gross Benefits Rp'000	Net Benefits Rp'000	Capital Cost Rp'000	Oper. Cost Rp'000	Total Cost Rp'000	Gross Benefits Rp'000	Net Benefits Rp'000	Capital Cost Rp'000	Oper. Cost Rp'000	Total Cost Rp'000	Gross Benefits Rp'000	Net Benefits Rp'000
1996	40,539	0	40,539	0	-40,539	69,230	0	69,230	0	-69,230	70,605	0	70,605	0	-70,605
1997		2,672	2,672	6,733	4,062		4,630	4,630	6,821	2,191		2,519	2,519	5,386	2,867
1998		2,672	2,672	6,935	4,264		4,630	4,630	7,025	2,395		2,519	2,519	5,547	3,028
1999		2,672	2,672	7,143	4,472		4,630	4,630	7,236	2,606		2,519	2,519	5,714	3,195
2000		2,672	2,672	7,358	4,686		4,630	4,630	7,453	2,823		2,519	2,519	5,885	3,366
2001		2,672	2,672	7,578	4,907		4,630	4,630	7,677	3,047		2,519	2,519	6,062	3,543
2002		2,672	2,672	7,806	5,134		4,630	4,630	7,907	3,277		2,519	2,519	6,243	3,724
2003		2,672	2,672	8,040	5,368		4,630	4,630	8,144	3,514		2,519	2,519	6,431	3,912
2004		2,672	2,672	8,281	5,609		4,630	4,630	8,389	3,759		2,519	2,519	6,624	4,105
2005		2,672	2,672	8,530	5,858		4,630	4,630	8,640	4,010		2,519	2,519	6,822	4,303
2006		2,672	2,672	8,785	6,114		4,630	4,630	8,900	4,270		2,519	2,519	7,027	4,508
2007		2,672	2,672	9,049	6,377		4,630	4,630	9,167	4,537		2,519	2,519	7,238	4,719
2008		2,672	2,672	9,321	6,649		4,630	4,630	9,442	4,812		2,519	2,519	7,455	4,936
2009		2,672	2,672	9,600	6,928		4,630	4,630	9,725	5,095		2,519	2,519	7,679	5,160
2010		2,672	2,672	9,888	7,216		4,630	4,630	10,017	5,387		2,519	2,519	7,909	5,390
2011		2,672	2,672	10,185	7,513		4,630	4,630	10,317	5,687		2,519	2,519	8,146	5,627
2012		2,672	2,672	10,490	7,819		4,630	4,630	10,627	5,997		2,519	2,519	8,391	5,872
2013		2,672	2,672	10,805	8,133		4,630	4,630	10,945	6,315		2,519	2,519	8,642	6,123
2014		2,672	2,672	11,129	8,457		4,630	4,630	11,274	6,644		2,519	2,519	8,902	6,383
2015		2,672	2,672	11,463	8,791		4,630	4,630	1,1,612	6,982		2,519	2,519	9,169	6,650
NPV	36,196	17,571	53,767	53,199	-568	61,812			53,890	-38,372	63,040	16,566	79,607	42,552	-37056
EIRR					0.12		30,450	92,262		0.02					0.02

Annex 5 **Financial Benefit-Cost Analysis**

Year	Alternative 1				
	Capital Cost (Rp'000)	Operating Cost (Rp'000)	Total Cost (Rp'000)	Gross Benefits (Rp'000)	Net Benefits (Rp'000)
1996	48,330	0	48,330	0	-48,330
1997		1,612	1,612	1,612	0
1998		1,612	1,612	1,612	0
1999		1,612	1,612	1,612	0
2000		1,612	1,612	1,612	0
2001		1,612	1,612	1,612	0
2002		1,612	1,612	1,612	0
2003		1,612	1,612	1,612	0
2004		1,612	1,612	1,612	0
2005		1,612	1,612	1,612	0
2006		1,612	1,612	1,612	0
2007		1,612	1,612	1,612	0
2008		1,612	1,612	1,612	0
2009		1,612	1,612	1,612	0
2010		1,612	1,612	1,612	0
2011		1,612	1,612	1,612	0
2012		1,612	1,612	1,612	0
2013		1,612	1,612	1,612	0
2014		1,612	1,612	1,612	0
2015		1,612	1,612	1,612	0
FNPV	43,152	10,601	53,753	10,601	-43,152

GLOSSARY

Ability-to-pay (ATP). The affordability or the ability of the users to pay for the water services, as expressed by the ratio of the monthly household water consumption expenditure to the monthly household income.

Average incremental cost (AIC). The present value of investment and operation costs, divided by the present value of the quantity of output. Costs and output are calculated from the difference between the with- and without-project situations, and are discounted. It is expressed in the following formula:

$$\sum_{t=o}^{n}(C_t / (1+d)^t) / \sum_{t=o}^{n}(O_t / (1+d)^t)$$

where C_t is project investment and operation cost in year t;
O_t is project output in year t;
n is the project life in years;
and d is the discount rate.

Average incremental economic cost (AIEC). The present value of investment and operation costs *at economic prices*, divided by the present value of the quantity of output consumed. Costs and output are calculated from the difference between the with- and without-project situations, and are *discounted at the economic opportunity cost of capital.*

Average incremental financial cost (AIFC). The present value of investment and operation costs *at financial prices* divided by the present value of the quantity of output sold. Costs and output are calculated from the difference between the with- and without-project situations, and are *discounted at the financial opportunity cost of capital.*

Benefit stream. A series of benefit values extending over a period of time.

Border price. The unit price of a traded good at a country's border; that is, f.o.b. price for exports and c.i.f. price for imports. The border price is measured at the point of entry to a country or, for landlocked countries, at the railhead or trucking point.

Capital recovery factor. The factor expressed as: $[i(1 + i)^n] / [(1 + I)^n - 1]$ where i = the rate of interest and n = the number of years, is used to calculate the annual payment that will repay a loan of one currency unit in n years with compound interest on the unpaid balance. The factor permits calculating equal annual value (amortized value) of a loan (or initial cost) of a project.

***Ceteris paribus* assumption**. Literally means "other things being equal"; usually used in economics to indicate that all other relevant variables, except the ones specified, are assumed not to change.

Constant prices. Price values from which any change (observed or expected) in the general price level is omitted. When applied to all project costs and benefits over the life of the project, the resulting project statement is in constant prices with value of money at the year when the project statement is made.

Consumer surplus. Savings to consumers arising from the difference between what they are willing to pay for an output and what they actually have to pay.

Contingency allowance in an estimate. An amount included in a project account to allow for adverse conditions that will add to base costs. Physical contingencies allow for physical events, such as adverse weather during construction, and are included in both the financial and economic benefit-cost analysis. Price contingencies allow for general inflation during the implementation period and are omitted from the financial and economic benefit-cost analyses since the analyses are done in constant prices.

Contingent Valuation Method (CVM). A direct method of nonmarket valuation in which consumers are asked directly their willingness to pay for a specific quantity or quality of goods or services such as water supply.

Conversion factor. Ratio between the economic price and the financial price for a project output or input, which can be used to convert the financial values of project benefits and costs to economic values. Conversion factors can also be applied for groups of typical items, such as water supply, transport, etc., and for the economy as a whole, as in the standard conversion factor.

Cost-effectiveness analysis (CEA). An analysis that seeks to find the best alternative activity, process, or intervention that minimizes resource use to achieve a desired result. Alternatively, where resources are constrained, analysis that seeks to identify the best alternative that maximizes results for a given application of resources. CEA is applied when project effects can be identified and quantified but not adequately valued, such as health benefit due to safe water and sanitation.

Cost recovery. The extent to which user charges for goods and services recover the full costs of providing such services, including a return on capital employed. Can be defined in terms of financial cost recovery using financial costs or economic cost recovery using economic costs.

Cost stream. A series of cost values extending over a period of time.

Cross-subsidization. Any subsidy that is received by a given group, usually poor people, is paid by higher-income group through higher prices.

Current prices. Price values that include the effects of general price inflation; that is, a past price value as actually observed and a future value or price as expected to occur. Current prices are only used in financial analysis. In financial and economic benefit-cost analyses, constant prices are used.

Cut-off rate. The rate of return below which a project is considered unacceptable, often taken to be the opportunity cost of capital. The cut-off rate would be the minimum acceptable internal rate of return for a project. The cut-off rate is the FOCC in financial analysis and the EOCC in economic analysis.

Demand curve. A graphic representation of the inverse relationship between the price of water and the quantity of the water that consumers wish to purchase per period of time, *ceteris paribus*.

Demand for water. The various quantities of water which buyers are willing to purchase per period of time depending on the price of water charged, their income, time spent on collecting water, seasonal variation, etc.

Demand Management. Demand management refers to the controlling of water demand; hence, production. This may be effected in a number of ways: (i) leakage detection; (ii) reduction of illegal or unmetered consumption; and (iii) pricing policies. The demand management is sometimes effected through intermittent water supplies and restriction of the use of garden hoses, etc.

Demand price. The price at which purchasers are willing to buy a given amount of project output, or the price at which a project is willing to buy a given amount of a project input. For any good or service, the demand price is the market price received by the supplier plus consumption taxes and less consumption subsidies.

Depletion premium. A premium imposed on the economic cost of depletable resources, representing the loss to the national economy in the future because of using up the resource today. The premium is frequently estimated as the additional cost of an alternative supply of the resource, or a substitute, when the least cost source of supply has been depleted.

Depreciation. The anticipated reduction over time in the value of an asset that is brought about by physical use or obsolescence.

Discounting. The process of finding the present value of a future amount by multiplying the future amount by a discount factor.

Discount factor. How much 1 at a future date is worth today, as in the expression $1 / (1 + i)^n$ where i = the discount rate (interest rate) and n= the number of years. Generally, this expression is obtained in the form of a discount factor from a set of compounding and discounting tables, or can be calculated using a computer.

Discount rate. A percentage representing the rate at which the value of benefits and costs decrease in the future compared to the present. The rate can be based on the alternative return in other uses given up by committing resources to a particular project, or on the preference for benefits today rather than later. The discount rate is used to determine the present value of future benefit and cost streams.

Distribution analysis. An analysis of the distribution of gains and losses as a result of the project between different project participants, users, government, etc. It also forms the basis for calculating the Poverty Impact Ratio.

Economic analysis. An analysis done in economic values. In general, economic analysis omits transfer payments and values all items at their value in use or their opportunity cost to the society. External costs and benefits are included in the economic analysis.

Economic benefit. A monetary measure of preference satisfaction or welfare improvement from a change in quantity or quality of a good or service. A person's welfare change is the maximum amount that a person would be willing to pay to obtain that improvement.

Economic benefit-cost analysis. The analysis for estimating the internal rate of return and NPV of the project costs and benefits measured in economic prices over a specified period of time.

Economic efficiency. An investment or intervention is economically efficient when it maximizes the value of output from the resources available or minimizes the value of inputs to meet an output.

Economic life. The period during which a fixed asset is capable of yielding services. It is that life of an asset beyond which it is uneconomic to use the asset and below which it is uneconomic to give up the asset. As distinguished from physical life, it is a period which is often longer, during which a fixed asset can continue to function notwithstanding its acquired obsolescence, inefficient operation, and high cost of maintenance or obsolete product.

Economic price. Price of goods and services which reflect their values or opportunity costs to the economy as a whole. This is also called the shadow price.

Economic resource. An economic resource is a scarce resource in the sense that it is limited in quantity related to the desire for the resource. Water as a scare resource is an economic good.

Economic subsidy. The difference between the average tariff and the average incremental economic cost (AIEC) of water sold when the price per m^3 of water charged to the users is below the economic costs.

Economies of scale. This occurs when the increasing size of production in the long run permits the per unit cost of production to fall, or each unit of output to be produced more cheaply.

Efficient water pricing. From an economic viewpoint, the efficiency-pricing rule in the long run is one that equalizes price to (long run) marginal costs (LRMC). As the LRMC is difficult to estimate, AIEC is used as an approximation.

Economic internal rate of return (EIRR). The rate of return that would be achieved on all project resource costs, where all benefits and costs are measured in economic prices. The EIRR is calculated as the rate of discount for which the present value of the net benefit stream becomes zero, or at which the present value of the benefit stream is equal to the present value of the cost stream. For a project to be acceptable, the EIRR should be greater than the economic opportunity cost of capital.

Economic opportunity cost of capital (EOCC). The real rate of return in economic prices on the marginal unit of investment in its best alternative use. The value of the EOCC is difficult to calculate and the Bank uses 12 percent in most projects.

Economic viability. A project is economically viable if the economic internal rate of return (EIRR) is above the EOCC.

Effective demand for water. The quantity of water demanded of a given quality at a specified price based on the economic cost of water supply provision to ensure optimal use of the facility.

Elasticity (point) of demand for water. A measure of the responsiveness of quantity of water demanded (e.g., m^3) to a small change in market price, defined by the formula:

$$\eta = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in price}}$$

Also called demand elasticity, price elasticity.

Environmental sustainability. The assessment that a project's outputs can be produced without permanent and unacceptable change in the natural environment on which it and other economic activities depend, over the life of the project.

Environmental sanitation. The concept generally refers to facilities and services regarding (i) human waste disposal; (ii) solid waste management; and (iii) stormwater drainage, sewerage, and wastewater treatment. Human waste disposal covers both on-site low-cost sanitation facilities (latrines, septic tanks, soakpits) and use of tankers for sludge removal and off-site disposal and treatment. Solid waste management and disposal is generally not a component in Bank-assisted water supply and sanitation projects; but it is usually included in integrated urban development projects. Solid waste disposal facilities may comprise dumpsites, access roads, collection facilities, composing equipment, etc.

Environmental valuation. The estimation of the use and nonuse values of the environmental effects of a project. These valuations can be based on underlying damage functions for environmental stressors, identifying the extra physical costs of projects or the physical benefits of mitigatory actions. They can also be based on market behavior, which may reveal the value placed by different groups on avoiding environmental costs or enjoying environmental benefits.

Equalizing discount rate (EDR). The discount rate at which the present values of the costs of two project alternatives are equal. It is the same as the internal rate of return on the incremental effects of undertaking an alternative with larger net costs earlier in the net benefit stream rather than an alternative with also early but lower net costs. The EDR is compared with the opportunity cost of capital to determine whether the alternative with larger net costs is worthwhile. Also referred to as the crossover discount rate, it is also the discount rate above or below which the preferred alternative changes from one to another.

Export and import parity prices. Estimated prices at the farmgate or project boundary, which are derived by adjusting the c.i.f. or f.o.b. prices by all the relevant charges between the farmgate and the project boundary and the point where the c.i.f. or f.o.b. is quoted.

External effects. Effects of an economic activity not included in the project statement from the point of view of the main project participants, and therefore not included in the financial costs and revenues that accrue to them. Externalities represent part of the difference between private costs and benefits, and social costs and benefits. As much as possible, externalities should be quantified and valued and included in the project statement for economic analysis.

Financial analysis. An analysis done using constant market prices of goods and services to arrive at the financial internal rate of return (FIRR). Financial analysis is also done for the entire project entity and includes the preparation of Income Statements, Fund or Cash Flow Statements and Balance Sheet Statements with current prices over a certain period.

Financial benefits. Refer to the financial revenues that would accrue to the main project participant.

Financial benefit-cost analysis. The analysis for estimating the FIRR that would be achieved on all project costs and benefits measured in financial prices over a specified period of time.

Financial internal rate of return (FIRR). The rate of return that would be achieved on all project costs, where all costs are measured in financial prices and when benefits represent the financial revenues that would accrue to the main project participant. The FIRR is the rate of discount for which the present value of the net revenue stream becomes zero, or at which the present value of the revenue stream is equal to the present value of the cost stream. It should be compared with the financial opportunity cost of capital to assess the financial sustainability of a project.

Financial price. Market price of any good or service.

Financial subsidy. The difference between the average tariff and the average incremental financial cost (AIFC) of water sold when the price per m^3 of water charged to the users is below the financial costs.

Financial sustainability. The assessment that a project will: (i) have sufficient funds to meet all its resource and financing obligations, whether these funds come from user charges or budget sources; (ii) provide sufficient incentive to maintain the participation of all project participants; and (iii) be able to respond to adverse changes in financial conditions.

Financial opportunity cost of capital (FOCC). The opportunity cost of using investment resources at market prices in a project. This is often taken as the weighted average borrowing rate of capital used in the project.

Foreign exchange premium. The proportion by which the official exchange rate overstates the real exchange rate to the economy or, in other words, the true opportunity cost of using a dollar.

Gross economic benefit. The total economic value of project output, measured as the sum of the economic value of nonincremental output that displaces other supplies and the economic value of incremental output that increases supplies.

Household. All the people who live under one roof and who make joint financial decisions.

Household size. The number of people who live under one roof and who make joint financial decisions.

Income elasticity of demand. A measure of the responsiveness of quantity demanded to a small change in income, defined by the formula:

$$\eta_Y = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in income}}$$

Incremental. Increase in quantity with the project.

Incremental benefit. An additional benefit received from a project over and above what would be received without project situation.

Incremental demand for water. An increase in existing consumption generated by the additional supply of water.

Incremental input. Input that is supplied from an increase in production of the input over and above what would be produced and supplied in the without-project situation.

Incremental output. Additional output produced by a project over and above what would be available and demanded in the without-project situation.

Inflation rate. The rate of increase per year in the general price level of an economy.

Intangible. In project analysis, refers to a cost or benefit that, although having value, cannot realistically be assessed in actual or approximate money terms. Intangible benefits include health, education, employment generation, etc. Intangible costs, on the other hand, are often the absence of the related benefits such as, disease, illiteracy, environmental degradation, etc.

Least-cost analysis. Analysis used to identify the least-cost option for meeting project demand for water by comparing the costs of technically feasible but mutually exclusive alternatives for supplying comparable quantity and quality of water. The analysis should be carried out using discounted values over the life of a project using the opportunity cost of capital, where possible, as the discount rate.

Least-cost alternative in economic analysis. An alternative that represents the least-cost addition to the optimal expansion plan for water supply in the project area. Costing is in economic, not in financial terms, and the discount rate to be used is the EOCC.

Net present value (NPV). The difference between the present value of the benefit stream and the present value of the cost stream for a project. The net present value calculated at the discount rate should be greater than zero or positive in order for a project to be acceptable. When analyzing (mutually exclusive) alternatives, the alternative with the greatest net present value is preferred.

Nominal prices. See Current prices.

Nonincremental. Non-increase in quantity with the project.

Nonincremental benefit. Benefit arising out of giving up an existing supply of goods and services as a result of a project.

Nonincremental demand for water. Existing consumption of water wherein the additional (or new) supply of water displaces the existing water sources.

Nonincremental output. Output, produced by a project, that substitutes for supplies that would be available in the without-project situation.

Nonincremental input. Input that is supplied to a project that, in the without-project situation, would be produced and supplied to another project.

Non-revenue water. The water produced but not paid for.

Non-technical loss. The water produced but lost through water theft as in using unmetered taps or tampered meters, for instance. This increases the cost of supply and reduces sales revenue, but benefits consumers who do not pay.

Nontraded outputs and inputs. Goods and services, related with a project, that are not imported or exported by the country because: (i) by their nature they must be produced and sold within the domestic economy – for example, domestic transport and construction; (ii) of government policy that prohibits international trade; or (iii) there is no international market for the product given its quality or cost.

Numeraire. A unit of measure that makes it possible to find out the real change in net national income (i.e. ENPV). It can be measured at two different price levels. These are: the domestic price level, where all economic prices are expressed in their equivalent domestic price level (the domestic price numeraire); and the world price level, where all economic prices are expressed at their equivalent world price level (the world price numeraire).

Official exchange rate (OER). The rate, established by the monetary authorities of a country, at which domestic currency may be exchanged for foreign currency. Where there are no currency controls, the official exchange rate is taken to be the market rate.

Opportunity cost. The value of something foregone. The benefit foregone from not using a good or resource in its best alternative use. Measured at economic prices, it represents the appropriate value to use in project economic analysis.

Opportunity cost for labor. The opportunity cost of using labor input in a project rather than in its next best alternative use.

Opportunity cost for land. The opportunity cost of using land as input in a project rather than in its next best alternative use.

Opportunity cost for water. The opportunity cost of water as input in a project rather than in its next best alternative use.

Peak factor. The rate at which the demand for water reaches a maximum level during the day.

Present value. The value at present of an amount to be received or paid at some time in the future. Determined by multiplying the future amount by a discount factor.

Profit (or loss). The excess of revenue over cost or of cost over revenue.

Poor. Refers to household whose income falls below the country-specific poverty line.

Poverty impact ratio. The ratio of the net economic benefits accruing to the poor to the total net economic benefits of a project.

Productive efficiency. Achievement of a specific level of output or objective using the most cost-effective means. In economic analysis of a given water supply project, the analyst uses least-cost analysis of feasible project alternatives to test for productive efficiency.

Project alternatives. Technically feasible ways of achieving a project's objective. Project alternatives can be defined in terms of different possible locations, technologies, scales and timings. It can also refer to alternatives between physical investments, policy changes and capacity building activities. Mutually exclusive project alternatives are such that the selection of one option leads to the rejection of others.

Project cycle. A sequence of analytical phases through which a project passes. This includes identification, preparation, appraisal, implementation and evaluation of projects.

Project framework. A logical framework for a proposed project, which serves as a tool for preparing the project design, project monitoring and evaluation. It describes the goals, objectives, outputs, inputs and activities, verifiable indicators, means of verification and key risks and assumptions and project costs.

Real exchange rate. The price of foreign currency in terms of domestic currency where the rate of exchange is adjusted for the relative value of actual or expected domestic and international inflation.

Risk analysis. The analysis of project risks associated with the value of key project variables, and therefore the risk associated with the overall project result. Quantitative risk analysis considers the range of possible values for key variables, and the probability with which they may occur. Simultaneous and random variation within these ranges leads to a combined probability that the project will be unacceptable. When deciding on a particular project or a portfolio of projects, decision-makers may take into account not only the expected scale of project net benefits but also the risk that they will not be achieved.

Sensitivity analysis. The analysis of the possible effects of adverse changes on a project. Values of key variables are changed one at a time, or in combinations, to assess the extent to which the overall project result (NPV, IRR) would be affected. Where the project is shown to be sensitive to the value of a variable that is uncertain, that is, where relatively small and likely changes in a variable affect the overall project result, mitigating actions at the project, sector, or national level should be considered.

Sensitivity indicator. The ratio of the percentage change in NPV to the percentage change in a selected variable. A high value for the indicator indicates project sensitivity to the variable.

Shadow exchange rate. The economic price of foreign currency used in the economic valuation of goods and services. The shadow exchange rate can be calculated as the weighted average of the demand price and the supply price for foreign exchange. Alternatively, it can be estimated as the ratio of the value of all goods in an economy at domestic market prices to the value of all goods in an economy at their border price equivalent values. Generally, the shadow exchange rate is greater than the official exchange rate, indicating that domestic purchasers place a higher value on foreign currency resources than is given by the official exchange rate.

Shadow exchange rate factor (SERF). The ratio of the economic price of foreign currency to its market price. Alternatively, the ratio of the shadow to the official exchange rate. In general, greater than 1. The inverse of the SCF.

Shadow price. The price of goods and services from the point of view of a nation. The value used in economic analysis for a cost or benefit in a project when the market price is a poor estimate of their national opportunity costs.

Shadow wage rate (SWR). The economic price of labor measured in the appropriate numeraire (domestic or world price) as the weighted average of its demand and supply price. For labor that is scarce, the SWR is likely to be equal to or greater than the project wage. For labor that is not scarce, the SWR is likely to be less than the project wage. Where labor markets for labor that is not scarce are competitive, the SWR can be approximated by a market wage rate for casual unskilled labor in the relevant location, and adjusted to the appropriate numeraire.

Shadow wage rate factor (SWRF). The ratio of the shadow wage rate of a unit of a certain type of labor, measured in the appropriate numeraire, and the project wage for the same category of labor. Alternatively, the ratio of the economic and financial cost of labor. The SWRF can be used to convert the financial cost of labor into its economic cost.

Standard conversion factor (SCF). The ratio of the economic price value of all goods in an economy at their border price equivalent values to their domestic market price value. It represents the extent to which border price equivalent values, in general, are lower than domestic market price values. The SCF will generally be less than one. For economic analysis using the world price numeraire, it is applied to all project items valued at their domestic market price values to convert them to a border price equivalent value, while items valued at their border price equivalent value are left unadjusted. The SCF and SERF are the inverse of each other.

Subsidy. In the provision of utility services, the difference between average user charges and the average incremental cost of supply. A subsidy can be estimated in economic terms using economic costs of supply, or in financial terms using financial costs of supply. The economic effects of a subsidy include the consequences of meeting them through generating funds elsewhere in the economy. Subsidies need explicit justification on efficiency grounds, or should be justified to ensure access to a selected number of basic goods.

Supply price. The price at which project inputs are available, or the price at which an alternative to the project is available. In the economic evaluation of projects, the supply price should be converted to economic values and transfer payments should be excluded.

Switching value. In sensitivity analysis, the percentage change in a variable for the project decision to change, that is, for the NPV to become zero or the IRR to fall to the cut-off rate.

Technical loss. The water produced which is lost through pipe leakages in the transmission and distribution networks, or in the storage. This increases the cost of supply and reduces sales revenue.

Traded inputs and outputs. Inputs and outputs of a project which go across the border of the country. These are the goods and services whose production or consumption affects a country's level of imports or exports. Project effects estimated in terms of traded goods and services can be measured directly through their border price equivalent value — the world price for the traded product for the country concerned, adjusted to the project location. Border prices for exported outputs can be adjusted to the project location by subtracting the cost of transport, distribution, handling and processing for export measured at economic prices. Border prices for imported inputs can be adjusted by adding such costs to the project site. Outputs that substitute for imports can be adjusted by the difference in transport, distribution and handling costs between the existing point of sale and the project site. Project inputs that reduce exports can be adjusted by the difference in domestic costs between the point of production and the project location. The border prices can be adjusted to the project location in either financial or economic terms. See also import parity price and export parity price.

Transactions costs. The costs, other than price, incurred in the process of exchanging goods and services. These include the costs of negotiating and enforcing contracts, and the costs of collecting charges for goods and services provided. The scale of economic and financial transactions costs can affect the market structure for a good.

Transfer payment. A payment made without receiving any good or service in return. Transfer payments transfer command over resources from one party to another without reducing or increasing the amount of resources available as a whole. Taxes, duties and subsidies are examples of items that, in most circumstances, may be considered to be transfer payments.

Unaccounted for Water (UFW). The difference between the water produced (and distributed) and the water sold, or the water produced but not sold. UFW may consist of technical losses and non-technical losses. The distinction between technical and non-technical losses is important for the economic analysis of water supply projects. Whereas both technical and non-technical losses increase the cost of supply and reduce sales revenue, non-technical losses benefit consumers who do not pay. Usually, UFW is expressed as a percentage of production, i.e.,

$$UFW = \frac{\text{Water Produced - Water Sold}}{\text{Water Produced}} \times 100\%$$

Unit of account. The currency used to express the economic value of project inputs and outputs. Generally, the currency of the country in which the project is located will be used as the unit of account. Occasionally, however, an international currency may also be used as the unit of account. Economic values using the domestic price numeraire can be expressed in either a domestic or international currency. Similarly, economic values using the world price numeraire can be expressed in either a domestic or international currency.

User fee. A charge levied upon users for the services rendered or goods supplied by a project.

Water management. Concerned with finding an appropriate balance between the costs of water supply and the benefits of water use. Water supply management includes the activities required to locate, develop and exploit new sources of water in a cost-effective way. Water demand management addresses the ways in which water is used and the various tools available to promote more desirable levels (decreases or increase in water use) and patterns of use.

Water Sector. All water uses, including water supply. Potable water supply is treated as a subsector. Water supply to irrigation, industry, hydropower, etc. is also treated as a subsector.

Weighted average cost of capital (WACC). Measured on after-tax income tax basis, WACC is determined by ascertaining the actual lending (or onlending) rates, together with the cost of equity contributed as a result of the project. To obtain the WACC in real terms, the inflation factor is to be deducted from the estimated cost of borrowing and equity capital.

Willingness to pay (WTP). The maximum amount consumers are prepared to pay for a good or service. The total area under the demand curve represents total WTP.

WTP curve. A curve that represents the relationship between the quantity of water and the price of water that consumers are prepared to pay per period of time, *ceteris paribus.*

WTP studies. Household surveys in which members of a household are asked a series of structured questions designed to determine the maximum amount of money the household is willing to pay for a good or service. Also termed "contingent valuation" studies because the respondent is asked about what he or she would do in a hypothetical (or contingent) situation.

With- and without-project. The future situations with and without a proposed water supply project. In project analysis, the relevant comparison is the net benefit with the project compared with the net benefit without the project. This is distinguished from a "before- and after-" project comparison because even without the project, the net benefit in the project area may change.

World price. The price at which goods and services are available on the international market. The world price for the country is the border price, the price in foreign exchange paid for imports. It is the c.i.f. value (inclusive of cost, insurance and freight) at the port, railhead or trucking point or the f.o.b. value (price in foreign exchange received for exports at the port, railhead, or trucking point).

REFERENCES

ADB. 1997 (February). *Guidelines for the Economic Analysis of Projects.*

ADB. 1995. *Interim Guidelines for the Economic Analysis of Water Supply Projects.*

ADB. 1998. *Guidelines for the Economic Analysis of Water Supply Projects.*

ADB – Report and Recommendation to the President. 1997. Loan No 1544 - PRC: Zhejiang-Shanxi Water Supply Project.

ADB. *Melamchi Water Supply Project*. Fact Finding Mission, Preliminary Economic and Financial Analysis.

ADB. *Guidelines for Preparation and Presentation of Financial Analysis.*

ADB. 1997. *The Project Framework: A Handbook for Staff Guidance*.

ADB. 1997. *Board Information Paper: Bank Criteria For Subsidies*.

ADB. 1993 (November). *Water Utilities Data Book: Asia and Pacific Region*.

Belli, P., J. Anderson, H. Barnum, J. Dixon and J. Tan. 1998. *Handbook on Economic Analysis of Investment Operations*. Operational Core Services Network and Learning & Leadership Center.

Bhatia, Ramesh; Rita Cestti and James Winpenny. *Water Conservation and Reallocation: Best Practice Cases in Improving Economic Efficiency and Environmental Quality*. A World Bank-ODI Joint Study.

Bhatia, R. 1993. *Water Conservation and Pollution Control in Industires: How to Use Water Tariffs, Pollution Taxes and Fiscal Incentives* (Draft).

FAO. 1995. *Reforming Water Resources Policy: A Guide to Methods, Processes and Practices*. FAO Irrigation and Drainage Paper No. 52.

Garn, Harvey A. 1993 (August). *Pricing and Demand Management: A Theme Paper on Managing Water Resources to Meet Megacity Needs*. The World Bank.

Garn, Harvey A. 1992. “Financing of Water Supply and Sanitation Services” in *Water Supply and Sanitation: Beyond the Decade*. World Bank.

Hanley, Nick and Clive L. Spash. 1993. *Cost-benefit analysis and the environment*. Aldershot, Hants, England : Brookfield, Vt. : E. Elgar.

Hubbell, L.K. 1977. "The Residential Demand for Water and Sewerage Service in Developing Countries: A Cse Study of Nairobi." A paper prepared for the Urban and Regional Economics Division of the World Bank. 26 pages.

IWACO-WASECO. 1989 (October). *Bogor Water Supply Project: The Impact of the Price Increase in June 1988 on the Demand for Water in Bogor*.

Katzman, M. T. 1977 (February). "Income and Price Elasticities of Demand for Water in Developing Countries." *Water Resources Bulletin*. Vol. 13, No. 1, pp. 47-55.

Lovei, Laszlo. 1992 (October). "An Approach to the Economic Analysis of Water Supply Projects". Policy Research Working Paper, Infrastructure and Urban Development, The World Bank (WPS 1005).

McPhail, Alexander A. (1993). *The "Five Percent Rule" For Improved Water Service: Can Households Afford More?* The World Bank, World Development, Vol. 21, No 6, pp. 963-973.

Meroz, A. 1968. "A Quantitative Analysis of Urban Water Demand in Developing Countries." Working Paper, The World Bank, Development Economics Department.

Powers, T. and C. A. Valencia. 1980. "SIMOP Urban Water Model: Users Manual. A Model for Economic Appraisal of Potable Water Projects in Urban Areas". Inter-American Development Bank. Papers on Project Analysis No. 5. Economic and Social Development Department, Country Studies Division, Project Methodology Unit. Washington D.C. 37 pages plus appendices.

RETA 5608 Case Studies on ADB Water Supply and Sanitation Projects
Bangladesh Second Water And Sanitation Project
Rawalpindi (Pakistan) Urban Water Supply and Sanitation Project
Thai Nguyen City (Viet Nam) Provincial Towns Water Supply and Sanitation Project
Phan Thiet Town (Viet Nam) Provincial Towns Water Supply and Sanitation Project
Indonesia Rural Water Supply and Sanitation Sector Project

RETA 5608 Case Studies on the Opportunity Cost of Water in the Philippines and the People's Republic of China.

Serageldin, Ismail. 1994. *Water supply, sanitation and environmental sustainability: the financing challenge*. Washington : World Bank.

UNDP-World Bank Water and Sanitation Program, *Willingness to Pay for Water in Rural Punjab, Pakistan.*

The World Bank Water Demand Research Team. 1993. *The Demand for Water in Rural Areas: Determinants and Policy Implications*. Research Observer, Vol. 8, No. 1. World Bank.

Water and Sanitation for Health (WASH) Project. 1988 (October). "Guidelines for Conducting Willingness to Pay Studies for Improved Water Services in Developing Countries". WASH Field Report No. 306 prepared for the Office of Health, Bureau for Science and Technology, U.S. Agency for International Development.

Whitlam, G. and L. Lucero. 1994 (June). *An Economic Analysis of Piped Water Projects*. ADB - EDRC/EDEV.

Whittington, Dale; X. Mu and R. Roche. 1990. "Calculating the Value of Time Spent Collecting Water: Some estimates for Uganda, Kenya". World Development. Vol. 18, No. 2. Pp. 269-280.

Whittington, Dale and V. Swarna. 1994 (January). *The Economic Benefits of Potable Water Supply Projects to Households in Developing Countries*. Economic Staff Paper No. 53, EDRC, Asian Development Bank.

World Bank. 1996 (June). *Impact Evaluation Report on the Water Supply and Wastewater Services in Bombay, India.* Report No. 15849, page 23. Washington DC.

World Bank - Staff Appraisal Report. 1991. *Liaoning Urban Infrastructure Project, China.*

World Bank – Staff Appraisal Report. 1996. *Rural Water Supply and Sanitation Project, Nepal*.

Young, Robert A. 1996. *Measuring Economic Benefits for Water Investments and Policies*. World Bank Technical Paper No. 338.

Yepes, Guillermo. 1995. *Reduction of unaccounted-for-water, the job can be done*. The World Bank.

Young, Robert A. 1996. "Water Economics" in *Handbook of Water Resources.* L. Mays, ed. McGraw-Hill.

ABBREVIATIONS

ADB	-	Asian Development Bank
AES	-	Average economic subsidy
AFS	-	Average financial subsidy
AIC	-	Average incremental cost
AIEB	-	Average incremental economic benefit
AIEC	-	Average incremental economic cost
AIFB	-	Average incremental financial benefit
AIFC	-	Average incremental financial cost
ATP	-	Ability to pay
avg	-	Average
BME	-	Benefit monitoring and evaluation system
CEA	-	Cost effectiveness analysis
CF	-	Conversion factor
c.i.f.	-	Cost, insurance and freight
con	-	Connection
CVM	-	Contingent valuation method
d	-	Day
DMC	-	Developing member county
EBCA	-	Economic benefit-cost analysis
EIA	-	Environmental impact assessment
EIRR	-	Economic internal rate of return
ENPV	-	Economic net present value
EOCC	-	Economic opportunity cost of capital
FBCA	-	Financial benefit-cost analysis
FIRR	-	Financial internal rate of return
FNPV	-	Financial net present value
f.o.b.	-	Free on board
FOCC	-	Financial opportunity cost of capital
ha.	-	hectare
HH	-	Household
HC	-	Household connection
HLD	-	Health life days
HP	-	Hand pump
hr	-	hour
IRR	-	Internal rate of return
kwh	-	kilowatt hour
lcd	-	liters per capita per day

l/con/d	-	liters per connection per day
l/min	-	liters per minute
log	-	logarithm
LRMEC	-	Long-run marginal economic cost
m	-	meter
mm	-	millimeter
mn	-	million
m^3	-	cubic meter
Mm^3	-	million cubic meter
mo.	-	month
Ln	-	Natural logarithm
LCA	-	Least-cost analysis
MPW	-	Ministry of Public Works
NA	-	Not available/not applicable
NEB	-	Net economic benefits
NFB	-	Net financial benefits
ND	-	Not determined
NGO	-	Non-governmental organization
No.	-	Number
NPV	-	Net present value
NRW	-	Non-revenue water
NTL	-	Non-technical losses
O&M	-	Operation & maintenance
OCW	-	Opportunity cost of water
OER	-	Official exchange rate
Para.	-	Paragraph
PFW	-	Project Framework
PIR	-	Poverty impact ratio
PPTA	-	Project preparatory technical assistance
PT	-	Public tap
PV	-	Present value
RCS	-	Resource cost savings
Rp	-	Rupiah (Indian currency)
Re/Rs	-	Rupee/Rupees (Pakistan currency)
RWC	-	Rainwater collector
RETA	-	Regional Technical Assistance
RRP	-	Report and Recommendation to the President
RWSP	-	Rural Water Supply Project
RWSS	-	Rural Water Supply and Sanitation Project
SCF	-	Standard conversion factor
SER	-	Shadow exchange rate

SERF	-	Shadow exchange rate factor
SI	-	Sensitivity indicator
SV	-	Switching value
SWR	-	Shadow wage rate
SWRF	-	Shadow wage rate factor
TK	-	Taka (Bangladesh currency)
TL	-	Technical losses
TOR	-	Terms of reference
UFW	-	Unaccounted for water
UWSP	-	Urban Water Supply Project
VND	-	Viet Nam Dong
WACC	-	Weighted average cost of capital
WB-SAR	-	World Bank – Staff Appraisal Report
WHO	-	World Health Organization
WSP	-	Water supply project
WS&SP	-	Water supply and sanitation project
WTP	-	Willingness to pay
yr.	-	year

Notes
In this Handbook, "$" refers to US dollars