Draft Guidelines for Economic Analysis of Rural Water and Sanitation Projects

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The following is a guide to the issues one should cover in putting together an economic analysis for a rural water supply and sanitation project under preparation.

Most of the economic analysis for rural water supply and sanitation conducted in the World Bank in the past ten years has used one or more of the techniques described below.

This guide does not include specifics on how to conduct project preparation, including identifying project rationale and objectives, working through a logical framework approach to identify risks and specify indicators. It does not even specify how to calculate economic rates of return. General guidance on all of the above should be directed to economic texts.

Rather, it identifies, exposes, and explains many of the underlying assumptions made by team economists when conducting economic analysis of improved water and sanitation. In doing so, it proposes guidelines for 'good practice' for the sector.

World Bank operational guidelines on economic analysis are cited as follows:

- O.P. and B.P. 10.04 Economic Evaluation of Investment Operations; and
- O.P. and B.P. 6.50 Project Cost Estimates and Contingency Allowances.

Neither of these have directives which isolate examples specific to rural water supply. O.P. 10.04 gives general guidelines for all economic analysis in Bank projects, and B.P. 10.04 delineates responsibilities across the steps of the project cycle and those implicated in the management of the project. O.P. and B.P. 6.50 should be consulted for Bank standards for base cost estimates, physical and price contingency allowances. These will be further explained below.

Both O.P. 10.04 and B.P. 10.04 refer to G.P. 10.04, which has recently been released as Economic Analysis of Investment Operations: Analytical Tools and Practical Operations (2001). It can be purchased at the InfoShop, and is the Bank methodological handbook for economic analysis. An earlier version of the handbook was widely circulated in May 1996. The current version is considerably editorial tightened, but it is not substantially different.

There is a very good, short "Checklist of Key Issues to be Considered during Economic Analysis of Projects" which is located on the Africa Regional Guidelines and Procedures webpage. It is 4-5 pages in length, and so is very portable for taking along on mission or discussing with the TTL or project core team.

The Asian Development Bank Handbook is comprehensive, contains case studies on preparing urban and rural water supply, and has a glossary of terms not found elsewhere. However, in several places it advocates methods which are at variance with good economic practice, as pointed out by a recent Water and Sanitation Economic Review article. It uses "rule of thumb" constant elasticity estimates to evaluate changes over long periods of time and large real price increases. It also calls for long-run marginal economic cost pricing when, if applied to system extensions, will almost always yield excess profits for the system as a whole. The Handbook argues against fiscal subsidies to water systems while condoning cross-subsides. Lastly, its case study on rural water supply has been criticized for the quality of the demand-responsive model, as well as the decision to proceed with the funding of a project with a negative NPV. It has been suggested that the ADB document be consulted judiciously.

The Young document on measuring economic benefits is not specific to rural water supply and sanitation. However, it does explain at length different approaches to benefit estimation: 'input-output' method, revealed preference methods (travel cost and hedonic price), contingent valuation (including willingness-to-pay), etc. It also includes a section on residential water demand in developing countries, which explains the basic microeconomics underpinning the benefits side of the equation.

Economic Analysis of RWSS
Draft Checklist

√ **Gathering Existing Data:**

- √ Preceding World Bank and other projects in sector and related sectors in project area;
- √ Socio-economic baseline data in project area, financial and macroeconomic data as needed;
- √ Water supply (treatment) and health-related statistical data as specific to water-borne diseases and sanitation linkages;
- √ Cost recovery, O&M, and willingness-to-pay data in existence;
- √ Any information on effective demand, demand projections, price elasticity, etc;
- √ Prepare TORs and estimate budget for work as necessary to complete tasks as outlined below;

√ **Set Up Analytical Framework:**

- √ Understand project rationale: sectoral context within logframe, etc.
- √ Situate the "least-cost" alternative, across the same or an array of different outputs and benefits;
- √ Prepare a "with" and "without" project scenario;

√ **Prepare Cost Analysis:**

- √ Annex A of O.P. 6.50 as Bank standard cost table;
- √ Capital investment costs;
- √ Recurrent costs: Operations and maintenance, depreciation, etc.;
- √ Institutional development costs;
- √ Community development costs: organization, training, sanitation, hygiene, etc.
- √ Other issues on the cost side: shadow prices, contingencies & externalities

√ **Prepare Benefits Analysis:**

- √ Time savings;
  - √ Income vs. wage rate basis;
  - √ Seasonal variations: changes in volume (consumption);
  - √ Seasonal variations: distance and queuing (total time);
  - √ Willingness-to-pay studies;
- √ Health benefits;
  - √ Accrue to individuals;
  - √ Accrue to government/society;
- √ Increases in consumption;
- √ Increases in water use for productive / commercial purposes;
- √ Institutional and capacity building.

√ **Calculating and Testing Economic Viability**

- √ Calculating the economic internal rate of return (EIRR) and NPV;
- √ Standard country and Bank values;
- √ Sensitivity and risk analysis;
  - √ Impact of cost overruns;
  - √ impact of changes in time savings,

- √ impact of changes in health benefits;
- √ impact of changes in productivity benefits;
- √ impact of change in institutional benefits;
- √ impact in changes in per capita consumption;
- √ impact in changes in services fees for social investment funds;
- √ impact of changes in water tariffs water consumption pattern;
- √ impact of project delays

√ Switching values;

√ Distribution analysis and poverty impacts;

√ **Other Economic Issues Specific to RWSS**

- √ Targeted interventions;
- √ Measuring sustainability;
- √ Evaluating fiscal impact;
- √ Tariffs;
- √ Cost recovery;
- √ Demand-responsive analysis;

Notes on Setting Up The Analytical Framework

Ideally, an economist would want a project to start from a **demand analysis** in the proposed project area, from which the project determine the size, timing, and service levels of the project investments. However, the type of economic analysis performed usually derives from the way in which the project objective was formulated.

If the project is choosing amongst alternative technologies which deliver the same output, the economic analysis may follow a **"least-cost"** analysis. However, if multiple technologies are being offered to consumers, then a **"willingness-to-pay"** study to test for demand for each of the service levels may form the backbone of the economic analysis.

Either way, at this point, two important scenarios should then be established: a comparison between **"with"** and **"without" project scenarios**; and a **benefit-cost analysis** framework. Care should be taken to understand that "with" and "without" project differs from "before" and "after" project. Economic costs and benefits will be treated in detail below.

The minimum data to be considered in the construction of these scenarios is water consumption, and the price (economic cost- including time) with and without project. Other important information like population projections should be held constant in both scenarios (unless there is evidence that water availability will generate some migration to the project area).

The calculation of an internal rate of return and net present value, with sensitivity analyses and switching values, will be treated later in this paper. All of these are standard to Bank economic analyses for investment operations, so they will be highlighted in terms of issues particular to rural water supply and sanitation projects.

Notes on Preparing Costs Analysis

Notes on Capital Investment Costs

All incremental costs should be included in the analysis, even those that will not be financed by the project, but that are necessary to be incurred in order to enjoy the expected benefits of the project (these costs should be part of the economic analysis only and should not be part of the financial analysis). For example, in the case of household connections, most projects do not finance the investments needed at the household level (plumbing, installation of taps), or the connection and meter, even though they are required for the benefits to materialize.

All incremental investment costs as provided by the engineer for each level of service, including costs to be paid directly by the user, like water and sewerage connections, engineering designs, contingencies, supervision of works, promotion, community work, hygiene education and other associated costs, should similarly be considered as part of the costs, many of these costs are specific to RWSS, including only some contingencies may not be enough to capture all associated costs to the economy.

The cost of repositioning of investments should be included in all cases but is specially important when pumping is involved, as pumps and other electromechanical equipment should be replaced every 5 to 8 years. This is important in the cases were the benefit stream is projected to 15 to 20 years and benefits will not materialize. Most projects omit these costs.

Notes on Recurrent Costs

Most economic analyses completed do not explain whether they have included an estimate of the future stream of administration (including billing, collection, etc.), operations and maintenance costs in the investment costs of a particular technology. This costs must be included in all cases, they need to be projected during the life of the project and discounted and included in the calculation of the net present value. In projects with no investment cost recovery, a good estimation of administration, operation and maintenance costs are extremely important as this will be the basis for the tariff and for the sustainability of the investment. .

Notes on Other Issues on the Cost Side: Shadow Prices, Contingencies, and Externalities

Correcting for shadow prices and distortions: In many developing countries, unskilled labor in rural areas have a lower opportunity cost than that reflected by market prices that usually are based on a legal minimum wage. As most rural investments are intensive in the use of unskilled labor, it is important for the economist to reflect this value in the analysis, as in these situations the economic costs of investment and O&M could be considerably less than financial costs. Other transfers and distortions should also be corrected, at least those of substantial nature, and at the minimum taxes and subsidies should not be included in the economic analysis. Also, some costs, like the unskilled labor contributed by the community as a counterpart fund and any land that the municipalities provide as a contribution, should be assessed and included in the costs.

Standard versus actualizing methods for shadow prices and exchange rates: Although some projects seem to include some standard rates for the cost of physical contingencies, shadow prices for unskilled labor, and shadow prices for exchange rates, these are not recommended. Contact Maria for a small working table in Excel to estimate the shadow price of labor/skilled and unskilled. Some developing countries have estimated their shadow prices already and may only need an actualization. This is the preferred solution. Standard shadow price for labor and exchange rates will not serve the purpose of eliminating distortions in the economy.

O&M collection and hyperinflation: Economists are often asked to comment on the issue of financial sustainability, especially with regards to community savings accounts for operations and maintenance. If any amount of inflation or hyperinflation exists in the country, communities are wise not to hold currency in hand or in saving accounts. Two alternatives to propose to communities are to hold savings in spare parts, or to form an association of rural water and sanitation committees, then to open and hold a foreign currency account inside the country or nearby.

Externalities: Should be quantified when possible, specially important when the EA has defined that in the "with project scenario" there will be some damage to the environment. When competing uses are in place the true cost of water should be included in the analysis for example when irrigation is an alternative use—the project should include the opportunity cost of water. In absence of some type of treatment the project could pollute downstream and the opportunity cost should also be included as a cost. It is important to include negative externalities in the costs as positive externalities like impact on health should also be quantified when possible and included in the benefits..

Contingencies: Contingencies should not be standard in the Bank projects, but may be a standard number in the country and one that local engineers will be able to provide. Foreign price contingencies are estimated from O.P. 6.50, Annex B, "Guidelines on Expected Price Increases and Interest Rates," which should be updated periodically.

Notes on Preparing Benefits Analysis

Economic benefits of RWSS projects: The main benefits of RWSS projects are the resource savings that result from the substitution of bad quality, unreliable and/or expensive sources for improved water supply and or sanitation by the project. The incremental quantity of water supplied under a project can be divided into two parts: one part replaces the previous sources and quantity of water used, the other part is a net increase in water consumption. In this context, the benefit of the first part is equal to the savings of economic costs of consumers who no longer use the former water sources. These include time savings, reduced costs for alternative purification methods such as boiling the water, substitution of more costly sources such as bottled water and water tankers, and reduced costs for health related expenditures due to water borne diseases. The benefit of the second part is equal to the area below the demand curve between the with-project and without-project use of each consumer.

Time savings: Time savings can be calculated by estimating an annual household income, then collecting information on number of water fetching trips taken daily to the traditional source (with a specified distance), and amount of water carried in each trip. With additional information on average laborers per household, assumed hours of work per year, an average income per hour can be calculated. This can be converted to a labor cost per cubic meter, and compared to an expected labor cost per cubic meter when the improved source is installed.

Using an income versus a wage base: the time savings above uses a household income found for the country or region, then converts it to an estimated hourly wage rate. Annual household income could be higher than the sum of all wage earnings, if it also includes money sent from family members abroad or land rented out. However, it may be a reasonable approximation if non-wage earnings are thought to be small.

Women and children as wage earners: The setting of the appropriate income wage rate is open to some debate, as water fetchers are often children and women, who otherwise would not garner a competitive (read "full market") wage rate. Wage rates which appear in World Bank project preparation documentation range from adjusted wage rates equal from a low of 30% to a high of 100% percent of the rural wage rate.

Capturing seasonal variations I – changes in consumption: Before-project fetching and consumption patterns may need to be generated for both dry and rainy seasons. However, this may force you to think ahead, i.e. you may need to sample twice, i.e. during the dry season and the rainy season, or there would be a possibility of recall errors, i.e. respondents' faulty memory in relating how many basins of water are carried in last years' rainy season. Also, as total volume collected drops during the dry season, consumption patterns may change, including seeking access to multiple sources of water not usually accessed during the rainy season.

Capturing seasonal variations II – changes in travel times: In regions with substantial variability in surface water flows or ground water access to water during the dry season, time spent fetching may rise dramatically A proper accounting of the travel time to access water will sample twice, during the dry season, as well as during the rainy season, and will measure travel time to the primary source, as well as any time spent queuing there in peak hours.

Congestion effects: Establishment of an improved point source in the form of a hand-dug well or bore hole may often decrease the linear round trip distance from the household to the point source. However, total time spent fetching water may increase, as fetchers queue with their buckets to wait their turn. Also, households may increase their per capita consumption of improved water, thus leading to net increases in total fetching time per household after installation of the point source. These congestion effects can dampen economic rates of return which include a value of water based on value of time saved fetching water. A separate, cautionary effect of congestion is the possibility of fetchers reverting to the original unimproved source in lieu of standing in line Bank projects have both worked with service standards of supplying communities with sufficient numbers of water points per members (hand-dug wells 150 persons, boreholes 300 persons) and/or recommended cost-recovery methods to reduce peak load problems and 'outsider' free-riding.

Replacing other expensive sources and reducing copying costs: Other type of economic benefit results form the substitution of water from more expensive sources like bottled water and water bought from trucks. This information can be easily assessed from surveys in the project areas. In other rural water projects the costs of individual supply like the use of electric pumps with average of 3 to 5 year life is a major cost saving of the project. In other rural areas benefits of purified water can be measured on the savings of copying costs like the electricity used for boiling water.

Estimating health benefits with improved water supply and sanitation: The major disease relating to inadequate water supplies and sanitation is diarrhea, which primarily affects children under five. Most rural water supply and sanitation projects which attempted some form of quantification of improved health benefits relating to improved water quality chose reduced incidences of diarrhea as a "representative" case, i.e. one of several examples of health benefits attributable to improved water supplies. Quantification of this case included costs associated either with treatment in health facilities, not including travel time and costs to and from a local health clinic, or treatment with Oral Rehydration Salts or similar types of treatments bought locally and prepared in the home.

In the case that an analysis were to quantify the cost per avoided healthy year lost from diarrhea using a time horizon 10 years beyond the end of any given rural water supply and sanitation project, the project could stand on the cost-benefit ratio of that element alone. However, the project would need to implement, monitor and evaluate a hygiene education, knowledge, and practice component of the project, as well as an intensive and successful latrine construction component, in order to defend substantial health benefits due to improved water supply.

Splitting health benefits between the individual and Government: Most Bank projects which quantify health benefits specify those which accrue to individuals, i.e. cost savings from not purchasing medications, cost savings from not visiting clinics and doctors for waterborne-related diseases. However, there are also resource savings which accrue to Government from a reduction in waterborne diseases, i.e. supplying a public clinic with one less skilled practitioner. These savings are rarely captured in project analysis, even qualitatively.

Estimating increases in incomes from productive activities with improved water source as intermediate input: A few rural water supply and sanitation projects have quantified returns from productive activities making use of quantities of water drawn from improved water sources, that were not previously applied to that use prior to the installation of that improved source. One such example might be small patio gardens, which aggregated to a community or regional scale might be worth including.

There is some argument to be made that decreasing time spent fetching allows children more time spent in school and on homework and gives children and women more time to spend on other productive uses (weeding, winnowing, etc.) Quantifying this alternative productive labor within the context of rural water supply analysis is not often seen.

Representing the consumer surplus easily: There is some value to quantitatively representing the gap between supply and demand when the pre-project community is consuming low levels of water per day. Aconservative approach to economic analysis in terms of calculating benefits is to assume that there will be a constant level of liters per capita per day (lpcd) consumption preand post-project. Low levels of lcpd, i.e. in the 5-10 range, imply unmet demand and higher risk of exposure to waterborne diseases. Capturing the value of the gains to consumer surplus when the supply curve is shifted outward is one way to graphically represent the story in its most basic form. Price elasticity of demand for water is not easy to estimate for most rural communities, so it is not easy to start quantifying this story, unless, by luck, research work has been conducted in that area.

Other Economic Benefits:

Estimating institutional benefits from installation and training in use of community-managed water supply infrastructure: Similarly, as a large number of community standpipe operators, area mechanics, latrine artisans, water board accountants, etc. are trained and certified, these individuals benefits from their enhanced status in the local community. It is assumed that the average income of these private sector participants in the rural water supply and sanitation sector improve their wage rate by an average of 50 percent relative to that of unskilled rural labor.

Expressing other non-quantifiable institutional benefits from improved water supply: These include the benefits associated with the institutional strengthening of the capacity of communities and districts to plan and manage their water supply and sanitation services. Increased local institutional capacity can also extend to the planning and implementation of other rural development projects. Also, increased water quality associated with improved point sources can relate not only to its taste, color, odor, etc., but also to the improved reliability of its supply.

However, rural water supply projects which originate in health units or sanitation stand-alone components often approach economic analysis from the estimation of health benefits as primary economic valuation.

The role of willingness-to-pay studies: Willingness-to-pay studies can be a useful tool of analysis if used properly. The potential consumer is usually asked his or her willingness-to-pay for access to a certain benefit or asset (like a public standpipe within 500 meters). These questions are sometimes phrased in terms of ranges, and are called single- and double-bound, i.e. "would you be willing to pay up to $.50 per day to draw water from a standpipe located within 500 meters?" is an example of a single-bounded question. Willingness-to-pay questions are usually expected to be gathered in tandem with accurate data on household income, so that an estimate of household demand for a service as a percentage of monthly household income can be generated. Willingness-to-pay studies still are viewed as spurious survey tools; questionnaires must be very well designed and tested and the enumerators must be skilled. Willingness-to-pay studies tend to work better as the income and education level of the respondents increase, with the caveat that respondents will tend to understate willingness to pay for services currently being provided by the government at all income and education levels.

Notes on Calculating and Testing Economic Viability

Notes on IRR and NPV for RWSS

Most analyses in the Bank then calculate internal (economic) rate of return (IRR). This is calculated for one or more different technology options (open wells, handpumps, piped systems, latrines, sanitation services, etc.) and service levels (standposts, house connections, with meters, etc.) to be described in more below. The IRR is the discount rate which results in a zero net present value (NPV) for a project. This was usually not calculated in the first-generation of 'stand-alone' rural water and sanitation projects, but is usually done so now, although there may projects—rural population is usually declining, due to urbanization, and often project capacity is too high, accordingly and when cost recovery is part of the design then tariffs will be too high.

Standard figures to use: Some numbers that keep popping up in economic analyses:

- Hand-dug wells should serve no more than 150 persons;
- Bore-holes 300 persons;
- Beneficiaries should be located within 500 meters radius;
- Discount rates are in the 10-15% range;
- Opportunity cost of capital estimates of 10%;
- Costs of physical contingencies;

Distribution analysis and poverty impacts: Once the economic and financial net present value of the project has been determined the impact on the direct beneficiaries and the government (fiscal impact) can be calculated. The quantifiable impact is defined as the net present value of the benefits that the direct beneficiaries will receive in the with project scenario, that is the present value of the economic benefits after deducting the financial costs the direct users would pay (e.g. 30% of investment costs and total operation and maintenance costs).

Poverty impact: The distributive analysis is a good tool to estimate the poverty impact of the project. To do so you need to differentiate the beneficiaries of the project by income. (If a survey was conducted during project preparation then the income information could be derived from the survey's results.)

Notes on Other Economic Issues Specific to RWSS:

An economist's comment on "programs of targeted interventions": most team economists on rural water supply and sanitation projects might be asked to comment (or be held responsible) for justifying why a project is categorized as a program of targeted intervention. One commonly-held belief is that all programs that benefit beneficiaries with a median income below a certain threshold are necessarily programs of targeted interventions. A more rigorous application of this categorization would exclude most "demand-responsive" rural water supply and sanitation projects unless they were to include specific set-aside criteria or quotas for those communities with demonstrated need. If income level (or a demonstrated proxy that could not be easily falsified) was to serve as one of several selection criteria in community selection process, there would need to be a strict monitoring and accounting of selection procedures in order to ensure integrity of the poverty targeting. With regards to small towns water supply projects, tariff structures which cross-subsidized poorer households might qualify the project as one of targeted intervention.

Measuring sustainability: In strictest economic terms, sustainability should be measured by the ability of the responsible jurisdiction (community or municipalty) to pay for the full costs of the operation and maintenance costs, all administration costs, replacement costs of electromechanic parts replacement on a five years schedule, through implementation of a tariffs schedule. This measure of sustainability can be merged with other measures of sustainability: institutional, fiscal, etc.

Fiscal impact is the impact of the project on the government finances. It can be calculated by adding all incremental taxes the government will receive as a result of the project and deducting all incremental subsidies, including the loan and its associated financial costs (if the users are not expected to pay back the Bank's loan).

be several benefits named and left as qualitative and thus left as non-quantifiable, i.e. not included in the IRR. Thus the IRR can be said to be underestimated.

Calculating internal rates of return across technology options and service levels: Most of the rural water supply and sanitation projects prepared in the World Bank are demand-driven and offer the potential beneficiary communities a palette of technology options and service levels from which to choose. Most rural water supply and sanitation projects first prepare an initial economic evaluation of each of the different technology options, which calculates its net present value, internal rate of return, and cost-benefit ratio. There is usually a "base case" mix of technologies that is used upon which to estimate a net present value, internal rate of return, and benefit-cost ratio for the entire component or project. As the project is demand-driven, the actual result may be higher or lower based on the final technology mix and other variables.

Long-run average incremental costs: This technique is useful in determining incremental costs associated with the construction and subsequent operation and maintenance of new, additional capacity added to an existing system. Rehabilitation of existing systems would be considered increase in total water system uptake. Extending the concept of capturing long-run average incremental costs, were communities expected to cover the long-run marginal cost of water supply and sanitation, they would need to put into place tariffs which generate sufficient resources to meet the operations and maintenance costs of the system as well as to replace the investments after their useful life. This type of technique might be more applicable in small towns and peri-urban areas in middle-income communities.

Selecting and justifying the level of community contribution: Selection of the level of community contribution to the capital cost of the improved water supply provisioning is often made at the political level. However, there are certainly tools for measuring the extent to which the community is willing to shoulder capital costs of improved infrastructure. One such tool is willingness-to-pay studies, as described below.

Sensitivity analyses and switching values: Sensitivity analyses should be carried out on the most fundamental of assumptions in the analysis, with examples including the following:

To be reviewed on the cost side of the cost-benefit analysis --
- impact of cost overruns investment, O&M and replacement costs);

To be reviewed on the benefits side of the cost-benefit analysis --
- impact of changes in time savings,
- impact in changes in per capita consumption,;
- impact of changes in productivity benefits;
- impact of changes in institutional benefits;
- impact in changes in services fees for social investment funds;
- impact of changes in health benefits.

as well as other standard sensitivity values --
- impact on changes in population projections (population growth rates);
- impact of changes in water tariffs and water consumption pattern;
- impact of project delays.

Switching values usually refer to the amount of the increase (or decrease) in the value of one variable needed to invoke the change of the project from being economically viable or economically not viable, holding all other variables constant.

Impact of changes in the population growth rate:Especially important in RWSS projects because engineers tend to design these systems with same population projections as urban

An economist's perspective on the demand-responsive approach: When individuals are presented with a slate of technologies between which they are solicited preferences, often they are not fully informed as to the costs which accompany each technology choice. There is often an initial capital cost for the community to collect from each household, there is perhaps a 'follow-up' capital cost, there is usually a O&M cost collected through a variety of means (per bucket, per month, etc.), and there may also be additional costs to the household, such as the purchase of a meter. If these costs have not been fully disclosed and properly assessed during the decision-making process, the community may not select the proper "basket" of technologies. Also, the benefits accruing to each technology should be properly and fully represented to the communities. The economist may be best placed to list these benefits for each technology, in the process of preparing similar analysis for the project appraisal.

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