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EVALUATION OF THE PROVINCIAL WATER PROJECT IN THE PHILIPPINES

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EXECUTIVE SUMMARY

A Brief Description of the Study

The Provincial Water Project was designed by AID to expand and improve the existing water systems in five provincial cities in the Philippines and to foster the institutional development of the Philippines' Local Water Utilitie Administration (LWUA). Through improvement of the city water systems, it was envisioned that the project would achieve its goals of improved water quality and availability to residents of the urban communities and positive health and economic impacts. The first phase project was active between 1977 and 1983.

The evaluation study undertaken was highly quantitative and fairly broad in scope, and fully involved evaluators from the LWUA. It was designed to measu actual project output delivery as well as project purpose and goal achievemen The cities chosen for the study were Bacolod and Cagayan de Oro, which were selected for the project along with the Davao, San Pablo, and Tacloban cities In the two study cities, key health and economic status indicators as well as numerous water/sanitation indicators, were measured via three rounds of house hold surveys. These surveys were conducted before the project-sponsored wate system enhancements were made, again shortly after system improvements were completed, and still later approximately 5 years after completion of water system improvements.

In both cities, the surveys were conducted in areas served by the water syste (experimental areas) as well as in areas where water system improvements were not scheduled for the first phase of the project (control areas).

The key indicators of health status used in the study were incidence of diarrhea in young children and childhood nutritional status. The key economi impact indicators used were household-based, water-related economic activitie and water-fetching practices. Selected intermediate variables linking water to health such as household water use and hygienic practices, and access to sanitary facilities were also measured.

For a full description of the study methodology, see appendix B.

Major Findings in the Study Areas

IT WOULD APPEAR THAT THE PROJECT WAS FULLY SUCCESSFUL IN TERMS OF OUTPUT DELIVERY BUT WAS LESS SUCCESSFUL IN ATTAINING ITS ULTIMATE GOAL.

WATER SYSTEM COVERAGE INCREASED DRAMATICALLY during the project period. The number of active system connections increased from approximately 4,000 to 19,000 in Cagayan de Oro and from 4,000 to 13,000 in Bacolod. Survey estimates indicate an increase from 52 to 89 percent in Cagayan de Oro and from 37 to 54 percent in Bacolod in the proportion of households using the water systems as their major water source. An additional 4 percent of households in Cagayan de Oro and 19 percent in Bacolod were using the water systems as a secondary water source by the end of the evaluation period.

WATER FROM THE PROJECT WATER SYSTEMS WAS BEING USED by primary users of the water systems for all household purposes, and by secondary users and sharers for drinking and gardening purposes.

GENERALLY, HOUSEHOLDS WHICH USE THE PROJECT WATER SYSTEMS ARE OF HIGHER SOCIO-ECONOMIC STATUS THAN NONUSERS. Followup survey data reveal median monthly household incomes of 1,000 pesos for water system users in Cagayan de Oro as compared to 799 pesos for nonusers. The corresponding figures for Bacolod were 954 pesos per month for system users and 749 for nonusers. The magnitude of socioeconomic differences between system users and nonusers appears to have increased somewhat during the evaluation period. A significant differential in terms of socioeconomic status indicators was also observed when comparing user households which have their own connection with households which share another household's connection. NEVERTHELESS, A SIGNIFICANT NUMBER OF LOWER INCOME HOUSEHOLDS WERE PROVIDED ACCESS TO A RELIABLE SUPPLY OF WATER AS A RESULT OF THE PROJECT.

THE WATER DISTRICTS AND THE LWUA PERFORMED QUITE WELL TECHNICALLY during the evaluation period. Reliability of service and customer satisfaction improved significantly in both cities. In terms of convenience, fewer system user households were fetching, storing, and filtering water at the end of the evaluation period than at the beginning. Both water districts achieved substantial (i.e., greater than 50 percent) reductions in the volume of water lost through system leakages, illegal connections, etc.

THE QUALITY OF WATER AT THE SOURCE WAS CONSISTENTLY HIGH in both cities after the project system enhancements. The quality of water at the point of use, although significantly improved in one city (Bacolod), remained less than satisfactory in both cities due largely to improper water-handling practices by household members.

THE FINANCIAL PERFORMANCE OF THE WATER DISTRICTS WAS LESS POSITIVE. A substantial operating surplus was achieved in Cagayan de Oro only in the last full year of the evaluation period. The financial viability of the Bacolod water district remained tenuous despite two rate increases during this period.

THERE IS NO EVIDENCE OF A PROJECT IMPACT ON THE NUMBER OF HOUSEHOLD BUSINESSES. However, significant increases were observed in the proportion of system user households engaged in gardening for home consumption. Many households apparently also spent less time fetching water as a result of the project. The data do not, however, permit the economic value of these impacts to be calculated.

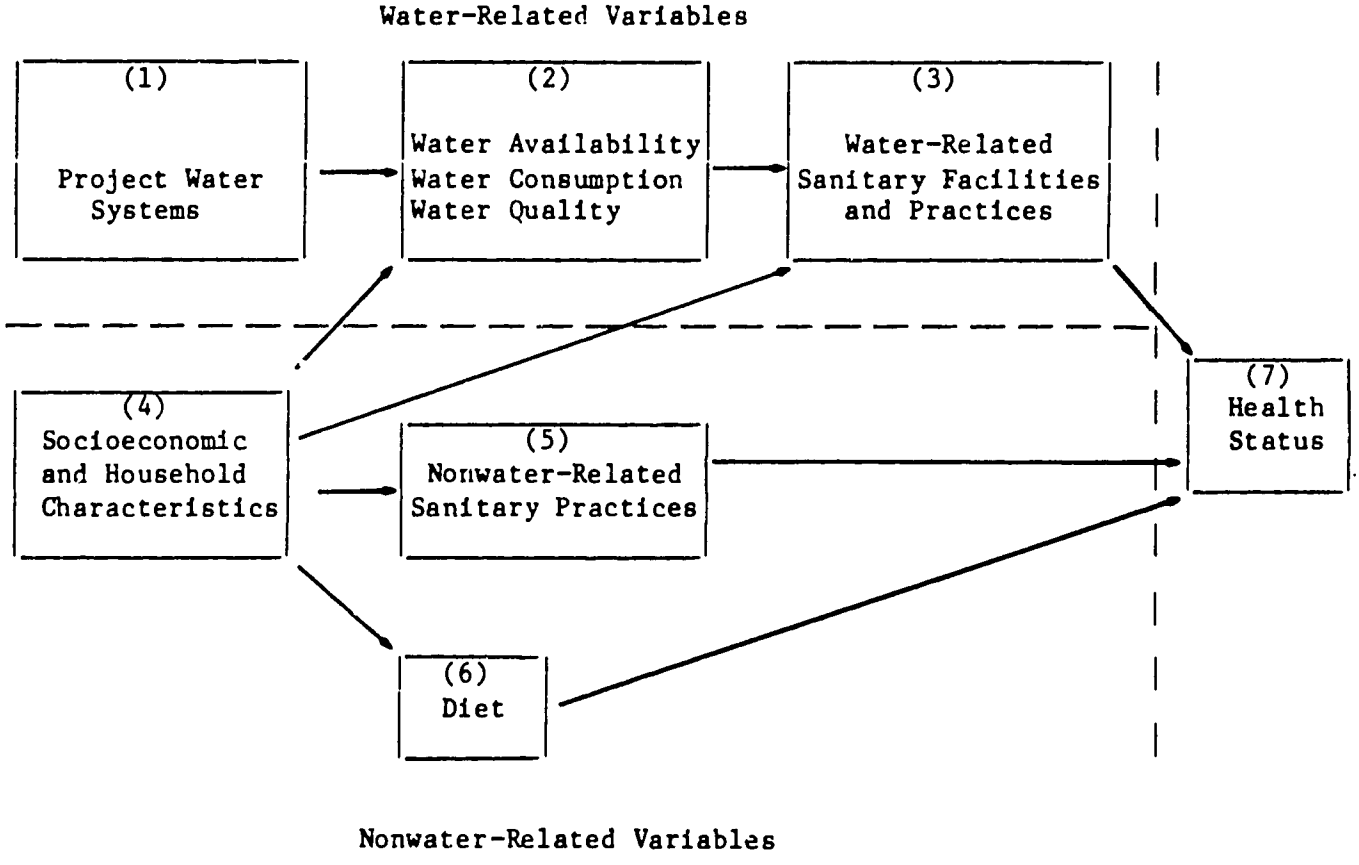
THE STUDY REVEALED NO CLEAR EVIDENCE OF A SUBSTANTIAL POSITIVE PROJECT HEALTH IMPACT. The observed changes in levels of childhood nutrition, the primary health indicator used in the study, for system user households were not significantly different from those for nonuser households in either city when changes in other factors were statistically controlled. There were, however, indications of favorable trends for user households in both cities. There is also the very real possibility that the project's health impacts were dampened

somewhat by generally deteriorating economic conditions during the evaluation period.

Exploring the Water Supply-Health Model

Multivariate analyses of the relationships between water and health variables were conducted as part of this study. For a detailed account of methodology and findings, see chapter 6.

These analyses were based upon the following analytic model outlining hypothesized causal relationships among water, sanitation, socioeconomic, and health variables:



The following observations may be made on the basis of our empirical testing of this model:

- The variables having the strongest impact on childhood health (7) were the nonwater-related variables, income (4) and diet (6).

- Of the water-related variables studied, there was no significant direct association between the source of water (1) and health (7) when socioeconomic variables were controlled. Installation of an improved water source alone was not found to be sufficient to result in improved health.

- Water quality (2) had a positive, direct impact on health (7) in one of the cities, but only among higher income households (i.e., households in the upper 25 percent of the income distribution). Poor water quality represented a major constraint to adequate nutritional status among children in the more affluent households but was only one of several factors contributing to substandard levels of childhood nutrition in lower income households.

- The "use of water" variables (2), including total consumption and frequency of water use for hygienic practices, had no significant direct effect on the nutritional levels of the children studied when socioeconomic factors were controlled. They were, however, found to be related to the incidence of diarrhea, an indicator used to measure short-term, water-related maladies. Since prolonged diarrhea contributes to malnutrition (the association between diarrhea and nutrition was, as in many other studies, found to be significant in this study), the water-use variables (2) can be said to indirectly influence nutrition levels.

- The "types of sanitary facilities used by households" variables (3), particularly the type of toilet and bathroom facilities, were found to affect nutrition and health directly. In fact, of the water-related variables, the "type of sanitary facilities" variables had the strongest net influence on health status.

The results of these cross-sectional analyses provide some insight into the factors underlying the observed changes in health indicators in the two cities. It was found that after controlling for the effects of income (4) and diet (6), some of the important sanitary facility (3) and water use (2) variables (i.e., the "intermediate" variables) improved for water system users in comparison with nonusers in Bacolod, while they did not improve to the same extent in Cagayan de Oro (see table 6.22). Given this information, our model would predict no significant positive change in health in Cagayan de Oro, but the possibility of an impact in Bacolod. The empirical evidence was consistent with these expectations--although the improvement in health indicators for city water user households in Bacolod was not significantly different from that observed for nonuser households. Thus, the observed improvements in health cannot be directly attributed to the project intervention.

Conclusions and Implications

1. PROVIDING IMPROVED WATER SERVICE TO HOUSEHOLDS WHICH ALREADY ENJOY A REASONABLE STANDARD OF LIVING AS WELL AS ACCESS TO ADEQUATE SANITARY FACILITIES AND SOUND HYGIENIC PRACTICES SHOULD RESULT IN IMPROVED HEALTH. On the other hand, providing improved service to households where those preconditions are not present is not likely to bring about significant health impacts (in the short term). A reliable source of potable water can therefore be thought of as a necessary but not sufficient condition for improved health.

2. SAFE WATER IN THE WATER SYSTEM PIPES MAY NOT REMAIN SAFE AFTER IT IS HANDLED AND STORED BY HOUSEHOLD MEMBERS. Education in proper water-handling and storage practices along with provision of improved sanitary facilities may also be necessary before health impacts can be realized.

3. LINKAGES BETWEEN WATER SUPPLY IMPROVEMENTS AND WATER-RELATED ECONOMIC ACTIVITIES WHICH RAISE THE STANDARD OF LIVING IN THE TARGET POPULATION SHOULD BE INCORPORATED INTO PROJECTS DESIGNED PRIMARILY FOR HEALTH-SECTOI IMPACTS. Residents of project areas should be encouraged to use water in ways which can improve their diet and, hence, potentially contribute to improved health. These ways include gardening and raising of pigs and chickens.

4. THE SANITARY ENVIRONMENT IN AND AROUND THE HOUSEHOLD HAS AN IMPORTANT EFFECT ON HEALTH. Realizing this, and the fact that these conditions vary greatly across project settings, it is critical that an assessment of local conditions be made at the beginning of future water-supply improvement projects in order to prescribe an appropriate mix of project outputs.

Methodological Considerations

In addition to monitoring project implementation and measuring project healtl impacts, this evaluation was designed to contribute to the development of a methodology for future evaluations of similar projects. Several lessons regarding appropriate study methodologies were learned or reinforced during the evaluation:

- This study has shown that an examination of short-term intermediate variables alone could have been misleading. If a study is designed to measure achievement of long-term health impacts, there may be no quick or inexpensive alternatives to a large-scale, long-term study of this type.

- In a prospective study lasting more than a relatively short time, quasi-experimental design studies are likely to deteriorate over the life of the experiment due to migration into and out of the study population and other external factors. Under such conditions, it is very difficult to attribute observed changes unequivocally to the project intervention.

- The use of a geographically distinct "control" group in an experiment of this type tends to introduce exogenous influences ("noise") into the data. It may be more efficient to study the "treatment" population intensively and assess the impact of the project intervention through the comparison of changes for subgroups which vary in terms of duration and intensity of exposure to the project intervention.

- The 5 years allowed in this study for health impacts to appear may not have been sufficient for those impacts to mature, if only because the requisite behavioral changes in the study population (e.g., improved

water-handling and sanitary practices) do not occur that quickly. This may be true even when all elements of the population are exposed to the project for the entire study period. In this study, many of the "user" households had been using the water systems for only a short time prior to the followup survey.

- Consistent data collection and processing procedures, close supervision by one party involved throughout the entire life of the experiment, and a carefully thought out study design are critical requirements for the success of this type of study. Many of the important health and economic impact indicators are difficult to measure accurately and are quite sensitive to even minor changes in field and processing procedures. In this project evaluation, some potentially useful morbidity data were lost because of poor quality control procedures during portions of the baseline survey.

- Future studies using nutritional anthropometry to measure health impacts should also measure, in greater detail, dietary intake and related variables which have a significant impact on health. Given the large effect of these variables on nutritional status, it is important that variations in these variables be taken into account when attempting to assess the influences of water on health.

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CHAPTER 1

PROJECT BACKGROUND AND STUDY OBJECTIVES

A. PROJECT BACKGROUND

The Philippines Provincial Water Project (AID project number 492-U-033), jointly sponsored by the Government of the Philippines (GOP) and the U.S. Agency for International Development (USAID), was formulated in 1974 with two primary objectives: (1) the development of water systems in selected urban areas of the Philippines which would provide potable water on a reliable and economic basis to a significant proportion of the population of the project cities, and (2) the development of the technical and institutional capability to extend such service to other cities in the Philippines (U.S. Agency for International Development 1974). To achieve these objectives, the project provided funds to replace the aging and inadequate water systems in selected cities with modern systems that included new wells, treatment plants, storage reservoirs, pumping and distribution systems, and administrative and support facilities. Financial and technical assistance was also provided to foster the institutional development of the Local Water Utilities Administration (LWUA), the project implementing agency.

The immediate beneficiaries of the project were to be residents of the urban communities chosen for the project. USAID/Manila estimated that as of 1978 the existing water systems in the project cities served only about 30 percent of project city households. It was anticipated that by the end of 1982 (the end of the first phase of the project), 50 to 60 percent of households in the project cities would be using the water from the new systems, with the extension of service to continue under secondary phases of the project.

Benefits from the project water systems were expected to accrue in several domains. In terms of health, it was anticipated that access to an adequate supply of potable water would play a significant role in reducing the incidence of several waterborne and waterbred diseases, most notably gastrointestinal diseases in young children, passed through the oral-fecal route of transmission. It was anticipated that the water systems would help break the oral-fecal route of disease transmission both by reducing the level of water contaminants at the source as well as by permitting the adoption of water-handling and excreta-disposal practices which would reduce the level of environmental pollution of existing water supplies and distribution facilities.

Direct and indirect economic benefits were also anticipated. Direct economic benefits included an increased capacity of households to engage in water-related activities involving the production of income and the processing of goods for home consumption. Indirect benefits involved the time saved from fetching water, which could potentially be used for other productive purposes.

The project loan agreement between the GOP and the USAID establishing funding for water systems in five provincial cities was signed on May 23, 1974. The urban localities selected for the project were Bacolod (Negros Occidental),

Cagayan de Oro (Mindanao), Davao City (Mindanao), San Pablo (Luzon), and Tacloban City (Leyte).[1] The LWUA, the agency responsible for the financial and technical operations of the local water districts in the Philippines, was designated as the project implementing agency by the GOP.

By the beginning of 1979, the project-funded water systems in each of the five project cities were operational. Extension of the systems' coverage continued throughout the 5-year project period, with all system expansion after 1980 being funded by loans which the local water districts obtained from the LWUA.

B. EVALUATION STUDY BACKGROUND AND OBJECTIVES

One of the conditions precedent to the loan agreement was that an evaluation study be conducted to assess water-system performance levels and project impacts on health and economic development. The project evaluation was requested by the USAID for the following purposes:

(1) To provide information on the health and economic impacts of water-system improvements in water systems in urban areas of developing countries,

(2) To assess the performance of the LWUA in constructing and maintaining the water systems, and

(3) To establish a framework for the evaluation of future water projects.

A major concern in developing the evaluation plan for the Provincial Water Project was that a fundamentally sound approach to the impact evaluation of AID water projects be initiated. It was recommended that the basic study design be expandable to accommodate larger, more comprehensive studies, reducible for smaller special-purpose studies, and applicable to projects in other developing countries.

A plan for conducting a 5-year evaluation study in three of the five project cities was developed in 1975 (Silver, Keeve, and Warner 1975). The proposed evaluation plan required data from household surveys that would be conducted at three points in time in both project and nonproject areas in each of the cities. The evaluation study was designed to investigate the following specific questions:

(1) How are the improved water systems performing?

(2) Who is using the water from the new systems?

(3) What are the short-term benefits to the users of the new systems?

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[1]Baguio (Luzon) was also included among the project cities at the outset of project planning, but was later eliminated.

(4) What are the long-term health, economic, and social benefits to the users of the new systems?

(5) Are there causal relationships between the improved water systems, water use, and the observed short- and long-term benefits?

(6) What are the preferred health and socioeconomic measurement techniques for this type of evaluation study?

A slightly modified version of the proposed evaluation study was carried out in two of the five project cities, Bacolod and Cagayan de Oro, from 1977 to 1983. The study was carried out jointly by the Research and Evaluation Division of the LWUA and the International Statistical Programs Center (ISPC), U.S. Bureau of the Census.

The study's key impact indicators and explanatory variables were measured via three rounds of household surveys. The first survey round (the baseline survey) was conducted prior to project implementation; the second (the interim monitoring surveys) 1 to 2 years after completion of the water-system improvements; and the third (the followup survey) approximately 5 years after completion of the water-system improvements.

The key health indicators used in the study were measurements of nutritional status and incidence of diarrhea among young children. For methodological reasons, nutritional status was the principal variable used in the analysis of health changes over time (see appendix B for justification). The economic indicators used included the proportion of households engaged in water-related activities for producing income or goods for home consumption, and the amount of water fetched by households.

Project effects and impacts were assessed by comparing changes in key indicators among two separate groups of households (i.e., experimental and control groups). The first comparison was between households located in areas which were served by the project water systems during the evaluation period (experimental areas) as opposed to those in areas which were not served during the first phase of the project (control areas). The second comparison considered households which were actually using the city water systems versus households which were not.

All comparisons of relative changes over time were tested for statistical significance using conventional procedures for tests of differences between means and proportions (i.e, t-tests). The health data were subjected to multivariate analyses in order to control for the effects of initial differences and changes over time in the composition of the experimental groups and in other exogenous factors.

The evaluation study design and research methodology are described in greater detail in appendixes A and B.

SUMMARY OF FINDINGS AND POLICY IMPLICATIONS

A. PROJECT OUTPUTS

1. Physical Improvements

The major project-funded physical improvements to the water system in Cagayan de Oro consisted of the construction of five deep wells with pumping stations and chlorinators, the construction of a 1.4 million gallon reservoir, and the installation of 73,000 meters of water mains. In Bacolod, nine deep wells with pumps and chlorinators and a 2.6 million gallon reservoir were constructed, a 1.0 million gallon reservoir was rehabilitated, and more than 116,000 meters of water mains were installed. See appendix D for full documentation of these improvements.

2. Service Coverage

Before their enhancement, the water systems in each of the study cities served approximately 4,000 active connections. During the 5-year study period, the number of active connections quadrupled in Cagayan de Oro and nearly tripled in Bacolod.[1] On the basis of survey estimates,[2] the Cagayan de Oro water district increased its coverage of project area households from 52 percent at the time of the baseline survey to approximately 89 percent at the end of the study period. The latter figure does not include 4 percent of the households which were using the city water system as a secondary source of water. The Bacolod water district increased its coverage from 37 to 54 percent, with an additional 19 percent using the city water system as a secondary source.

3. Performance of the Water Systems

From a technical point of view, the Bacolod and Cagayan de Oro water districts performed quite well during the study period. Both achieved substantial reductions (greater than 50 percent) in the volume of water unaccounted for (i.e., wastage due to system leakage, illegal connections, etc.). Both also conducted periodic bacteriological analyses of water samples which indicated that, by the end of the study period, over 90 percent of the samples tested were meeting the Philippine national safety standard. This represents a significant improvement in Bacolod, where only about two-thirds of the samples

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[1]Included in these figures are "in-house" piped connections, as well as community taps and pumps. The data provided by the water districts did not indicate the distribution of active service connections by type.

[2]The estimates of water-system coverage pertain only to the city areas which were designated as targets for the first phase of the project. See appendix B for definitions of the target populations in the two study cities.

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analyzed in 1979 met the national standard. In Cagayan de Oro, more than 90 percent of the water samples met the national safety standard every year of the study period. This is roughly comparable to the quality of water measured prior to project implementation.

According to the survey data, both water districts succeeded not only in extending their service to previously unserved households but also in improving system reliability. The proportion of user households reporting that water was available to them 24 hours per day increased during the evaluation period, from 90 to 99 percent in Cagayan de Oro and from 89 to 95 percent in Bacolod. Significant increases in the proportion of users reporting satisfaction with the service were also observed in both cities. Satisfaction among user households increased from 47 to 98 percent in Cagayan de Oro and from 72 to 95 percent in Bacolod.

The financial performance of the two water districts was less positive. The Bacolod water district showed net year-end income in only 1 of the 5 years in the study interval (despite two rate increases). While the Cagayan de Oro water district showed net income in 4 of the 5 years (with only one rate increase), it did not achieve a significant operating surplus--17 percent of revenue--until the last full year of the evaluation period.

Detailed data on project outputs are presented in chapter 3.

B. PROJECT EFFECTS

1. Access to the City Water Systems

The evaluation baseline survey indicated that the households which were using the Cagayan de Oro and Bacolod water systems prior to project implementation were of somewhat higher socioeconomic status than nonuser households. This pattern was still apparent at the end of the evaluation period, although a substantial number of lower-income households had gained access to the water systems in both cities (particularly in Cagayan de Oro) during the project period.

A sharper distinction in terms of socioeconomic status was apparent between connected households (customers of the water districts) and households which shared the connection of another household. These "sharer" households were (aggregately) the most economically disadvantaged among the project area households in both cities.

These patterns very likely reflect the differential ability of households to pay for city water service. Followup survey data show that primary users in both cities paid (on average) 1.5 times more per gallon of water and 6 to 10 times more in monthly water expenditures than nonusers. These figures also reflect a higher per capita consumption of water for primary user households.

2. Accessibility of Water

The data indicate clearly that the improvements in service coverage and reliability (in terms of 24-hour availability) resulted in greater convenience for the water-system users. Significant declines were observed in the proportions of user households fetching, storing, and filtering water for home consumption. A significant decline in the average distance from the house to the major water source was also observed in Cagayan de Oro.

3. Effects on Household Sanitation

The evidence regarding project effects on household sanitation and sanitary practices is mixed. On the positive side, significant increases in the proportions of user households with in-house toilets and enclosed bathrooms (both of which were found to be associated with better health) were observed in both cities. The presence of these facilities is linked to the project intervention to the extent that it is dependent upon a reliable supply of piped water. A significant increase in the proportion of user households using closed-sewer systems for disposal of waste-water was also observed in Bacolod.

There do not appear to have been any changes in the frequency of washing/bathing among user households in either city during the evaluation period. The data suggest, however, that this aspect of household sanitation was already adequate in the study populations.

4. Water Quality in the Household

The findings regarding project effects on another aspect of household sanitation, the quality of water at the point of use, were decidedly less positive. As noted previously, the results of both water districts' bacteriological analyses consistently showed high quality water at the source by the end of the project period. However, analyses of samples taken from the drinking-water supply of user households indicated that only 13 percent of such households in Cagayan de Oro and 51 percent in Bacolod were drinking water which met the national safety standard at the time of the followup survey. Further analyses suggest that the difference between the water quality at the source and the water quality at the point of use is primarily due to inadequate water-handling practices (e.g., the use of unclean water taps and containers for fetching and storing water).

Thus, the project was more successful in improving the water districts' ability to produce water which meets the national safety standard than in improving the quality of the water actually consumed by households using the water systems. It should be noted, however, that the percentage of households with water samples tested as safe improved significantly (from 32 to 51 percent) in Bacolod during the evaluation period.

C. PROJECT IMPACTS

1. Economic Impacts

There is some evidence that the project intervention had a positive economic impact. Both cities showed significant increases in the proportion of households engaged in nonincome-generating gardening activities and significant reductions in the amount of water fetched by user households. The former indicator was viewed as a measure of potential savings on food expenditures and improvement in diet, while the latter was conceptualized as an indicator of increased opportunity for household members to engage in other productive activities. There was no evidence, however, that participation in income producing water-related activities had increased during the evaluation period.

The magnitude of the economic impact is somewhat difficult to assess because the observed changes are nonmonetary in nature and depend largely upon other factors which were not measured as part of the evaluation effort. With regard to potential food expenditure savings and dietary improvement resulting from gardening activities, the actual benefit derived by city water user households depends upon such factors as the types and quantity of food grown, the substitutability of food produced for food purchased, the size of the household, etc. Similarly, the economic benefit derived from time savings in fetching water is entirely dependent upon whose time is saved and how it is used.

Thus, while the analyses indicate that the project increased the city water users' potential for economic gain, the magnitude of the gains cannot be quantified with the data available.

2. Health Impacts

a. Longitudinal Analyses

The study revealed no conclusive evidence that the project had a substantial health impact during the evaluation period. There were, however, marginal indications of favorable health trends for the project's beneficiaries as well as the possibility that the project's health impact may have been dampened by exogenous factors.

Multivariate analyses of changes in nutritional levels for children 0 to 4 years old (the primary health impact indicator used in the study) revealed no significant differences between the trends for users and nonusers of the water systems in either city. In Cagayan de Oro, childhood nutrition levels in user households remained more or less stable during the study period, while those for nonuser households declined somewhat. In Bacolod, a statistically significant improvement for user households was observed, although this improvement was not significantly different from that observed for nonuser households.

These results are not suggestive of a substantial project health impact. However, other factors should be considered before concluding that there was no impact at all. First, the signs of the parameter estimates (obtained from

logistic regressions) for user households in both cities were uniformly positive, suggesting that the trends over time were in the hypothesized direction. Second, given the rapid deceleration of economic growth in the Philippines during the evaluation period, it is entirely possible that any positive influence of the project may have been offset by generally deteriorating economic conditions in the study cities. This proposition is supported by the study finding that childhood nutrition levels are more sensitive to variations in standard of living indicators than to variations in any of the water variables included in the study. No direct evidence is available, however, to substantiate this interpretation.

All things considered, the most reasonable conclusion emerging from the analyses of changes in nutrition levels of young children would be that the project intervention had at best a marginal impact on health.

b. Cross-Sectional Analyses

Analyses of the cross-sectional relationships between the socioeconomic, water, and sanitation variables, and the health indicators in the followup survey data yielded several interesting findings. Specifically, the following observations may be made.

First, while most of the water-related variables included in the analyses behaved as expected (i.e., were associated with the nutritional status in the anticipated manner), the magnitude of their effects was generally small in relation to that of the standard of living and diet variables studied.

Second, there is little evidence of a strong, direct association between water source and nutrition. The data suggest quite strongly that the manner in which water is handled and used to improve environmental sanitation has a more telling effect on health than the source of water per se.

Third, the statistical associations between the water/sanitation variables and diarrhea were considerably stronger than the associations between these variables and childhood nutrition. However, since the presence of diarrhea was found to be strongly associated with undernourishment, an indirect association between the water/sanitation variables and nutrition is suggested. These findings are consistent with the study's analytic framework which hypothesizes that the water/sanitation variables affect nutrition through frequent and/or prolonged bouts of diarrhea or other gastrointestinal infections.

Finally, of the water-related variables included in the study, those measuring the types of sanitation facilities used had, overall, the strongest total effects on health.

The results of these cross-sectional analyses and the monitoring of changes in the water/sanitation variables during the study period suggest an explanation for the trends observed in childhood nutrition levels for water system users in the study cities. In Cagayan de Oro, where user households did not show a measurable improvement in childhood nutrition levels during the study period,

there was little evidence of significant improvements in the water/sanitation variables which were found to be most strongly associated with adequate nutrition.

However, in Bacolod, where city water users did show a significant improvement in nutrition levels (on an absolute, but not a relative, basis), there were coincidental improvements in several of the water/sanitation variables having the strongest effects on health. This apparent correspondence between changes in water/sanitation variables and in childhood nutrition indicators for users of the project water systems in the two study cities provides further empirical support for the linkage between water and health.

The reader is referred to chapter 6 for a detailed presentation of these findings, a discussion of some of the limitations of the analyses performed, and a discussion of issues warranting further research using the data collected for this project evaluation.

D. IMPLICATIONS OF THE STUDY FINDINGS FOR FUTURE AID WATER PROJECTS

1. Effectiveness of Water Supply Projects in Producing Health Impacts

The effectiveness of water supply projects is considered here on an absolute and on a relative basis. In terms of absolute effectiveness, this is one of a number of water supply project evaluations which have failed to demonstrate conclusively and unambiguously that this type of project has a significant health impact. Yet, like several others, this evaluation presents findings which are not unequivocally negative. Indeed, it provides marginal indications of a positive health impact and considerable evidence of changes in the water/sanitation variables, which (according to the research literature) are necessary conditions for improved health.

The cumulative findings of this and other evaluations of water supply project interventions suggest, however, that the short-term health impact of such projects may not be as substantial as anticipated. It would seem reasonable to assume that access to an adequate water supply and appropriate sanitation facilities are necessary conditions if health levels in developing-country settings are to approach those of the developed countries. In fact, a plausible argument can be made that the long-term impact of other health sector interventions (including those having more substantial short-term effects) depends largely upon the extent to which overall environmental sanitation conditions are improved. In this sense, water supply project interventions might be considered more effective in providing the "foundation" for health improvements in the long term than in providing impacts directly in the short term.

There would appear to be a growing consensus that water supply interventions are not particularly cost effective in comparison with other health-sector interventions, at least in the short run. Research reported by Warren and Walsh (1979) suggests, in fact, that such interventions are among the most expensive in terms of "payoff" (measured in terms of number of infant deaths

averted) in relation to cost. The evidence provided by this evaluation does not contradict this contention.

2. Assessing the Critical Needs of the Target Population

The results of this evaluation provide further support for the proposition that the social, economic, and environmental contexts within which water supply projects are undertaken are critical determinants of their success. Since comprehensive discussions of the social and economic preconditions for successful interventions are available elsewhere,[3] greater attention is given here to describing a "system" that links water availability, usage, and health.

It is generally accepted that there is a complex network of relationships between the provision of water and ultimate health impacts.[4] This network of relationships can be seen as an overall "water supply and use system." The results of the analyses performed for this report point to multiple "dependencies" among the water, sanitation, economic, and health variables studied. While the water/sanitation variables do have some bearing upon health, the economic and environmental conditions facing populations in which water supply interventions are programmed appear to be strong determinants of the magnitude of the health impact realized. This result is consistent with the "Threshold-Saturation Theory" proposed by Shuval et al. (1980). Water supply interventions introduced into economically disadvantaged populations with inadequate diets and without access to (or the ability to gain access to) adequate sanitary facilities would appear to be unlikely to produce the intended results in the short term.

Also important is the complementarity between sanitary facilities/hygienic practices and water supply. The data collected for this evaluation suggest very strongly that the manner in which the water is handled and the sanitary facilities which are made possible by the improved water supply are more important than the quality or quantity of the water consumed per se. This is illustrated clearly by the study finding that water quality is associated with better nutrition (when other factors are controlled) only among the higher-income groups who have access to these facilities. Water thus represents a necessary but not sufficient condition for health improvements.

Water supply interventions should consider not only the extension of service coverage and the improvement of the water quality at the source; they should consider also the distribution system's efficiency in providing quality water at the point of use (which requires proper handling practices by system

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[3]See Warner (1981) and Shuval et al. (1980) for discussions of necessary preconditions, development thresholds, and complementary investments.

[4]Several authors, including Carruthers (1973) and Feachem et al. (1978), have argued that this network of relationships is so complex that water/sanitation interventions should be planned as part of an overall integrated development program rather than as a single input.

users), the types and adequacy of the sanitation facilities supported by the intervention, and the extent to which the behavior and practices of the "treatment" population change in response to the intervention. In short, there must be changes in other water/sanitation variables if health impacts are to materialize.

Furthermore, given the variability in hygienic/sanitation practices and facilities in different settings of developing countries, water supply interventions must be designed on a setting-specific basis if impacts are to be realized. In the Philippines, for example, since the hygienic practices of the study populations with respect to washing were apparently adequate, this part of the "system" did not need further attention. However, there were other parts of the system, such as the water quality at the point of use (particularly in Cagayan de Oro) and the use of sanitation facilities, which were not adequate and which are in need of further improvement. Thus, emphasis on different components of the system may be required, depending on the developing-country setting.

In summary, this and other studies indicate that it is most important that research into the water-related behavior and needs of the target population precede or be a major part of the project design process.[5] The research should indicate which elements of the larger water-supply and use "system" need improvement. Once determined, the appropriate components can be integrated into the project. The following measures may be necessary, depending upon existing conditions:

(1) Instructing the population in proper hygienic practices;

(2) Encouraging the population to use existing sanitary facilities that provide a more sanitary environment in and around the house; and/or

(3) Instructing the population in proper water-handling practices.

If adequate sanitary facilities are not available in the area, then the construction and promotion of such facilities should be considered as an integral component of the project.

The preproject research should also investigate ways in which water can be used to enhance the diet and economic well-being of the target population. Small-scale food production activities might be encouraged, especially if the major constraint to such activities is an adequate water supply.

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[5]The planning model proposed by Warner (1981) would be a useful guide in this preproject research.

3. Impact Evaluations of Water Supply Projects

One of the objectives of this evaluation effort was to develop a methodology for future impact evaluations of AID water supply projects. A number of methodological lessons emerge from the more than 6 years that the Bureau of the Census has been involved in this project evaluation. These are discussed in appendix C.

In brief, there would not appear to be justification for replicating this study's research design in future water supply project evaluations. This design has several problematic aspects, including the use of quasi-experimental groups and the length of the study period required, which suggest the need for alternative methodologies. Another problem is that the phenomena studied in an evaluation of this type are quite complex and perhaps not amenable to sufficiently precise measurement within reasonable resource constraints.

There remains a need for further testing of smaller-scale, cheaper, and more efficient methods of evaluating water supply improvement projects. These methods may necessarily favor the measurement of short-term project effects instead of long-term health impacts.

PROJECT OUTPUTS

A. IMPROVEMENT AND EXPANSION OF THE WATER SYSTEMS

This section describes the project-sponsored expansion of the city water systems in Cagayan de Oro and Bacolod. In Cagayan de Oro, five deep wells with pumping stations and chlorinators were constructed along with a 1.4 million gallon reservoir. In Bacolod, nine deep wells with pumps and chlorinators as well as a 2.6 million gallon reservoir were constructed, and a 1.0 million gallon reservoir was rehabilitated. Over 73,000 meters of water mains were installed in Cagayan de Oro and more than 116,000 in Bacolod. The physical improvements resulting from the project are documented more fully in appendix D.

1. Growth in the Number of Service Connections

Cagayan de Oro and Bacolod had approximately 4,500 active connections each when the construction of the new water systems was completed in 1978 and 1979, respectively. Over the next 5 years, the number of connections quadrupled in Cagayan de Oro and nearly tripled in Bacolod (see table 3.1).

Table 3.1 Total Active Connections, by Water District: 1977 to 1982

Year	Cagayan de Oro				Bacolod			
	1st qtr.	2nd qtr.	3rd qtr.	4th qtr.	1st qtr.	2nd qtr.	3rd qtr.	4th qtr.
1977.....	4,032	4,167	4,311	4,507	(NA)	(NA)	(NA)	(NA)
1978.....	4,741	4,958	5,824	6,627	4,286	4,332	4,363	4,375
1979.....	7,543	8,124	9,206	10,118	4,414	4,540	4,997	6,016
1980.....	11,007	11,962	12,824	13,479	7,738	8,746	8,961	9,370
1981.....	14,147	14,811	15,682	16,415	9,709	10,396	10,689	10,980
1982.....	17,026	17,715	18,458	19,056	11,479	11,808	12,318	12,753

NA Not available.
Source: Cagayan de Oro and Bacolod water district records.

The most rapid growth in the number of connections in both cities occurred immediately after the completion of the project. The number of connections in Cagayan de Oro increased by an average of 13 percent per quarter in 1979, the year after the system was completed. In Bacolod, the number of connections increased by 19 percent per quarter during the year after the system was completed. By 1983, the quarterly growth rate had slowed to approximately

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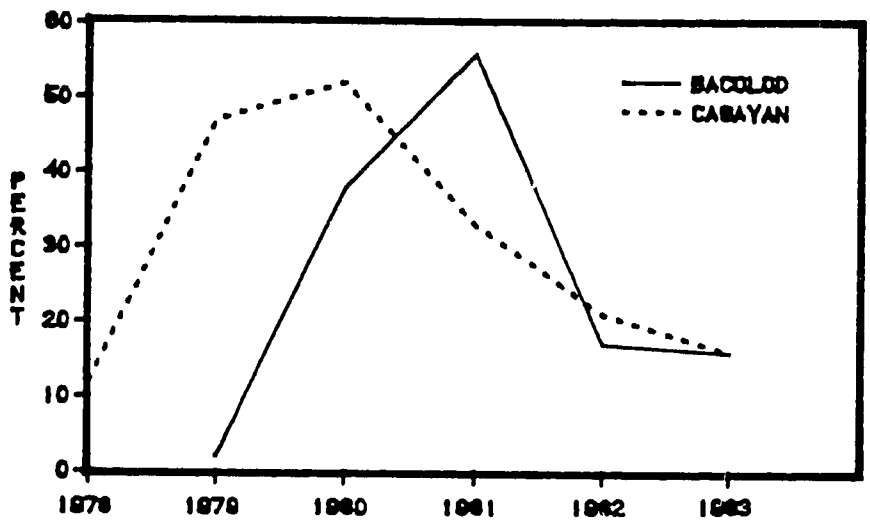
4 percent in each city. Figure 3-A shows the growth rates of each city system connections from 1978 to 1983.

Figure 3-A Growth Rate of Active Connections



2. Growth in the Volume of Water Delivered

The volume of water produced by the water districts and delivered to customers increased markedly since project completion. Tables 3.2 and 3.3 indicate the amount of water actually consumed by the customers. Table 3.2 shows that total water consumption grew roughly proportionally with the number of new connections. Overall, the average quarterly consumption of city water per connection remained nearly constant in both cities since 1979, with only a minor upward tendency.[1] The average water consumption per connection was greater in Bacolod than in Cagayan de Oro from 1978 to 1982 (see table 3.3).

3. Service Coverage of the Target Population

The 1983 followup survey data indicate that 89 percent of the project area households in Cagayan de Oro and 54 in Bacolod used the city water system as their major water source. Of these "primary users," 70 percent in Cagayan de Oro and 68 percent in Bacolod were customers of the water district. The others were "sharer" households, which used another household's connection as their major water source (see figures 3-B and 3-C).

[1]The figures found in tables 3.2 and 3.3 refer only to consumption of city water. They do not include consumption from other sources.

Table 3.2 Total Water Consumption and Growth Rates of Active Connections, by City: 1977 to 1982

Year	Cagayan de Oro		Bacolod	
	1,000 cubic meters	% increase from previous year	1,000 cubic meters	% increase from previous year
1977....	1,846	(NA)	2,084	(NA)
1978....	2,013	9	2,309	11
1979....	3,750	86	2,758	20
1980....	4,910	31	4,911	78
1981....	5,639	15	6,507	33
1982....	7,082	26	7,233	11

NA Not available.
Source: Cagayan de Oro and Bacolod water district records.

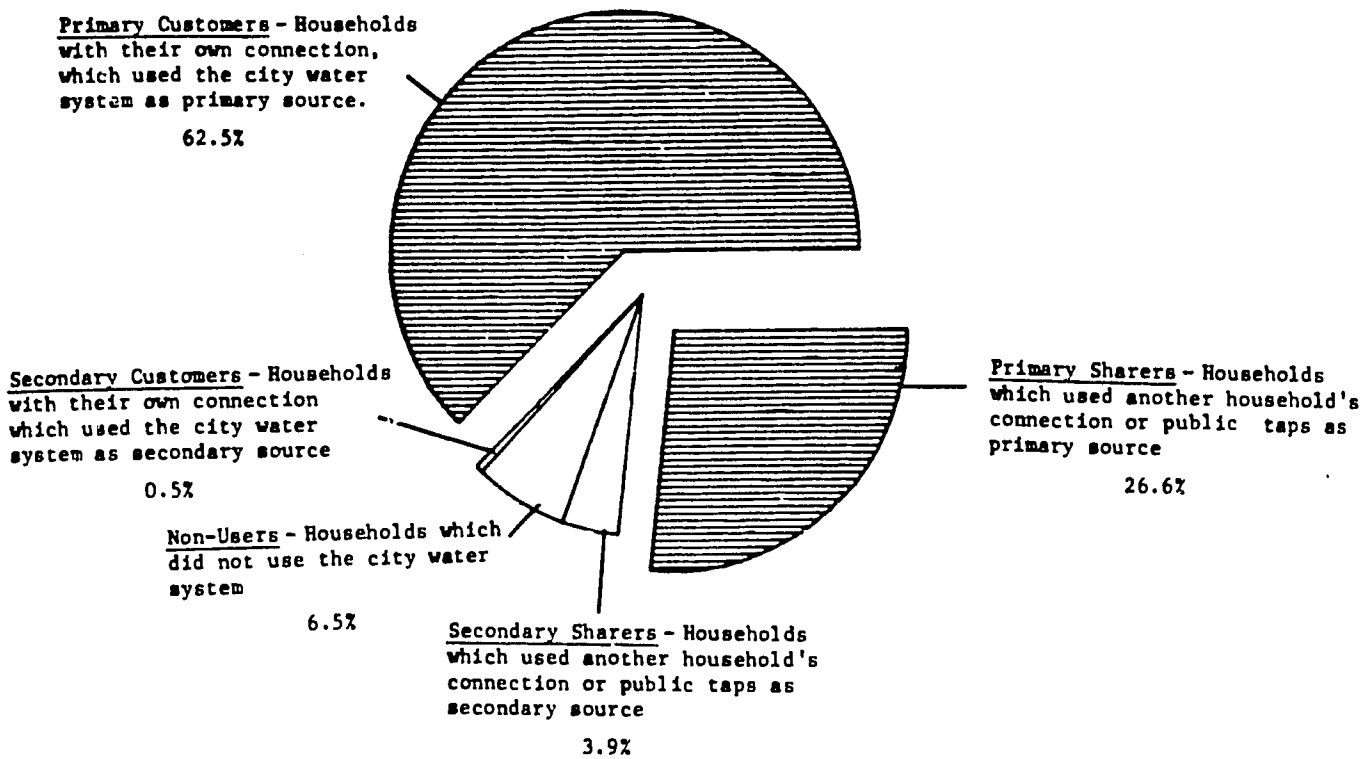
Table 3.3 Average Quarterly Water Consumption per Connection, by Water District: 1977 to 1982

[In cubic meters]

Year	Cagayan de Oro				Bacolod			
	1st qtr.	2nd qtr.	3rd qtr.	4th qtr.	1st qtr.	2nd qtr.	3rd qtr.	4th qtr.
1977...	110.1	122.9	103.3	99.0	(NA)	(NA)	(NA)	(NA)
1978...	86.2	89.3	84.9	100.7	130.5	135.0	128.2	138.3
1979...	99.8	114.3	108.4	105.9	146.5	143.0	134.3	131.4
1980...	96.4	114.3	108.4	105.9	118.1	132.7	144.9	164.3
1981...	85.1	94.6	94.2	94.7	154.8	160.6	154.7	153.0
1982...	93.0	98.5	101.2	99.0	148.1	153.0	151.4	146.0

(NA) Not available.
Source: Derived from table 3.1 and quarterly data on consumption from water district records.

Figure 3-B Users of the Cagayan de Oro Water Systems: 1982



The remaining households in Cagayan de Oro (11 percent of the project area) and Bacolod (46 percent of the project area) either used the city water systems as a secondary source or did not use them at all. In Cagayan de Oro, 60 percent of these nonuser households used no city water, 36 percent used another household's connection, and 5 percent used their own system connection. In Bacolod, 68 percent used no city water, 31 percent used another household's connection, and 1 percent used their own connection.

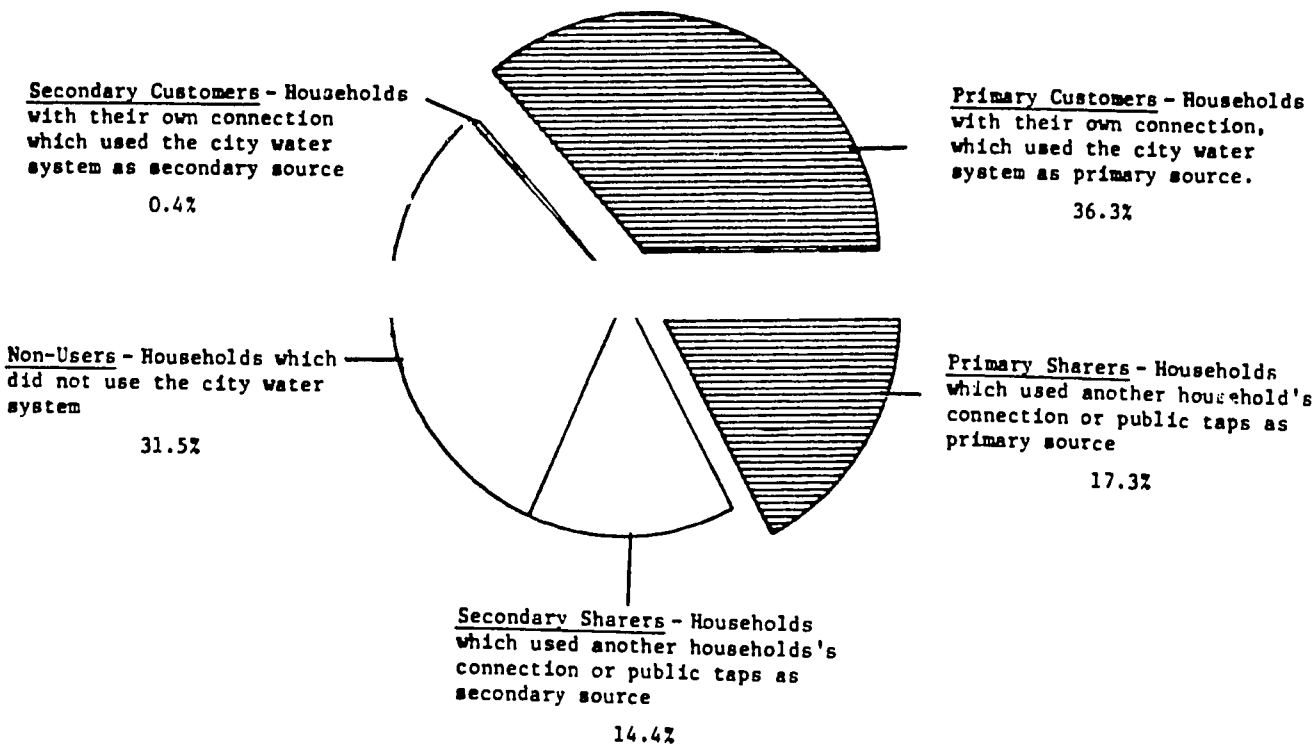
B. PERFORMANCE OF THE WATER SYSTEMS

This section examines the technical and financial performance of the Cagayan de Oro and Bacolod water systems during the evaluation period. Included are measures of system water losses, water quality, water availability, water cost to customers, customer satisfaction, and financial viability of the water districts.

Overall, both city water districts performed quite well from a technical point of view. System water losses (water "unaccounted for") were dramatically reduced, the quality of the water delivered was improved, and customer satisfaction with the water availability and water systems increased.

However, the financial performance of the water districts was not as positive. Despite water rate increases, both water districts' profitability was marginal.

Figure 3-C Users of the Bacolod Water Systems: 1982



1. Operational Efficiency

a. System Water Losses

During the period of rapid system expansion, both water districts achieved substantial reductions in the volume of water unaccounted for due to system leakages, illegal connections, etc. (see figure 3-D). Between 1977 and 1982, the volume of water unaccounted for as a percent of total production declined from 59 to 25 percent in Cagayan de Oro and from 67 to 21 percent in Bacolod.

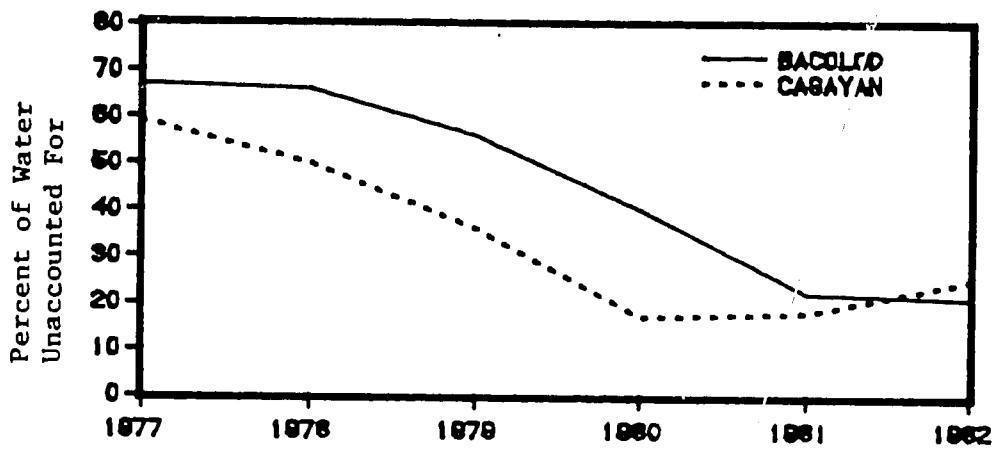
b. Water Quality in System Distribution Lines

The local water districts in the Philippines are required by the LWUA to periodically conduct bacteriological analyses to determine if the water meets the national safety standards.[2] These analyses are based on laboratory tests of water samples collected from the tap or the reservoir(s). Figures

[2]The standards for "safe" water are described in detail in appendix B.

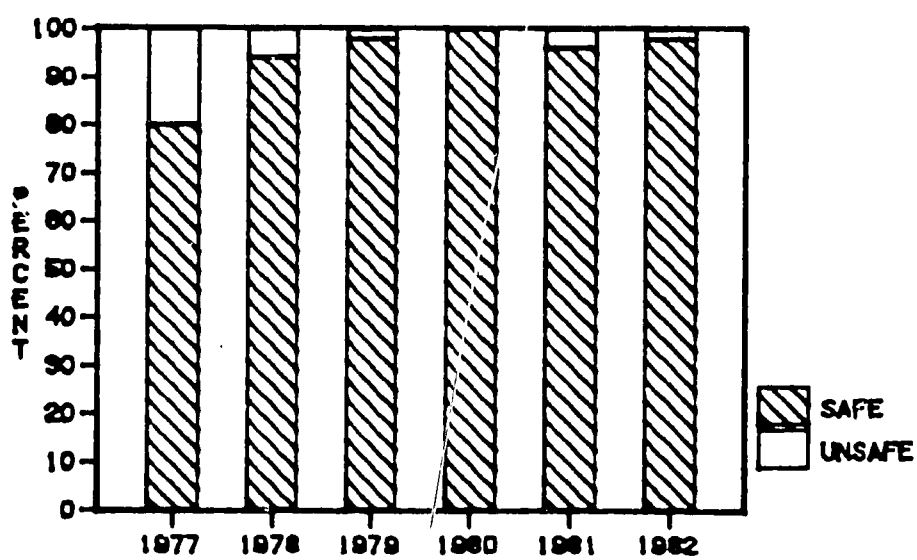
3-E and 3-F provide annual summary data of the bacteriological analyses conducted from 1977 to 1982.

Figure 3-D System Water Losses by Year



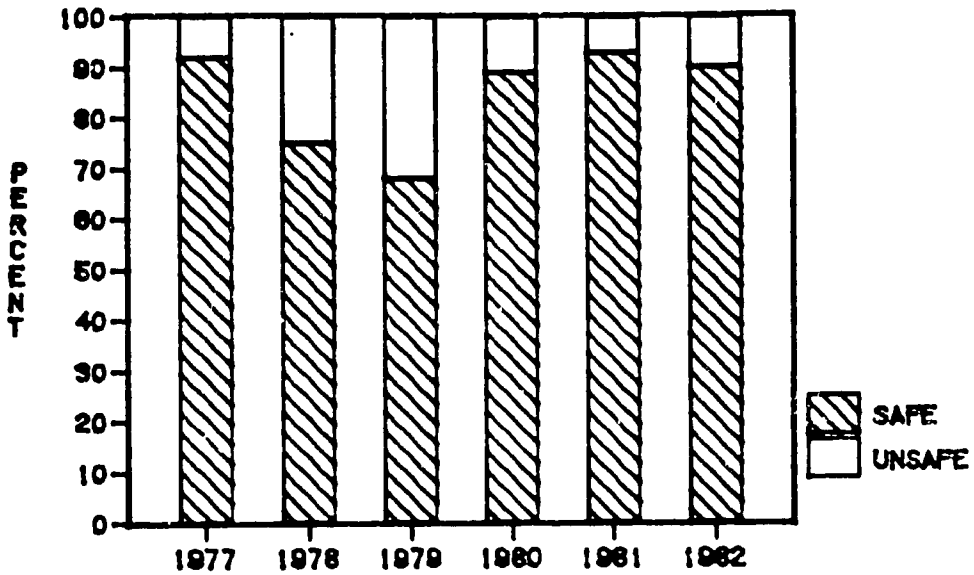
Source: Cagayan de Oro and Bacolod water district records.

Figure 3-E Percent of "Safe" Water Samples in Cagayan de Oro: 1977 to 1982



Source: Cagayan de Oro water district records.

Figure 3-F Percent of "Safe" Water Samples in Bacolod: 1977 to 1982



Source: Bacolod water district records.

The data indicate that water quality improved in both districts after the system improvements were completed. In Cagayan de Oro, more than 90 percent of the water samples met the Philippine water safety standards consistently from 1978 to 1982. In Bacolod, the proportion of safe water samples increased from 68 percent in 1979 to 90 percent in 1982.

c. Water Quality at Point of Use

It is important to note that a higher percentage of unsafe water samples was discovered as a result of the evaluation's household survey efforts. In Cagayan de Oro, only 7 percent of the households' water samples were rated as safe in 1977 and only 13 percent in 1983. In Bacolod, 23 percent of the samples were rated as safe in 1978 and 33 percent in 1983.

The reasons for the apparent discrepancy between the results in sections b and c above seem to be poor water storage and handling practices by household members. This issue is discussed in more detail in chapter 4 and appendix E.

2. Financial Performance of the Water Districts

Financial operating highlights for the two water districts are presented in table 3.4. As shown, operating revenues increased at an average rate of 34 percent per year in Cagayan de Oro and 38 percent per year in Bacolod from 1977 to 1982. The largest increases in both cities occurred the year after the water system improvements were completed and resulted primarily from the rapid growth of new connections during that year.

Table 3.4 Financial Operating Highlights by Water District: 1977 to 1982

Water districts	Operating revenues per connection (1,000 of pesos)	Operating revenues per connection per month	Operating expense per connection per month	Interest/ operating revenue	Net income ratio	Current ratio	Percent water unaccounted for
Cagayan de Oro							
1977.....	2,776	51.33	32.00	.39	-.004	1.62	59
1978.....	3,449	43.42	27.08	.34	.04	2.42	50
1979.....	5,966	49.17	29.58	.45	-.02	1.93	36
1980.....	7,857	48.58	30.58	.37	.03	1.75	17
1981.....	9,247	46.91	30.92	.32	.05	1.99	18
1982.....	11,367	52.50	22.48	(NA)	.17	(NA)	26
Bacolod							
1977.....	2,548	49.50	40.28	(NA)	.206	(NA)	67
1978.....	2,522	49.06	41.48	(NA)	-.342	1.113	66
1979.....	3,209	57.75	40.24	(NA)	-.045	.007	56
1980.....	6,658	72.15	35.51	(NA)	.141	2.06	40
1981.....	9,460	87.91	92.48	(NA)	-.04	2.45	22
1982.....	10,883	74.85	62.52	(NA)	-.03	(NA)	21

NA Not available.
Source: Cagayan de Oro and Bacolod water district records.

Notwithstanding the increases in operating revenues, the profitability of the water district operations for both cities remained tenuous. The Bacolod water district showed a year-end positive net income only in 1977 and 1980. While the Cagayan de Oro water district managed to maintain year-end positive net income in all but 2 years of the evaluation period, it was not until 1982 that a modest surplus (of 17 centavos for every peso of revenue) was realized. The profitability of the water district operation may have suffered due to the interest charges on the LWUA loans for system development.

On a more positive note, both water districts seem to have checked water losses (see figure 3-D). The Cagayan de Oro water district also managed to reduce operating expenses from an average of 32 centavos per connection per month in 1977 to 22 centavos per connection per month in 1982. Bacolod was less successful in this respect.

3. Water Rates Charged to Customers

The water rate structures of the Cagayan de Oro and Bacolod water districts are shown in tables 3.5 and 3.6, respectively. The "service charge" refers to the amount paid by customers for the first 10 cubic meters of water consumed, while the "commodity charge" is the amount paid per cubic meter in excess of 10 cubic meters of water consumed.

The three major types of water system users are residential/government, commercial/industrial, and wholesale. Meter sizes varied by user type and were assigned differing rates by the water districts. The first customer type consists of the typical residential connection with a meter size of 1/2-inch diameter and with a service charge ranging from ₱20.00 to ₱22.00 per month (in 1983), depending on the water district. The other two major customer types include users who usually consume a large volume of water, such as commercial and industrial establishments or households which use the water for income-generating activities.

As shown in the succeeding tables, both water districts increased the rates for water service between 1977 and 1982. The Cagayan de Oro water district increased both the service and commodity charges in 1979. Service charges were increased for all except the lowest-volume users of residential/government connections, with the larger rate increases charged to the large-volume users.

Commodity charge increases for all customers were enacted in Bacolod in 1979 and again in 1981. All types of users and meter sizes were affected by these rate increases, although the magnitude of the increases varied both by user type and meter size. The Bacolod water district also shifted from a fixed to a variable rate commodity charge in 1979, with unit costs increasing with the volume of water consumed. The average monthly cost of water to customers is discussed further in chapter 4.

Table 3.5 Cost of Water by Type of User and Meter Size, Cagayan de Oro: 1977 to 1978 and 1979 to 1982

Type of water charge	Cost to user (pesos)[1]					
	Residential/Govt.		Commercial/Ind.		Wholesale	
	1977-78	1979-82	1977-78	1979-82	1977-78	1979-82
Service charge						
3/8-inch meter....	10.00	10.00	(X)	(X)	(X)	(X)
1/2-inch meter....	20.00	20.00	40.00	50.00	60.00	75.0
3/4-inch meter....	32.00	40.00	64.00	80.00	96.00	120.0
1-inch meter.....	64.00	80.00	128.00	160.00	192.00	240.0
1 1/2-inch meter..	160.00	200.00	320.00	400.00	480.00	600.0
2-inch meter.....	400.00	500.00	800.00	1,000.00	1,200.00	1,500.0
3-inch meter.....	720.00	900.00	1,440.00	1,800.00	2,160.00	2,700.0
4-inch meter.....	1,440.00	1,800.00	2,880.00	3,600.00	4,320.00	5,400.0
Commodity charge[2]						
3/8-inch meter....	.80	1.00	(X)	(X)	(X)	(X)
1/2-inch meter....	.80	1.00	1.60	2.00	2.40	3.0
3/4-inch meter....	.80	1.00	1.60	2.00	2.40	3.0
1-inch meter.....	.80	1.00	1.60	2.00	2.40	3.0
1 1/2-inch meter..	.80	1.00	1.60	2.00	2.40	3.0
2-inch meter.....	.80	1.00	1.60	2.00	2.40	3.0
3-inch meter.....	.80	1.00	1.60	2.00	2.40	3.0
4-inch meter.....	.80	1.00	1.60	2.00	2.40	3.0

X Not applicable.
[1]In 1977-78, the peso/dollar exchange rate was 7.4/1. By 1982 it had increased to 9/1
[2]Cost per cubic meter when consumption exceeds 10 cubic meters.

4. Availability of Water to Customers

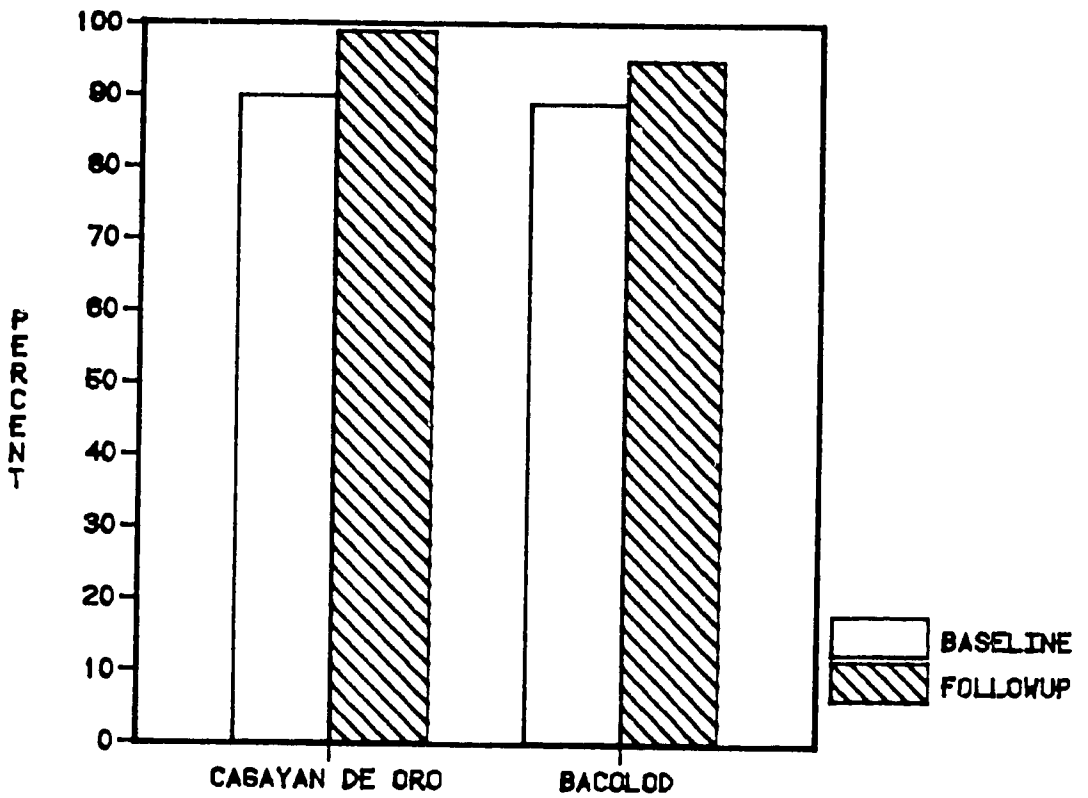
Followup survey data show that 99 percent of the project area households in Cagayan de Oro and 95 percent in Bacolod reported that water was available to them 24 hours per day. The corresponding baseline survey estimates were 90 percent in Cagayan de Oro and 89 percent in Bacolod. This represents a relatively modest but statistically significant increase among project area households in both cities (see figure 3-G).

Table 3.6 Cost of Water by Type of User and Meter Size, Bacolod: 1977 to 1978, 1979 to 1980, and 1981 to 1982

Type of water charge	Cost to user (pesos)[a]								
	Residential/Govt.			Commercial/Ind.			Wholesale		
	1977-78	1979-80	1981-82	1977-78	1979-80	1981-82	1977-78	1979-80	1981-82
Service charge									
3/8-inch meter.....	6.00	8.00	0.60	(X)	(X)	(X)			
1/2-inch meter.....	15.00	18.00	22.00	30.00	32.00	40.00			
3/4-inch meter.....	24.00	29.00	35.00	48.00	52.00	64.00			
1-inch meter.....	48.00	57.00	70.00	96.00	102.00	125.00	(X)	(X)	(X)
1 1/2-inch meter.....	120.00	144.00	177.00	240.00	260.00	320.00			
2-inch meter.....	300.00	350.00	430.00	600.00	630.00	775.00			
Commodity charge									
11-20 cubic meters...		0.70	0.90		1.25	1.60			
21-30 cubic meters...		0.80	1.00		1.45	1.80			
31-50 cubic meters...	0.06[b]	0.90	1.10	1.20[b]	1.60	1.95	1.80[c]	2.50[c]	3.50
51-70 cubic meters...		1.00	1.20		1.80	2.20			
71-100 cubic meters..		1.20	1.45		2.15	2.60			
101+ cubic meters....		1.30	1.55		2.95	2.80			

(X) Not applicable.
[a]In 1977-78, the peso/dollar exchange rate was 7.4/1. By 1982 it had increased to 9/1.
[b]Fixed rate in 1977-78.
[c]Cost per cubic meter when consumption exceeds 10 cubic meters.

Figure 3-G Percent of Project Area Households with Water 24 Hours per Day



5. Customer Satisfaction

This is another area in which a statistically significant improvement was observed. The followup survey data show that 98 percent of the customers in Cagayan de Oro and 95 percent in Bacolod were either "very satisfied" or "satisfied" with the water service. The corresponding baseline survey estimates were 47 percent for Cagayan de Oro and 72 percent for Bacolod (see figures 3-H and 3-I).

6. Disconnections

Data on the number of service disconnections by year are shown in table 3.7. The number of disconnections increased from about 500 in each city in 1978 to more than 1,600 in Cagayan de Oro and nearly 900 in Bacolod in 1982. Disconnections are initiated either by water district customers for various reasons or by the water district for nonpayment of service charges.

It is interesting to note that the number of disconnections as a percent of total active connections, which ranged from 1 to 4 percent (see table 3.8), has remained roughly constant over the 6-year period in both cities.

The increase in the number of new connections and reconnections was more than sufficient to offset the disconnections (see tables 3.9 and 3.10).

Data showing the reason for disconnections were not available for Bacolod. However, a Bacolod water district official reported that the most common reason for disconnection was the nonpayment of water bills. The data in table 3.11 indicate that, in Cagayan de Oro, many of the disconnections were requested by the customers themselves.

Figure 3-H Level of Satisfaction of Water-System Users in Cagayan de Oro

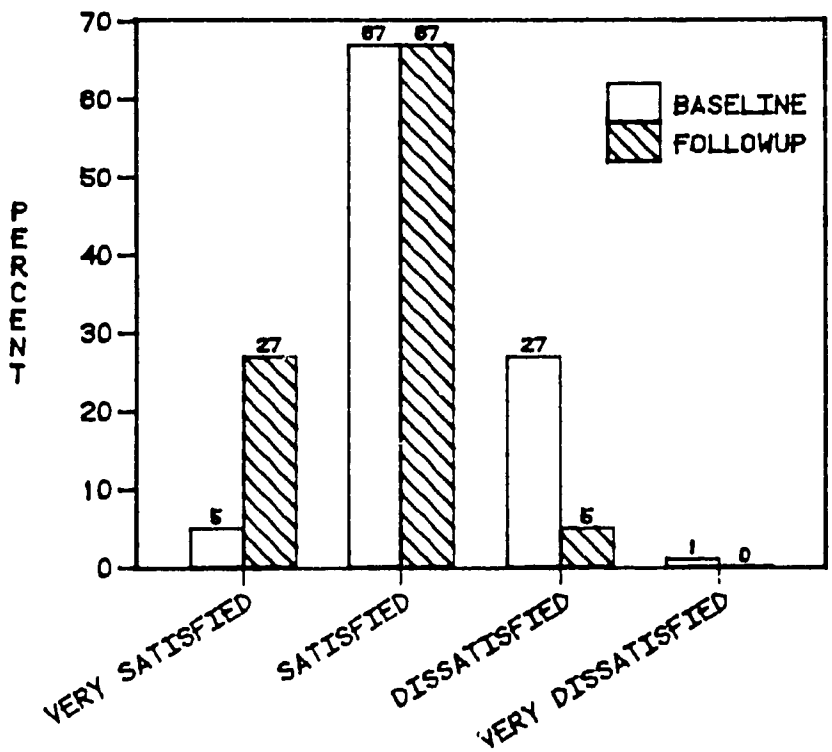


Figure 3-I Level of Satisfaction of Water-System User in Bacolod

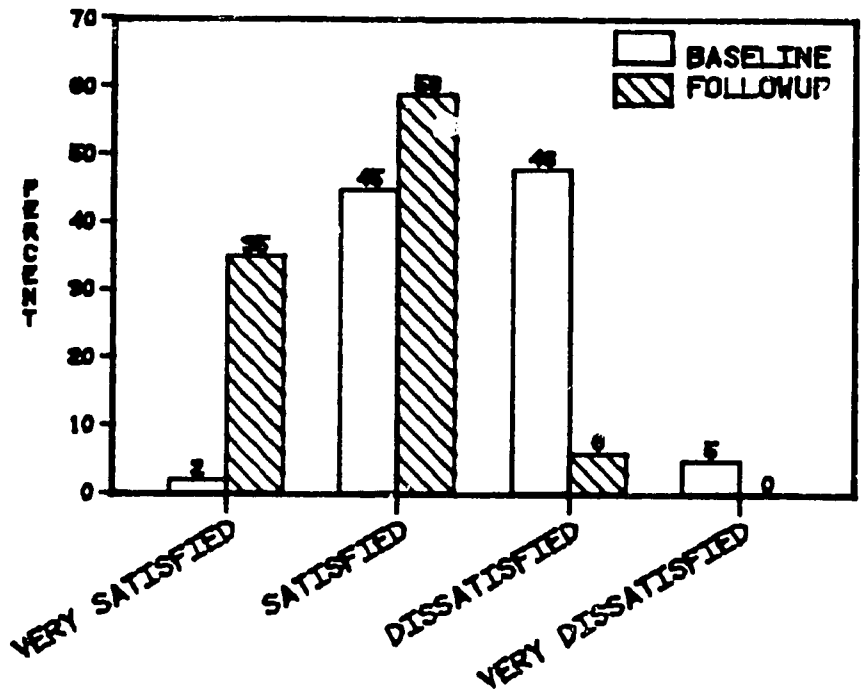


Table 3.7 Disconnections by Water District: 1978 to 1982

Water district	1978	1979	1980	1981	1982
Cagayan de Oro...	527	675	1,?00	1,444	1,645
Bacolod.....	476	527	656	1,334	862

Source: Cagayan de Oro and Bacolod water district records.

Table 3.8 Disconnections as a Percent of Total Active Connections by Water District: 1977 to 1982

Year	Cagayan de Oro				Bacolod			
	1st qtr.	2nd qtr.	3rd qtr.	4th qtr.	1st qtr.	2nd qtr.	3rd qtr.	4th qtr.
1977....	4.2	2.7	3.8	3.0	(NA)	(NA)	(NA)	(NA)
1978....	3.2	2.9	2.3	1.4	4.2	1.0	3.3	2.5
1979....	1.3	2.0	2.2	2.1	1.7	1.6	2.5	4.2
1980....	2.2	2.0	2.6	2.8	0.6	0.8	1.7	4.1
1981....	2.2	2.6	2.4	2.4	3.6	1.9	4.5	3.1
1982....	2.8	2.6	2.2	2.2	2.4	1.2	2.0	1.5

NA Not available.

Table 3.9 Number of Connections by Type and Percent Active Connections, Cagayan de Oro: 1977 to 1982

Year	Net new connections	Percent of active connections	Type of connection		
			New connections	Reconnections	Disconnections
1977					
1st qtr....	70	1.7	125	113	168
2nd qtr....	135	3.2	161	85	111
3rd qtr....	144	3.3	248	59	163
4th qtr....	196	4.4	244	89	137
1978					
1st qtr....	234	4.9	292	94	152
2nd qtr....	217	4.4	259	104	146
3rd qtr....	866	14.9	928	71	133
4th qtr....	803	12.1	825	74	96
1979					
1st qtr....	916	12.1	957	55	96
2nd qtr....	581	7.2	671	75	165
3rd qtr....	1,082	11.8	1,153	127	198
4th qtr....	912	9.0	981	147	216
1980					
1st qtr....	889	8.1	982	159	252
2nd qtr....	955	8.0	1,022	177	244
3rd qtr....	862	6.7	998	192	328
4th qtr....	655	4.9	778	253	376
1981					
1st qtr....	668	4.7	774	211	317
2nd qtr....	664	4.5	795	242	373
3rd qtr....	871	5.6	983	248	360
4th qtr....	722	4.4	880	236	394
1982					
1st qtr....	(NA)	(NA)	(NA)	(NA)	479
2nd qtr....	(NA)	(NA)	(NA)	(NA)	462
3rd qtr....	(NA)	(NA)	(NA)	(NA)	404
4th qtr....	(NA)	(NA)	(NA)	(NA)	414

NA Not available.
Source: Cagayan de Oro water district records.

Table 3.10 Number of Connections by Type and Percent Active Connections, Bacolod: 1977 to 1982

Year	Net new connections	Percent of active connections	Type of connection		
			New connections	Reconnections	Disconnections
1977					
1st qtr....	(NA)	(NA)	(NA)	(NA)	(NA)
2nd qtr....	(NA)	(NA)	(NA)	(NA)	(NA)
3rd qtr....	(NA)	(NA)	(NA)	(NA)	(NA)
4th qtr....	(NA)	(NA)	(NA)	(NA)	(NA)
1978					
1st qtr....	92	21.5	44	228	180
2nd qtr....	30	0.7	20	53	43
3rd qtr....	31	0.7	63	111	143
4th qtr....	12	0.3	58	69	110
1979					
1st qtr....	39	0.9	46	70	77
2nd qtr....	126	2.8	83	115	72
3rd qtr....	457	9.2	484	97	124
4th qtr....	1,019	16.9	1,021	252	254
1980					
1st qtr....	1,722	22.3	1,669	101	48
2nd qtr....	1,008	11.5	1,018	63	73
3rd qtr....	215	2.4	272	91	148
4th qtr....	409	4.4	487	309	387
1981					
1st qtr....	339	3.5	391	258	310
2nd qtr....	687	6.6	668	221	202
3rd qtr....	293	2.7	352	424	483
4th qtr....	291	2.7	283	347	339
1982					
1st qtr....	(NA)	(NA)	(NA)	(NA)	279
2nd qtr....	(NA)	(NA)	(NA)	(NA)	141
3rd qtr....	(NA)	(NA)	(NA)	(NA)	247
4th qtr....	(NA)	(NA)	(NA)	(NA)	195

NA Not available.
Source: Bacolod water district records.

Table 3.11 Percentage of Disconnections, by Reason, in Cagayan de Oro: 1977 to 1982

Reason	1977	1978	1979	1980	1981	1982[a]
Total disconnections.....	100.0	100.0	100.0	100.0	100.0	100.0
Delinquent....	99.8	37.8	18.7	19.9	39.3	31.1
Requested.....	(NA)	29.8	31.3	35.5	36.5	30.8
Vacant.....	(NA)	4.4	2.4	1.3	1.3	1.8
Burnt.....	(NA)	(NA)	1.2	0.3	0.6	(NA)
Meter stolen..	0.2	(NA)	(NA)	(NA)	(NA)	0.1
Not reported..	(NA)	28.1	46.5	42.9	22.3	36.2

NA Not available.
[a]January to November only.

CHAPTER 4

ACCESS TO AND USE OF WATER

This chapter presents detailed data on patterns of water use by households in the study cities and the extent of changes in water-use patterns during the evaluation period. Specifically, the following four questions are addressed:

(1) What sources of water are being used by households in the study cities?

(2) For what purposes is water from the various sources being used?

(3) Who is using water from the project water systems?

(4) Were there any changes in water availability, quality, and cost or in related water-handling practices, sanitary uses of water, and types of sanitary facilities used during the evaluation period?

The chapter is organized into four sections, each dealing with one of these four issues.

In examining these questions, comparisons are made between various "water source" groups of households. The bulk of the analysis presented in this chapter is based upon comparisons between nonusers of the project water systems and several categories of water-system users: primary customers, who use the city water system as their major source and have their own connection; primary sharers, who use another household's system connection as their major source; and secondary customers, who use a noncity source as their major source of water and a city water connection as a secondary source. A fourth group, secondary sharers, is not considered in this chapter due to their small number. See figures 3-B and 3-C for information on the relative size of these groups in each city.

In the analysis of evaluation period changes in water use patterns, comparisons are made between water-system user and nonuser households. These user and nonuser households are defined in two different ways: first, on an areal basis (i.e., project area versus nonproject area households) and, second, on a household basis (i.e. actual user versus nonuser households). The methodology for these comparisons is described more fully in section D of this chapter.

A. SOURCES OF WATER IN THE STUDY POPULATION

As described in chapter 3, the project resulted in a significant expansion in the coverage of the city water systems in both study cities. This section documents the sources of water being used by households in the study population at the end of the evaluation period. The data are presented by means of comparisons between various groups of households. The first comparison is between households who used any city water source (either as a primary or as a secondary

source). Comparisons are then made between various subgroups within the group of city water-user households.

1. Users versus Nonusers of City Water

Table 4.1 shows the major source of water for users and nonusers of the project water in both cities. Ninety-six percent of the user households in Cagayan de Oro and 79 percent in Bacolod use the city water as their major source. The other households use city water as a supplement to their major source (wells and other water sources). There is greater use of city water sources located outside of the user's house (either public taps or neighbor's connections) in Cagayan de Oro than in Bacolod.

Table 4.1 Percentage Users and Nonusers by Major Water Source

Type of source	Percentage			
	Cagayan de Oro		Bacolod	
	User	Nonuser	User	Nonuser
City water--				
Piped inside.....	49	-	56	-
Outside.....	47	-	23	-
Covered well.....	1	47	12	71
Open well.....	3	22	9	27
Other source.....	1	31	-	2

No observations in this category.
Source: Followup survey.

2. City Water Users: Customers versus Sharers

Not surprisingly, 99 percent of the customers (households with their own system connection) in both Cagayan de Oro and Bacolod use city water as their major source (see table 4.2). Eighty-nine percent of the customers in Bacolod and 68 percent in Cagayan de Oro have this water piped directly into their house. The others use a piped source (usually shared) outside the house. Furthermore, 92 percent of these households in Cagayan de Oro and 87 percent in Bacolod use city water exclusively. Other customers supplement city water with another source of water (see table 4.3).

Among the group of households sharing another household's connection, 87 percent in Cagayan de Oro and only 55 percent in Bacolod use city water as their major source. Comparatively few (8 percent in Cagayan de Oro and 17 percent

in Bacolod) reported that they used inside connections.[1] Furthermore, only 60 percent of the sharers in Cagayan de Oro and 41 percent in Bacolod used the city water as their exclusive source (see tables 4.2 and 4.3).

Table 4.2 User Households: Percentage of Customers and Sharers by Type of Water Source

Type of source	Connection status			
	Cagayan de Oro		Bacolod	
	Customers	Sharers	Customers	Sharers
City water--				
Piped inside.....	68	8	89	17
Outside.....	31	79	9	38
Covered well.....	1	3	(Ƶ)	26
Open well.....	-	8	1	20
Other source.....	(Ƶ)	1	-	-

Ƶ Less than 1/2 of 1 percent.
- No observations in this category.
Source: Followup survey.

Table 4.3 User Households: Number of Water Sources Used by Connection Status

Number of sources	Connection status			
	Cagayan de Oro		Bacolod	
	Connected	Non-connected	Connected	Non-connected
1 source.....	92	60	87	41
2 sources.....	8	35	12	55
3 sources.....	-	5	1	3
4 sources.....	-	-	-	-

- No observations in this cell.
Source: Followup survey.

[1]Households using another household's inside connection probably responded "inside connection" when they really should have responded "outside connection" as their major source.

These figures are indicative of differences in the sharer group of households between the study cities. More households in Cagayan de Oro than in Bacolod use city water as their major source, and fewer supplement it with additional sources. These observations are further supported by data on the number of households reporting shared connections. In Cagayan de Oro, customers who shared connections report that, on the average, they shared with 1.9 other households. In Bacolod the customers who shared did so with an average of three other households (see table 4.4).

Table 4.4 Connected Households: Percent Sharing Connections and Average Number of Households Shared with

Connected households	Cagayan de Oro	Bacolod
Percent sharing.....	23	20
With 1 other household.....	13	4
With 2 other households.....	6	7
With 3 other households.....	1	3
With 4 or more.....	2	6
Average number of households sharing a connection.....	1.9	3.0

Source: Followup survey.

B. USES OF WATER FROM THE PROJECT WATER SYSTEMS

1. Household Uses of Water

This subsection examines the household purposes for which city water is used in the project area. Comparisons are limited in this subsection to project area households. First, we address the question of how water is used in households whose major source is the city water system. Second, differences in water uses between the connected customers and the sharers are investigated. Third, the use of city water by project area households whose major source is not city water is investigated. Finally, a table indicating water sources by use is presented to provide insight into the alternate water sources being used by project area households in lieu of the city water systems. Economic uses of water are examined in subsection 2.

Table 4.5 presents the findings for primary users of city water. A large majority of households in both cities use the city water for all household activities. The only activity for which more than 5 percent of the households do not use city water is laundering. Eleven percent of Cagayan de Oro households and 8 percent of Bacolod households use alternate water sources for laundering.

Table 4.5 Project Area Households: Percent of Primary Users by Household Activity

Household activity	Percent of primary users	
	Cagayan de Oro	Bacolod
Drinking.....	100	100
Washing hands after work/play.....	98	97
Bathing children.....	98	95
Washing hands after toilet use.....	97	96
Washing dishes.....	98	97
Laundering.....	89	92

Source: Followup survey.

Table 4.6 provides more detailed data disaggregated into customers and sharers. Nearly all customers and sharers in each city utilize the city water for all household activities. This partially illustrates the spread effects of the city water systems. That is, a substantial number of non-customers also use the water for nearly all household purposes.

Table 4.7 examines the use of city water among project area households whose major source was not the city water system (i.e., secondary users and nonusers). The data show that the use of the water systems had also spread to these households by the end of the project period, particularly as a source of drinking water.

Table 4.8 shows the major water source used by all project area households for each household activity. Data are presented for three groups: customers, sharers, and households whose major source was not the project water system (secondary users and nonusers).

As noted earlier, nearly all customers and sharers used city water for all purposes. These data show that approximately two-thirds of the customers used water piped inside the house, while the vast majority of the sharers used outside connections. Approximately two-thirds of the nonuser households in Bacolod and one-half in Cagayan de Oro used water from covered wells. The remaining households used open wells or other sources.

Table 4.6 Project Area Households: Percent of Primary Users by Household Activity and Connection Status

Household activity	Percent of primary users			
	Cagayan de Oro		Bacolod	
	Customers	Sharers	Customers	Sharers
Drinking.....	100	100	100	100
Washing hands after work/play.....	100	95	100	90
Bathing children.....	99	91	99	88
Washing hands after toilet use.....	99	93	99	90
Washing dishes.....	100	97	99	94
Laundering.....	96	76	96	86

Source: Followup survey.

Table 4.7 Project Area Households: Percent of Nonprimary Users of City Water by Household Activity

Household activity	Percent of nonprimary users	
	Cagayan de Oro	Bacolod
Drinking.....	35	33
Washing hands after work/play.....	6	1
Bathing children.....	4	2
Washing hands after toilet use.....	8	6
Washing dishes.....	9	2
Laundering.....	1	3

Source: Followup survey.

Table 4.8 Project Area Households: Percent of Users by Household Activity and Type of Water Source

Household activity and type of water source	Percent and type of users					
	Cagayan de Oro			Bacolod		
	City water main source		City water not main source	City water main source		City water not main source
	Customers	Sharers		Customers	Sharers	
DRINKING						
Piped inside.....	69	10	3	91	34	5
Piped outside.....	31	90	32	9	66	28
Covered well.....	-	-	44	-	-	52
Open well.....	-	-	14	-	-	14
Other.....	-	-	7	-	-	2
WASHING HANDS AFTER WORK/PLAY						
Piped inside.....	68	10	1	91	33	1
Piped outside.....	32	85	5	9	58	1
Covered well.....	-	2	48	-	5	65
Open well.....	-	3	35	-	5	31
Other.....	-	1	10	-	-	2
BATHING CHILDREN						
Piped inside.....	61	9	-	89	30	1
Piped outside.....	38	81	4	10	58	1
Covered well.....	-	1	53	-	6	66
Open well.....	-	4	32	-	3	29
Other.....	-	4	12	1	4	3
WASHING HANDS AFTER TOILET USE						
Piped inside.....	66	10	1	90	33	(Ƶ)
Piped outside.....	33	84	6	9	58	(Ƶ)
Covered well.....	-	1	44	-	5	65
Open well.....	1	5	37	-	5	32
Other.....	-	1	12	1	-	2
WASHING DISHES						
Piped inside.....	68	10	1	90	33	1
Piped outside.....	32	87	8	9	61	22
Covered well.....	-	1	47	1	2	63
Open well.....	(Ƶ)	2	36	(Ƶ)	3	32
Other.....	(Ƶ)	1	8	-	1	(Ƶ)
LAUNDERING						
Piped inside.....	57	7	-	87	34	-
Piped outside.....	38	69	1	9	52	-
Covered well.....	2	3	46	2	6	63
Open well.....	1	8	36	-	4	34
Other.....	2	14	17	2	5	4

- No observations in this category.
Ƶ Less than 1/2 of 1 percent.
Source: Followup survey.

2. Economic Uses of Water

Water was used by project area households for a variety of economic activities. The most frequently cited activities were gardening, poultry raising, and pig raising. Table 4.9 shows the percentage of households engaged in each kind of activity. Data are shown for customer households, sharer households, and households whose major source was not the city water system.

Table 4.9 Project Area Households: Percent Using Water per Selected Economic Activities, by User Status

Economic activity	Percentage and type of user					
	Cagayan de Oro			Bacolod		
	City water main source		City water not main source	City water main source		City water not main source
	Customers	Sharers		Customers	Sharers	
Food processing...	5	3	6	10	5	6
Water selling.....	4	-	(Ƶ)	5	2	-
Laundering.....	1	2	3	1	28	6
Gardening.....	37	28	25	29	16	19
Poultry raising...	6	7	10	11	16	17
Pig raising.....	12	10	13	13	9	16
Restaurant.....	3	1	3	4	2	2
Other.....	1	-	3	2	7	4

- No observations in this category.
Ƶ Less than 1/2 of 1 percent.
Source: Followup survey.

Table 4.10 shows the percentage of households engaged in the three main economic activities: gardening, poultry raising, and pig raising, which are also the three most common activities. Because of the relatively small percentage of households engaged in the other activities, the table only covers the main activities. The estimated number of households engaged in each of the activities considered in the study and the water source used for each activity are shown in table 4.11.

Nearly all of the connected households in both cities use the city water when gardening, pig raising, or poultry raising. More than 70 percent of the non-connected households also use the city water when engaged in these activities. The other households use sources other than the city water systems when engaged in these activities.

Table 4.10 Project Area Households: Percent Engaged in Selected Economic Activities by User Status

Type of activity	Percent and type of user					
	Cagayan de Oro			Bacolod		
	City water main source		City water not main source	City water main source		City water not main source
	Customers	Sharers		Customers	Sharers	
Gardening.....	95	78	0	92	70	0
Poultry raising..	100	98	0	96	70	0
Pig raising.....	98	70	0	91	73	2

The results of a fuller analysis of the economic impacts of the project water systems are reported in chapter 5.

C. EQUALITY OF ACCESS TO THE PROJECT WATER SYSTEMS

One of the concerns of the USAID during the design of the Provincial Water Project was that the project should improve access among the poor in the project cities to an adequate water supply. This section examines the extent to which the poor were being served by the project water systems during the evaluation period as well as the affordability of the water system service.

1. Socioeconomic Characteristics of Water System Users

The project evaluation baseline survey indicated that project area households who were using the existing city water systems at the time of project implementation were of somewhat higher socioeconomic standing than nonusers. The differentials were relatively small in magnitude, however.

To investigate the extent to which lower income households had been provided access to the project water systems during the first phase of the project, similar comparisons were made with the followup survey data for the various categories of water system users and nonusers defined earlier in this chapter.

The socioeconomic indicators utilized in comparing the various groups of interest included: the household's source of lighting, quality of house structure, income, food expenditures, number of selected household items owned, and educational attainment of the household head. A summary of the findings is presented in table 4.12. Households appearing in column 1 consist of primary users in the project areas of each city (including customers and sharers), those in column 2 consist of secondary user or nonuser households in the project area, and column 3 consists of households outside the project area (the "control" population in the experimental design adopted for the study).

Table 4.11 Project Area Households: Number Using Water for Economic Activities, by Type of Water Source and User Status

Household activity and type of water source	Number and type of user					
	Cagayan de Oro			Bacolod		
	City water main source		City water not main source	City water main source		City water not main source
	Customers	Sharers		Customers	Sharers	
Total Households....	23,779	10,123	3,983	9,956	4,750	12,578
FOOD PROCESSING						
City water.....	1,318	288	52	1,026	190	114
Covered well....	-	-	136	-	-	494
Open well.....	-	-	52	-	38	190
Other.....	-	-	-	-	-	-
WATER SELLING						
City water.....	860	-	14	456	-	-
Covered well....	52	-	-	-	-	-
Open well.....	-	-	-	-	-	-
Other.....	-	-	-	-	-	-
LAUNDERING						
City water.....	208	52	-	38	114	152
Covered well....	-	-	52	-	-	380
Open well.....	-	52	-	38	-	228
Other.....	52	104	52	-	-	-
GARDENING						
City water.....	8,250	2,221	-	2,698	722	-
Covered well....	274	52	480	190	76	1,596
Open well.....	104	378	400	38	152	684
Other.....	104	208	104	-	76	152
POULTRY RAISING						
City water.....	1,418	733	-	1,026	532	-
Covered well....	-	-	250	38	114	1,292
Open well.....	-	14	108	-	114	722
Other.....	-	-	52	-	-	76
PIG RAISING						
City water.....	2,718	742	-	1,178	304	38
Covered well....	-	52	326	114	76	988
Open well.....	-	260	184	-	38	874
Other.....	-	-	14	-	-	114
RESTAURANT						
City water.....	605	104	52	380	114	38
Covered well....	-	-	-	38	-	228
Open well.....	-	-	-	-	-	-
Other.....	-	-	-	-	-	38
OTHER						
City water.....	340	-	-	228	152	38
Covered well....	-	-	66	-	76	304
Open well.....	-	-	14	-	76	152
Other.....	-	-	-	-	38	-

- No observations in this category.
Source: Followup survey.

Table 4.12 All Households: Socioeconomic Characteristics by Area and User Status

Socioeconomic characteristics	Project area: Primary users of city water	Project area: Secondary users and nonusers	Nonproject area
CAGAYAN DE ORO			
Annual household income (in pesos):[1]			
Mean	1,990	2,152	1,644
Median	1,000	601	900
Percent of households with electric lighting	76	47	70
Percent of households with permanent/semi-permanent structure	66	42	53
Average number of household items owned	6.8	4.3	6.1
Average monthly food expenditures (in pesos)[1]	750	570	660
Percent of household heads with college degrees	41	21	31
BACOLOD			
Annual household income (in pesos):[1]			
Mean	2,266	1,400	1,477
Median	1,049	700	800
Percent of households with electric lighting	88	61	57
Percent of households with permanent/semi-permanent structure	66	36	42
Average number of household items owned	8.5	4.9	4.7
Average monthly food expenditures (in pesos)[1]	1,020	660	720
Percent of household heads with college degrees	46	23	21

[1]At the time of the followup survey, the peso/dollar exchange rate was approximately 9/1.
Source: Followup survey.

The data show that households using city water as their major source tend to be economically advantaged in comparison with secondary users and nonusers. In fact, the city water users in both cities score higher than project area nonusers on every indicator considered in table 4.12, with the exception of average household income in Cagayan de Oro, and higher than nonproject area households on all indicators.

Table 4.13 reveals that the inconsistent behavior of the mean monthly household income variable vis-a-vis the other socioeconomic variables is in fact an artifact of the use of the mean as the measure of central tendency. These data show that the income distributions for users in both cities are quite favorable in relation to both of the other comparison groups. The higher mean income observed above for project area nonusers in Cagayan de Oro is the result of a distorting influence on the mean of a small number of households with extremely high incomes. For further comparisons of these groups with respect to income, the median is relied upon as a measure of central tendency in order to minimize this distortion.

Table 4.13 All Households: Annual Household Income by Area and User Status

City and annual household income (pesos per year)[1]	Area and user status		
	Project area		Nonproject area
	Users	Nonusers	
Cagayan de Oro			
1 - 4,000.....	10	23	13
4,001 - 8,000.....	19	33	25
8,001 - 15,000.....	28	21	31
Over 15,000.....	43	23	31
Bacolod			
1 - 4,000.....	8	16	12
4,001 - 8,000.....	20	31	26
8,001 - 15,000.....	28	37	35
Over 15,000.....	44	26	27

[1]At the time of the followup survey, the peso/dollar exchange rate was approximately 9/1.
Source: Followup survey.

Table 4.14 presents the results of comparisons of socioeconomic characteristics for project area users of any city water (i.e. primary and secondary users) versus nonuser households. The results are very similar to those in table 4.12, with users of city water appearing to be positively selected with respect to socioeconomic status.

Table 4.14 All Project Area Households: Socioeconomic Characteristics by City and User Status

Socioeconomic characteristics	Project area	
	Users	Nonusers
CAGAYAN DE ORO		
Annual household income (in pesos):[1]		
Mean	1,950	2,436
Median	1,000	799
Percent of households with electric lighting	75	51
Percent of households with permanent/semipermanent structure	64	46
Average number of household items owned	6.6	5.1
Percent of household heads with college degrees	40	26
BACOLOD		
Annual household income (in pesos):[1]		
Mean	2,037	1,469
Median	954	749
Percent of households with electric lighting	83	58
Percent of households with permanent/semipermanent structure	57	41
Average number of household items owned	7.5	5.1
Percent of household heads with college degrees	59	25

[1]At the time of the followup survey, the dollar/peso exchange rate was approximately 9/1.
Source: Followup survey.

Table 4.15 presents the results of a further comparison of socioeconomic characteristics for customers and sharers of the water systems. (These two groups combined comprise column 1 of table 4.7.) The data suggest that customers are significantly better off socioeconomically than the sharers. In fact, sharers appear to be the most disadvantaged among the comparison groups.

Table 4.15 City Water User Households: Socioeconomic Characteristics by Connection Status

Socioeconomic characteristics	Connection status	
	Customers	Sharers
CAGAYAN DE ORO		
Monthly household income (in pesos):[1]		
Mean	2,431	962
Median	1,400	600
Percent of households with electric lighting	91	43
Percent of households with permanent/semipermanent structure	79	34
Average number of household items owned	8.1	3.6
Percent of household heads with college degrees	50	19
BACOLOD		
Monthly household income (in pesos):[1]		
Mean	2,646	1,469
Median	1,450	600
Percent of households with electric lighting	96	68
Percent of households with permanent/semipermanent structure	81	30
Average number of household items owned	10.3	4.3
Percent of household heads with college degrees	58	17

[1]At the time of the followup survey, the peso/dollar exchange rate was approximately 9/1.
Source: Followup survey.

Several conclusions emerge from these results. First, it is apparent that economically advantaged households are considerably more likely to be users of the project water systems than the less well-off in both cities. Furthermore, a comparison of the baseline and followup survey data suggests that the gap between users and nonusers in terms of socioeconomic characteristics had widened during the evaluation period. This indicates that economically advantaged households were disproportionately represented among new users of the water systems (i.e., households who b[illegible]sing the water systems during the evaluation period).

This phenomenon may, however, be an artifact of the way in which the water systems were expanded in the study cities. In both cities, system expansion began in the center of the city and spread to the outlying areas. Since many of the poor households in both cities are located in outlying "barrios," it is possible that the apparent pattern of differential access to the project water systems according to economic status will be alleviated once the systems are fully developed.

Second, despite the substantial differences in socioeconomic status among water system users and nonusers, it should be noted that improved access to the water systems during the evaluation period was not limited solely to economically advantaged households. The fact that significant proportions of project area households in both cities were using the water systems as their major water source by the end of the evaluation period indicates that a sizeable number of middle and lower income households had been provided water system service. This is particularly so in Cagayan de Oro, where nearly 90 percent of project area households were primary users of the water system by the end of the study period.

Finally, while nonuser households tend to be disadvantaged economically in relation to users, a much sharper distinction is apparent between water district customers and sharers. This suggests that sharing a connection with other households is the primary means of gaining access to the project water systems for poor households.

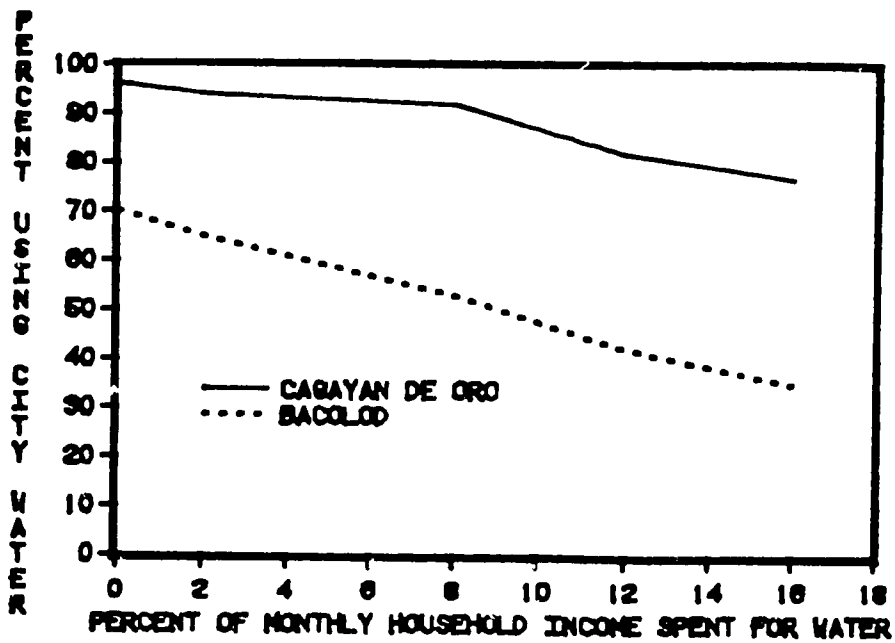
2. Affordability of City Water

The socioeconomic indicators point to substantial socioeconomic differences between water system users and nonusers and among customers and sharers. This suggests that the use of city water may be prohibitively expensive for some households. Followup survey data show a very close association between the percent of households using city water and the amount they paid for water in the month preceding the survey (see figure 4-A). It is therefore likely that many of the lower income households simply cannot afford water service. For others, access to the water systems may be possible only by sharing connections (which is illegal under water district regulations in both study cities).

Table 4.16 displays followup survey estimates of the monthly water expenditures for each of the three groups described earlier. The first line shows the total household expenditure for water in the month prior to the survey, which for user households consists of the sum of the previous month's water

bill plus the amount paid for any other water purchased. For nonusers, the figures reflect the actual amount spent for water during the previous month. The second line shows the amount paid per 10 gallons of water for each of the groups.

Figure 4-A Percent Using City Water by Percent of Monthly Household Income Spent for Water



On the average, the cost to city-water users on a per gallon basis was double that for project area nonusers in Cagayan de Oro and 1.6 times more expensive than for nonproject area households. In Bacolod, city water cost 1.5 times more than the water from other sources in the project area (this result is only marginally significant) and 26 times more than water used by households in the nonproject area (which is obviously significant).

The total amount paid for water per month follows the same pattern. City-water users paid significantly more for water in the previous month than the two nonuser groups in both cities. These results imply that city-water user households also consumed significantly more water on a per capita basis, an inference supported by the water consumption data shown in table 4.16.

Table 4.16 All Households: Water Consumption and Cost of Water by Area and User Status

Water consumption and amount paid for water	Area and user status		
	Project area		Nonproject area
	Primary users	Secondary users and nonusers	
CAGAYAN DE ORO			
Amount paid for water (in pesos, previous month).....	31.87	5.45	3.34
Amount paid for 10 gallons of water (in centavos)..	14.6	7.6	9.1
Per capita water consumption (in gallons per day).....	27.6	7.3	8.5
BACOLOD			
Amount paid for water (in pesos, previous month).....	55.88	7.24	0.27
Amount paid for 10 gallons of water (in centavos)..	13.0	8.5	0.50
Per capita water consumption (in gallons per day).....	43.5	10.4	7.1

D. CHANGES IN THE ACCESSIBILITY AND USE OF WATER AND SANITATION FACILITIES

This section presents the results of analyses of the extent of project-related changes in the availability, quality, and cost of water and of resulting changes in water-handling practices, sanitary uses of water, and types of sanitation facilities during the evaluation period. Due to the large number of variables to be considered, the findings are presented in summary form in this section. Detailed tabulations and a discussion of each variable are presented in appendix E.

The presentation begins with a description of the methodology used to measure project-related changes (i.e., changes attributable to the project) in the variables of interest. The findings are then summarized in tabular and narrative form.

1. Methodology for Measuring Project-Related Changes

In order to provide a basis for attribution of observed changes to the project intervention, the analyses reported in this section are based upon the comparison of changes observed for "treatment" and "control" groups.[2] These groups are defined in two different ways. Comparisons were first made between experimental groups defined on an areal basis, that is between project and nonproject area households. These are the primary experimental groups in the original project evaluation design. The comparisons were then repeated for experimental groups defined on a household basis with respect to actual use of the water systems, that is households which use the water systems in comparison with those which do not.

One of the concerns that arises in experimental-design studies undertaken in free-living populations involves the extent to which the changes observed in the impact variables are affected by changes in the composition of the groups under study. To investigate this problem in the present study, several steps were taken. First, the socioeconomic characteristics of households with varying lengths of residence in the study areas were compared to assess the extent of differences between such groups. Tables 4.17 to 4.20 show the results of one such set of comparisons. These tables compare households with at least 5 years of residence in the same housing unit (i.e., the full evaluation period) and households with shorter lengths of residence in the housing unit in which they were interviewed for the followup survey. The results are presented separately by experimental group and city.

The results indicate clearly that, in both cities, short-term residents in each of the experimental groups are of lower socioeconomic standing than the longer-term residents.

To investigate the implications of these findings for the analyses reported in this section, followup survey estimates for each variable for the full sample were compared to estimates for a restricted sample consisting only of households which had resided in the same housing unit for the full evaluation period (i.e., the "survivors" of the baseline survey populations). With few exceptions, the conclusions reached with respect to relative changes in the water-related variables were not affected by this sample restriction.[3]

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[2]The rationale for attributing changes to the project intervention through the comparison of changes for two or more "experimental" groups is outlined in appendix B.

[3]The "mobility" factor was, however, found to affect conclusions regarding health impacts of the project (see chapter 6).

Accordingly, the analyses reported in this chapter utilize the full followup survey sample.

Table 4.17 Percent Distribution of Project Area Households, by Selected Socioeconomic Characteristics and Length of Residence in Housing Unit

Socioeconomic characteristics	Number of years in housing unit			
	Cagayan de Oro		Bacolod	
	5 or more	Less than 5	5 or more	Less than 5
Quality of construction of housing unit:				
High quality.....	66	61	54	50
Low quality/rundown.....	34	39	46	50
Annual household income (in pesos):				
1 - 4,000.....	12	11	11	12
4,001 - 8,000.....	19	22	23	28
8,001 - 15,000.....	26	29	27	30
15,001 or more.....	43	39	38	30
Households with electric lighting.....	81	67	78	71

Source: Followup survey.

Table 4.18 Percent Distribution of Nonproject Area Households, by Selected Socioeconomic Characteristics and Length of Residence in Housing Unit

Socioeconomic characteristics	Number of years in housing unit			
	Cagayan de Oro		Bacolod	
	5 or more	Less than 5	5 or more	Less than 5
Quality construction of housing unit:				
High quality.....	62	51	42	42
Low quality/rundown.....	38	49	58	58
Annual household income (in pesos):				
1 - 4,000.....	13	13	13	11
4,001 - 8,000.....	21	27	21	31
8,001 - 15,000.....	29	32	36	33
15,001 or more.....	37	27	30	25
Households with electric lighting.....	82	63	56	44

Source: Followup survey.

Table 4.19 Percent Distribution of Primary Users of City Water, by Selected Socioeconomic Characteristics and Length of Residence in Housing Unit

Socioeconomic characteristics	Number of years in housing unit			
	Cagayan de Oro		Bacolod	
	5 or more	Less than 5	5 or more	Less than 5
Quality of construction of housing unit:				
High quality.....	67	65	67	63
Low quality/rundown.....	33	35	33	37
Annual household income (in pesos):				
1 - 4,000.....	10	9	7	8
4,001 - 8,000.....	18	20	19	22
8,001 - 15,000.....	28	29	27	30
15,001 or more.....	44	43	46	40
Households with electric lighting.....	83	71	89	86

Source: Followup survey.

Table 4.20 Percent Distribution of Secondary Users and Nonusers of City Water, by Selected Socioeconomic Characteristics and Length of Residence in Housing Unit

Socioeconomic characteristics	Number of years in housing unit			
	Cagayan de Oro		Bacolod	
	5 or more	Less than 5	5 or more	Less than 5
Quality of construction of housing unit:				
High quality.....	59	34	38	38
Low quality/rundown.....	41	66	62	62
Annual household income (in pesos):				
1 - 4,000.....	20	22	16	14
4,001 - 8,000.....	25	37	28	34
8,001 - 15,000.....	18	27	28	30
15,001 or more.....	38	14	29	23
Households with electric lighting.....	67	41	62	57

Source: Followup survey.

Apparent differences observed in the comparison of changes for the various experimental groups were tested for statistical significance using conventional techniques for the estimates of means and proportions (i.e. t-tests). Differences in changes for "treatment" and "control" groups during the evaluation period which were significant at the 90 percent level of confidence were significant for the analyses reported in this section.

2. Summary of Findings

Table 4.21 summarizes the findings regarding changes in the variables measuring the accessibility and use of water analyzed in this study. The table indicates whether a statistically significant difference was observed in comparing changes between project and nonproject area households, and between user and nonuser households.

The results of these analyses indicate that project benefits were apparently derived by users of the water systems in both cities. The data indicate quite clearly that, if nothing else, the project resulted in greater convenience for city water users of the water systems. Improvements in the availability of water 24 hours per day were reported by water system users in both cities. A decrease in the average distance to the major water source was also observed among system users in Cagayan de Oro. Further evidence of improved access to an adequate water supply is provided by the observation of significant declines in the proportions of both project area and city-water user households fetching, storing, and filtering water during the evaluation period.

There is evidence, however, that the benefits derived went beyond merely increased convenience. Although the magnitude of the observed changes varied between the study cities, the data suggest that increasing proportions of water system users in both cities were using more adequate sanitation facilities (e.g., toilets located inside the house and enclosed bathrooms) during the evaluation period. The finding has important long-term implications since the use of these types of sanitation facilities was found to be associated with better health (see chapter 6).

With respect to improvements in the quality of water, the results are decidedly mixed. While the water in the system pipelines was of high quality throughout most of the evaluation period in both cities, significant improvements in quality at the point of use were evident only in Bacolod. The data point to the need for further improvements in the distribution systems and in the handling of water in both cities. (See appendix E for a fuller discussion of the study findings pertaining to water quality.)

Finally, the data do not suggest that substantial improvements in the use of water for hygienic purposes occurred during the evaluation period. Examination of the data indicates, however, that hygienic practices such as the frequency of washing were quite adequate at the beginning of the evaluation period. Hygienic practices would not seem to be an important constraint to further improvements in sanitation levels in the study cities.

Table 4.21 Summary of Changes in Water-Related Variables during the Evaluation Period

Variable	Evaluation period change observed			
	Experimental groups compared in Cagayan de Oro		Experimental groups compared in Bacolod	
	Project vs. nonproject	User vs. nonuser	Project vs. nonproject	User vs. nonuser
Water available 24 hours from source.....	Yes	Yes	No	Yes
Distance to main water source.....	No	Yes	No	No
Percent fetching water.....	Yes	Yes	Yes	Yes
Percent storing water.....	Yes	Yes	Yes	Yes
Cost of water per gallon.....	Yes	No	No	No
Water quality.....	No	No	Yes	Yes
Boiling of drinking water.....	No	No	No	Yes
Chemical treatment of water.....	No	No	No	No
Filtering water.....	Yes	Yes	Yes	Yes
Frequency washing hands after toilet.....	No	No	No	No
Frequency washing hands after playing.....	Yes[1]	No	No	No
Frequency bathing children.....	No	No	No	No
Percent with flush toilets.....	No	No	No	No
Toilet inside the house.....	No	Yes	Yes	Yes
Enclosed bathrooms.....	No	Yes	No	Yes
Closed sewer system.....	No	No	No	Yes
Garbage collection.....	No	No	Yes[1]	Yes[1]

[1]The observed change favors the nonproject area or nonuser households. All other observed changes favor the project area or user households.

The reader is referred to appendix E for detailed tabulations and further discussion of these findings.

Overall, these findings suggest that "spinoff" benefits in the form of improvements in sanitary conditions/facilities/practices resulted from the improvements in water supply funded by the project. While these were not directly supported

by project funding, it was anticipated that such improvements would take place in the study populations following the introduction of a reliable and convenient supply of water. The extent to which these sanitary improvements resulted in health improvements is assessed in chapter 6.

CHAPTER 5

ECONOMIC IMPACTS OF THE PROJECT WATER SYSTEMS

This chapter presents the results of statistical analyses of data from all three survey rounds which attempt to measure the level of economic benefits of the project water systems to project area and city water-user households. The economic indicators examined are changes in participation rates of households in water-related economic activities (both income-producing activities and activities involving the production of goods for home consumption) and in the amount of water fetched. A decline in the amount of water fetched by user households was viewed as an indicator of increased opportunity for household members to engage in other economically beneficial activities. However, the extent to which economic or social benefits actually resulted from such time savings was not measured in this study.

The analyses are based upon comparisons of changes in activity rates and water-fetching behavior between project and nonproject area households and between actual users and nonusers of the city water systems to provide a basis for attributing the observed changes to the project intervention.

A. HOUSEHOLDS ENGAGED IN WATER-RELATED ECONOMIC ACTIVITIES

Table 5.1 shows the baseline and followup survey estimates of the proportions of households (in project and nonproject areas of each city) that received income from water-related economic activities during the 12 months preceding the respective surveys. Included as relevant activities were food processing, water selling, gardening, poultry and pig raising, and the operation of restaurants.

The data indicate that very few households actually received income from these activities during the evaluation period. Further, they are not suggestive of significant changes in the proportion of project area households receiving income from these activities in either city during the evaluation period. Thus, it would not appear that the project water systems resulted in a notable increase in income for households having access to them during the period covered by this evaluation.

Table 5.2 shows the followup survey estimates of the percentage of households engaged in selected water-related activities, irrespective of whether income was actually received from them. These data indicate that many households were involved in water-related economic activities for the production of goods for home consumption purposes rather than for generating income. A substantial number of households were engaged in gardening, pig, and poultry raising. The data also show that activity rates were, in general, quite similar for project and nonproject area households in both cities.

Since the baseline survey data pertaining to water-related activities were restricted to income-producing activities, it was not possible to evaluate the extent of changes in activity rates during the full evaluation period.

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Comparisons were possible, however, with the data collected in the interim monitoring phase round of surveys.

Table 5.1 Percentage of Households Receiving Income from Water-Related Economic Activities, by Area and Survey Round

Economic activity	Cagayan de Oro		Bacolod	
	Project area	Nonproject area	Project area	Nonproject area
FOOD PROCESSING				
Baseline survey.....	1.7	-	0.7	-
Followup survey.....	0.8	0.4	1.5	1.5
WATER SELLING				
Baseline survey.....	3.3	1.0	0.1	-
Followup survey.....	1.8	2.0	1.1	-
LAUNDERING				
Baseline survey.....	0.5	-	0.8	0.9
Followup survey.....	1.5	5.1	3.5	2.1
GARDENING				
Baseline survey.....	-	-	0.6	-
Followup survey.....	0.4	1.8	2.1	1.9
POULTRY RAISING				
Baseline survey.....	0.3	1.4	-	-
Followup survey.....	0.5	-	2.4	7.7
PIG RAISING				
Baseline survey.....	0.6	-	1.1	-
Followup survey.....	1.3	2.4	4.2	9.6
RESTAURANTS				
Baseline survey.....	0.7	-	1.4	-
Followup survey.....	2.1	0.4	2.7	1.3

- No observations for this category.
Source: Baseline and followup surveys.

Table 5.2 Percentage of Households Engaged in Selected Water-Related Activities, by Area

Economic activity	Cagayan de Oro		Bacolod	
	Project area	Nonproject area	Project area	Nonproject area
Food processing.....	5	2	8	6
Water selling.....	2	3	2	0
Laundering.....	2	5	3	2
Gardening.....	33	31	23	26
Poultry raising.....	7	3	14	36
Pig raising.....	11	6	14	26
Restaurants.....	2	0	3	1

Source: Followup survey.

Table 5.3 displays the results of comparisons of the interim monitoring and followup survey data for the most common household activities, gardening and pig/poultry raising. The results indicate an increase in the proportion of project area households engaged in gardening in both cities. In comparison with the apparent trend for nonproject area households, however, only the change for project area households in Bacolod is statistically significant. No significant changes in the proportions of project area households engaged in pig/poultry raising were observed.

Table 5.3 Percent of Households Engaged in Selected Water-Related Activities, by Area and Survey Round

Economic activity	Cagayan de Oro		Bacolod	
	Project area	Nonproject area	Project area	Nonproject area
GARDENING				
Interim monitoring surveys.....	26	25	12	41
Followup survey.....	33	31	23	26
PIG/POULTRY RAISING				
Interim monitoring surveys.....	16	21	17	40
Followup survey.....	16	8	20	46

Source: Interim monitoring and followup surveys.

To further investigate possible project-related economic impacts, trends in activity rates with respect to gardening and pig/poultry raising were compared for households whose major water source was the city water system (i.e., primary users), project area households using other major water sources (secondary users and nonusers), and nonproject area households. Table 5.4 shows the results of these comparisons.

Table 5.4 Percent of Households Engaged in Selected Water-Related Activities, by Area and Water-User Status

Activity	Cagayan de Oro			Bacolod		
	Project area households			Project area households		
	Primary users of city water	Secondary users and nonusers	Nonproject area households	Primary users of city water	Secondary users and nonusers	Nonproject area households
GARDENING						
Interim monitoring surveys.....	28	16	50	15	19	36
Followup survey...	34	25	31	27	19	26
PIG/POULTRY RAISING						
Interim monitoring surveys.....	15	21	34	18	21	42
Followup survey...	14	15	8	19	26	47

Source: Interim monitoring and followup surveys.

These data suggest that project-related impacts with respect to gardening had taken place in both cities. In Bacolod, a significant relative increase in the percentage of the user households engaged in gardening is apparent in comparison with the other experimental groups. In Cagayan de Oro, a larger increase is observed for the city water-user group than for nonproject area households, but the increase in gardening activity rates was very similar to that observed for secondary users and nonusers in the project area.

There is no evidence, however, of a substantial change in activity rates for pig/poultry raising for user households in either city.

B. FETCHING OF WATER BY HOUSEHOLD MEMBERS

Another potential benefit of the project water systems involves the reduction in the amount of time spent fetching water, assuming that the time saved can be reallocated to other productive activities or leisure. To investigate this, evaluation period changes in the amount of water fetched (on a per capita basis) for project area and nonproject area households and city water user and nonuser households were examined. The results of these comparisons are shown in tables 5.5 and 5.6.

Table 5.5. Gallons of Water Fetched per Month per Household, by Area and Survey Round

Survey round	Cagayan de Oro		Bacolod	
	Project area	Nonproject area	Project area	Nonproject area
Baseline survey...	1,017	977	1,403	1,499
Followup survey...	508	1,890	1,415	1,957

Source: Baseline and followup surveys.

Table 5.6. Gallons of Water Fetched per Month per Household, by User Status and Survey Round

Survey round	Cagayan de Oro		Bacolod	
	User households	Nonuser households	User households	Nonuser households
Baseline survey....	805	1,246	957	1,623
Followup survey....	424	1,359	554	2,338

Source: Baseline and followup surveys.

The project area/nonproject area comparisons reveal a significant reduction in the amount of water fetched for project area households in Cagayan de Oro, but no significant change for project area households in Bacolod. In making the user/nonuser household comparisons, it would appear that the amount of water fetched by user households in both cities decreased dramatically between the baseline and followup surveys. This reduction is even more striking when we consider that the amount of water fetched by nonuser households increased in both cities (see table 5.6).

C. SUMMARY AND CONCLUSIONS

The results of the analyses of the economic impact indicators utilized in this study suggest the possibility of a beneficial project impact. However, the magnitude of the impact is difficult to quantify due to its nonmonetary nature. The more evident impacts were an increase in the proportion of city water users engaged in nonincome-generating gardening activities (presumably for home consumption) and a significant reduction (on both an absolute and a relative basis) in the amount of water fetched by city water-user households.

The net benefit to city water users from these apparent impacts depends largely upon factors which were not measured by the survey instruments used in this evaluation. Regarding the increase in the proportion of households engaged in gardening activities, it would seem reasonable to assume that these households would receive some indirect economic benefit by way of reduced food expenditures. The magnitude of these savings, however, was not measured.

Home gardening may also be expected to have a positive impact on the diets of households engaging in such activities. Once again, however, the net impact for any particular household depends upon such factors as the quantity and variety of foods produced, the size of the family, and the total quantity of food consumed by the household.

With regard to time saved in fetching water, it is likely that social benefits to city water-user households will accrue as a result of the project intervention. However, the extent to which economic benefits are derived is entirely dependent upon whose time is saved and how it is used. Given that the "marginal utility" of labor in many developing countries is thought to be low, it is by no means certain that economic benefits resulted from these time savings.

CHAPTER 6

HEALTH IMPACTS OF THE PROJECT

A. ANALYSIS BASED ON THE ORIGINAL EXPERIMENTAL DESIGN

This is the first of four sections which focus on the health impacts of the project water systems. The primary health indicator used in this study is the nutritional level of children aged 0 to 4 years. This section reports the results of "before and after" (project implementation) comparisons for the two experimental groups which form the basis of the original research design (i.e., project and nonproject (control) area households). Section B repeats the "before and after" comparisons for comparison groups which are defined on the basis of their use of the project water systems rather than their location. Section C presents the results of detailed multivariate analyses of the followup survey data, which attempt to quantify the effects of the use of water from the city water systems on health when the influences of exogenous factors are controlled statistically. Section D synthesizes the results of the multivariate analyses presented in section C and the findings of the analyses of changes in water-related behavior and sanitary facilities presented in chapter 4 and appendix E to provide an overall interpretation of the health impacts.

1. Overall Changes in Nutritional Levels during the Evaluation Period

In order to provide a context for the interpretation of changes in nutritional levels for the various comparison groups analyzed in this study, we begin with an assessment of overall childhood nutrition levels and trends in the study cities during the evaluation period (refer to tables 6.1 to 6.3 and figures 6-A and 6-B).

Table 6.1 shows the estimates of nutritional levels for children aged 0 to 4 years for the three survey rounds (baseline, interim monitoring phase--all eight quarters combined--and followup); based upon weight-for-age comparisons using the Philippines National Nutrition Council (PNNC) standard for Filipino children. Also shown are followup survey estimates of nutritional levels for children in the study cities based on the U.S. National Institutes of Health/Center for American Disease Control (NIH/CDC) weight-for-age standard for American children. These estimates are presented to allow comparisons with other nutritional assessments, many of which use the NIH/CDC standard.

It is evident from the data that some degree of nutritional deficiency is fairly widespread among young children in the study cities. The followup survey estimates corresponding to the end of the evaluation period show that 61 percent of the children in Cagayan de Oro and 65 percent in Bacolod were malnourished under the 90 percent weight-for-age definition of malnutrition (i.e., all three levels or degrees of malnutrition) using the Philippine standard. The corresponding estimates were 60 and 62 percent respectively using the U.S. standard. Under the 75 percent weight-for-age definition of malnutrition (i.e., moderately and severely malnourished children), 18 percent

of the children in Cagayan de Oro and 30 percent in Bacolod were malnourished on the basis of the PNNC standard, and 21 and 33 percent respectively under the NIH/CDC standard.

Table 6.1 Percent Distribution of Children Aged 0-4 Years, by Nutritional Level and Survey Round

[Nutritional levels based on weight-for-age standards set by the Philippines National Nutrition Council (PNCC) and the National Institutes of Health/Center for Disease Control (NIH/CDC)]

Nutritional level	PNNC standard			NIH/CDC standard
	Baseline survey	Interim monitoring surveys	Followup survey	
CAGAYAN DE ORO				
Number of children.....	22,960	18,192	33,094	33,094
Percent distribution:				
Normal.....	41	50	39	40
Mildly malnourished.....	42	32	43	39
Moderately malnourished..	14	12	15	17
Severely malnourished....	3	6	3	4
BACOLOD				
Number of children.....	28,733	25,305	21,154	21,154
Percent distribution:				
Normal.....	32	37	35	38
Mildly malnourished.....	35	36	35	29
Moderately malnourished...	26	19	19	22
Severely malnourished.....	7	8	11	11

With respect to trends over time, the data are not suggestive of substantial improvements in overall health conditions for children in either city during the evaluation period, although some shifting among nutritional categories is evident. In Cagayan de Oro, the nutritional distributions of children for the baseline and followup surveys are nearly identical. The largest shifts are observed when comparing the interim monitoring surveys with the baseline and followup surveys. This is likely due to the fact that the interim monitoring surveys were conducted quarterly over a 2 year period, thus minimizing seasonal shifts in the environmental conditions (most notably rainfall) that affect the measurement of nutritional levels of young children in the baseline and followup surveys.

A somewhat better nutritional profile for young children is also evident when comparing the interim monitoring survey estimates with the baseline and followup survey estimates for Bacolod (likely for the same reason). However, the data suggest that childhood nutrition conditions may have improved slightly during the evaluation period, on the basis of a slightly higher proportion of children having a normal weight-for-age relationship in the interim monitoring and followup surveys as opposed to the baseline survey. This apparent trend is investigated below.

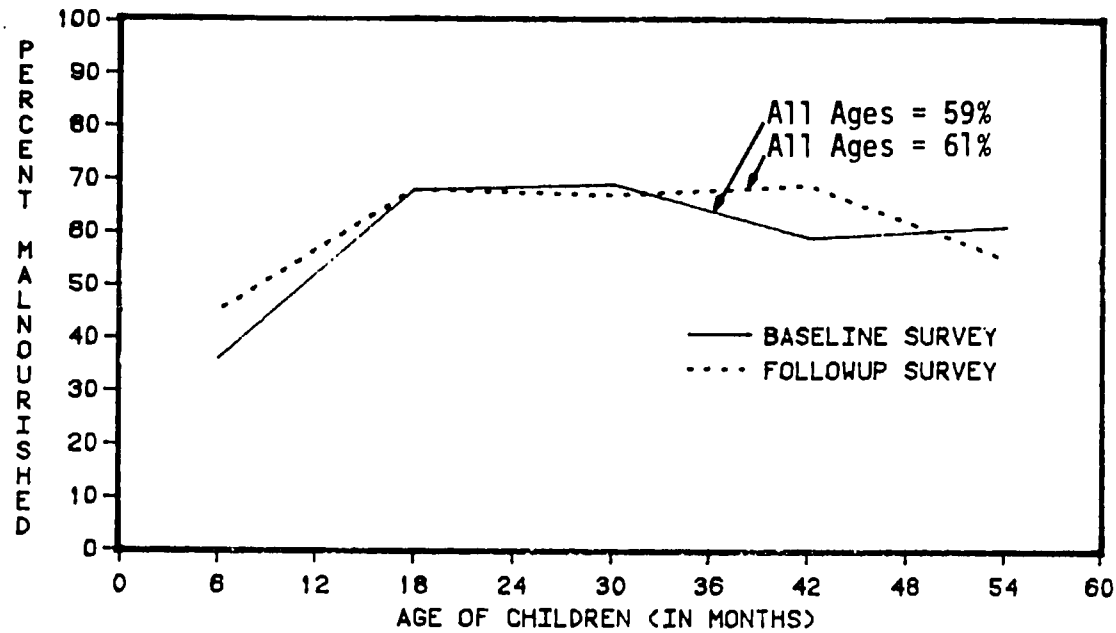
Estimates of nutritional levels of children by age for the baseline and followup surveys are shown in table 6.2. The age pattern of nutrition levels evident in the data generally conforms to the well-documented nonlinear relationship between age and level of nutrition among children--a relatively low initial rate of malnutrition which climbs to a peak during a susceptible period during weaning and eventually falls to a more or less stable level which depends upon environmental and economic conditions. This pattern is evident in the malnutrition age curves (figures 6-A and 6-B) for both the 90 and 75 percent weight-for-age definitions of malnutrition, although it is more pronounced in the 75 percent curve (figure 6-B) due to the relatively high proportion of children in the study cities who suffer from at least mild malnutrition (i.e., children whose weight was less than 90 percent of the weight of well nourished children of the same age).

Table 6.2 Percent Distribution of Children Aged 0-4 Years, by Age and Nutritional Level: Baseline and Followup Surveys

Nutritional level	Baseline survey						Followup survey					
	All children 0-4 years	0-11 months	12-23 months	24-35 months	36-47 months	48-59 months	All children 0-4 years	0-11 months	12-23 months	24-25 months	36-47 months	48-59 months
CAGAYAN DE ORO												
Number of children.....	22,960	4,833	4,848	4,352	4,433	4,494	3,094	6,835	6,563	6,334	6,936	6,426
Percent distribution:												
Normal.....	41	63	32	31	40	40	39	56	32	32	31	45
Mildly malnourished.....	42	28	42	48	46	46	43	25	43	46	56	43
Moderately malnourished..	14	6	22	19	11	12	15	14	21	18	11	11
Severely malnourished....	3	3	4	2	3	2	3	5	4	4	1	1
BACOLOD												
Number of children.....	28,733	6,568	5,744	5,904	5,933	4,584	21,154	5,372	3,894	4,185	4,627	3,076
Percent distribution:												
Normal.....	32	52	27	22	23	36	35	51	35	29	27	28
Mildly malnourished.....	35	32	22	39	39	39	35	28	34	36	36	47
Moderately malnourished..	26	12	43	30	32	13	19	11	13	22	30	17
Severely malnourished....	7	4	8	9	6	7	11	10	18	13	7	8

Figure 6-A

Percent of Children Aged 0-4 Years Malnourished, Based on the 90% Weight-for-Age Definition: Cagayan de Oro



Percent of Children Aged 0-4 Years Malnourished, Based on the 90% Weight-for-Age Definition: Bacolod

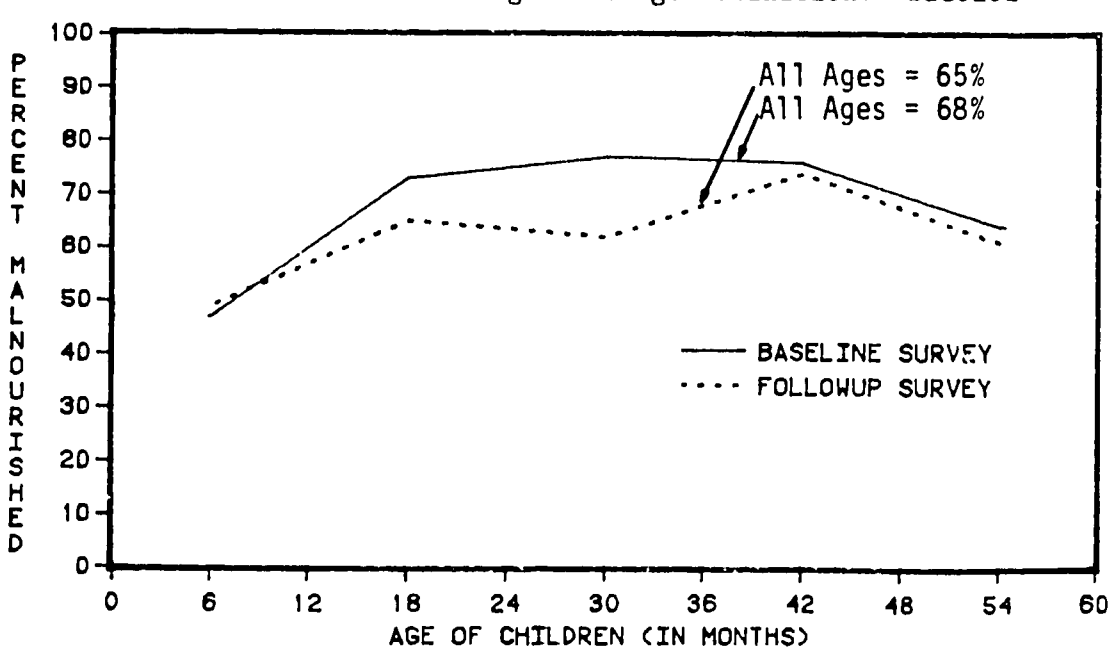
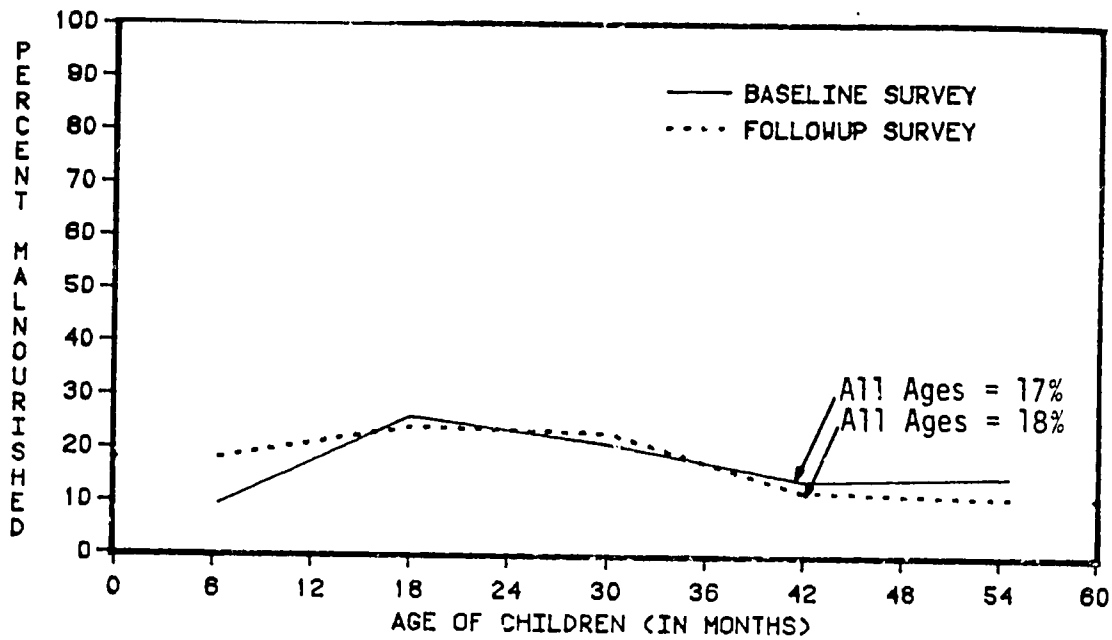
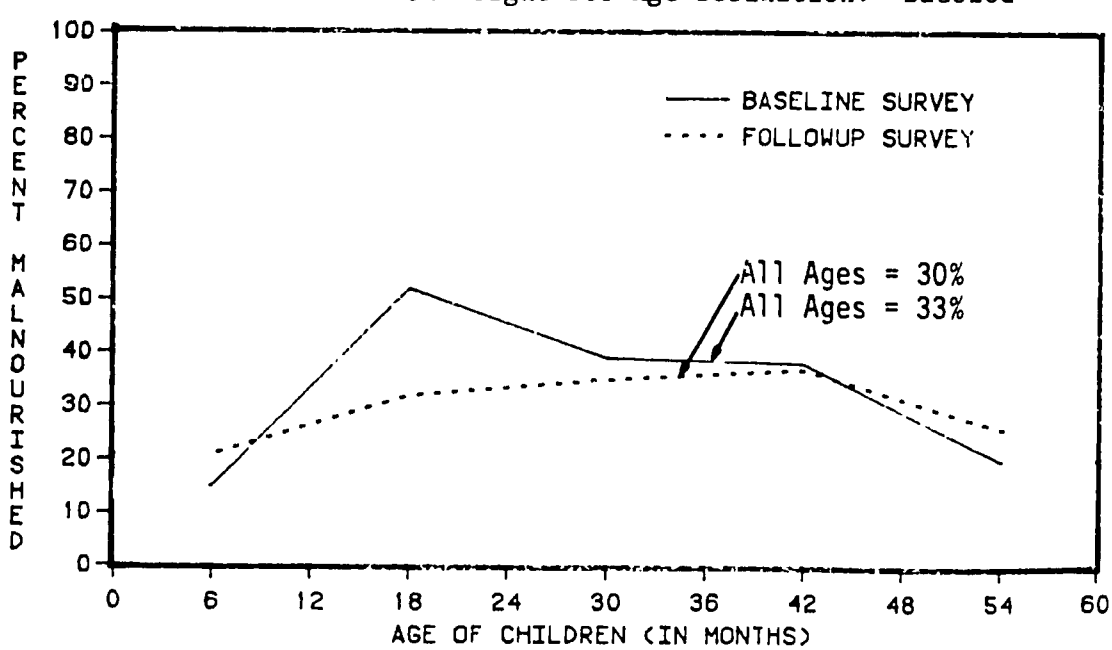


Figure 6-B

Percent of Children Aged 0-4 Years Malnourished, Based on the 75% Weight-for-Age Definition: Cagayan de Oro



Percent of Children Aged 0-4 Years Malnourished, Based on the 75% Weight-for-Age Definition: Bacolod



The malnutrition curves for Cagayan de Oro do not suggest a clear trend in nutrition levels with respect to age between the baseline and followup surveys. In Bacolod, the curves suggest some improvement for children between the ages of 1 and 4, particularly under the 75 percent definition of malnutrition, but only a modest improvement overall due to somewhat higher malnutrition rates for children under 1 year and over 45 months of age.

To test the significance of the observed changes in childhood nutritional levels during the evaluation period, log-linear models were fit to the baseline and followup survey data summarized in table 6.2. The tests were performed using different definitions of malnutrition in order to minimize the chances of drawing conclusions as an artifact of the definition chosen. Accordingly, separate tests were performed to assess the significance of changes in distribution among categories of the full, four-category nutritional classification as well as distributional changes in the "normal" and "malnourished" categories using 90 and 75 percent weight-for-age definitions of malnutrition respectively.

The results are summarized in table 6.3. Two sets of statistics are presented for each nutritional classification/definition. First, the lambda parameters from maximum likelihood logistic regressions of nutritional status on survey round (controlling for age) are presented. These parameters indicate the direction of magnitude of the evaluation period change in the proportion of children observed in each category of the classification and are interpretable in the same way as multiple regression coefficients. Second, the results of tests for the significance of changes in the overall distribution of children for the nutritional classification/definition are indicated. These statistics provide a summary measure of the magnitude of the changes in all of the categories of the classification considered simultaneously (i.e., the average change across all categories).[1]

The results indicate no significant changes in Cagayan de Oro either in overall distribution or between the well nourished and malnourished categories under either the 90 or 75 percent weight for age criteria. In Bacolod, a significant change in overall nutritional distribution is observed. Examination of the regression parameters reveals, however, that the significant shift occurred entirely between the moderately and severely malnourished categories,[2] with a significant decrease in the proportion of children who were moderately malnourished and a significant increase in the proportion of children who were

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[1]The tests for changes over time were carried out using the conventional procedure of comparing "adjacent" log-linear models. The "baseline" model for the tests consisted of the nutrition-age and age-survey associations and was compared to a model which also contained the nutrition-survey association. The tests for significance are based on differences in the log-likelihood chi-squares and degrees of freedom for the two models.

[2]The coefficients for these categories are at least 1.96 times as large as their standard errors.

severely malnourished. These shifts did not, however, result in an overall shift in nutrition levels during the evaluation period under either definition of malnutrition. This is evidenced by the lack of significance of the shifts between the well nourished and malnourished categories under either the 90 or 75 percent weight-for-age nutrition criteria.

Table 6.3 Results of Tests for Changes in the Distribution of Children Aged 0 to 4 Years, by Nutritional Level

Weight-for-age definition of malnutrition	Lambda parameters (std. errors)[a]	
	Cagayan de Oro	Bacolod
FULL CLASSIFICATION:		
Normal.....	-.030 (.056)	.019 (.057)
Mildly malnourished.....	.007 (.060)	-.015 (.074)
Moderately malnourished.....	.042 (.065)	-.195[b] (.040)
Severely malnourished.....	-.020 (.118)	.191[c] (.085)
Significance of change in distribution.....	(NS)	p<.01
90 PERCENT DEFINITION:		
Normal.....	-.022 (.027)	.031 (.041)
Malnourished.....	.022 (.027)	-.031 (.041)
Significance of change in distribution.....	(NS)	(NS)
75 PERCENT DEFINITION:		
Normal.....	-.021 (.041)	.040 (.030)
Malnourished.....	.021 (.041)	-.040 (.030)
Significance of change in distribution.....	(NS)	(NS)

NS Not significant.

[a]The signs of the lambda parameters are indicative of the direction of change between the baseline and followup surveys. A positive number indicates a net increase in the proportion of children in the category for the followup survey, while a negative sign indicates a net decline.

[b]Parameter is at least 0.96 times its standard error (p<.05).

[c]Parameter is at least 2.57 times its standard error (p<.01).

Thus, the data suggest general stability in childhood nutritional levels in the two study cities during the evaluation period. However, there does appear to have been a modest deterioration in nutritional levels in Bacolod with a significant increase in the proportion of children who were severely malnourished (i.e., children whose weight was less than 60 percent of the PNNC standard).

2. Changes in Nutrition Levels for the Primary Experimental Groups

The primary experimental groups for the project evaluation under the original design were: (1) households located in areas of the study cities which either were within the coverage area of the city water systems prior to project implementation or were to be provided access to the systems during the evaluation period, and (2) households located beyond the coverage areas of the city water systems during the evaluation period. It was hypothesized that, as a result of the project water systems, households which had access to (and presumably were using) the city water systems would show improvement with respect to health indicators during the evaluation period in comparison with households located in areas without access to (and presumably not using) the city water systems. The analyses reported in this section assess the extent to which these expectations were borne out.

The data on nutritional levels shown in table 6.4 and displayed graphically in figures 6-C to 6-F suggest quite different patterns of change during the evaluation period for the experimental groups in the two study cities. In Cagayan de Oro, the proportions of children in the project areas who were classified as malnourished under both the 90 and 75 percent definitions of malnutrition remained relatively stable between the baseline and followup surveys. In contrast, nonproject area households show a substantial increase in the proportions of malnourished children under both definitions of malnutrition, with the proportion of malnourished children under the 75 percent criterion more than doubling (from 15 to 31 percent) during the evaluation period (refer to figures 6-C and 6-D).

In Bacolod, the nutrition profile of project area children also remained more or less constant during the evaluation period, with a very slight (and not statistically significant) decline overall in the proportion of children classified as malnourished under both definitions of malnutrition apparent (see figures 6-E and 6-F). For nonproject area households, however, the survey estimates indicate a substantial decline in the proportion of malnourished children under the 75 percent weight-for-age criteria (from 49 to 37 percent) and a more modest decline under the 90 percent definition of malnutrition (from 77 to 71 percent).

Four variable (nutrition level, age, experimental group, and survey) log-linear models were fit to the data to test the significance of changes in childhood nutrition levels for the experimental groups during the evaluation period (i.e., the "nutritional level-experimental group-survey" interaction).[3]

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[3]See appendix B for a discussion on the interpretation of higher order interaction terms in log-linear models.

The function of this test is to provide a means for determining whether the observed changes for project area households were sufficiently different from those observed for the nonproject area to be beyond the differences that might be attributable to sampling error alone.[4] Age was controlled in these tests to minimize the influences of differences in age composition among the experimental groups and changes across survey rounds. The results are summarized in table 6.5.

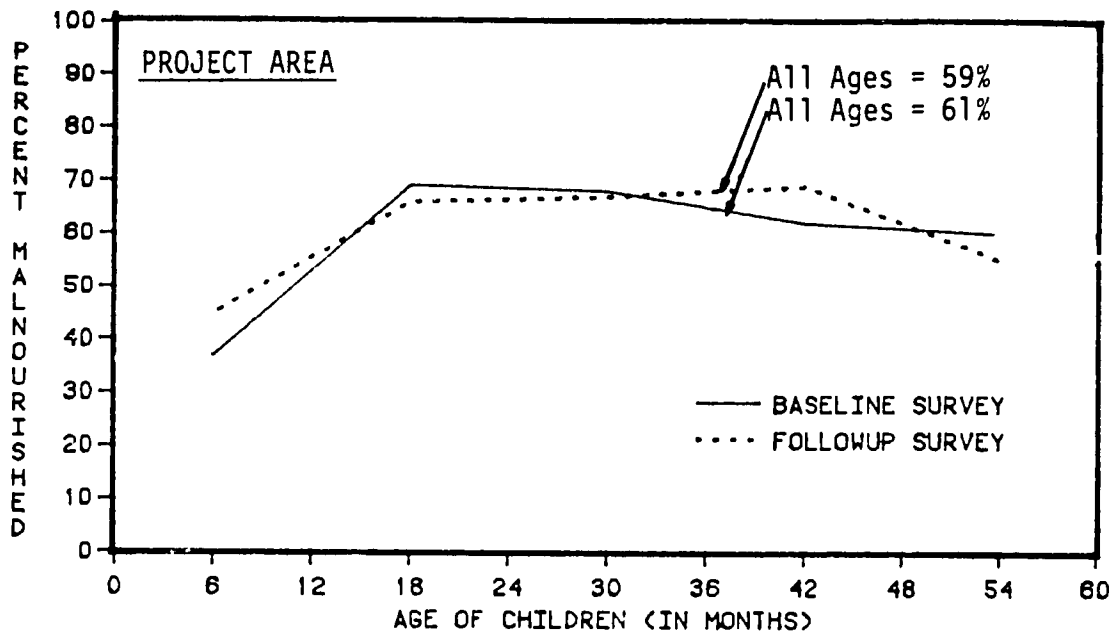
Table 6.4 Percent Distribution of Children Aged 0 to 4 Years, by Nutritional Level and Experimental Group

City and nutritional level	Experimental group and survey round					
	Project area			Nonproject area		
	Baseline survey	Interim monitoring surveys	Followup survey	Baseline survey	Interim monitoring surveys	Followup survey
CAGAYAN DE ORO						
Number of children.....	21,923	14,078	31,978	1,036	4,125	1,116
Percent distribution:						
Normal.....	41	51	39	48	48	39
Mildly malnourished.....	42	32	43	37	31	31
Moderately malnourished..	12	11	15	10	16	24
Severely malnourished....	5	6	3	5	4	7
BACOLOD						
Number of children.....	24,723	19,258	19,114	4,003	6,042	2,040
Percent distribution:						
Normal.....	34	38	35	23	32	29
Mildly malnourished.....	36	37	36	28	35	34
Moderately malnourished..	24	17	18	37	23	25
Severely malnourished....	6	8	11	12	10	12

[4]The models used to test the significance of changes over time for experimental groups included all significant two and three-way associations among the four variables so as to provide the "purest" test of the nutritional level-experimental group-survey parameter.

Figure 6-C

Percent of Children Aged 0-4 Years Malnourished, Based on the 90% Weight-for-Age Definition: Cagayan de Oro



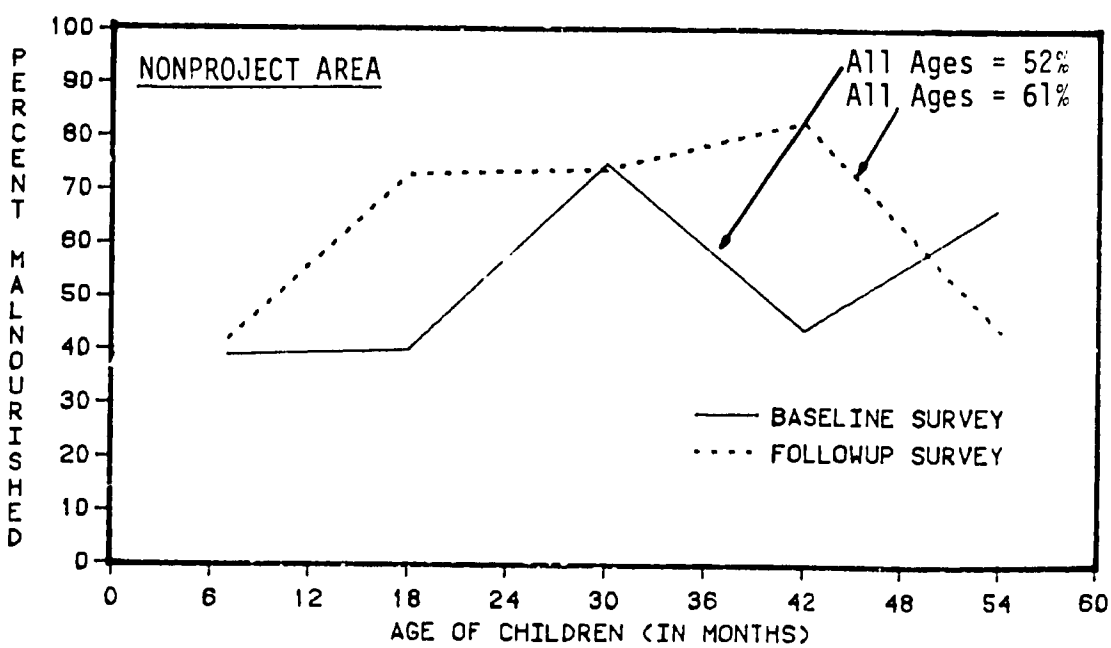
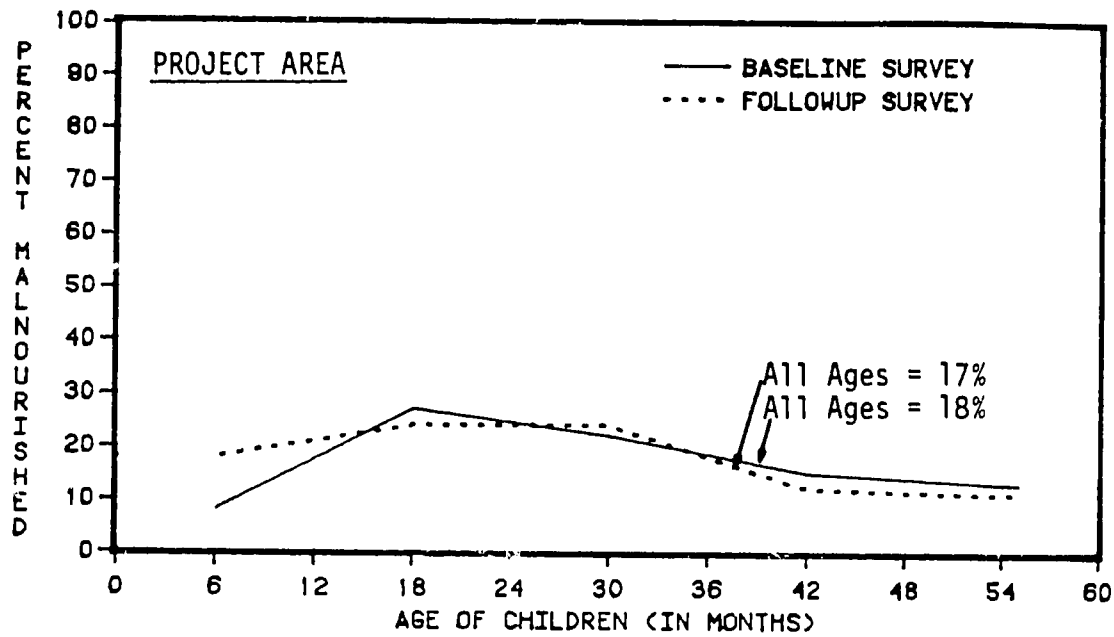


Figure 6-D

Percent of Children Aged 0-4 Years Malnourished, Based on the 75% Weight-for-Age Definition: Cagayan de Oro



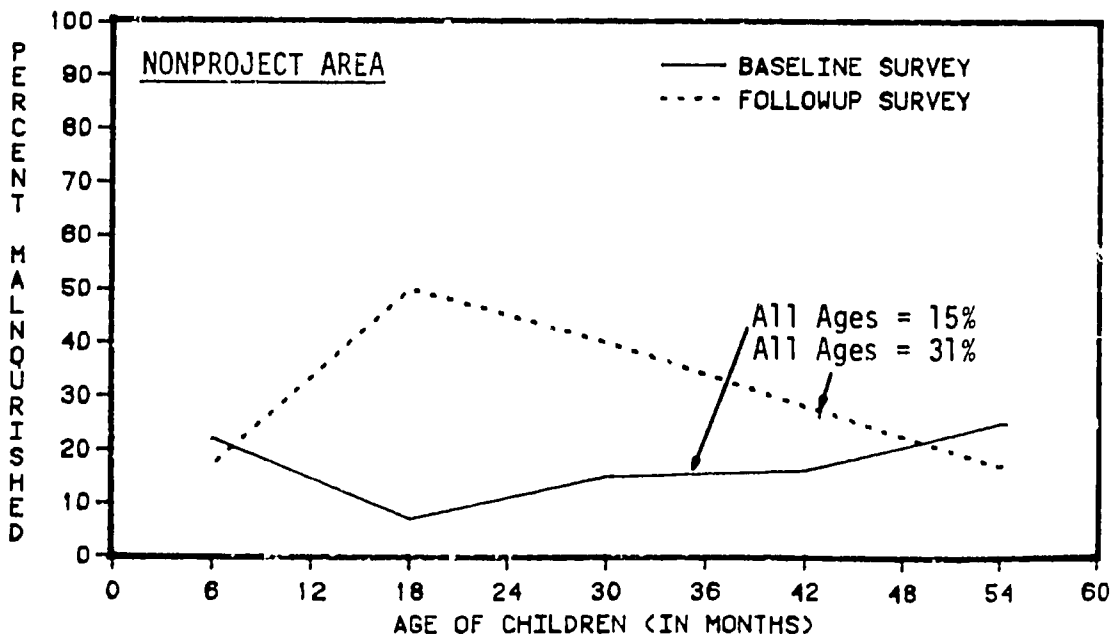
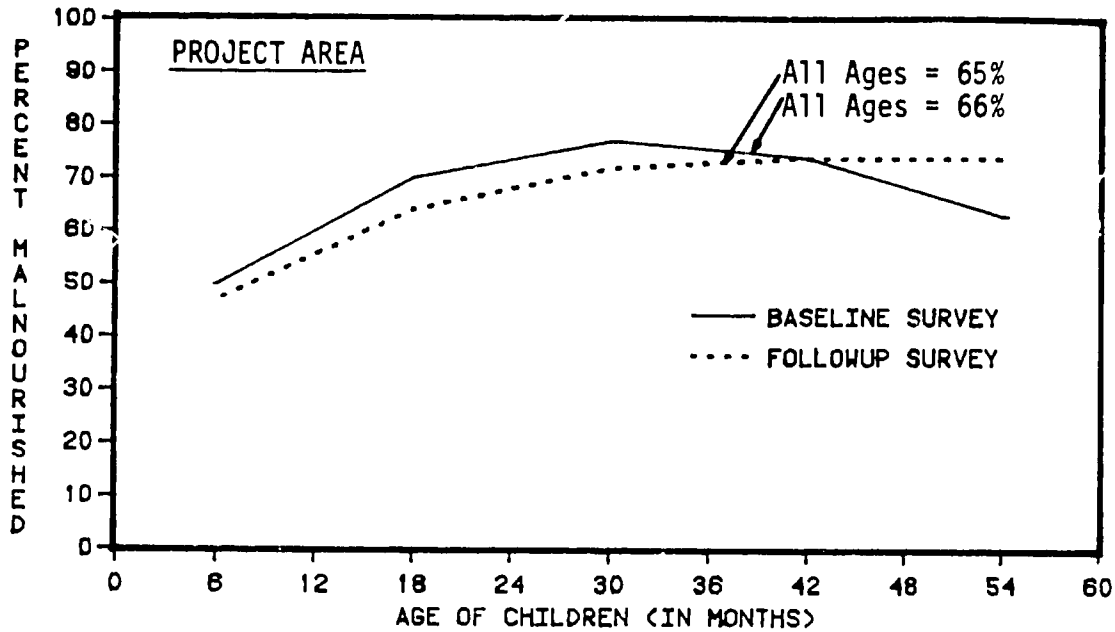


Figure 6-E

Percent of Children Aged 0-4 Years Malnourished, Based on the 90% Weight-for-Age Definition: Bacolod



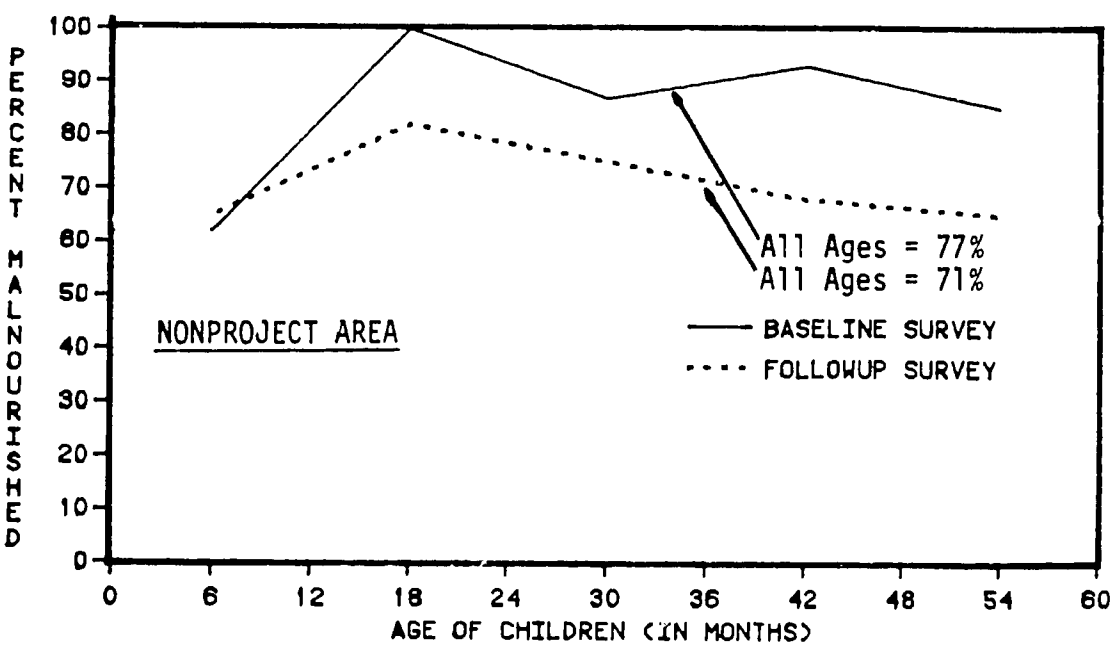
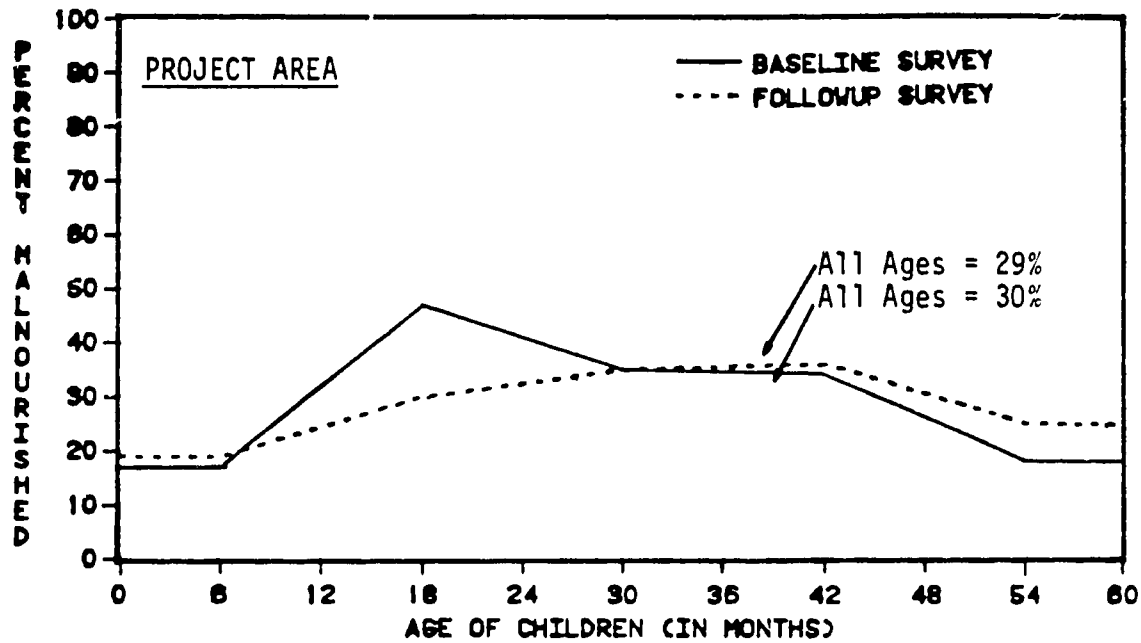


Figure 6-F

Percent of Children Aged 0-4 Years Malnourished, Based on the 75% Weight-for-Age Definition: Bacolod



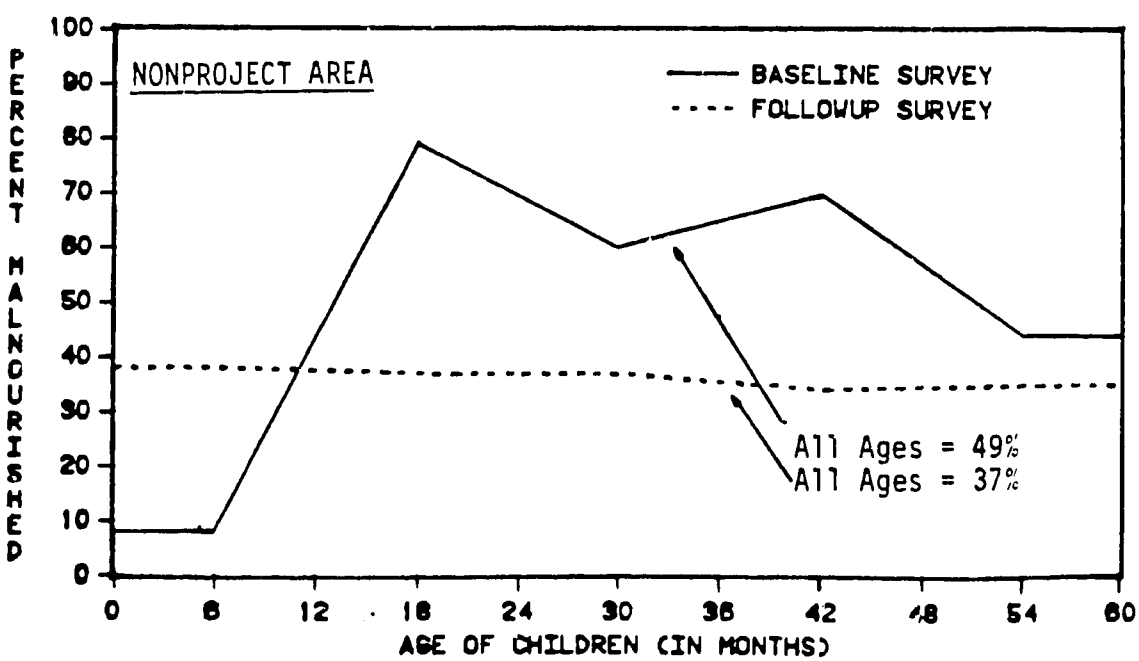


Table 6.5 Results of Tests for Differential Changes in the Distribution of Children Aged 0 to 4 Years, by Nutritional Level among Project and Control Group Households

Definition of malnutrition (weight for age)	Lambda parameters (std. errors)[a]	
	Cagayan de Oro	Bacolod
FULL CLASSIFICATION		
Normal.....	.091 (.089)	-.089[b] (.047)
Mildly malnourished.....	.105 (.103)	-.051 (.045)
Moderately malnourished...	-.116[b] (.054)	.033 (.048)
Severely malnourished.....	-.031 (.153)	.108[c] (.048)
Significance of change in distribution.....	(NS)	p<.10
90 PERCENT DEFINITION		
Normal.....	.039 (.056)	-.049 (.034)
Malnourished.....	-.039 (.056)	.049 (.034)
Significance of change in distribution.....	(NS)	(NS)
75 PERCENT DEFINITION		
Normal.....	.112[d] (.044)	-.071[d] (.027)
Malnourished.....	-.112[d] (.044)	.071[d] (.027)
Significance of change in distribution.....	p<.001	p<.05

NS Not significant.

[a]The signs of the lambda parameters are indicative of the direction of change between the baseline and followup surveys for project area households. A positive number indicates a net increase in the proportion of children in a particular category, while a negative sign indicates a net decrease.

[b]Coefficient is at least 1.65 times its standard error (p<.10).

[c]Coefficient is at least 1.96 times its standard error (p<.05).

[d]Coefficient is at least 2.53 times its standard error (p<.01).

For Cagayan de Oro, the tests indicate no significant changes in differences in overall distribution or in the proportion of children classified as malnourished under the 90 percent weight-for-age definition of malnutrition for groups, although the positive signs of the lambda parameters indicate a tendency in the hypothesized direction (i.e., a positive trend during the evaluation period for project area relative to nonproject area households in terms of proportions of adequately nourished children).

With respect to changes in the proportion of children who were classified as malnourished under the 75 percent weight-for-age nutrition criteria, the test results indicate a highly significant improvement ($p<.001$) for project area relative to nonproject area households during the evaluation period. This significant net shift would appear, however, to have been due to a deterioration of nutrition levels in nonproject area households rather than an improvement in project area households.

In Bacolod, the tests indicate a marginally significant shift ($p<.10$) in the overall distribution resulting primarily from a significant shift ($p<.05$) in the proportion of children who were classified as malnourished under the 75 percent weight-for-age criteria. The data indicate improvements for nonproject area households relative to project area households under both nutritional classifications (this is evidenced by the negative coefficients for the well nourished categories and the positive coefficients for the malnourished categories in each of the classifications).

Thus, the results indicate that the relative changes in nutrition levels of children in the two experimental groups were in the hypothesized direction (i.e., favorable for project area households relative to nonproject area households) in Cagayan de Oro and contrary to expectations in Bacolod. In neither city, however, were significant improvements observed for project area households on an absolute basis.

It is imperative, in assessing the impact of project interventions under experimental conditions in which the experimental groups are neither randomized nor matched initially with respect to characteristics which either affect or interact with the treatment, to take account of initial differences and changes in such characteristics in the experimental groups during the evaluation period. In the present study, analyses of the baseline survey data revealed that project area households in both cities were, on the average, of higher socioeconomic status than nonproject area households. To the extent that this relative advantage in terms of standard of living was maintained during the evaluation period, comparisons of nutritional levels over time for the two experimental groups should not be distorted by differential changes in factors exogenous to the project intervention. However, differential changes in composition of the experimental groups during the evaluation period with respect to factors which are exogenous to the project intervention but are correlated with the impact indicator(s) can confound the interpretation of relative changes in the impact variables for the experimental groups.

To assess the extent to which the observed changes in childhood nutritional levels for the experimental groups were being affected by differential

compositional changes in the experimental groups, statistical controls were introduced into the log-linear models. A number of variables were considered to serve as control variables in the analysis. Total annual household income was ultimately selected as the most appropriate variable for two primary reasons.[5] First, it represents an efficient proxy (i.e., is correlated with) for many of the variables which need to be taken into account for making comparisons over time under the present design (e.g., socioeconomic background variables and nonwater-related proximate determinants of childhood nutrition). Second, the income variable can be "standardized" over time to approximate more or less constant standards of living between the baseline and followup surveys through the conversion of the followup survey income data to comparable baseline survey income levels (i.e., constant 1978 pesos). The income distributions for project and nonproject area households by survey round are shown in table 6.6.

Table 6.6 Percent Distribution of Households, by Annual Household Income

[Annual household income in constant 1978 pesos]

Annual household income	Cagayan de Oro		Bacolod	
	Project area	Nonproject area	Project area	Nonproject area
Baseline Survey				
1 to 4,000.....	18	24	21	29
4,001 to 8,000.....	28	32	27	34
8,001 to 15,000.....	27	24	26	17
15,001 and above.....	27	20	26	20
Followup Survey				
1 to 4,000.....	36	27	48	30
4,001 to 8,000.....	33	33	36	38
8,001 to 15,000.....	15	22	8	21
15,001 and above.....	16	17	8	10

[5]The use of multiple control variables was also investigated, but produced results very similar to those found when only a single control variable for household income was included in the models.

The estimates of the lambda parameters from logistic regressions including the income control variable are shown in table 6.7.[6] The parameters from the models which did not include the income variable (from table 6.5) are also shown for comparative purposes.

The inclusion of the income control in the model has very little effect on either the sign or magnitude of the coefficients in Cagayan de Oro, although the coefficients are generally reduced in magnitude. Further, the introduction of the income variables does not alter the level of significance of the positive relative trend in nutrition levels for project area households during the evaluation period under the 75 percent weight-for-age criterion. This suggests that this effect was not an artifact of changing composition of the experimental groups with respect to variables for which income is an efficient proxy.

In Bacolod, however, the introduction of the statistical control for differential shifts in composition in terms of household income reduces quite substantially the magnitude of the relative improvement in nutritional levels for nonproject area households. In fact, the significant relative improvement ($p<.01$) for nonproject area households indicated by the model not including the income variable under the 75 percent weight-for-age definition is reduced to a nonsignificant level ($p<.20$) when experimental group shifts in relative income during the study period are taken into account (although the signs of the parameters remain negative). This result suggests that the relative improvement in nutrition levels for nonproject area households during the study period was largely a function of changes in factors exogenous to water-related practices. Overall, there would appear to have been very little relative change in nutrition levels for the experimental groups in Bacolod, which is not accounted for by changes in relative standards of living.

With respect to inferences from these analyses regarding the health impact of the project water systems, caution should be exercised for several reasons. First, there is some variability in the geographical coverage of the baseline and followup survey estimates, which was introduced by the selection of a supplementary sample of nonproject area PSU's for the followup survey. While these PSU's were within the sampling universe for the original sample (i.e., the PSU's selected for the baseline survey) and were selected in accordance with conventional sampling practices, the possibility nevertheless remains that the supplementary sample PSU's may be distorting the trends over time in health indicators for the nonproject area households.[7]

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[6]Because of the small number of primary sampling units (PSU's) in the control stratum, it was not possible to obtain stable estimates of this effect through the conventional procedure of comparing adjacent models. Thus, it was necessary to evaluate the impact of adding the income control variable through the comparison of the regression parameters.

[7]Given the small sample size for nonproject area households, the possibility that the estimates are being affected by purely random factors looms large.

Table 6.7 Logistic Regression Lambda Parameters for the Experimental Group-Survey "Effect" on Nutrition Levels

Definition of malnutrition (weight for age)	Lambda parameters (std. errors)[a]			
	Cagayan de Oro		Bacolod	
	Without income control	With income control	Without income control	With income control
FULL CLASSIFICATION				
Normal.....	.091 (.089)	.078 (.063)	-.089[b] (.047)	-.058 (.044)
Mildly Malnourished.....	.105 (.103)	.099 (.099)	-.051 (.045)	-.044 (.045)
Moderately Malnourished.....	-.116[c] (.054)	-.155[d] (.058)	.033 (.048)	-.006 (.039)
Severely Malnourished.....	-.031 (.153)	-.022 (.137)	.108[c] (.048)	.108[c] (.047)
90 PERCENT DEFINITION				
Normal.....	.039 (.056)	.029 (.047)	-.049 (.034)	-.030 (.033)
Malnourished.....	-.039 (.056)	-.029 (.047)	.049 (.034)	.030 (.033)
75 PERCENT DEFINITION				
Normal.....	.112[d] (.044)	.102[d] (.040)	-.071[d] (.027)	-.039 (.028)
Malnourished.....	-.112[d] (.044)	-.102[d] (.040)	.071[d] (.027)	.039 (.028)

[a]See footnote a of table 6.5 regarding interpretation of the lambda parameters.
[b]Coefficient is at least 1.65 times its standard error ($p<.10$).
[c]Coefficient is at least 1.96 times its standard error ($p<.05$).
[d]Coefficient is at least 2.53 times its standard error ($p<.01$).

Second, there is the problem faced by all field experiments in free-living populations that the populations under study are not controllable during the evaluation period with respect to population mobility. While the influences of the mobility factor on the composition of the experimental groups are likely to be minimized through the introduction of the control variable for income in the analyses reported above, the problem remains that the environmental conditions to which the in-migrants had been exposed prior to their arrival in the project cities cannot be adequately controlled in this manner. To the extent that environmental conditions have a cumulative effect on health, and there is ample justification to assume that they do, the comparisons of changes in health indicators over time for experimental groups under "non-panel" designs are subject to "contamination" which cannot be measured on the basis of the original design.

To evaluate the influence of these factors on the analyses reported above, the followup survey estimates of the proportions of malnourished children for the primary experimental groups were recalculated under various restrictions of the followup survey samples. To assess the impact of the supplementary sample of the followup survey on estimated changes in nutritional levels for nonproject area households, the followup survey nonproject area sample was restricted to households located in PSU's which were included in the original (baseline) sample.

Two restrictions were imposed upon the followup survey sample to assess the influence of the population mobility factor on the observed changes in health indicators for the experimental groups. The samples (both project and non-project area households) were first restricted to households that had resided in the same barangay for at least 5 years (i.e., the full evaluation period), and secondly to households that had resided in the same housing unit for at least 5 years. While these restrictions do not provide a means for measuring the effects of out-migration from the study areas on estimated changes,[8] they do restrict the followup survey samples to households that had been exposed to the project experimental conditions for the full evaluation period and thus provide a closer approximation to controlled experimental conditions than is possible with the full samples.

Followup survey estimates of proportions of children classified as malnourished under the 90 and 75 percent weight-for-age definitions of malnutrition for the primary experimental groups under the various sample restrictions described above are shown in table 6.8. With respect to the impact of the supplementary sample on followup survey estimates for the nonproject areas, table 6.8 shows that survey estimates of proportions of malnourished children for nonproject area households are considerably lower in Cagayan de Oro (e.g., 22 percent for the original sample PSU's as compared to 31 percent for the full sample under the 75 percent weight-for-age criteria) and somewhat lower in Bacolod

[8]The effects of out-migration on the composition of the experimental groups should, however, be minimized through the introduction of the income control variable.

(33 versus 37 percent) when the followup survey sample is restricted to PSU's included in the original sample.

Table 6.8 Estimates of Proportions of Malnourished Children Aged 0 to 4 Years for Project and Nonproject Area Households under Restrictions of the Followup Survey Sample

Sample restriction	Cagayan de Oro			Bacolod		
	Number of children	Percent malnourished		Number of children	Percent malnourished	
		90% weight-for-age definition	75% weight-for-age definition		90% weight-for-age definition	75% weight-for-age definition
PROJECT AREA						
Full sample.....	31,978	61	18	19,114	64	29
Five-year residence in barangay.....	15,038	62	17	12,350	64	30
Five-year residence in housing unit.....	1,656	61	16	10,412	64	30
NONPROJECT AREA						
Full sample.....	1,116	61	31	2,039	71	37
Five-year residence in barangay.....	584	51	25	1,333	70	38
Five-year residence in housing unit.....	323	40	18	921	74	39
Original sample PSU's..	478	54	22	1,350	69	33
Five-year residence in barangay.....	249	51	25	716	68	33
Five-year residence in housing unit.....	167	52	18	534	69	32

Source: Followup survey.

The impact of this sample restriction on the tests for the significance of differential evaluation period changes in nutritional levels for project and nonproject area households are indicated in Table 6.9.[9] In Cagayan de Oro, the restriction of the followup survey nonproject area sample to the original PSU's reduces the size of the experimental group-survey parameter somewhat (from .102 to .070), although the parameter is still highly significant ($p<.01$). In Bacolod, the sample restriction results in the re-emergence of a significant relative improvement ($p<.05$) in nutritional levels under the 75 percent weight-for-age criteria for nonproject area households during the evaluation period.

Investigation of the causes of the substantial differences between the original and supplementary PSU's did not suggest any grounds to suspect sampling bias

[9]The income control variable was included in these and all subsequent models estimated in this chapter.

as a plausible explanation. The most plausible explanation would seem to be that this phenomenon is the result of sampling variability associated with small sample sizes. Nevertheless, these results indicate that it will be necessary to restrict the followup survey sample to the original PSU's in order to make valid comparisons of changes over time for the experimental groups.

Table 6.9 Logistic Regression Lambda Parameters for the Experimental Group-Survey "Effect" on Nutrition Levels, by Selected Followup Survey Sample Restrictions

Sample restrictions	Lambda parameters (std. errors)[@] and weight-for-age definition of malnutrition			
	Cagayan de Oro		Bacolod	
	90% definition	75% definition	90% definition	75% definition
FULL SAMPLE.....	.029	.102*	-.030	-.039
	(.047)	(.040)	(.033)	(.028)
Five-year residence in barangay.....	-.039	.059	-.046	-.058§
	(.056)	(.036)	(.032)	(.033)
Five-year residence in housing unit....	-.087	-.002	-.028	-.059†
	(.094)	(.059)	(.055)	(.029)
ORIGINAL SAMPLE PSU's..	.012	.070†	-.044	-.056†
	(.062)	(.026)	(.041)	(.026)
Five-year residence in barangay.....	-.012	.054§	-.053	-.063†
	(.074)	(.031)	(.021)	(.025)
Five-year residence in housing unit....	-.012	.025	-.061§	-.075†
	(.095)	(.039)	(.036)	(.034)

[@]See footnote a of table 6.5 regarding interpretation of the lambda parameters.
§Parameter is a least 1.65 times its standard error ($p<.10$).
†Parameter is a least 1.96 times its standard error ($p<.05$).
*Parameter is a least 2.53 times its standard error ($p<.01$).

Tables 6.8 and 6.9 reveal that the magnitudes of observed changes over time in the proportion malnourished for the two experiment groups are also affected when the followup survey samples are restricted to households who had resided in the same barangay or the same housing unit for the full evaluation period. Particularly noteworthy is the large impact these restrictions have on the sample sizes supporting the survey estimates under these restrictions (see table 6.8). In Cagayan de Oro, for example, the project area sample for the followup survey is reduced by 53 percent (from 31,978 to 15,038) when the

sample is restricted to households with at least 5 years of residence in the barangay, and by 63 percent (from 31,978 to 11,656) when the sample is restricted to households with at least 5 years of residence in the housing unit.

The sample "attrition" factor is even greater for the nonproject area in Cagayan de Oro, with a 71 percent reduction in sample size when the sample is restricted to 5-year residents of the housing unit. When the "housing unit" restriction is combined with the "original PSU" restriction, the sample size for nonproject area followup survey estimates for Cagayan de Oro is reduced by a full 85 percent, leaving a sample of insufficient size from which to assess the impact of the project water systems under the original experimental design.

A similar situation arises in Bacolod with respect to remaining sample sizes under the various restrictions of the followup survey sample, although the magnitude of the reductions in sample size is not as substantial as in Cagayan de Oro.

As concerns the impact of the population "mobility" restrictions on followup survey estimates for the experimental groups, table 6.8 shows that in Cagayan de Oro the proportions of children classified as malnourished tend to be lower in the restricted samples, most notably for nonproject area households. Table 6.9 shows that the significant relative increase in the proportion of children classified as malnourished for nonproject area households under the 75 percent weight-for-age criterion disappears when the sample is restricted to 5-year residents of the housing unit. This suggests that the apparent significant increase in malnutrition among nonproject area households observed in the full sample may have been due more to the in-migration of a less adequately nourished population than to a deterioration of nutrition levels for "survivors" of the original nonproject area populations.[10] Given the instability of the estimates for nonproject area households in the restricted sample, however, this should be viewed as speculative.

That "new" residents (less than 5 years in the housing unit) are negatively selected in comparison with long-term residents is evident from the data shown in table 6.10. The comparisons of socioeconomic indicators for short- and long-term residents in each experimental group show clearly that the short-term residents fare less well on all of the indicators considered than the long-term residents in both experimental groups, although the differences are somewhat more pronounced among nonproject than project area households.

In Bacolod, the restriction of the followup survey sample to 5-year residents of the barangay and/or housing unit does not alter the survey estimates of the proportions of children who were malnourished for either experimental group under either nutrition criterion as substantially as in Cagayan de Oro.

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[10]Cagayan de Oro received a sizeable number of migrants from rural Mindanao, in all likelihood attempting to escape the political violence which characterized the study period.

The sample restrictions, however, tend to increase somewhat the statistical significance of the relative improvement in nutritional levels during the evaluation period for the nonproject area households under both criteria (see table 6.9). The population mobility effect on the followup survey estimates is much less pronounced in Bacolod than in Cagayan de Oro due to the closer similarity between short- and long-term residents in both experimental groups in terms of socioeconomic characteristics (see table 6.10).

Table 6.10 Percent Distribution of Households on Selected Socioeconomic Characteristics, by Length of Residence in Housing Unit and Experimental Group

Selected socioeconomic characteristics	Cagayan de Oro				Bacolod			
	Project area		Nonproject area		Project area		Nonproject area	
	Less than 5 years in unit	5 or more years in unit	Less than 5 years in unit	5 or more years in unit	Less than 5 years in unit	5 or more years in unit	Less than 5 years in unit	5 or more years in unit
Quality of house construction:								
High quality.....	61	66	51	62	50	54	42	42
Low quality/rundown.....	39	34	49	38	50	46	58	58
Annual Household Income (in pesos):								
4,000 or less.....	11	12	13	13	12	11	11	13
4,001 to 8,000.....	22	19	27	21	28	23	31	21
8,001 to 15,000.....	29	26	32	29	30	27	33	36
15,001 or more.....	39	43	27	37	30	38	25	30
Type of household lighting:								
Electric.....	67	81	63	82	71	78	44	56
Other.....	33	19	37	18	29	22	56	44

Source: Followup survey.

3. Summary and Conclusions

Based upon comparisons of changes in the nutrition levels of young children for the primary experimental groups under the original evaluation design, there is little evidence to suggest that the project intervention resulted in marked improvements in health in either study city.

In Cagayan de Oro, trends over time with respect to nutrition levels of children are very similar for the two experimental groups when various controls and restrictions are applied to the data. Conclusions as to relative trends for project and nonproject area households during the evaluation period should be regarded as tentative, however, due to the instability of the estimates for the nonproject (control) area households. The estimates for project area

households, which are sufficiently stable for the purpose of assessing trends, indicate nutrition levels which were essentially constant on an absolute basis during the evaluation period.

Similarly, there is little in the way of evidence for a significant beneficial health impact of the project intervention in Bacolod. The data indicate that, in fact, nonproject area households showed a more significant improvement in childhood nutrition levels when statistical controls and sample restrictions to approximate controlled experimental conditions are applied to the data. On an absolute basis, project area households showed a minimal (and not statistically significant) improvement in childhood nutrition levels.

These conclusions should, however, be tempered by the recognition of a fundamental weakness of the original evaluation design, namely the areal basis used in defining the experimental groups. While efficient under some conditions, areal definitions of comparison groups obscure an important source of variability within the "treatment" group--the fact that not all households availed themselves of the use of the city water systems during the evaluation period. Thus, the possibility remains that positive project health benefits are accruing to actual users of the city water systems but are being obscured by the use of areal definitions of the experimental groups.[11]

The analyses reported in the following section attempt to overcome this problem by defining experimental groups on the basis of actual usage of the city water systems.

B. ANALYSIS WITH COMPARISON GROUPS DEFINED ON A HOUSEHOLD BASIS

1. Methodological Note

This section, in contrast to section A, reports the results of further analysis of the nutrition data (focusing on changes in nutrition levels) for experimental groups defined on a household basis with respect to use of the city water systems. The two comparison groups analyzed are: (1) households using the project water systems as their major source of water and (2) households using other sources as their major source of water. For those analyses, the original experimental groups defined on an areal basis are disregarded.

The rationale for undertaking these analyses was to assess the extent to which actual project health benefits were being obscured by including nonusers of the city water systems as part of the "treatment" group in the analysis of the areally-defined experimental groups in the original evaluation design (section A of this chapter). An important advantage of defining the exprimental groups

[11]Within the population of the city water users, it is also possible that differential health benefits may be realized for households varying with respect to duration and intensity of use. The effects of these variables are investigated in section C of this chapter.

on a household rather than an areal basis is that it substantially improves the homogeneity of the experimental groups with respect to the "treatment" whose impact is being measured (i.e., the use of the city water systems) and thus provides a closer approximation to controlled experimental conditions than is possible with experimental groups defined on an areal basis in the present study.

A second advantage of defining the experimental groups on a household basis in the present study is that the difficulties encountered in obtaining stable estimates for a control population (i.e., nonusers of the city water systems) in the analyses reported in section A are ameliorated to some extent due to a larger sample size for nonusers.[12] This feature is especially important in Cagayan de Oro, where it was not possible to draw firm conclusions as to changes in nutritional levels for households exposed to the project "treatment" relative to a control population in the analyses of the areally-defined experimental groups.

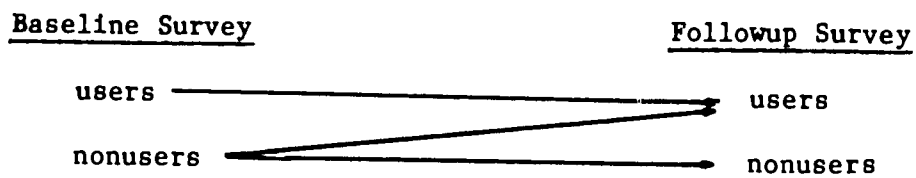
An important methodological problem arises, however, in identifying the appropriate comparison populations in the baseline and followup surveys when the experimental groups are defined on a household basis. The problem arises because some portion of the "control" population at the time of the baseline survey (i.e., nonusers of the city water systems) had shifted to the "project" population (i.e. had become users) by the time of the followup survey.[13] In this situation, the appropriate baseline survey comparison population for the followup survey sample of water-system users would consist of the users of the water systems at the time of the baseline survey as well as some portion of the sample of nonusers (see figure 6-G). Similarly, the appropriate baseline survey comparison group for nonusers of the city water systems at the time of the followup survey would consist of some, but not all, of the nonusers at the baseline survey. Since the study was designed with independent samples of the experimental groups in each survey round rather than a panel design in

[12]The effect of the household-based classification on estimated variances is especially noteworthy. The primary advantage here arises in having a considerably larger number of degrees of freedom for estimating the between-PSU variance.

[13]Estimates of the increase in the number of city water user households during the evaluation period are reported in chapter 3.

which the same households were reinterviewed in each survey round, it is not possible to directly match the comparison groups across survey rounds.[14]

Figure 6-G Corresponding Baseline Survey Comparison Groups for Followup Survey Water System Users and Nonusers



If it could be assumed that the households who first became users of the city water systems during the evaluation period (i.e., subsequent to the baseline survey) represented a random sample of the population of nonusers at the time of the baseline survey (i.e., were similar with respect to characteristics other than the use of city water), a simple solution to the problem would be to randomly select a sample of baseline survey nonusers to be combined with the baseline survey sample of city water users for comparison with the followup survey population of city water users.

However, the baseline and followup survey data show clearly that city water users tend to be of higher socioeconomic status than nonuser households in both cities. Hence, the random selection of baseline survey nonuser households would result in a form of "selectivity bias" comparable to that encountered in migration research, and which would confound comparisons of the baseline and followup survey childhood nutrition levels for the experimental groups.

Since the net effect of this experimental group shift between survey rounds is to change the composition of the groups with respect to nonwater-related determinants of health (a problem similar to that encountered in the analyses of the original areally-defined experimental groups), the problem is addressed by introducing statistical controls into the log-linear models used in the analysis. Thus, we do not attempt to identify a baseline survey sample

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[14]A question was included on the followup survey questionnaire involving the year in which the household began using the city water system. An attempt was made to use this question to partition the followup survey sample into short- and long-term users (i.e., less than and greater than 5 years) in order to resolve this problem. However, investigation of the behavior of this variable in relation to the baseline survey PSU-level estimates of proportions of users indicated considerable inconsistency. The investigation suggested that the distribution of this variable was being dis[illegible]ted by the high level of population mobility in the study cities during the evaluation period. Accordingly, this approach was rejected in favor of the approach to the problem described in the text. The effects of length of use on nutrition levels are, however, investigated in section C of this chapter.

population of "new users" from among the population of nonusers, but rather compensate for the resulting compositional shift statistically. Annual household income was selected as a control variable in the analyses. As was the case in the analyses of the areally-defined experimental groups reported in section A, this approach permits the estimation of the portion of the observed relative change in the impact variable which is not accounted for by differential shifts in composition.[15]

2. Results

The baseline and followup survey estimates of nutrition levels for the two experimental groups are shown in table 6.11 and displayed graphically in figures 6-H to 6-K. These data suggest a similar pattern to that observed in the comparison of the areally-defined experimental groups in Cagayan de Oro, but a somewhat more promising trend in Bacolod. In Cagayan de Oro, the preliminary comparisons once again suggest a relative improvement in childhood nutrition levels for city water users, which results primarily from a deterioration of nutritional levels for nonuser households. The data are not suggestive of a marked improvement for city water users on an absolute basis, although a slight improvement is apparent.

In Bacolod, the data suggest a substantial improvement for the "treatment" group (i.e., the city water users) under both nutrition criteria on an absolute basis. The proportion of children classified as malnourished in city water user households declined from 66 to 58 percent under the 90 percent weight-for-age definition of malnutrition and from 32 to 24 percent under the 75 percent definition. Nutrition levels for nonuser households would appear to have remained relatively stable during the evaluation period, with no apparent changes in the proportions of children classified as malnourished under either nutrition criterion.

Following the approach employed in the analyses of the original areally-defined experimental groups presented in section A, log-linear models were fit to the data in table 6.11 to test the statistical significance of between-survey changes in nutritional distribution for the comparison groups. The results are summarized in table 6.12.

[15]The introduction of the income control variable compensates for compositional shifts resulting from migration and differential economic fortunes as well as shifts between experimental groups. The effects of migration are examined explicitly, however, in the analyses.

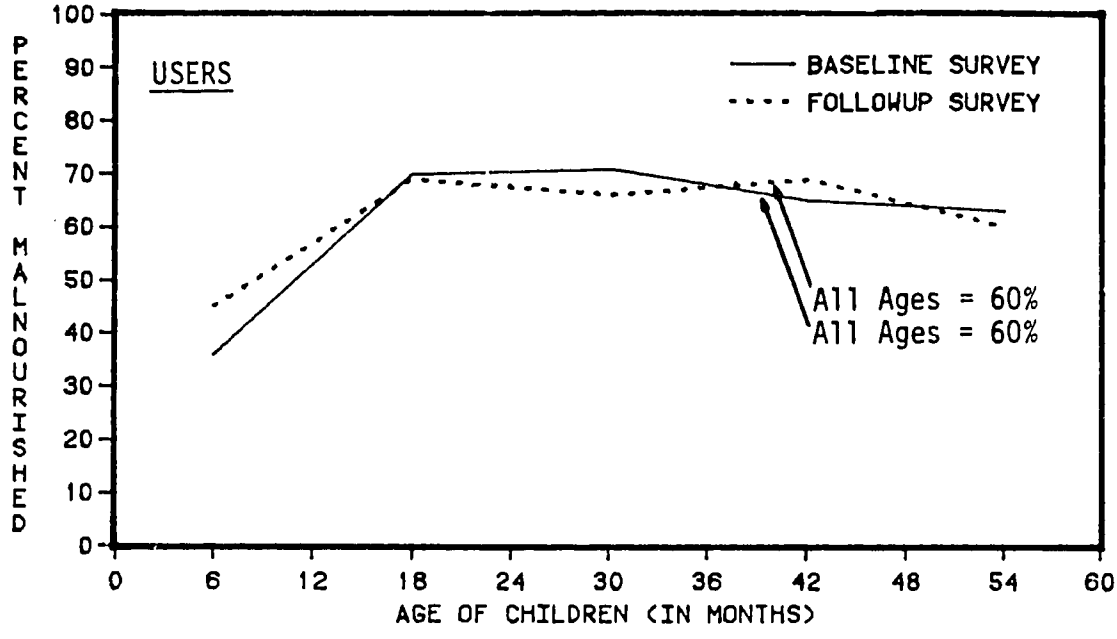
Table 6.11 Percent Distribution of Children Aged 0 to 4 Years, by Nutritional Level and Experimental Group

Nutritional level	Experimental group and survey round			
	Users		Nonusers	
	Baseline survey	Followup survey	Baseline survey	Followup survey
CAGAYAN DE ORO				
Number of children.....	10,934	27,834	10,661	5,259
Percent distribution:				
Normal.....	40	40	40	34
Mildly malnourished.....	41	43	41	42
Moderately malnourished...	15	15	12	18
Severely malnourished.....	4	2	7	6
BACOLOD				
Number of children.....	7,925	9,690	20,577	11,464
Percent distribution:				
Normal.....	34	42	31	30
Mildly malnourished.....	34	34	35	36
Moderately malnourished...	26	17	26	20
Severely malnourished.....	6	7	8	14

The tests indicate that only the relative improvement in nutrition levels for city water users vis-a-vis nonusers in Cagayan de Oro under the 75 percent weight-for-age definition of malnutrition was significant, and at that only marginally significant ($p<.10$). As was noted above, however, the significance of this change reflects an apparent worsening of nutritional levels for nonusers of the city water systems to a greater extent than an improvement for city water users on an absolute basis. Nevertheless, it is worthy of note that the signs of the lambda parameters for all well nourished categories under both nutritional classifications in both cities are uniformally positive, although the coefficients are of insufficient magnitude to infer a positive relative trend for city water users with any reasonable degree of confidence.

Figure 6-H

Percent of Children Aged 0-4 Years Malnourished, Based on the 90% Weight-for-Age Definition: Cagayan de Oro



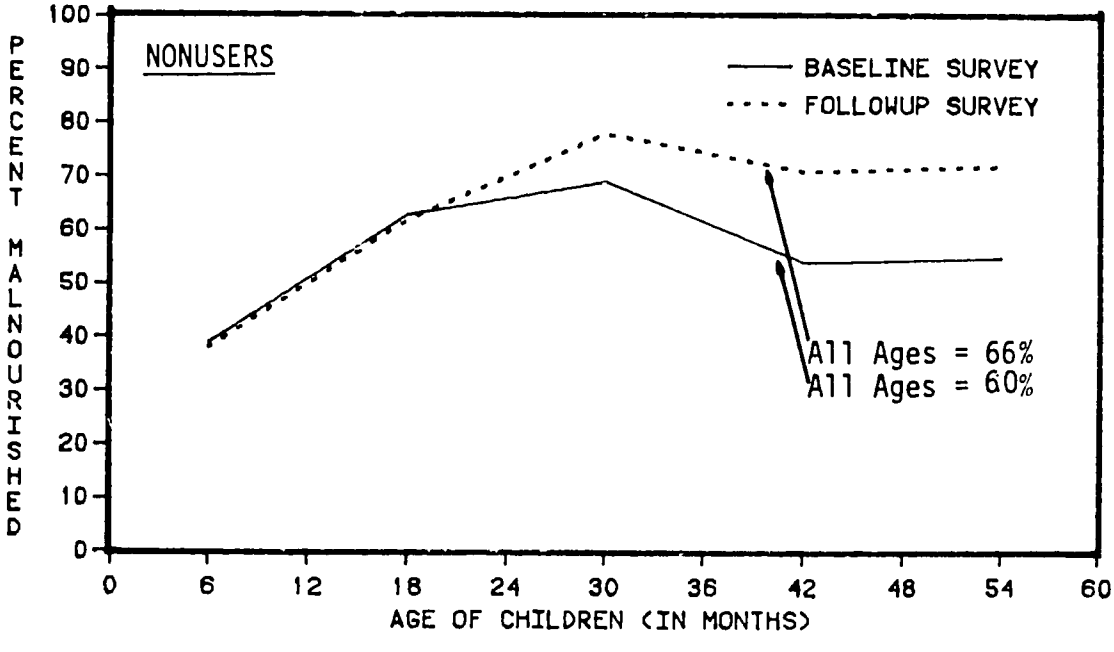
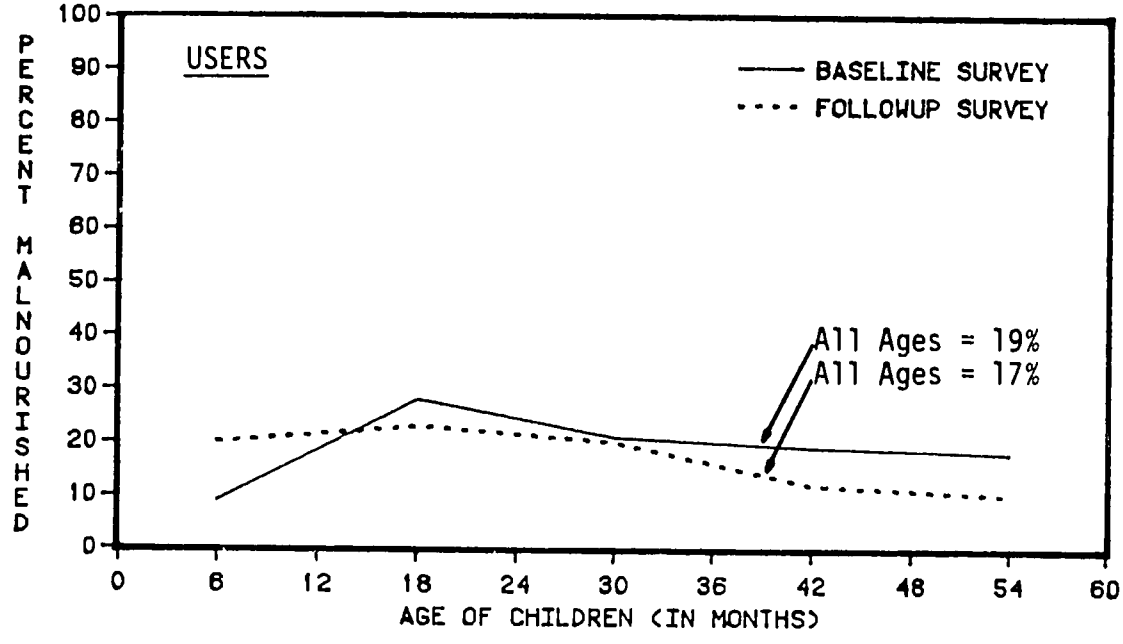


Figure 6-I

Percent of Children Aged 0-4 Years Malnourished, Based on the 75% Weight-for-Age Definition: Cagayan de Oro



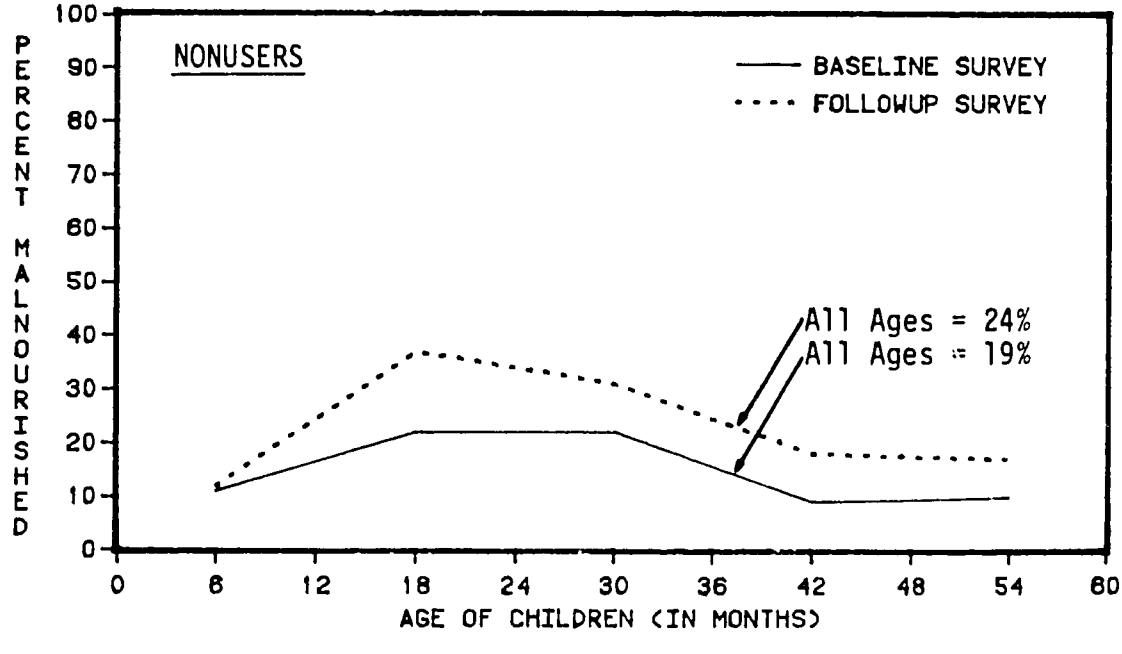
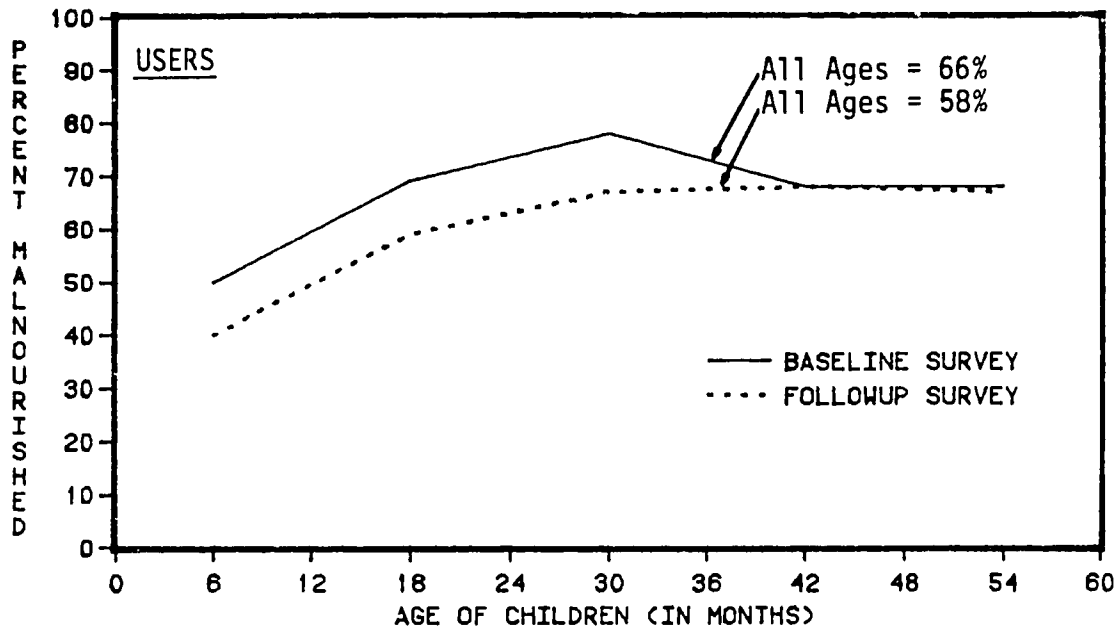


Figure 6-J

Percent of Children Aged 0-4 Years Malnourished, Based on the 75% Weight-for-Age Definition: Bacolod



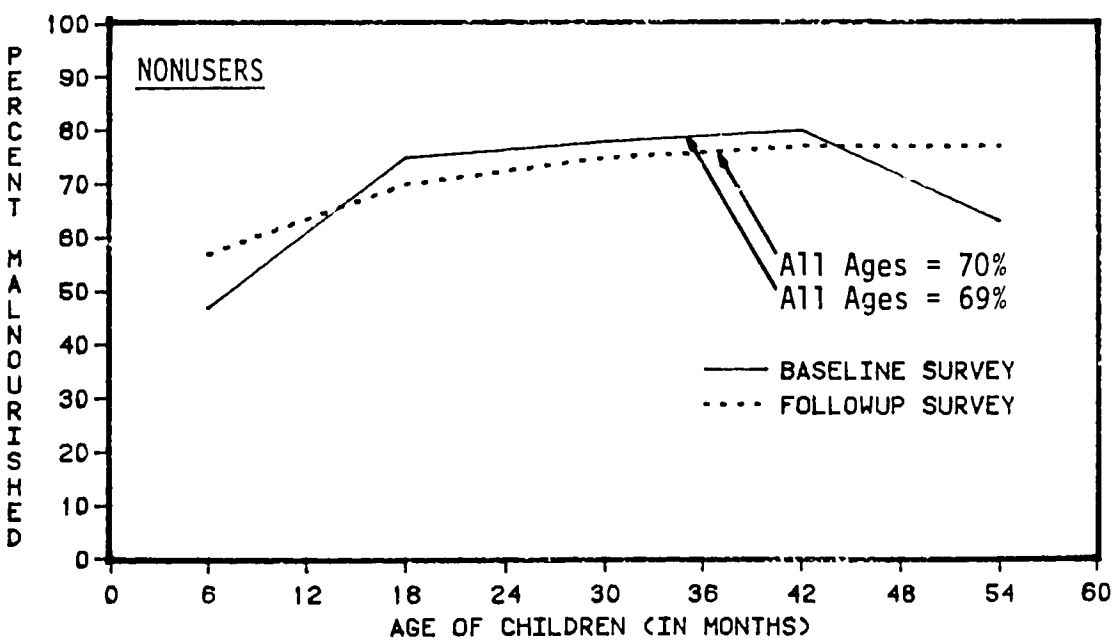
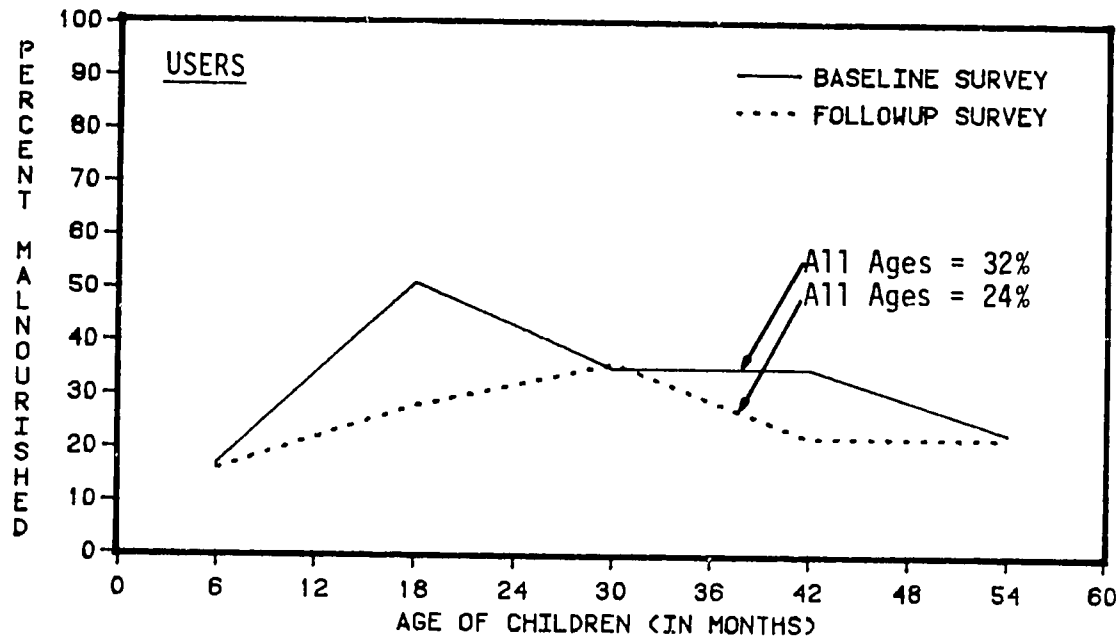


Figure 6-K

Percent of Children Aged 0-4 Years Malnourished, Based on the 90% Weight-for-Age Definition: Bacolod



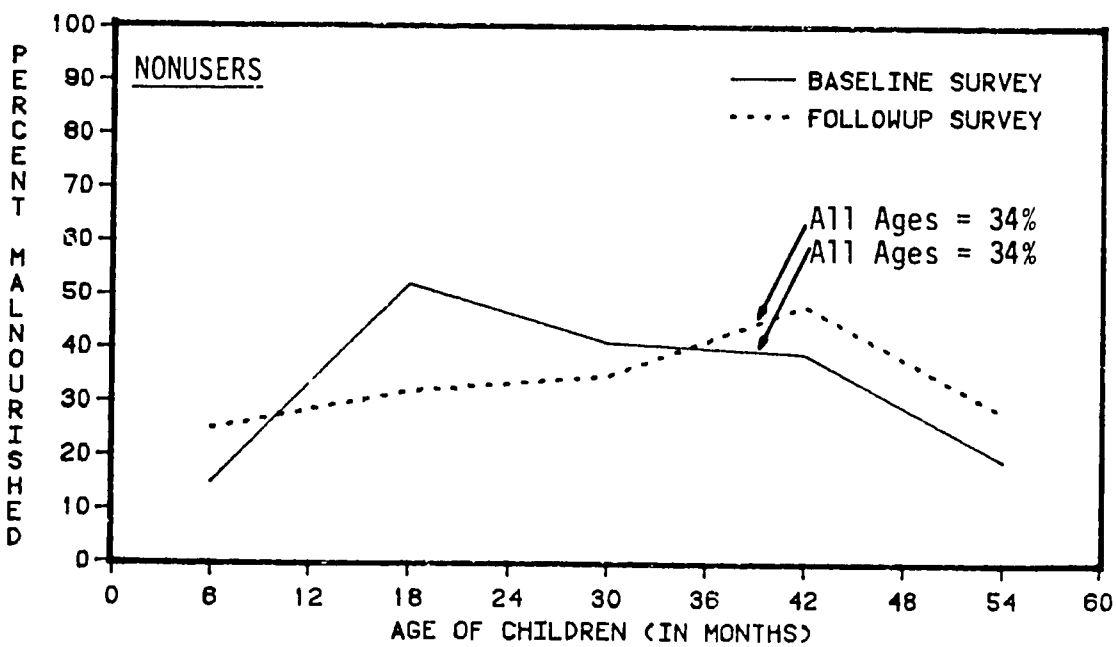


Table 6.12 Logistic Regression Lambda Parameters for the Experimental Group-Survey "Effect" on Nutrition Levels

Definition of malnutrition (weight for age)	Lambda parameters (std. errors)[a]	
	Cagayan de Oro	Bacolod
FULL DEFINITION		
Normal.....	.129[b] (.077)	.092 (.057)
Mildly malnourished.....	.070 (.053)	.022 (.050)
Moderately malnourished.....	-.051 (.061)	-.007 (.038)
Severely malnourished.....	-.148 (.188)	-.108 (.072)
Significance of change in distribution.....	(NS)	(NS)
90 PERCENT DEFINITION		
Normal.....	.051 (.040)	.051 (.033)
Malnourished.....	-.051 (.040)	-.051 (.033)
Significance of change in distribution.....	(NS)	(NS)
75 PERCENT DEFINITION		
Normal.....	.084[b] (.043)	-.053 (.036)
Malnourished.....	-.084[b] (.043)	-.053 (.036)
Significance of change in distribution.....	p<.10	(NS)

NS Not significant.

[a]A positive number for a parameter indicates an increase in the proportion of children falling into the category of water system user households during the evaluation period. A negative sign has the opposite meaning.

[b]Coefficient is at least 1.65 times its standard error (p<.10).

A critical aspect of the analysis of comparison groups defined on a household basis with respect to the use of city water systems concerns the extent to which these relationships hold up when account is taken of the effects of the shifting of households between the experimental groups during the evaluation period. Comparison of the lambda parameters from logistic regressions with and without a control for experimental group changes in household income to account for the resulting compositional shift indicates, however, that such shifts account for only a very small portion of the observed relative change in nutritional levels for the experimental groups (see table 6.13). While the general effect of the introduction of the income control variable is to reduce the magnitude of the coefficients, the impact is very small and does not alter the conclusions drawn above the respect to relative changes in nutrition levels for users and nonusers of the city water systems during the evaluation period.

Table 6.13 Logistic Regression Lambda Parameters for the Experimental Group-Survey "Effect" on Nutrition Levels

Definition of malnutrition (weight for age)	Lambda parameters (std. errors)[a]			
	Cagayan de Oro		Bacolod	
	Without income control	With income control	Without income control	With income control
90 PERCENT DEFINITION				
Normal.....	.051 (.040)	.050 (.034)	.051 (.033)	.045 (.034)
Malnourished.....	-.051 (.040)	-.050 (.034)	-.051 (.033)	-.045 (.034)
75 PERCENT DEFINITION				
Normal.....	.084[b] (.043)	.072[b] (.041)	.053 (.036)	.046 (.041)
Malnourished.....	-.084[b] (.043)	-.072[b] (.041)	-.053 (.036)	-.046 (.041)

[a]See footnote a of table 6.12 regarding interpretation of the lambda parameters.
[b]Coefficient is at least 1.65 times its standard error ($p<.10$).

Given the substantial impact of the various sample restrictions of the followup survey data observed in the analyses of the original experimental groups, the same set of restrictions was applied to the data for the user-nonuser comparison groups to assess the extent to which they alter conclusions as to relative trends in nutrition levels for city water users during the evaluation period. The results are shown in tables 6.14 and 6.15.

Table 6.14 Estimates of Proportions of Malnourished Children Aged 0 to 4 Years, for User and Nonuser Households under Various Restrictions of the Followup Survey Sample

Sample restriction	Cagayan de Oro			Bacolod		
	Number of children	Percent malnourished		Number of children	Percent malnourished	
		90% weight-for-age definition	75% weight-for-age definition		90% weight-for-age definition	75% weight-for-age definition
USERS						
Full sample.....	27,834	60	17	9,690	58	24
Five-year residence in barangay.....	12,906	61	15	6,194	58	25
Five-year residence in housing unit.....	10,080	60	14	5,472	58	24
NONUSERS						
Full sample.....	5,259	66	24	11,464	70	34
Five-year residence in barangay.....	2,716	66	24	7,489	70	35
Five-year residence in housing unit.....	1,899	63	21	5,861	71	36
Original sample PSU's..	4,608	66	23	10,774	70	34
Five-year residence in barangay.....	2,381	69	21	6,872	71	34
Five-year residence in housing unit.....	1,743	67	19	5,474	71	35

Table 6.14 shows the followup survey estimates of proportions of children classified as malnourished under the 90 and 75 percent weight-for-age nutrition criteria, respectively, for user and nonuser households. In general, the sample restrictions have little effect (and roughly equivalent for each of the groups) on the survey estimates, with the largest impact observed for the estimates of proportions of children classified as malnourished under the 75 percent weight-for-age classification for both experimental groups in Cagayan de Oro. This would appear to be due more to a negative "migration effect" on overall nutrition levels than to variability introduced by the supplementation of the followup survey sample.

Of interest in table 6.14, however, is the fact that when the followup survey sample of user households in Cagayan de Oro is limited to 5-year residents of the housing unit, a more substantial improvement since the baseline survey for user households with respect to proportions of children malnourished under the 75 percent criterion on an absolute basis is observed (i.e., a decline from 19 to 14 percent). On a relative basis, however, this is offset by a corresponding improvement for nonusers when the followup sample is limited to 5-year residents of the housing unit.

Table 6.15 Logistic Regression Lambda Parameters for the Comparison Group-Survey "Effect" on Nutrition Levels, by Followup Survey Sample Restrictions

Sample restriction	Lambda parameters (std. errors)[a] and weight-for-age definition of malnutrition			
	Cagayan de Oro		Bacolod	
	90% definition	75% definition	90% definition	75% definition
FULL SAMPLE.....	.050 (.034)	.072[b] (.041)	.045 (.034)	.046 (.041)
Five-year residence in barangay.....	.054 (.039)	.102[b] (.059)	.051 (.040)	.046 (.046)
Five-year residence in housing unit.....	.051 (.055)	.093 (.094)	.051 (.038)	.057 (.047)
Original sample PSU's.....	.050 (.037)	.060 (.044)	.043 (.034)	.043 (.042)
Five-year residence in barangay.....	.069 (.043)	.103 (.065)	.051 (.041)	.044 (.047)
Five-year residence in housing unit.....	.070 (.058)	.099 (.096)	.047 (.039)	.053 (.048)

[a]See footnote a of table 6.12 regarding interpretation of the lambda parameters.
[b]Parameter is at least 1.65 times its standard error ($p<.10$).

The results of the statistical tests for the significance of relative changes in nutrition levels for the comparison groups under the various followup survey sample restrictions are summarized in table 6.15. The results show that when account is taken of the influences of variability in the composition of the samples with respect to PSU's and compositional changes in the experimental groups resulting both from nonusers becoming users and migration, none of the relative changes in nutrition levels for the comparison groups meets the prescribed standard for statistical significance, although several are close. Even applying the full set of restrictions and controlling for income, however, the signs of the lambda parameters for the well nourished categories are positive in both cities, although small in magnitude.

3. Summary and Conclusions

The results of the over time comparisons for the experimental groups defined on a household basis with respect to the use of city water are, in general, more favorable as concerns the hypothesized health impact of the project than

were the results of the analysis of original areally-defined experimental groups. Since the baseline survey, improvements in the proportion of children classified as malnourished under the 75 percent weight-for-age definition of malnutrition are apparent for users of the city water systems in both cities on an absolute basis, although the improvement was statistically significant only in Bacolod. On a relative basis (i.e., in comparison with nonusers), the observed changes in nutrition levels for user households during the evaluation period were not significantly different from those of nonuser households in either city, although seemingly in the direction hypothesized (i.e., favorable to user households).

Thus, based upon the analyses of changes over time for experimental groups defined both on an areal and on a household basis, there is little evidence of a strong health impact of the project intervention in either city. This is not to say, however, that there was not any health benefit derived from the project. The data do suggest positive relative trends in childhood nutrition for water system users in both cities. Further, there is the very real possibility that declining economic conditions in the study cities during the evaluation period may have dampened any positive project effects. The late 1970's and early 1980's was a period of sharply decelerating economic growth in the Philippines generally. Further, the local economy of one of the study cities (Bacolod) was adversely affected by declining commodity prices for its principal product (sugarcane) during this period. Accordingly, it is the opinion of a number of persons knowledgeable about economic and health conditions in the Philippines that the study period was one of declining health and nutrition levels for the country as a whole (although it should be emphasized that there is no hard evidence to support this view). If this were to be the case, however, a more positive interpretation of the findings of these analyses would be suggested.

On the basis of the experimental design adopted for this study, however, and in the absence of data on trends in economic and health conditions in the study cities during the evaluation period, the magnitude of the observed changes are insufficient to infer a beneficial project health impact with any reasonable degree of confidence.

C. EFFECTS OF WATER AND SANITATION ON HEALTH: CROSS SECTIONAL ANALYSES OF THE FOLLOWUP SURVEY DATA

1. Objectives and Methodology

This section presents the results of multivariate analyses of the followup survey data which were to address the following questions:

(1) Are there statistical associations between water-related variables and health indicators?

(2) What is the relative strength of these associations in comparison with those for nonwater-related determinants of health?

(3) What is the net effect of the water-related variables when the effects of variables exogenous to water supply project interventions are taken into account (i.e., controlled statistically)?

The analyses consider the relative strength of statistical associations among the primary health indicator used in the study, the nutritional levels of children aged 0 to 4 years, and variables falling into the following six categories: 1) socioeconomic and household characteristics, 2) diet, 3) malabsorption (diarrhea), 4) sources and quality of water, 5) water-handling practices and related sanitary practices, and 6) sanitary facilities used by household members. A portion of the analyses is also directed to the investigation of the factors associated with the incidence of diarrhea, which is conceptualized as a proximate response to water supply/sanitation deficiencies that may ultimately result in nutritional deficiency given sufficiently frequent occurrence.

The analyses were undertaken for two primary purposes: 1) To explore further the relationships between water-related variables and health in order to provide a firmer basis for the explanation or interpretation of the observed changes in health indicators reported in sections A and B, and 2) to provide policy-relevant information as to the relative magnitude of the health effects of variables which can be "manipulated" within the context of water supply/sanitation project interventions vis-a-vis those which are beyond the scope of such interventions.

Log-linear techniques for the analysis of multidimensional contingency tables were utilized in the cross-sectional analyses. The form of the cross-sectional analyses is similar to that utilized in the analyses of observed changes in nutrition levels for the experimental groups reported in sections A and B, except that distributional changes over time for the variables under study are not of concern in these analyses. Of primary interest in the cross-sectional analyses is the explanatory power of water-related variables relative to that of nonwater-related variables.

The analyses were carried out in two stages. First, the gross statistical associations of each of the variables (i.e., the association prior to the introduction of control variables) with nutritional levels of children were assessed. Given the age-dependence of childhood nutritional levels (see sections A and B), age was included in the log-linear models used to measure the association between each of the "explanatory" or "independent" variables and nutrition. Although actually multivariate in nature, the results of these analyses are labeled "bivariate analyses" since the focus of these analyses is the net "two-way" relationship between the independent variables and nutrition.

In the second analytic stage, additional control variables are added to the log-linear models to assess the association between selected independent variables and nutrition, net of the influences of these other variables. Due to time and resource limitations, attention in the analyses performed

for this report was limited to the effects of water-related variables net of the influences of two control variables: household income and diet.[16]

Income was included as a control variable in the analyses, since it was found to be correlated with many of the water-related variables. The inclusion of the income variable in the log-linear models permits the assessment of the net effects of the water-related variables on nutrition (i.e., the effects not accounted for by their association with income).

The implications of household dietary practices for the nutritional status of children seem obvious. However, analyses of the data indicated that the effects of the various indicators of dietary sufficiency studied were not fully accounted for by the household income variable (see table 6.18). Thus, a control variable for diet is included in the log-linear models in addition to the household income variable to provide more adequate statistical control for variations in overall standard of living in the measurement of the "net" effects of the water-related variables on nutrition.

The analyses begin using the full four-category classification of nutrition levels described in appendix B of this report. However, given the relatively high prevalence of mild malnutrition among children in the study populations (i.e., a high proportion of children weighing 75 to 90 percent of the median weight for children of the same age in the well nourished "standard" population), the bulk of the analyses are focused upon how well the variables analyzed discriminate between children who were well-nourished according to the 75 percent weight-for-age nutrition criterion and those who fell below this level (i.e., the moderately and severely malnourished children).

2. Bivariate Analyses

This section presents the results of bivariate analyses of the nature and magnitude of associations between the nutritional status of children aged 0 to 4 years and all followup survey variables which can reasonably be expected to influence childhood nutrition. The relationships between each variable and nutrition were assessed first using the full four-category classification of nutritional status, then using a two-category classification (well nourished and malnourished) based upon the 75 percent weight-for-age criterion.

Table 6.16 presents the associations between each variable and nutrition using both (the four- and two-category nutrition classifications. The results are shown separately for each city and include statisical controls for the age of the child. Where the association was significant statistically (based upon the jackknifed chi-square test), the level of significance is indicated. An "NS" appears in the table for variables for which the measure of association failed to achieve the 90 percent level of confidence (i.e. $p<.10$).

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[16]These analyses represent only a small subset of the policy-related analyses that could be performed with these data.

Table 6.16 Summary of Tests of Association between Nutritional Status and Selected Variables, Controlling for Age

Variable[a]	Nutritional classification			
	Cagayan de Oro		Bacolod	
	Four category classification	Two category classification	Four category classification	Two category classification
SOCIOECONOMIC/HOUSEHOLD CHARACTERISTICS				
Income:				
4 categories	p<.005	p<.01	p<.01	p<.005
3 categories	p<.005	p<.005	p<.005	p<.005
Household size	(NS)	(NS)	(NS)	(NS)
Number of children	(NS)	(NS)	(NS)	(NS)
DIET				
Food consumption	p<.01	p<.001	p<.01	p<.005
Ever breast-fed	p<.001	p<.001	(NS)	(NS)
Protein consumption	p<.001	p<.001	p<.005	p<.01
MALABSORPTION				
Diarrhea	(NS)	p<.05	p<.05	p<.005
WATER SOURCE AND QUALITY				
Main water source:				
4 categories	(NS)	p<.05	(NS)	(NS)
5 categories	p<.025	p<.01	(NS)	(NS)
City water inside/other	p<.01	p<.025	p<.10	(NS)
Number of sources	(NS)	(NS)	p<.10	(NS)
Piped water	(NS)	(NS)	p<.10	p<.10
Length of use--city water	(NS)	(NS)	(NS)	(NS)
Water quality	(NS)	(NS)	p<.025	p<.01
WATER USE				
Water consumption	p<.05	p<.005	p<.10	p<.10
Storing water	p<.05	p<.025	(NS)	(NS)
Washing hands after toilet	p<.01	(NS)	(NS)	p<.05
Washing hands after playing	p<.10	p<.10	(NS)	p<.025
Frequency bathing children	(NS)	(NS)	(NS)	(NS)
SANITARY FACILITIES				
Excrata disposal:				
5 categories	p<.025	p<.10	(NS)	(NS)
Flush/nonflush	p<.01	p<.10	(NS)	p<.10
Location of toilet	p<.01	p<.025	p<.025	p<.025
Bathroom enclosed:				
3 categories	p<.001	p<.001	(NS)	p<.05
2 categories	p<.001	p<.001	p<.05	p<.05
Water disposal system	(NS)	(NS)	(NS)	(NS)
Garbage collection	(NS)	p<.05	(NS)	p<.10

NS Not significant (p>.10).
[a]The categories for these variables are shown in subsequent tables.

The results show, not surprisingly, that the income and diet variables are among the variables most strongly associated with childhood nutrition. Of greater interest, however, is the fact that many of the water-related variables (i.e. sources and uses of water and water-dependent sanitary practices) also exhibit statistically significant associations with the nutrition variables. While the strength of the effects of these variables varies somewhat between the two cities, the data provide preliminary support for the significance of water-related factors as determinants of childhood nutrition in both cities.

It should be noted that somewhat different conclusions as to the relative magnitude of the effects of several of the variables (especially the diarrhea variable) are reached depending upon which of the nutrition classifications is utilized. In general, however, variables tend to be significantly associated under neither or both classifications. Differences in the two sets of results reflect the fact that some of the variables discriminate well between the finer levels of nutritional status within the broader classes of the 75 percent weight-for-age nutrition criterion (i.e., between normal and mildly malnourished on the one hand, and moderately and severely malnourished on the other), while others measure nutritional adequacy in the broader sense. That is, they discriminate well between children who are relatively well nourished (i.e., mildly malnourished and better) and those who are decidedly undernourished (i.e., the moderately and severely malnourished children).

Given the somewhat arbitrary nature of the "cutoff" points for the various levels of nutrition in anthropometric-based assessments,[17] it was decided to focus the thrust of these analyses on the identification of variables which distinguish between children who were relatively well nourished (i.e., 75 percent weight-for-age and above) and those who would be considered malnourished under most reasonable definitions (i.e., less than 75 percent weight-for-age).

Table 6.17 provides more detailed information as to the nature of the relationships between the variables under consideration and the two-category childhood nutrition variable. In addition to the results of tests for significance of the overall association between each of the variables with nutrition (controlling for age),[18] it also presents the lambda parameters and associated standard errors from logistic regressions of nutrition status on each variable (also controlling for age). The lambda parameters enable the reader to assess the "direction" (i.e., positive or negative) of the association as well as examine and/or compare the effects of particular

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[17]See Drake et al. (1980) for a discussion of the limitations of anthropometry in defining degrees of malnutrition.

[18]The tests for overall association were performed following the conventional procedure of comparing the log-likelihood chi-squares and degrees of freedom from "adjacent" log-linear models which differ only in terms of the parameter being tested.

categories of the variables.[19] A positive sign for a coefficient indicates that a higher proportion of the observations in that category of the variables in question were well nourished than were malnourished. A negative sign has the opposite interpretation. The magnitude of the excess of either well nourished or malnourished children falling into a particular category is indicated by the size of the coefficient relative to its standard error.

The highlights of the bivariate analyses are summarized below:

(1) Higher household income was very strongly associated with better nutritional status.

(2) Diet, measured by either per-capita food expenditures or household expenditures on high-protein foods, was also highly significant. Breast-feeding, however, was found to be associated with inferior nutritional status in Cagayan de Oro and has no relationship in Bacolod.[20]

(3) Neither of the household size or composition variables were significantly related to nutrition.

(4) The incidence of diarrhea in the previous 24-hour period, used in this study as a short-term indicator of water-related maladies, was found to be negatively associated with nutritional status, and very strongly so. This result establishes a linkage between the short- and long-term water-related health indicators used in this study.

(5) There is evidence that the household's source of water (i.e., the use of the city water system) is associated with nutrition, particularly in Cagayan de Oro.

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[19]In some instances, the results of the tests for overall association and the regression estimates may not be fully consistent with respect to the significance of the "effect" for a particular variable. This is due to the different statistical properties of the two procedures. In general, the lambda parameters represent a more "conservative" test of the magnitude of a particular effect, although in some cases one parameter among a set of parameters will emerge as significant when the overall association is not significant.

[20]Preliminary investigation of various infant feeding variables indicated that they were highly interactive with several other variables (e.g., income, age, food expenditures) in their effects on nutritional status. The negative or inverse association between breastfeeding and nutritional status appears to be the the result of the breastfeeding variable being overwhelmed by the effects of differences in income. Income has a strong positive association with nutritional status, but a strong negative association with both the incidence and duration of breastfeeding. Because of the complex nature of the relationship between breastfeeding and nutrition, these variables were set aside for future analyses of these data.

Table 6.17 Lambda Parameters from Logistic Regressions of Nutrition on Selected Variables, Controlling for Age

Variable	Lambda parameters (standard errors)	
	Cagayan de Oro	Bacolod
SOCIOECONOMIC/HOUSEHOLD CHARACTERISTICS		
Annual household income (in pesos):		
Less than 4,000	-.019 (.107)	-.262* (.086)
4,001 - 8,000	-.159 (.106)	-.112 (.090)
8,001 - 15,000	-.134 (.084)	.219* (.079)
More than 15,000	.312* (.106)	.155† (.062)
Overall association	p<.01	p<.005
Less than 8,000	-.134§ (.074)	-.227† (.059)
8,001 - 15,000	-.156† (.079)	.145† (.074)
More than 15,000	.290* (.094)	.082 (.058)
Overall association	p<.005	p<.005
Household size:		
1 - 4 persons	.023 (.130)	.068 (.137)
5 - 6 persons	.106 (.127)	.044 (.119)
7 - 8 persons	-.088 (.115)	-.032 (.082)
9 or more	-.041 (.099)	-.056 (.089)
Overall association	(NS)	(NS)
Number of children aged 0 to 4 years:		
1 child	-.117 (.080)	.085 (.082)
2 children	.132 (.084)	-.125† (.063)
3 or more	-.015 (.098)	.039 (.079)
Overall association	(NS)	(NS)
DIET		
Household per capita food expenditures (in pesos per month):		
Less than 25 (low)	-.306* (.069)	-.276* (.078)
25 - 44 (medium)	-.081 (.116)	.049 (.054)
45 or more (high)	.387† (.153)	.227* (.085)
Overall association	p<.001	p<.005
Household expenditures on high protein foods (in pesos per month):		
Less than 14 (low)	-.247* (.085)	-.193† (.085)
14 - 36 (medium)	-.172* (.063)	-.046 (.053)
37 or more (high)	.418* (.088)	.239* (.062)
Overall association	p<.001	p<.01
Breast-fed	-.207† (.057)	-.078 (.048)
Overall association	p<.001	(NS)
MALABSORPTION		
Diarrhea	-.209† (.093)	-.123* (.038)
Overall association	p<.05	p<.005

See footnotes at end of table.

Table 6.17 Lambda Parameters from Logistic Regressions of Nutrition on Selected Variables, Controlling for Age--Continued

Variable	Lambda parameters (standard errors)	
	Cagayan de Oro	Bacolod
WATER SOURCE AND QUALITY		
Major water source:		
City.....	.178† (.090)	.147 (.186)
Covered well.....	.318* (.185)	-.104 (.176)
Open well.....	-.275* (.155)	-.080 (.255)
Other.....	-.221§ (.120)	.037 (.565)
Overall association...	p<.01	(NS)
City:		
Piped inside.....	.292* (.097)	.210 (.210)
Piped outside.....	.031 (.092)	-.004 (.149)
Covered well.....	.269 (.192)	-.124 (.153)
Open well.....	-.323§ (.159)	-.100 (.230)
Other.....	-.269† (.120)	-.018 (.596)
Overall association...	p<.01	(NS)
City (piped inside).....	.144† (.058)	.150 (.100)
Overall association...	p<.025	(NS)
Number of sources:		
Use only city water.....	.066 (.071)	.101 (.074)
Use both city water and other source.....	-.006 (.104)	.074 (.066)
Use no city water.....	-.060 (.105)	-.176§ (.105)
Overall association...	(NS)	(NS)
Use piped water.....	.055 (.073)	.133§ (.079)
Overall association..	(NS)	p<.10
Years using city water:		
1 - 2 years.....	-.118 (.075)	-.044 (.081)
3 - 4 years.....	.074 (.094)	.029 (.098)
5 or more.....	.045 (.086)	.014 (.081)
Overall association..	(NS)	(NS)
Water quality (safe).....	-.095 (.077)	.207* (.078)
Overall association..	(NS)	p<.01
WATER USE		
Per capita water consumption (in gallons per month):		
170 or less (low).....	-.243* (.070)	-.161§ (.089)
171 to 700 (medium).....	.097 (.097)	-.057 (.089)
701 or more (high).....	.146 (.098)	.218† (.101)
Overall association..	p<.005	p<.10
Storing water.....	-.181† (.073)	-.076 (.087)
Overall association..	p<.025	(NS)
Washing hands after toilet:		
Always.....	.297§ .169	-.090 (.140)
Sometimes/mostly.....	.192 (.168)	.264† (.114)

See footnotes at end of table.

Table 6.17 Lambda Parameters from Logistic Regressions of Nutrition on Selected Variables, Controlling for Age--Continued

Variable	Lambda parameters (standard errors)		Variable	Lambda parameters (standard errors)	
	Cagayan de Oro	Bacolod		Cagayan de Oro	Bacolod
Rarely/never	-.489 (.314)	.353 (.233)	Bath enclosed:		
Overall association	(NS)	p<.05	Fully enclosed	.101 (.139)	.180§ (.100)
Washing hands after playing:			Partially enclosed	.260 (.192)	-.004 (.123)
Always	.082§ (.043)	.091† (.040)	Open	-.361* (.092)	-.176 (.080)
Overall association	p<.10	p<.025	Overall association	p<.001	p<.01
Frequency bathing children:			Bath enclosed fully or partially	.247* (.056)	.160* (.059)
More than once a day	.043 (.117)	.008 (.032)	Overall association	p<.001	p<.01
Overall association	(NS)	(NS)	Waste disposal system:		
SANITARY FACILITIES			Closed sewer	.033 (.113)	-.037 (.164)
Excreta disposal:			Open sewer	.079 (.095)	-.224* (.081)
Automatic flush toilet	.332§ (.187)	.308§ (.161)	Other	-.112 (.079)	.261 (.203)
Manual flush	.028 (.098)	-.027 (.101)	Overall association	(NS)	(NS)
Outhouse with pit	-.228† (.101)	-.259† (.114)	Closed sewer	-.009 (.092)	-.087 (.080)
Wrap and throw/other	-.123 (.184)	-.022 (.089)	Overall association	(NS)	(NS)
Overall association	p<.10	(NS)	Garbage collection	.167† (.079)	.158§ (.093)
Flush toilet	.179 (.119)	.190 (.106)	Overall association	p<.05	p<.10
Overall association	p<.10	p<.10			
Location of toilet (inside)	.137† (.056)	.177† (.069)			
Overall association	p<.025	p<.025			

NS Not significant.
§Coefficient is at least 1.65 times its standard error (p<.10).
†Coefficient is at least 1.96 times its standard error (p<.05).
*Coefficient is at least 2.53 times its standard error (p<.01).

(6) Length of time using city water sources was not associated with nutritional status in either city.

(7) "Safe" drinking water was associated with better nutrition in Bacolod. The failure of this variable to behave as expected in Cagayan de Oro may be atributable to the fact that relatively few cases of safe water were observed in that city, or may be an artifact of the methodology used in measuring water quality.[21]

(8) Nearly all of the "use of sanitary facility" variables were found to be associated with nutrition in the expected manner in at least one of the cities. Exceptions included the frequency with which children were bathed and the household's type of waste-water disposal system. Particularly significant variables included the location of the toilet (inside or outside the housing unit) and whether the bathroom was enclosed.

3. Multivariate Analyses Controlling for Income and Age of Child

This section examines the extent to which the observed water-related associations with nutritional status remain significant when statistical controls are introduced for key nonwater-related variables. The first step in the analyses was to consider the effects net of the influences of differences in income level, which was found to be strongly associated with nutrition.

Table 6.18 presents the results with respect to associations between nutrition and the water-related variables, controlling for income and age. The major findings may be summarized as follows:

(1) The diet variables, household food and high protein food expenditure, remained highly significant. We also experimented with alternative specifications of these variables, most of which were also strongly associated with nutritional levels of children.

(2) Diarrhea remained significant in both cities, but at a somewhat reduced level of significance.

(3) The household's major water source was reduced to marginal significance in Cagayan de Oro and failed to attain marginal significance in Bacolod ($p<.15$). All of the other variables pertaining to water source failed to achieve significance in either city when the income control variable was introduced.

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[21]The likely attenuating effect of the subsampling procedure used in the survey for measuring the quality of water at the point of use could have contributed to this result. See appendix B for further discussion of this issue.

(4) Water quality remained significant in Bacolod and nonsignificant in Cagayan de Oro.

(5) The significance of per capita water consumption disappeared in Cagayan de Oro and was reduced to marginal significance in Bacolod.

(6) Water storage was reduced to marginal significance in Cagayan de Oro and remained nonsignificant in Bacolod.

(7) The handwashing variables were reduced to nonsignificance in both cities.

(8) Most of the sanitary facility variables remained significant, but at reduced levels. However, the significance of the toilet location and garbage collection variables disappeared in Cagayan de Oro.

4. Multivariate Analyses Controlling for Income, Diet, and Age of Child

The next step in the analysis was to assess the magnitude of the net associations between the water-related variables and nutrition when the influences of the diet variables are removed. Table 6.19 shows the findings after statistical controls were introduced for income, age, and level of household expenditures on high protein foods. Two sets of results are presented. The first set of results, labeled the "main effects model," was derived from log-linear models which consider all of the two-way associations (nutrition and age, nutrition and income, and nutrition and diet as well as the nutrition and water-related variable association) in assessing the significance of the relationships between the water-related variables and nutrition. All higher order interactions were ignored in estimating the lambda parameters and associated standard errors in these models.

The second model considers all three-way interactions among the variables included in the models (such as between income, nutrition, and the water-related variable). The "interactive model" results do alter some of the conclusions (e.g., some of the sanitary facility variables became less significant in Cagayan de Oro and more significant in Bacolod). Most of the conclusions, however, were consistent between the two models, indicating that the water-related variables and the control variables are, for the most part, additive in their effects on nutrition (see table 6.19).

Table 6.18 Lambda Parameters from Logistic Regressions of Nutrition on Selected Variables, Controlling for Income

Variable	Lambda parameters (standard errors)	
	Cagayan de Oro	Bacolod
DIET		
Per capita food expenditures (in pesos per month):		
Less than 25 (low).....	-.256* (.071)	-.242* (.080)
25 - 44 (medium).....	-.075 (.111)	.044 (.057)
45 or more (high).....	.331 (.146)†	.198† (.081)
Overall association.....	p<.005	p<.025
Household protein expenditures (in pesos per month):		
Less than 14 (low).....	-.199† (.087)	-.132 (.095)
14 - 36 (medium).....	-.166* (.065)	-.056 (.054)
36 or more (high).....	.366* (.085)	.189* (.070)
Overall association.....	p<.001	p<.10
Per capita protein expenditures (in pesos per month):		
Less than 5 (low).....	-.248* (.082)	-.091 (.075)
5 - 8 (medium).....	.078 (.102)	.080 (.106)
8 or more (high).....	.170 (.109)	.012 (.082)
Overall association.....	p<.005	(NS)

Variable	Lambda parameters (standard errors)	
	Cagayan de Oro	Bacolod
Protein/rice expenditure ratio (per month):		
1.5 or less (low).....	-.199† (.096)	-.140 (.108)
1.51 - 2.5 (medium).....	.006 (.112)	.039 (.090)
2.5 or more (high).....	.205† (.102)	.101§ (.056)
Overall association....	p<.005	(NS)
MALABSORPTION		
Diarrhea.....	-.174§ (.103)	-.097* (.033)
Overall association....	p<.10	p<.01
WATER SOURCE AND QUALITY		
Major water source:		
City.....	.115 (.088)	.124 (.085)
Covered well.....	.322§ (.190)	-.076 (.079)
Open well.....	-.210 (.143)	-.048 (.096)
Other.....	-.228§ (.117)	- -
Overall association....	p<.10	(NS)
Water quality (safe).....	-.084 (.078)	.186† (.087)
Overall association....	(NS)	p<.025

See footnotes at end of table.

Table 6.18 Lambda Parameters from Logistic Regressions of Nutrition on Selected Variables, Controlling for Income--Continued

Variable	Lambda parameters (standard errors)	
	Cagayan de Oro	Bacolod
WATER USE		
Per capita water consumption (in gallons per month):		
170 or less (low).....	-.158§ (.085)	-.137§ (.083)
171 - 700 (medium).....	.102 (.105)	.062 (.079)
701 or more (high).....	.056 (.133)	.198† (.092)
Overall association.....	(NS)	p<.10
Storing water.....	-.132 (.083)	-.059 (.092)
Overall association.....	p<.10	(NS)
SANITARY FACILITIES		
Excreta disposal (flush toilet).....	.125§ (.067)	.028 (.079)
Overall association.....	p<.05	(NS)
Excreta disposal:		
Automatic flush toilet....	.313 (.222)	.188 (.149)
Manual flush.....	.224§ (.121)	-.049 (.120)
Outhouse with pit.....	.052 (.145)	-.209 (.139)
Wrap and throw/other.....	-.001 (.203)	.012 (.113)
Other.....	-.558† (.264)	.057 (.230)
Overall association....	p<.10	(NS)
Location of toilet (inside).....	.073 (.069)	.157† (.075)
Overall association....	(NS)	p<.05
Bathroom enclosed.....	.201* (.077)	.122† (.059)
Overall association....	p<.01	p<.05
Garbage collected.....	.125 (.083)	.137 (.086)
Overall association....	(NS)	p<.10

NS Not significant.
- No observations in this category.
§Coefficient is at least 1.65 times its standard error (p<.10).
†Coefficient is at least 1.96 times its standard error (p<.05).
*Coefficient is at least 2.53 times its standard error (p<.01).
Note: Variables which appear in table 6.17 and not in this table were not significantly associated with nutrition in either city when the income control variable was introduced.

Table 6.19 Lambda Parameters from Logistic Regressions of Nutrition on Selected Variables, Controlling for Age, Income, and Diet

Variable	Lambda parameters (standard errors)[a]	
	Cagayan de Oro	Bacolod
MALABSORPTION		
Diarrhea	-.203[§] (.106)	-.090[*] (.032)
Overall association:		
Main effects model	p<.10	p<.025
Interactive model	p<.10	p<.01
WATER SOURCE		
Main water source:[§]		
City	.115 (.084)	.091 (.078)
Covered well	.358[§] (.194)	-.052 (.081)
Open well	-.292[§] (.157)	-.040 (.089)
Other	-.180 (.120)	- -
Overall association:		
Main effects model	p<.10	(NS)
Interactive model	p<.10	(NS)
Water quality (safe)	-.056 (.078)	175[†] (.075)
Overall association:		
Main effects model	(NS)	p<.025
Interactive model	(NS)	p<.010
SANITARY FACILITIES		
Bathroom enclosed	.169[†] (.079)	.097 (.063)
Overall association:		
Main effects model	p<.05	(NS)
Interactive model	p<.05	p<.05
Location of toilet (inside)	.064 (.068)	.137[§] (.076)
Overall association:		
Main effects model	(NS)	p<.10
Interactive model	(NS)	p<.05
Garbage collection	.139 (.085)	.110 (.087)
Overall association:		
Main effects model	p<.10	(NS)
Interactive model	(NS)	(NS)

- No observations in this category.
NS Not significant.
[a]The beta parameters shown are those from the main effects model.
[§]Coefficient is at least 1.65 times its standard error (p<.10).
[†]Coefficient is at least 1.96 times its standard error (p<.05).
[*]Coefficient is at least 2.53 times its standard error (p<.01).
Note: Variables which appear in table 6.17 and not in this table were not significant in either city when the full set of control variables was introduced.

The major findings of these analyses are summarized below:

(1) The association with diarrhea remained at least marginally significant in both cities.

(2) Major water source remained marginally significant in Cagayan de Oro, and the presence of a piped water source, though not significant, approached marginal significance in Bacolod. It should be noted, however, that the significance of the water source variable in Cagayan de Oro is largely due to the beneficial effect of covered wells. Thus, the use of a city water source was not significantly associated with more adequate nutrition levels in either city, although the signs of the coefficients are uniformly positive.

(3) Water quality remained significant in Bacolod, but interaction with the income variable was observed. It would seem that poor quality water does not adversely affect the nutritional status of children of lower income households to the same extent that it affects those in higher income households, perhaps because these households do not have access to other important sanitation facilities. Water quality, then, may represent a constraint to better health in the higher income households who have access to the sanitary facilities which are more signficant determinants of health.

(4) The significance of the water consumption and storage of water variables disappears when the diet control variable is introduced.

(5) The presence of an enclosed bathroom remained significant in both cities in the additive models. In the interactive model, it remained significant only in Bacolod.

(6) The presence of a toilet located inside the house remained significant in Bacolod.

(7) The presence of a flush toilet in Cagayan de Oro was reduced to nonsignificance, although it approaches marginal significance (i.e. $p<.15$).

(8) Garbage collection is reduced to nonsignificance in the interactive model when the diet control variable is introduced.

Overall, the inclusion of the additional control variable for diet tends to diminish the magnitude of the effects of the water-related variables, although several remained significant. To reiterate a point that has been made on several previous occasions in these analyses, however, the water-related variables of primary interest in this evaluation (including those not shown in table 6.19) consistently exhibit nutritional effects in the expected direction, although the net effects of these variables would appear to be rather small in magnitude.

An additional point warranting mention in connection with the results displayed in table 6.19 is the fact that when appropriate statistical controls are

introduced, the "water source" variables are, by and large, reduced in the magnitude of their effects to very low levels. The sanitation facility variables would appear to be more significant in their effects on health. While several of these variables are water-system dependent (i.e., they are not possible without piped water) and in this sense are actually measuring an indirect effect of the project water systems, the results suggest that the manner in which the water is used may be more important than the presence of the city water systems per se. The policy implications of this finding are discussed in chapter 1.

5. Multivariate Analyses of Water-Related Determinants of Diarrhea

As a final step in the analyses undertaken for this report, the relationships between water-related variables and the incidence of diarrhea among children 0 to 4 years of age in the 24 hours prior to the survey were investigated. The rationale for undertaking these analyses was to examine the possibility that the total effect of the water-related variables on nutrition may be greater than that implied in the analyses reported above due to the fact that these variables have primarily indirect effects on nutrition (through diarrhea) which are not well measured by their direct association with nutrition. In such a case, the measured direct effect of these variables on nutrition would understate their "total" effect to the extent that the indirect effect through the diarrhea variable may be as large or larger than the direct effect.[22]

To investigate this possibility, the analyses performed with nutritional status as the dependent variable were repeated using the diarrhea variable as the dependent variable. Since diarrhea was found to be highly age and income dependent, these variables were included as control variables in the log-linear models. The results of these analyses are summarized in table 6.20. In reviewing these results, the reader is cautioned that the incidence of diarrhea was measured using a 24-hour reference period and, as such, is subject to considerable variability from both sampling and nonsampling sources. This is a fundamental weakness of impact evaluations focusing upon the incidence of diarrhea as the primary health indicator.

The results suggest that, in general, the net associations between the water-related variables of primary interest in this evaluation and diarrhea are somewhat stronger than were the net associations of these variables with nutrition. The water-related variables are clearly more important determinants of the incidence of diarrheal episodes than the diet variables, although the effects of these variables are, in general, not as large as the effects of income. Nevertheless, these results suggest that the total effect of the water-related variables on nutrition may be somewhat larger than that implied by the direct associations between these variables.

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[22]The formal estimation of the total effect and partitioning into direct and indirect components is beyond the scope of the analyses performed for this report. This would certainly seem to be, however, a fruitful topic for future analyses of these data.

Table 6.20 Lambda Parameters from Logistic Regressions of Diarrhea on Selected Variables, Controlling for Age and Income

Variable	Lambda parameters (standard errors)	
	Cagayan de Oro	Bacolod
DIET		
Per capita food expenditures (in pesos per month):[e]		
Less than 25 (low).....	.122 (.165)	.130 (.108)
25 - 44 (medium).....	.012 (.142)	.092 (.140)
45 or more (high).....	-.110 (.179)	-.222 (.211)
Overall association...	(NS)	(NS)
WATER SOURCE AND QUALITY		
Main water source:		
City.....	-.076 (.159)	-.097 (.124)
Covered well.....	-.199 (.230)	.253* (.093)
Open well.....	-.138 (.356)	-.157 (.135)
Other.....	.412§ (.228)	- -
Overall association...	(NS)	(NS)
City:		
Piped inside.....	-.120 (.195)	-.226 (.167)
Piped outside.....	-.030 (.158)	.087 (.118)
Covered well.....	-.176 (.252)	.275* (.105)
Open well.....	-.110 (.351)	-.136 (.162)
Other.....	-.436§ (.240)	- -
Overall association...	(NS)	(NS)
Main water source:		
City (piped inside).....	-.052 (.114)	-.177§ (.110)
Overall association..	(NS)	(NS)
Number of sources:		
City water only.....	-.075 (.162)	-.166 (.104)
City water and other sources.....	-.173 (.188)	.044 (.141)
Use no city water.....	.247† (.102)	.122 (.090)
Overall association..	(NS)	(NS)
Use piped water.....	-.174§ (.076)	-.095 (.068)
Overall association..	p<.05	(NS)
Years using city water:		
1 - 2 years.....	.087 (.143)	-.230 (.151)
3 - 4 years.....	-.182 (.196)	.330§ (.183)
5 or more.....	.095 (.171)	-.100 (.129)
Overall association..	(NS)	(NS)
Water quality (safe).....	-.204 (.190)	-.087 (.080)
Overall association..	(NS)	(NS)
WATER USE		
Per capita water consumption (in gallons per month):		
170 or less (low).....	.240 (.179)	.008 (.042)
171 - 700 (medium).....	.212 (.173)	.106 (.135)

See footnotes at end of table.

Table 6.20 Lambda Parameters from Logistic Regressions of Diarrhea on Selected Variables, Controlling for Age and Income--Continued

Variable	Lambda parameters (standard errors)	
	Cagayan de Oro	Bacolod
701 or more (high).....	-.452 (.299)	-.114 (.132)
Overall association...	(NS)	(NS)
Storing water.....	.085 (.127)	.138 (.098)
Overall association...	(NS)	(NS)
Washing hands after toilet:		
Always.....	-.241§ (.133)	-.091 (.129)
Sometimes.....	-.172 (.129)	-.246* (.084)
Rarely.....	.413* (.148)	.336† (.137)
Overall association...	p<.05	p<.05
Washing hands after playing:		
Always.....	-.198† (.098)	-.070 (.103)
Overall association...	p<.05	(NS)
Frequency bathing children:		
More than once a day.....	-.524 (.457)	-.499† (.199)
Once a day.....	.115 (.252)	.271 (.218)
Less than once a day.....	.409 (.259)	.228† (.106)
Overall association..	(NS)	p<.05
SANITARY FACILITIES		
Flush toilet.....	-.147† (.065)	-.074 (.085)
Overall association..	p<.025	(NS)
Location of toilet (inside).....	-.043 (.127)	-.012 (.072)
Overall association..	(NS)	(NS)
Bathroom enclosed¶.....	-.329† (.168)	-.078§ (.046)
Overall association..	p<.025	p<.05
Waste disposal system:		
Closed sewer.....	-.095 (.201)	-.159† (.079)
Overall association..	(NS)	p<.05
Garbage collection.....	-.036 (.153)	-.234§ (.139)
Overall association..	(NS)	p<.05

NS Not significant.
- No observations in this category.
[a]None of the alternative specifications of the diet variables were significantly associated with the incidence of diarrhea. Only the coefficients for the per capita food expenditure variable are shown.
§Coefficient is at least 1.65 times its standard error (p<.10).
†Coefficient is at least 1.96 times its standard error (p<.05).
*Coefficient is at least 2.53 times its standard error (p<.01).
¶The categories for this variable differed for the two cities:
Cagayan de Oro--fully and partially enclosed versus open.
Bacolod--fully enclosed versus partially enclosed and open.

In summary, the major findings presented in section C of this chapter are summarized in table 6.21 and below:

(1) The variables having the strongest impact on childhood nutrition (and substantially so) were income and diet. While this is by no means a surprising result, it has important policy implications for water supply interventions programmed in poorly nourished populations.

(2) There is little evidence of a strong direct association between the source of water and nutrition when the effects of income and diet are taken into account. In Cagayan de Oro, an association was observed between source of water and nutrition, but this reflected better nutrition levels for children in households using covered wells (primarily located inside the house) rather than the project water systems. There is, however, some indication of an indirect effect of water source variables on nutrition through the diarrhea variable, with at least one of the water source variables showing a significant relationship with diarrhea in the anticipated direction in each city.

(3) Water quality was observed to have a positive direct impact on childhood nutrition levels in Bacolod, but somewhat surprisingly was not significantly associated with diarrhea in either city. Investigation of the direct effects of this variable, however, indicated that its association with nutrition was significant only for moderate to high income households.

This result would seem to suggest that improved water quality in the absence of improvements in related sanitation factors is not likely to result in improved health conditions for low income populations.

(4) None of the water use variables were observed to have significant direct effects on nutrition when statistical controls were introduced. There is considerable evidence, however, of an indirect effect of many of the "washing" variables on nutrition through diarrhea. In particular, the "washing hands after toilet use" variable warrants special note. Most of the water-use variables studied, and in particular water consumption and the storage of water, showed evidence of possible indirect effects on nutrition through their effects on diarrhea, but these associations were not sufficiently strong to emerge as significant under the statistical criteria adopted for this study.

(5) Overall, variables measuring the types of sanitation facilities used by households were the strongest in their total effect on nutrition from among the water-related variables included in the study. The presence of an enclosed bathroom is the most important of these, with a significant direct association observed for both cities. This variable was also strongly associated with the incidence of diarrhea, raising the possibility of an additional indirect effect.

(6) Several of the variables measuring the type or location of the toilet used by the household also had significant direct effects on nutrition,

or effects that, while not quite significant statistically, are nevertheless worthy of note. Possible indirect effects through the diarrhea variable were also suggested for several other water-related variables (e.g., method of excreta disposal and type of water disposal system).

Overall, the analyses support the notion that health is influenced by water-related variables. Indeed, the analyses show that the overwhelming majority of the water-related variables studied behave as expected (i.e., are associated with nutritional status and diarrhea in the anticipated manner). However, the magnitude of the impact of these variables is, for the most part, small relative to the standard of living- and diet-related determinants of health.

The results point to adequate sanitation facilities as the most crucial of the water-related variables with respect to health. While some of the important sanitary facilites investigated in this study are dependent upon the existence of a reliable piped water system, this finding would imply that it is the manner in which the water systems are used to improve environmental sanitation rather than the quality or quantity of water consumed per se that is critical. Water quality was observed to have a positive health impact, but this was the case primarily for households of higher socioeconomic standing, most of which also have access to the types of sanitation facilities which were found to be most strongly associated with adequate health in this study.

It should be noted that the conclusions of these analyses regarding health effects of water-related variables are somewhat limited in scope to the extent that they do not consider effects on other forms of morbidity or mortality. In particular, they do not consider the benefits of water-related variables with regard to skin infections and other water-washed diseases which are quite prevalent in the developing countries. Previous research suggests that water supply interventions may be more effective in combating these types of diseases than gastrointestinal diseases. Data on water-washed diseases were not, however, collected for this study.[23] The analyses performed for this study suggest that water supply interventions may also have an impact on gastrointestinal diseases, but that the impact is not likely to be particularly large unless the water supply is complemented by adequate sanitation facilities and hygienic practices.

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[23]A successor evaluation study, which did focus on water-washed diseases (the Interim Demonstration Program in the Philippines) was cancelled after the baseline survey was conducted. The baseline survey data have, however, been processed by the LWUA and are available for editing and analysis.

Table 6.21 Summary of Associations between Water/Sanitation Variables and Childhood Nutritional Status

[Based upon net associations from log-linear models including control variables described in the text]

Variable	Variable/nutrition association			
	Direct association		Indirect association[1]	
	Cagayan de Oro	Bacolod	Cagayan de Oro	Bacolod
MALABSORPTION				
Diarrhea.....	Yes	Yes	-	-
DIET				
Per capita food expenditures.....	Yes	Yes	No	No
Expenditures on high protein foods.....	Yes	Yes	No	No
INCOME.....	Yes	Yes	Yes	Yes
WATER SOURCE				
Main water source.....	Yes	No	No	Yes
Household uses piped water.....	No	No[2]	Yes	No
Main source city water (piped inside).....	No	No	No	Yes
WATER QUALITY.....	No	Yes	No	No
WATER USE				
Per capita water consumption.....	No	No	No[2]	No
Storing water.....	No	No	No	No[2]
Washing hands after toilet use.....	No	No	Yes	Yes
Washing hands after playing.....	No	No	Yes	No
Frequency bathing children.....	No	No	No	Yes
SANITARY FACILITIES				
Method of excreta disposal.....	No[2]	No[2]	Yes	No[2]
Toilet inside.....	No	Yes	No	No
Bathroom enclosed.....	Yes	Yes	Yes	Yes
Water disposal system....	No	No	No	Yes
Garbage collected.....	Yes	No	No	Yes

- No observations in this category.
[1]Variables associated with diarrhea incidence.
[2]Net association approaches $p<.10$.

D. HEALTH IMPACTS OF THE PROJECT WATER SYSTEMS: A SYNTHESIS OF LONGITUDINAL AND CROSS-SECTIONAL FINDINGS

This section synthesizes the changes in water-related behavior and facilities analyzed in chapter 4 and the cross-sectional analyses of the water-related determinants of nutrition presented in the preceding section. The objective is to provide an interpretation of the results of the analyses of changes in nutrition levels for the user-nonuser experimental groups presented in section B of this chapter. These analyses were not suggestive of significant improvements in nutrition levels for water system users vis-a-vis nonusers in either city, although the relative trends were in the hypothesized direction (i.e., were favorable to user households). Improvements for water system users were suggested on an absolute basis in both cities, but were statistically significant only in Bacolod. As will be developed in the following pages, these "outcomes" are for the most part consistent with the changes observed for water-related "intermediate" variables during the evaluation period and the findings regarding the associations of these variables with nutrition.

The discussion which follows is based upon the summary of findings regarding cross-sectional associations between water-related variables and nutrition, and observed changes in these variables during the evaluation period presented in table 6.22. The stub of the table lists the water/sanitation variables which were observed to have significant net associations with childhood nutrition in each city in the analyses reported in section C (both direct and apparent indirect associations are included). The first column indicates whether changes were observed (on an absolute basis) on these variables for city water users during the evaluation period. The second column indicates the extent to which the changes observed for city water users were significantly different from those observed for nonusers. The "direction" of significant relative changes is also indicated in the second column of the table, where "positive" reflects a relative change that was favorable (in terms of anticipated health/sanitation impact) to water system users and "negative" indicates that the observed change was favorable to nonusers.

The information summarized in table 6.22 provides a basis for at least a partial explanation of the observed changes in health indicators during the evaluation period. With respect to the somewhat more substantial improvement in childhood nutrition levels noted for city water users in Bacolod, the data in table 6.22 are suggestive of a correspondence between this outcome and the extent of evaluation period changes in water/sanitation variables for city water users in the two cities.

In Cagayan de Oro, significant positive changes were observed for water system users during the study period for only one of the water/sanitation variables which was found to have a significant net association with nutrition. Further, the variable for which a change was observed involved a hygienic practice which was probably adequate at the beginning of the evaluation period (frequency of washing after playing). On the other hand, in Bacolod, significant improvements (both statistically and substantively) were observed for city water user households on six statistically important water/sanitation-related determinants of health. Thus, the observed changes in these water/sanitation

variables are consistent with the observation of a more significant improvement in nutritional status for water system users in Bacolod than in Cagayan de Oro.

Table 6.22 Summary of Evaluation Period Changes in Sanitary Practices and Facilities which Were Found to Be Associated with Nutrition

Variables associated with nutrition	Change for city water user group	Relative change for users versus nonusers
CAGAYAN DE ORO		
Enclosed bathroom.....	None	Positive
Type of toilet.....	None	None
Garbage collected.....	None	None
Frequency washing children's hands after toilet use.....	None	None
Frequency washing children's hands after playing.....	Yes (1.19 to 1.05)	Negative
BACOLOD		
Water quality (safe).....	Yes (33 to 51%)	Positive
Enclosed bathroom.....	Yes (60 to 72%)	Positive
Toilet inside house.....	Yes (28 to 41%)	Positive
Waste-water disposal (closed sewer system).....	Yes (25 to 45%)	Positive
Garbage collected.....	Yes (67 to 36%)	Negative
Frequency washing children's hands after toilet use.....	Yes (1.22 to 1.06)	None
Frequency bathing children.....	None	None
Water storage.....	Yes (88 to 66%)	Positive

Note: See the text for information on the categories and indices used in measuring these variables.

The evaluation period changes in water/sanitation variables provide less insight into the factors underlying observed changes in health indicators for city water users vis-a-vis nonusers. The findings summarized in the second column of table 6.22 would suggest that substantial improvements in health indicators were likely to have occurred for city water users relative to nonusers in Bacolod. The analyses reported in section B of this chapter, however, revealed no significant relative improvement for water system users in either city.

Several interpretations of these findings suggest themselves. One interpretation is that, despite the introduction of statistical controls and sample

and households which used project water systems sources as their sole source continuously throughout the evaluation period in comparison with those using multiple sources.

A third interpretation of the failure to observe more significant health benefits for city water users in this evaluation also warrants mention. The fact that the health indicators examined in this study were not nearly as "responsive" to the project intervention as were many of the water/sanitation variables may simply reflect the fact that the evaluation period was of insufficient length for measurable health impacts to emerge. While improvements in a number of the water/sanitation variables were noted, these improvements were not in effect in the entire treatment population for the full 5-year evaluation period. Indeed, a non-trivial number of the project area households which were using the city water systems at the time of the followup survey had been provided access to the water systems only months prior to the survey.

Making allowance for this and also for the fact that household water-related behavior is not likely to change instantaneously, the average city water user household in this study was exposed to the project "treatment" for considerably less than the 5-year evaluation period (which may in any event be too short for a measurable health impact to emerge). A more conclusive evaluation of the impact of the project intervention might be obtained by assessing the magnitude of changes taking place in the study populations after the systems had been fully operational for a longer period of time and the study populations had been given more of an opportunity to recognize the potential benefits of the intervention and adjust their behavior accordingly.[24]

Finally, it should be borne in mind that the findings presented here pertain to children born during the 1972 to 1982 period, who had survived to the respective dates of data collection. Recent research (Davanzo et al., 1983) in Malaysia suggests that several water/sanitation variables have significant impacts on infant mortality rates. If these relationships also apply in the Philippines, then it is entirely possible that the failure to observe more positive shifts in childhood nutritional levels during the evaluation period for users of the project water systems is the result of children who previously would have died surviving in response to the project intervention (albeit at low levels of nutritional adequacy). It was not possible, however, to test this proposition with the data collected for this study.

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[24]In addition to a post-evaluation exercise, there are opportunities for gaining further insights into the effects of improved water supply/sanitation on health through more refined analyses of the existing data. Among the possibilities are: (1) to repeat the analysis using height for weight as an anthropometric indicator of nutritional status and (2) limiting attention to a more restricted age range of children (e.g., 8 months to 4 years). These refinements have been strongly recommended by Iseley (1982) and Esrey and Habicht (1983).

APPENDIXES

APPENDIX A

Evaluation Study Design and Implementation

This appendix documents the evaluation study design and highlights in the implementation of the study. Chapter II of this report provides additional information on the study background and objectives.

A. Evaluation Study Background

At the time of conceptualization of the evaluation study for the Provincial Water Project, AID's concern for more precise knowledge about the relationship between improved water supply and health benefits was being addressed by the AID's Office of Nutrition in the Technical Assistance Bureau (TAB/N). Dr. Jack Keeve, M.D., of TAB/N, who participated in the preparation of the proposal for the Provincial Water Project evaluation, suggested that research be conducted to further define the "magnitude of benefits that may be expected from increments in quantity of water supply, and what additional conditions beyond improved water supply are needed to enhance the expected nutrition and health benefits."[1] To help define the research issues and AID's interest in same, Dr. Keeve collaborated with John Wall, an economist in the Water Supply Projects Division of IBRD in developing a monograph, "Water Supply, Diarrheal Disease, and Nutrition: A Survey of the Literature and Recommendations for Research," September 1974.[2]

As a result of Dr. Keeve's efforts, TAB/N funded a feasibility study whose purpose was to develop and test methodologies and prepare cost estimates for a research protocol which would provide statistically sound data on health impacts and their relationship to water supply and other environmental variables. A major objective of the feasibility study was to determine whether it would be possible for a large-scale field study to obtain such data.

The feasibility study was conducted in 1975-6 using a World Bank project area in Brazil as the focus of the research. Though the feasibility study concluded that a large-scale study could produce statistically sound data, the IBRD concluded that the amount of time and resources such a study would require were too great. In the process of developing the research protocols, considerable research was undertaken in developing and defining concepts, variables and survey designs and materials.[3] The Provincial Water Project evaluation was the beneficiary of this research, although unfortunately, the

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[1]Research Project Statement, "Feasibility Study for Health and Nutrition Benefits of New or Improved Water Supplies," AID, January 24, 1975.

[2]Water Supply, Diarrheal Disease, and Nutrition: A Survey of the Literature and Recommendations for Research, September 1974.

[3]The report of the feasibility study in Brazil is appended in a summarized form in Appendix F.

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results of the feasibility study were not finalized and disseminated in time to be fully incorporated into the Provincial Water Project evaluation.

B. Implementation of the Evaluation Study

In 1976, the Local Water Utilities Administration (LWUA) contracted the Institute for Philippine Culture (IPC) of the Ateneo de Manila University to implement the evaluation study in two of the five project cities--Bacolod and Cagayan de Oro. Under this contract, the IPC was responsible for designing the surveys (based on the 1975 Study Design[4]) and managing all evaluation activities. The USAID provided funding for the U.S. Bureau of the Census, International Statistical Programs Center to provide technical assistance to the IPC.

Baseline surveys were conducted by IPC subcontractors in Bacolod and Cagayan de Oro between October 1977 and May 1978. During the course of the baseline survey data collection and subsequent data processing activities, a variety of technical and operational problems were encountered which culminated in the IPC being unable to accurately and consistently convert the the baseline survey data to machine-readable form. In response to these difficulties, the research and evaluation unit within the LWUA was expanded in June of 1979 so that it could participate more actively in the implementation of the evaluation.

In July of 1979, the LWUA terminated its contract with the IPC and the LWUA evaluation unit assumed responsibility for managing the study. The U.S. Bureau of the Census was requested to increase its level of technical assistance and training for the study in order to develop a staff within the LWUA capable of performing the required survey related activities. All evaluation activities subsequent to mid-1979 were designed and implemented by the LWUA evaluation unit with technical assistance from the Bureau of the Census.

C. Evaluation Study Design

1. Research Design

In order to provide a basis for measuring the health and economic impacts attributable to the project intervention (i.e. those that would not have occurred during the study period had the project not been implemented), a quasi-experimental design was adopted for the study. In this design, the "treatment" group consisted of households located in areas of the study cities which were to be provided access to the improved water systems during the first phase of the project, while the "control" group consisted of households in areas which were not to be connected to the water systems during the initial project phase. The "effects" of the project intervention

[4]Silver, Keeve and Warner, Proposal for an Impact Study of the Philippine Provincial Cities Water Supply Project, January 17, 1975.

under such a design are appropriately measured through the comparison of changes in "before and after" measurements of study impact variables taken for each of the experimental groups.

Because a significant level of population mobility (i.e., migration) was anticipated in the study cities during the evaluation period, a "panel design" (i.e., a design in which the same households would be followed throughout the evaluation period) was not attempted. Instead, changes in household characteristics and impact indicators were monitored via independent samples of the experimental group populations at various points during the evaluation period (see Section 2 of this Appendix for the schedule of data collection).

The experimental groups for this study were neither randomly assigned nor "matched" initially with respect to characteristics which may affect or interact with the study impact indicators. Also, the experimental populations were not "controllable" during the study period from the standpoint of changing composition. It was necessary, therefore, in making comparisons of "before and after" measurements of impact variables for the experimental groups to take account of such initial differences and compositional changes. The statistical procedures employed for this purpose are described in Appendix B.

2. Sources of Data

Data for the study were provided by ten household surveys conducted over a five year period and by administrative records maintained by the Bacolod and Cagayan de Oro City Water Districts. The household surveys consisted of a baseline survey of a total of approximately 2,500 households in the project and nonproject areas of both study cities conducted prior to project implementation; eight rounds of quarterly interim monitoring phase surveys (approximately 125 households per round in each city); and a followup survey of approximately 1,000 households in each city. The household survey data collection schedule for the study is exhibited in figure A-1.

Figure A-1. Schedule of Household Surveys for the Philippines Provincial Water Project Evaluation

Activity	Bacolod	Cagayan de Oro
Baseline survey	Jan-Mar. 1978	Oct-Dec. 1977 May 1978
Interim monitoring surveys	(1) Dec. 1979 (2) Mar. 1980	Dec. 1979 Mar. 1980
	(3) June 1890 (4) Sept. 1980 (5) Dec. 1980 (6) Mar. 1981 (7) June 1981 (8) Sept. 1981	June 1980 Sept. 1980 Dec. 1980 Mar. 1981 June 1981 Sept. 1981
Followup survey	Jan-Feb. 1983	Nov-Dec. 1982

The primary purposes of the baseline survey were threefold:

(a) to obtain pre-project measurements of health and economic indicators in the study cities,

(b) to establish the similarity or dissimilarity of the experimental groups with respect to key variables, and

(c) to identify statistical relationships between (theoretically) causal and impact variables which could be re-examined in the analysis of the followup survey data and which would be taken into account in the analysis of trends and before/after comparisons.

The results of the analysis of the baseline survey data are reported in the June 1982 report, Evaluation of the Provincial Water Project in the Philippines: Baseline Survey Results.

The purposes of the eight interim monitoring phase (IMP) surveys were also threefold:

a. to provide data for a time-series depiction of trends in health status indicators in the study population,

b. to examine seasonal variations in health indicators, and

c. to provide data (by combining the eight surveys) that could be compared to the baseline and followup survey data to measure project impacts and provide further insights into causal relation ships between the water system and the observed impacts.

The findings of the IMP surveys are presented in the January 1983 report, Evaluation of the Provincial Water Project in the Philippines: Interim Monitoring Survey Results.

The followup survey was designed to provide a final set of measurements of health and economic status indicators in order to explore changes that took place in the study population since project implementation and to provide a basis for determining the extent to which these were attributable to the project intervention. The results of these analyses are presented in the text of this report.

The full study research design is illustrated in figure A-2.

Figure A-2 Research Design for Philippines Provincial Water Project Evaluation

	Baseline Survey	Interim Monitoring Surveys	Followup Surveys
Project Area	O_1 X_1	O_2 X_2 $O_3..X_2...O_9$	O_{10}
Nonproject Area	O_1	O_2 $O_3.....O_9$	O_{10}

In figure A-2, each "O" represents an observation (i.e., the occurence of a survey). Therefore, O_1 represents the baseline survey conducted prior to project implementation, O_2 to O_9 represent the eight quarterly interim monitoring phase surveys, and O_{10} represents the followup survey. The X's represent project interventions. X_1 represents the intervention of improved water service to households already connected to existing water systems at the time of project implementation, while X_2 represents the provision of a new service to project area households whose major water source was other than the city water system at the time of project implementation. Since the X_2 intervention occurred over the course of the evaluation study period (as more project area households were provided access to the city water system), it is shown after O_2, O_3, O_4, etc.

3. Selection of the Study Cities[5]

As part of the Provincial Water Project, there are USAID-assisted comprehensive water projects[6] in Bacolod, Cagayan de Oro, Davao, San Pablo

[5]IPC Research Proposal, The Health and Economic Impact of Improved Water Systems on Provincial Cities, 1976-79, Ateneo de Manila University, Institute of Philippine Culture, Q.C., 1976.

[6]Comprehensive projects refer to the provision of a water supply system that will provide water needs for the next 10-20 years.

and Tacloban Cities. From these cities, Bacolod and Cagayan de Oro Cities were purposively selected as study areas. The existence of a significant low-income sector was the primary criterion in the selection of study areas for this evaluation study. A substantial portion of the population in both Bacolod and Cagayan de Oro Cities fall into the low-income bracket and reside in slum and squatter areas throughout the poblacion and/or areas that were targeted for the improved water systems. Both cities have economies based largely on agriculture and fishing.

Davao City has similar characteristics, but was not considered due to its large and rapidly increasing population of approximately 512,000. In addition, relocation of squatter colonies in Davao had begun prior to the implementation of the evaluation study, thus further exacerbating the problem of changing population composition.

Tacloban City was also eliminated as a possible study area because there were plans for the city to become the target of several government development programs during the study period, making it difficult to isolate the effects and impacts of the improved water system from those attributable to other interventions. In addition, the city's water improvement project was scheduled to be completed later than in Bacolod or Cagayan de Oro. For the purposes of this study, it was desirable that the water supply improvements occur simultaneously (or approximately so) in the two study areas.

San Pablo was not considered because its water supply improvement project began in January 1976, before the evaluation plan was completed.

The two cities selected for the evaluation study provide interesting contrasts in several respects. First, Bacolod and Cagayan de Oro present quite different economic contexts. While both cities have agriculture and fishing based economies, the level of living among the population in Cagayan de Oro is somewhat higher than that in Bacolod. Secondly, the available evidence would suggest that this gap may be widening due to a heavy reliance in Bacolod upon sugar cane prices, which had been falling during the study period, and GOP efforts to stimulate economic development on Mindanao. Thirdly, and as a result of the factors described above, the population of Cagayan de Oro City grew at a moderately high rate during the study period fueled by in-migration from rural areas of Mindinao, while the rate of population growth in Bacolod during this period was close to zero, implying substantial out-migration given the relatively high rate of natural increase which characterizes the Philippines.

Thus, the two cities selected for the evaluation study provide two quite distinct contexts for the assessment of the impact of sanitary water systems in urban areas of developing countries - in one case a growing city with improving economic fortunes and the other a city stagnating due primarily to weak commodity prices for its principal agricultural product, sugar cane.

There is no scientific basis, however, for generalizing the results from these two cities to other areas of the Philippines or the developing

world without qualification. With respect to comparisons with other cities in the Philippines, we have no basis from which to assess the extent to which socio-cultural factors unique to the two study cities or the economic period during which the study period was conducted may have influenced the results. With regard to other developing countries, it should be noted that the populations of Cagayan de Oro and Bacolod are likely to be relatively advantaged economically in comparison with most mid-size cities in the developing world, and that piped water systems did exist in both cities prior to the project.

D. Analytic Framework

The conceptual linkages among the major categories of variables for the study and the anticipated paths of influence of the project intervention are indicated in the analytic framework illustrated in Figure A-3. As shown in the figure, the water system improvements were expected to influence the primary evaluation impact variables (i.e., health and economic status) through improvements in access to and the quality of water and various "spinoff" benefits from these improvements in the project cities. Economic benefits in the form of the establishment of water-related business activities and an increase in the number of project area households engaging in the production of goods for home consumption were expected to result directly from the improved availability of water (and to a lesser extent improved quality) and the convenience with which it could be obtained.

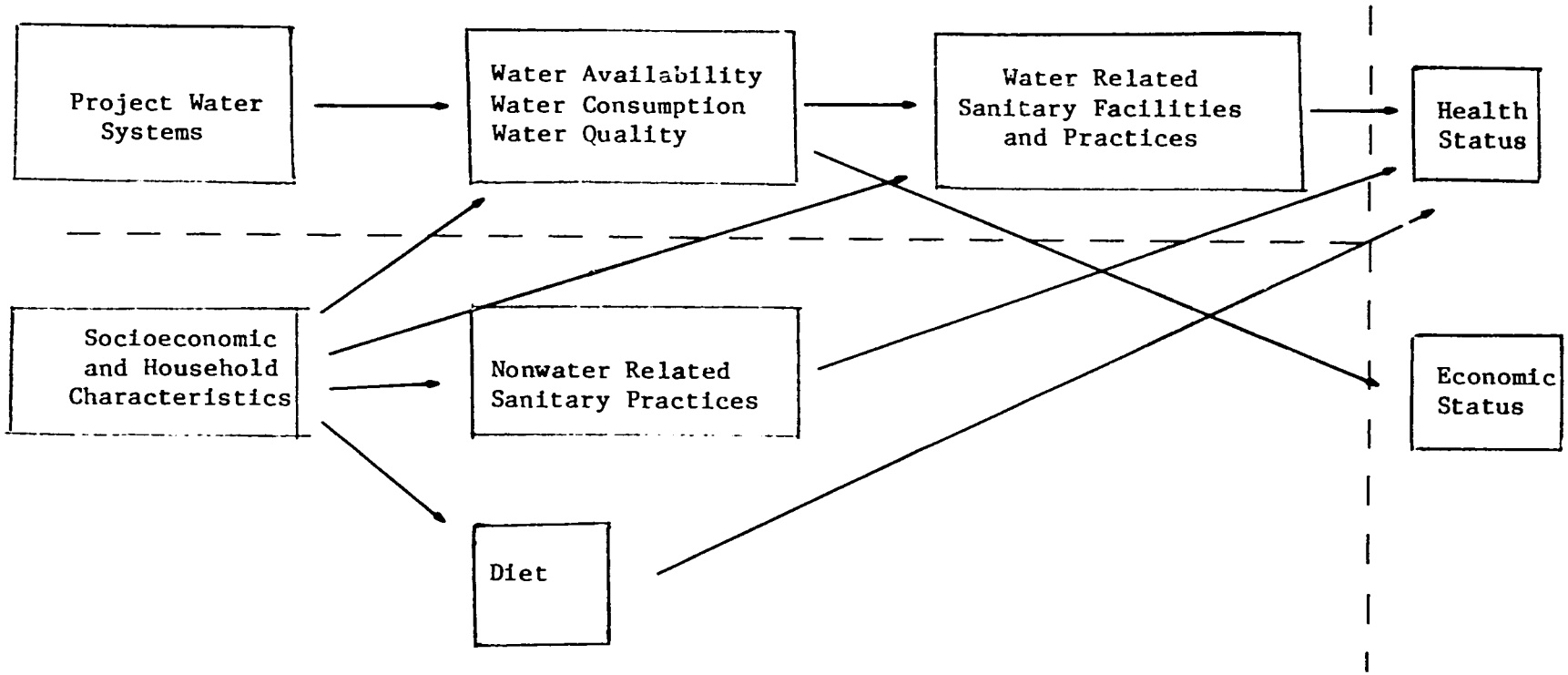
Health benefits were anticipated to result both directly from a reduction in the level of contaminants in the water available to Water District customers, as well as indirectly through improvements in water-related sanitary facilities and practices made possible by improved availability of water and reliability of the distribution system (resulting in an increased quantity of water consumed for these purposes). The anticipated paths of influence among these variables are indicated by the single headed arrows connecting the categories of variables above the horizontal dashed line in Figure A-3.

The other categories of variables shown below the dashed line in Figure A-3 are included in the analytic framework to facilitate attribution of observed changes in health and economic indicators to the project intervention. Socioeconomic and household characteristics were to be included in the analysis of the data to control for compositional differences in these characteristics in comparisons between project and nonproject area households and for other analytic comparison groupings. The inclusion of these variables in the analysis was required in order to measure the "net" effect of the project intervention, given the quasi-experimental study design, and to identify subpopulations for which the project intervention was more (or less) significant with respect to benefits. The other categories of variables (diet and nonwater-related sanitary practices) are intermediate variables which may potentially effect or interact with the influences of project intervention, but which were not expected to be influenced by the intervention itself. The effects of these variables were assessed separately from the effects of the water-related intermediate variables in the analysis of the data.

E. Variables Included in the Study

The following is a list of variables for which information was collected for the study. Operational definitions of the variables and the data collection methodology utilized in their measurement are described in Appendix B.

Figure A-3 Analytic Framework for the Project Impact Evaluation



Health Impact Variables

Incidence of diarrhea among children aged 0-4 years
Nutritional level of children aged 0-4 years

Economic Impact Variables

Household income
Household income from water-related activities
Home-consumption of goods from water-related activities

Characteristics of Water Supply

Number and type of water sources
Availability of water 24 hours per day
Sufficiency of supply
Cost of Water
Location of source(s)
Distance to source(s)
Amount of water
Amount of water fetched
Water quality

Water-Related Sanitary Facilities and Practices

Location of bathroom
Sharing of bathroom
Location of toilet
Type of toilet
Method of excreta disposal
Sharing of toilet
Method of waste water disposal
Fetching of water
Storage of water
Boiling of water
Treatment of water with chemicals
Filtering of water
Frequency of washing and bathing

Diet

Per capita food expenditure
Household expenditures on high protein foods
Breastfeeding of children

Non-Water-Related Sanitary Practices

Method of Garbage Disposal

Socioeconomic and Household Characteristics

Household income
Number of household items owned
Education of household head
Household size and composition
Housing quality
Source of energy for lighting
Ownership of house and lot

APPENDIX B

Research Methodology

A. Research Instruments

Much of the data collected for the evaluation was obtained from sample households through personal interviews conducted in the two study cities over a five year period. The remainder of the data were derived from administrative records of the Bacolod City and Cagayan de Oro City water districts. The information obtained from the sample households was recorded on pre-coded questionnaires which were also source-coded to facilitate data processing. The results of bacteriological analyses performed on water samples taken from the primary water supply of sample households were recorded on a reporting form and transferred clerically to the completed questionnaire for each household.

B. Measurement of Key Variables

The operational definitions of and procedures used in measuring the key variables for the study are given below.

1. Health Impact Variables

The primary health indicators included in the study were the incidence of diarrhea in the 24-hour period preceding the survey and the nutritional status of children aged 0 to 4 years. Information on the incidence of diarrhea was obtained for each child from a knowledgeable household respondent, usually the mother of the child. The baseline survey also collected information on the incidence of diarrhea among children in the 7 days preceding the survey, but this variable was dropped in subsequent survey rounds since it is considerably more prone to recall bias than the measurement with the shorter reference period (see Esrey and Habicht, 1983).

Nutritional levels for young children were measured using standard anthropometric measurement techniques.[1] During the household interviews, the height and weight of all children aged 0 to 4 years were measured using bar scales and recorded on the questionnaire. These measurements were compared to two sets of standards to provide an indication of nutritional status among young children in the study population: (1) a standard for Philippine children developed by the Philippines National Nutrition Council (NNC) and (2) the National Center for Health Statistics/Center for Disease Control (NCHS/CDC) standard for United States children. On the basis of sex- and age-specific comparisons with these standard populations, children were classified into one of four nutritional levels: normal, first degree (mildly) malnourished, second degree (moderately) malnourished, or third degree (severely) malnourished. The definitions of these categories for the weight for age and height for age measures are given in Table B-1.

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[1]The full battery of anthropometric measures of nutritional status is described in Martorell (1982).

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Table B-1 Anthropometric Classification of Height and Weight Measurements of Children Aged 0-4 Years (Ages in Completed Months)

A. Weight for Age

NCHS/CDC Classification	Gomez Classification	Percent of Ideal (Median) Weight for Age*
Normal	Normal	90%
Mildly Malnourished	1st Degree Malnourished	75-89%
Moderately Malnourished	2nd Degree Malnourished	60-74%
Severely Malnourished	3rd Degree Malnourished	60%

B. Height for Age

NCHS/CDC Classification	Percent of Ideal (Median) Height for Age*
Normal	95%
Mildly Malnourished	90-94%
Moderately Malnourished	85-89%
Severely Malnourished	85%

*The definitions of the various nutritional levels for the Philippine standard in terms of percent of median weight or height vary somewhat from age to age, although they approximate quite closely the category definitions of the NCHS/CDC standard.

The bulk of the analyses performed involving nutritional levels were based upon weight for age comparisons using the Philippine standard. The Philippine standard was used in this study since it is generally preferable to use a country-specific standard in nutritional assessments where a valid standard exists. In the present case, similar conclusions emerge from the comparisons of experimental study groups with respect to nutritional levels under both the Philippine and U.S. standards, although the absolute levels of inferred nutritional adequacy varied between standards. The comparability of the two standards is documented in Chapter 6.

The selection of weight for age as a measure of nutrition for this report rather than weight for height or height for age was based in part on the ability to obtain accurate determinations of age for children in household surveys in Philippine cities, although age is more difficult to collect in some other, less developed, areas of the world. Similarly, the use of bar scales provided accurate measurements of weight. Weight for age combines the effect of both acute and chronic malnutrition. For simplicity, this measure was chosen for all analyses presented in this report, although the data on height were collected and are available for further analyses.

Nutritional status was emphasized in the longitudinal analyses assessing the health impact of the project water systems for two major reasons: 1) given the high sampling variability associated with the measurement of the incidence of diarrhea in a 24-hour recall period, it was felt that the nutritional status measures would provide more stable estimates of trends in health conditions over time, and 2) there is some evidence that anthropometric measurements of nutritional status may be as responsive to changing water supply regimes than diarrheal incidence.[2]

Data on the incidence of other types of morbidity were also collected in the baseline surveys in the study cities. However, an examination of the methodology used in their collection by the IPC and the data actually collected revealed logical inconsistencies in the methodology employed and data of dubious quality. Accordingly, these data were not utilized in the analyses reported in this document.

2. Economic Impact Variables

The primary economic impact indicators for the study were the prevalence of water-related economic activities in study population households, household income derived from these activities, and household water fetching activities.

Information on the following water-related activities, including the source of water for the activity and whether the household had engaged in the activity prior to receiving access to the city water system, was collected from each sample household:

food processing
water selling
laundering for a fee
gardening
poultry raising
pig raising
eatery/restaurant operation
and other water-related, income-producing activities

3. Characteristics of Water Supply

Information on the availability of water, sufficiency of supply, and the number, type, location and distance to all sources of water used by the household was collected in the household interviews. Interviewers "paced off" all distances involved.

The cost of water to sample households was measured using a one month reference period (i.e., the month prior to the survey). Respondents were asked the amount of expenditures for the household during the previous

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[2]See Esrey and Habicht, 1983

month for water fetched, bought from vendors, or obtained from the city water systems. For customers of the water districts, monthly water bills were checked to verify the amounts reported. Total water expenditures were calculated by summing expenditures for the various sources.

The water expenditure data for city water system users should, however, be viewed with some caution because of the fairly widespread practice of sharing connections, a practice which was observed during the course of the surveys and which is illegal under water district regulations in both study cities. Because it was illegal, some respondents were reluctant to divulge the amount actually paid or the location of the system connection they were using so that the reported expenditure could be verified. As a result, the accuracy of the reported information is uncertain.

Consumption of water was also measured using a one month reference period. The measurement procedures differed, however, depending upon the source(s) of water used by sample households. For households that bought water from vendors, the quantity of water purchased during the previous month was ascertained based upon the number of containers purchased and the volume of the containers. For households that reported fetching water, information on the volume of containers used to fetch water and the number of times the containers were filled per day was used to estimate a monthly consumption figure. Finally, water consumption for the previous month for city water users was determined from monthly water bills. Information was collected for each source of water for households with multiple sources, and total household consumption was estimated by summing the estimates from each source.

The cautions noted above concerning survey estimates of the cost of water for city water users sharing connections with other households also apply to survey estimates of water consumption. Since respondents were reluctant to provide information on the households with which connections were being shared or on the number of persons residing in those households, the survey estimates of per capita water consumption should be interpreted with caution. However, an evaluation of the data on the reported number of households with which connected households shared their connections and the reported number of sharers reveals a somewhat surprising degree of internal consistency in view of the situation. Hence, there do not appear to be gross distortions in the consumption data, although a slight upward bias for city water users is suspected (particularly in Cagayan de Oro, where the number of sharers is quite high).

4. Water Quality

The quality of the water used for drinking purposes in the study population was evaluated through laboratory analyses of water samples collected for survey households during the course of the household interviews. To assess water quality at the point of use, water samples were taken from the faucet or container from which the household usually obtained water for drinking.[3]

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[3]When samples were taken from containers, the test tubes were dipped into the center of the container.

The samples collected during the household interview were delivered immediately (i.e., within four hours) to the water district laboratories in the study cities, where a "multiple tube technique" analysis was performed. The analysis included, as a first step, a "presumptive test" where the samples were incubated in solution to check for gas formation. Positive samples from the presumptive test were then incubated on aging plates to check for the formation of coliform colonies (the "confirmatory test"). The lack of colony formation was interpreted as indicative of safe water.

For water samples in which the formation of coliform colonies was observed, two further tests were performed: a "completed test" for fecal coliform and an "MPN" (most probable number) determination for all coliform. The completed test involved another incubation in solution to check for gas formation. The MPN determination involved a microscopic inspection of the sample to determine the coliform density per 100 ml. of water, with an MPN of 5.1 per 100 ml. of water or less considered safe.

Water samples were collected from all nonproject area households and from project area households on a subsample basis. Water samples were not collected from all project area households since it was felt that a sample would produce sufficiently reliable results given that most of the project area households would be using the city water systems as their primary source of drinking water. A one-in-ten subsampling rate (i.e., a ten percent sample) for project area households was used in the baseline and interim monitoring phase surveys. The subsampling rate was increased to one-in-four (i.e., 25 percent) for the followup survey.

Water quality test results were imputed for project area households for whom water samples were not collected. These imputations were performed using a "hot deck" procedure with two imputation domains, city water sources and non-city water sources, and were carried out such that values were imputed to households from other households in the same or adjacent primary sampling units (PSU's) wherever possible. The imputation of water quality in this manner to housing units not subsampled for the collection of water samples permits essentially unbiased comparisons of water quality between households with city water sources and those with non-city water sources. Comparisons of the effect of water quality on other variables, (e.g., nutrition), however, are likely to suffer from "attenuation" or "regression toward the mean" (i.e., a systematic underestimation of the actual effect). The amount of the attenuation would depend upon the relationship between the given variable and the imputations domains (source of water), with the largest relative impact for variables with little or no relation between the variable in question and the imputation domains. Consequently, results for analyses involving quality of water, particularly findings of no significant relationship between quality of water and other variables in the analysis, should be interpreted with caution.

5. Water-Related Sanitary Facilities and Practices

Survey respondents were asked to indicate the sanitary facilities used by the household and describe both the water- and non-water-related

sanitary practices of the household in the course of the household interview. Distances to the sanitation facilities used by the household were "paced off" by the interviewers and recorded on the household questionnaire.

6. Dietary Practices

Two aspects of household dietary practices were measured for the study: per capita food expenditures and breastfeeding practices for young children. Overall per capita food expenditures and expenditures for high protein foods (e.g., meats, fish, milk) were chosen as measures of household dietary adequacy in lieu of the nutritional value of food actually consumed by the household as a compromise measure in view of the already lengthy questionnaire. Information was collected on the amount paid for all food (by type) purchased by the household on the day preceding the survey, as well as the market value of all food items consumed in the previous day which were produced by the household. The estimates were then converted to monthly estimates. While admittedly crude, these measures proved to be effective control variables in the analyses of the impact of water on nutritional levels in the study population (see Chapter 6).

The information collected on breastfeeding of children, consisted of the following information provided by either the mother of each child aged 0 to 4 years or by other knowledgeable females in the household: (1) if the child was ever breastfed, (2) if the child was currently being breastfed, (3) the age at which the child was partially weaned, and (4) the age at which the child was fully weaned.

7. Socioeconomic and Household Characteristics

A variety of socioeconomic and household characteristics were collected in the household surveys. Household income was measured using a one month reference period by combining the reported incomes of all household members from primary and secondary occupations during the previous month along with reported income from other sources (pensions, investments, gifts, crop shares, remittances, etc.). The seasonal variability that frequently results from the use of a short reference period such as one month was minimized in the present study by conducting the baseline and followup during approximately the same months of the year in the two study cities. While this procedure will not necessarily improve survey estimates of total annual income, it will minimize seasonal distortions in the comparison of the baseline and followup survey income data. The income data were adjusted for inflation in making comparisons between survey rounds.

Information on ownership of the house in which the household resided, the land upon which it was located, and the number of specified household items owned by sample households were also was collected as measures of wealth. The household items on which information was collected included the following: living room set, dining set, dressing table or chest of drawers, tape recorder or cassette player, stereo set, television set,

range, refrigerator, air conditioner, washing machine, sewing machine, electric fans, chinaware set, wall or table clock and shelf of books or magazines.

The quality of housing construction was measured through interviewer observation of the permanency and state of repair of the household. The interviewers also ascertained the source of energy for household lighting as a measure of housing quality.

C. Sample Design and Selection Procedures

The basic sampling plan for the household surveys conducted for the evaluation study was a stratified multi-stage design. The first stage of selection sampled primary sampling units (PSU's), defined as blocks in Cagayan de Oro and as barangays in Bacolod, with probability proportional to size. Generally households within selected primary sampling units were chosen using systematic random selection.

Given the evaluation design with two experimental groups, PSU's were initially divided into two strata in each city for sampling purposes as follows:

> Stratum 1 (Project Stratum) -- First stage units located in areas of the city which either had access to the existing water system at the time of project implementation or were scheduled to be provided access to the system during the study period.
>
> Stratum 2 (Nonproject or Control Stratum) - First stage units located in areas of the city which were not expected to be provided access to the city water systems during the project period.

The intent behind the original sampling plan for the baseline and followup surveys in both cities was to select self-weighting samples within each stratum and to retain for the followup survey the same sample of first-stage units (PSU's) (although not the same households within PSU's) as the baseline survey in order to minimize the effects of between-PSU variance in the comparison of characteristics between survey rounds. Neither of these features were fully implemented as designed for reasons described below.

1. Cagayan de Oro

The sampling universe for Cagayan de Oro consisted of approximately 78 percent of the city's household population as enumerated in the 1975 Population Census. The remaining 22 percent were excluded from the sampling universe because they resided in areas of the city considerably beyond the projected coverage area of the water supply improvement project and because, unlike other areas of the city, they resided in rural-like and mountainous areas.

Under the sampling plan initially executed, interviews were conducted in 1,263 households. To compensate for an inadvertent large variation in the selection probabilities of households between different first

stage sample units (i.e., blocks) in the original selection, a second or "supplementary" selection of additional blocks and households within some selected blocks was performed. The necessity for a supplemental sample of blocks arose because the survey contractor originally attempted to select a probability proportional to size sample by selecting the sample through independent "draws" of single PSU's with probability proportional to size at each draw, and rejecting multiple hits.

If the multiple hits had been retained and additional sample drawn within the PSU for each hit, the sample would have remained effectively probability proportional to size. But rejection of multiple hits altered these relationships. (A more common procedure for drawing a sample with correct probabilities is to use systematic sampling, after identification of the units with probability of selection of one.) The manner of selecting the initial sample, combined with the formulas used to determine the within PSU selection, gave probabilities of selection for households varying by a factor of approximately 6. The supplemental sample was selected from the largest PSU's in order to give more equal overall probabilities of selection for households and thus recover some of the loss of efficiency which would have resulted from the original sample selection.

Two additional sampling-related problems were encountered by the survey contractors in the course of implementing the baseline survey. One problem was that the population of the blocks in the control stratum had grown considerably between the 1975 Census and the fieldwork period for the baseline survey. As a result, the size of the sample actually selected exceeded the target sample size by a considerable margin. In response to this problem, the contractors discontinued fieldwork once the target sample size had been reached, resulting in a failure to obtain interviews in the baseline survey for 5 of the 20 PSU's selected to represent the control stratum. This problem was corrected in subsequent survey rounds by including these PSU's in the sample, but the problem of increased between-PSU variance in comparisons over time remains.

The second problem encountered concerned the classification of PSU's (i.e., blocks) according to sampling stratum. Several blocks originally classified as being in areas of access to the city water systems during the study period (i.e., in the control stratum) were discovered to have had access to the city water systems during the course of fieldwork for the baseline survey and subsequent processing of the data. This problem plagued the study throughout its entire course. By October, 1982 (at which time listing of the sample PSU's was being performed for the followup survey), all but 3 of the 20 original control stratum PSU's had been provided access to the city water system.

Two actions were taken in response to this problem. First, PSU's which were misclassified in the original sample stratification were reclassified for analytic purposes so as to maintain the quasi-experimental design of the study. Secondly, a supplementary sample of PSU's that did not receive access to the city water system in the first project phase was selected for the followup survey in order to improve the precision of survey estimates for the control stratum. It was anticipated that the gain in efficiency

resulting from this action would more than offset the loss of efficiency in comparisons over time resulting from the increased between-PSU variance attributable to sampling from different PSU's.

The sample for the interim monitoring phase (IMP) surveys consisted of the 81 PSU's (blocks) selected for Cagayan de Oro for the baseline survey (including the blocks which were not covered in the baseline survey). PSU's were assigned to the same sampling stratum from which they were sampled in the baseline survey.[4] The selection of households within PSU's was performed in two stages. First, 1,011 households were selected from the sample PSU's using a systematic random sampling procedure within PSU's with sampling rates computed to yield a self-weighting sample. Following selection of the overall sample, households were randomly allocated to the eight IMP survey rounds using a systematic random selection procedure.

For the followup survey, PSU's were restratified on the basis of access to the city water systems such that all PSU's reclassified during the analysis of the baseline survey data were assigned to the appropriate sampling stratum in the followup survey. This adjustment was intended to increase the reliability for the followup survey estimates of characteristics of project stratum households. In addition, a supplementary sample of six PSU's which had not been included in previous survey rounds was selected to supplement the sample for the control stratum. However, between the time of listing for the followup survey and the completion of fieldwork, two more of the original control stratum PSU's had been provided access to the city water system, resulting in a final count of eight PSU's to represent the control stratum in the followup survey data.

Households were selected from the sample PSU's using selection rates intended to result in a self-weighting sample; subsequent recomputation of the probablities of selection for PSU's newly included in the followup survey led to modest variation in the final weights when the recomputed values were included.

Table B.2 shows the distribution of sample households for Cagayan de Oro by by sampling stratum assignment for analytic purposes for each survey round.

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[4]The sample design was not modified for the IMP surveys since, due to the difficulties encountered in processing the baseline survey data, the full extent of the misclassification problem had not been realized until fieldwork had already begun.

Table B.2 Distribution of Sample Households by Sampling Stratum and Analytic Stratum Assignment, by Survey Round: Cagayan de Oro

	Project Stratum	Control Stratum
BASELINE SURVEY		
Sampling Stratum	932	587
Analytic Stratum	1,474	45
IMP SURVEYS		
Sampling Stratum	671	231
Analytic Stratum	850	52
FOLLOWUP SURVEY		
Sampling Stratum	710	246
Analytic Stratum	799	157

Table B.3 Distribution of Sample Households by Sampling Stratum and Analytic Stratum Assignment, by Survey Round: Bacolod

	Project Stratum	Control Stratum
BASELINE SURVEY		
Sampling Stratum	759	242
Analytic Stratum	879	122
IMP SURVEYS		
Sampling Stratum	681	224
Analytic Stratum	798	107
FOLLOWUP SURVEY		
Sampling Stratum	721	244
Analytic Stratum	721	244

2. Bacolod

The sample design and selection procedures employed in Bacolod were essentially the same as those in Cagayan de Oro. The important differences were in the following areas:

(1) The primary sample units (PSU's) used, and

(2) The accuracy with which PSU's were classified initially with regard to access to the city water systems.

The sample universe for the baseline survey in Bacolod consisted of 60 of the 65 barangays located within the boundaries of the city, of which 45 were classified as belonging to the project stratum, 11 as belonging the control stratum, and 4 were not classifiable at the time of baseline survey and were excluded from survey universe. The excluded barangays included approximately 16 percent of the households in the city according to the the 1975 Census of Population.

Sampling for the baseline survey was performed in two stages. In the first stage, 12 barangays were selected to represent the project stratum and 4 to represent the control stratum on a probability proportional to size (PPS) basis using a systematic random selection procedure. Household counts from the 1975 Census of Population were used as measures of size in the selection of first stage units.

Households within selected barangays were then selected via systematic random sampling such that 50 or 51 households were selected from each barangay. This was accomplished by varying the sampling rates within first-stage units. As a result, the baseline survey sample was not self-weighting as originally intended. This selection procedure resulted in a sample of approximately 1,000 households for the baseline survey in Bacolod.

As was the case in Cagayan de Oro, errors were made in assigning first-stage units to sampling strata. Two barangays which were assigned to the control stratum were provided access to the city water system at about the same time as the fieldwork for the baseline survey was undertaken (January-March, 1978). The corrective actions taken in Bacolod were the same as those taken in Cagayan de Oro: (1) misclassified first-stage units were reclassified for analytic purposes, and (2) additional first-stage units were selected in the followup survey to supplement the control stratum sample.

The IMP and followup survey samples for Bacolod were selected in the same manner as described above for Cagayan de Oro. The followup survey sample included two additional barangays selected PPS from among the control stratum barangays which had not been selected for the baseline survey and had not been provided access to the city water system by end of the evaluation period.

The Bacolod sample and stratum assignments for analytic purposes are summarized in Table B.3.

D. Data Collection

The data collection and data preparation operations for the baseline survey were designed and implemented by the Institute for Philippine Culture (IPC) of the Ateneo de Manila University and its subcontractors. All subsequent data collection and preparation activities were performed by the staff of the Research and Evaluation Division of LWUA, with technical assistance from the ISPC, Bureau of the Census.

Since neither the IPC subcontractors nor the LWUA maintained a permanent field staff, interviewers were hired separately for each survey round in each of the study cities. Recruitment, training, and supervision of field workers was undertaken by the IPC and subcontractors for the baseline survey and by the LWUA for the IMP and followup surveys.

For the IMP and followup survey rounds, field operations were performed under the direction of field research teams from the LWUA. A member of the ISPC staff was present during at least part of each survey round in each of the study cities to observe and provide advice. The local water districts provided office space and logistical support for the field operations. All field personnel were hired locally by the LWUA field research teams. For the most part, the interviewers hired were young, college-educated females. Training was conducted in the field offices by the LWUA field research teams.

Supervision over the field operations was provided by the LWUA field research teams and by especially capable locally-hired interviewers, who were provided special training for supervisory functions. The supervisory functions consisted of designating team assignments, observation of ongoing interviews in the field, field and office edits of completed questionnaires, and resolution of problems encountered by the interviewer teams.

All completed questionnaires were edited for completeness and consistency in the field offices prior to transmittal of the questionnaires to LWUA headquarters for final coding and keying. An attempt was made to edit completed questionnaires on a flow basis to facilitate reinterviewing when problems could not be resolved in the field office. Following the completion of field operations, all materials were transmitted to LWUA headquarters for coding and data entry.

E. Estimation Procedures

1. Weighting

For the purpose of making estimates of survey characteristics for the full sample universe of the study cities, data from sample households in each survey round were weighted on the basis of the probability of the households' selection for the sample. Each household was assigned a weight which was equivalent to the inverse of its overall probability of selection (i.e. the product of the probability that the PSU within which the household is located was selected from among the PSU's in the sampling

stratum at the first stage of selection and the conditional probability (given the selection of the PSU) that the household was selected from among the households located in the selected PSU.

Households selected for the supplementary sample of the control stratum for the followup survey were assigned weights which reflected the fact that they had not been selected for the original sample in the baseline survey, as well as the probability of selection of the PSU's in which they were located and the probability of selection from among the households located within the PSU.

2. Treatment of Nonresponse

For estimation purposes, questionnaire nonresponse (i.e., households for which no information was obtained) was taken into account through adjustments to the sampling weights. The nonresponse adjustments (NRA) were calculated for each sampling stratum as follows:

$$\text{NRA} = \frac{\text{Number of Completed Interviews in Stratum } i + \text{Number of Non-responses in Stratum } i}{\text{Number of Completed Interviews in Stratum } i}$$

The nonresponse adjustments were multiplied by the sampling weights for households (described above) to yield a composite weight for estimation purposes. Response rates for each of the survey rounds in the study cities were quite high, ranging between 94 and 98 percent. Accordingly, bias due to questionnaire nonresponse is not expected to have a substantial impact on the survey estimates.

Item nonresponse (i.e. nonresponse for particular items/questions on the survey instruments) was taken into account by excluding households for which information was not obtained from the tabulations of the item(s)in question. This procedure is expected to perform satisfactorily for survey estimates of ratio characteristics (i.e. means and proportions), which are of primary concern in this study given the desire to monitor changes in behavior/characteristics for experimental groups over time. However, this procedure will result in a downward bias in survey estimates of population totals and should be borne in mind when interpreting such estimates.

F. Variance Estimation

1. Baseline Survey: Totals, Means and Proportions

The computation of sampling variances for results in this report reflect the complex sample design. Slightly different procedures were implemented for the computation of basic statistics, such as means and proportions, and for the more complex log-linear analyses. These procedures are discussed separately in this section.

As described in Section C, the sample design for the baseline survey involved a first-stage selection of primary sampling units from two strata in each city. Some primary sampling units were selected with certainty in both. Samples of housing units were selected from self-representing and from non-self-representing PSU's.

The general formula for the estimator of variance of an estimated total within each stratum was of the form:

$$\mathrm{Var} = Q \left\{\frac{n}{n-1} \sum_{i \varepsilon A} \left(X_i - n^{-1} \sum_{i \varepsilon A} X_i\right)^2\right\}$$

$$+ (1-Q) \left\{\sum_{i \varepsilon A} \frac{N_i - n_i}{N_i} \frac{n_i}{n_i - 1} \sum_j (X_{ij} - \bar{X}_{i.})^2\right\}$$

$$+ \sum_{i \varepsilon B} \frac{N_i - n_i}{N_i} \frac{n_i}{n_{i.} - 1} \sum_j (X_{ij} - \bar{X}_{i.})^2\}$$

where n represents the number of non-self-representing PSU's in set A, X_{ij} represents the characteristic in household j of PSU i, n_i and N_i are the sample and population total households in PSU i, and Q represents an approximate finite population correction for sampling at the first stage equal to one minus the ratio of the sampled PSU population to the total stratum population. PSU's belong either to set A (non-self-representing) or set B (self-representing). The first of the three terms in the formula includes the variance effect of sampling non-self-representing PSU's, although corrected by an approximate finite population correction Q. In order to estimate total variance, the second term includes (1-Q) times within PSU variance for these PSU's; the last term adds the contribution to total variance from sampling housing units within self-representing PSU's.

Since sampling was done independently in each city in the two strata, estimates of variance for estimates based on summation of a characteristic over strata were obtained by summing the variance estimates from each stratum.

Because of the systematic sampling in Bacolod to implement the first-stage of selection, PSU's with measure of size greater than the skip interval used in sampling were included in the sample with certainty, but with a variable number of hits. In applying the variance formula, the certainty PSU's were split into the certainty proportion represented in all samples and the noncertainty proportion included in only some samples; the noncertainty portion was treated as a component of the non-self-representing variance.

As discussed in Section C, the strata created for sampling failed to correspond exactly to the analytic strata to study the effect of the water system. The application of the preceding formula was carried out on the basis of the original sampling strata so that estimates of characteristics for analytic strata required summing the contributions to variance from each sampling strata.

Estimates of variance involving the ratio of two random variables, such as means or proportions, were based upon a Taylor series linearization of the statistic and computation of variances for the numerator and denominator of the ratio according to the preceding formula and of their covariance through a similar expression.

2. Interim Monitoring Phase and Followup Surveys: Totals, Means and Proportions

Essentially the same variance estimation procedures were applied to the interim monitoring phase and followup survey data as the baseline survey. Constants, such as N_i and n_i, were appropriately modified to reflect the modifications made to the IMP sample design described above.

As described in Section C, the design was effectively restratified for the followup survey in order to obtain an increased representation of the control stratum. In applying the variance formula to the followup survey data, the strata were taken to be the revised strata.

Again, constants such as n_i and N_i, were modified as necessary.

3. Baseline Survey: CPLX Analysis

Although replication methods can in principle implement variance estimators as complex as the preceding formula used for totals, a simpler approach was adopted for the analysis performed with CPLX (described below). One consideration was the questionable function served by the finite poulation correction factors at the second stage, since the emphasis in the CPLX analysis was on the interpretation of systems of causation instead of simply descriptive statistics of a finite population. Variances were estimated through recognition of the effect of sampling strata, but treating each PSU as if it were drawn with replacement. Consequently, this procedure might overestimate the finite population sampling variance somewhat, leading the analysis to be conservative with respect to finite population variances.

4. Followup Survey: CPLX Analysis

The variance formula of means and totals for the followup survey was applied to the restratified design; for CPLX applications the actual effect of the restratification was represented somewhat more completely by considering for each city the three strata: original baseline stratum 1, baseline stratum 2 not resampled, and baseline stratum 2 resampled.

In longitudinal analyses comparing baseline and followup results, the potentially beneficial effect of covariance between the two sample design was represented by treating the baseline and followup outcomes for the same PSU as all part of the same fraction used to define the replicates.

G. Data Processing

A computerized data processing system was specially developed for the survey data collected for the evaluation study. The survey data

were keyed on ENTREX, which provided a limited degree of checking of valid values at the point of data entry.

The data processing system developed consisted of the following components:

1. A program which reformatted the data keyed in fixed-field format to a full word, binary format. This facilitated the referencing of data items given the large number of items collected.

2. A program which checked the binary questionnaires for keying errors (i.e. a range edit program).

3. An edit program which checked records for internal consistency.

4. A test program which printed the contents of user-specified questionnaires.

5. An update and correction program which changed values on data records based upon user input.

6. A program which assigned sampling weights to questionnaires.

7. Recode programs written to create new variables from existing variables and modify categories of variables for tabulation and variance estimation purposes.

8. Several hundred tabulations (from simple cross-tabulations to complex analytic tables) written in CENTS (Census Tabulation System).

9. A variance program which calculated survey estimates and associated variances and performed statistical tests (i.e. t-tests) based upon user-specified parameters.

In addition to the data processing system described above, a software package (Contingency Table Analysis for Complex Sample Designs - CPLX) developed at the Bureau of the Census for analysis of cross-classified data resulting from surveys with complex sample designs was utilized extensively in the multivariate analyses of the health data. CPLX extends the use of log-linear analysis techniques for the analysis of contingency tables to situations where the assumption of multinomial or other simple distributions for the underlying frequencies is not appropriate. The weighted cell and marginal frequencies analyzed by CPLX were produced using the Statistical Package for the Social Sciences (SPSS) and input to CPLX through a special interface program.

H. Data Analysis

The bulk of the statistical analyses performed for this evaluation involve the comparison of various analytic groupings of households with respect to distribution and changes in distribution on selected impact indicators. All statistical statements made in this report regarding differences between

groups, changes during the evaluation period, and associations between variables were tested using the procedures described below. Differences, changes, and associations that were signficiant at the 95 percent level of confidence or above (i.e., $p<.05$) are labeled as "significant," while those that were significant at the 90 percent level of confidence (i.e., $p<.10$) are labeled as "marginally significant."

Two different statistical approaches were utilized in the analyses. The analyses of differences and changes over time in water-related behavior and economic impact indicators for the primary experimental groups were carried out using conventional procedures for the comparison of characteristics (i.e., means and proportions) derived from sample surveys (i.e., t-tests).

The analysis of relationships between water-related and health variables and changes in health indicators during the evaluation period were carried out using log-linear techniques for the analyses of contingency tables. These multivariate techniques were adopted for the analyses of the health data because of the need to control for other variables when making cross-sectional comparisons or measuring changes over time for the primary experimental groups on these indicators. Log-linear techniques were chosen for these analyses in lieu of more well-known linear regression techniques because of the large number of variables considered in the analyses which were measured on lower level scales (i.e., nominal or ordinal scales).

The analytic approach may be described briefly as follows. In the analyses of cross-sectional relationships between water-related variables and health indicators, the question examined is whether the variables are associated in a statistically significant manner; that is, whether the observed differences in the distribution of one variable at the different levels of the other variable are beyond the range that could be attributed to sampling variability alone. The familiar Pearson "chi-square" test is often used in making this determination in the case of simple random samples. The CPLX program used in the analyses performed for this report produces a test statistic, the "jackknifed chi-square," which performs an equivalent function while also taking into account the stratification and clustering procedures utilized in collecting the data.

The multivariate analyses extend the bivariate analyses by considering the joint effect of several variables on each other. This general notion may be illustrated by the following example. Suppose that diarrhea was shown in the bivariate analysis to be related to both age and nutritional status separately. Multivariate analyses of the three variables simultaneously could produce any of the following outcomes.[5]

1. Diarrhea is associated with age, but nutrition has no additional effect when age is considered.

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[5]This example utilized incidence of diarrhea as the dependent variable. In other situations, nutritional status could be the dependent variable.

2. Diarrhea is associated with nutrition, but age has no separate effect when nutrition is considered.

3. Both age and nutrition have effects on diarrhea. The separate effects of age and nutrition combine in an additive manner; i.e., the effect of age does not depend on the level of nutrition, and vise versa.

4. Both age and nutrition have effects on diarrhea, but the effect of one variable depends on the level of the other.

In the first two outcomes, one of the two variables "accounts for" or "explains" the effect of the other variable on diarrhea observed in the bivariate analysis. In the last two outcomes, both variables affect the incidence of diarrhea, with neither fully explaining the effect of the other. In the third outcome, the effect of each variable on diarrhea does not depend upon the level of the other variable, whereas in the last outcome, both variables may be said to interact in their effect. The distinction between 3 and 4 rests upon the logistic scale implied by the log-linear analyses, (i.e., in 3 the effects of the two variables are additive on a logistic scale).

In the case of simple random sampling, chi-square tests are used to distinguish between these outcomes. CPLX again provides "jackknifed" versions of these tests for the case of complex samples.

The analyses performed of changes in health indicators during the evaluation period represent an extension of the multivariate case described above to the situation where observations for each of the variables were made at two (or more) points in time. In this situation, the differences in the marginal and cell frequencies for the various survey rounds represent a "time" or "survey" effect, which can be viewed as a variable in the same way as nutrition, diarrhea, or age in the example above. Accordingly, the extent of change over time in health indicators may be assessed by examining the "association" between the health indicators and the implicit "survey" variable.

The extension of this approach to the evaluation differential changes over time for the experimental groups of interest is relatively straightforward. In this case, the primary concern is whether the association between the health indicator and the experimental group variable had changed between survey rounds; that is, the extent to which the association was stronger or weaker or had changed "direction" (i.e., from a positive or direct association to a negative or inverse association or vice versa) between survey rounds. The appropriate test in this situation is analogous to that described in the multivariate example above; that is, whether the association between two variables (health and experimental group) depends upon the level of a third variable (survey round). Thus, the appropriate test for differential changes in health indicators for the experimental groups is the (statistical) significance of the three-way association (or interaction) between health, experimental group, and survey.

In performing the tests for changes in health indicators, we also took advantage of the multivariate capabilities of the log-linear approach by including various control variables in models tested. The inclusion of control variables in the analyses permits the assessment of the extent of differential change in health indicators for the experimental groups, net of the influences of changes in the other (control) variables.

Finally, an additional useful feature of the CPLX package should be noted. In addition to providing tests for overall association between variables, CPLX is also capable of performing maximum likelihood logistic regressions. The parmeter estimates (lambda parameters - the analogue of linear regression coefficients) from the regressions provide the analyst a means to examine the effects of particular categories of an independent variable on the dependent variable. The regression capability of CPLX is utilized extensively in the analyses reported in Chapter 6 in this report.

APPENDIX C

Methodological Considerations and Recommendations

One of the major concerns of the evaluation team responsible for the design of the Philippines Provincial Water Project evaluation study was that a fundamentally sound approach to AID water project impact evaluations be developed. At the time that the study was designed (i.e., 1974-1975), there were no existing guidelines or precedents at AID regarding evaluation procedures for water supply impact studies,[1] nor was there a clear concensus among researchers in the field as to the appropriate methodology for the type of study proposed.[2] Accordingly, one of the objectives of the Philippines Provincial Water Project evaluation was to establish a methodological precedent for both large and small-scale water supply project impact evaluations at AID.

This appendix discusses a series of methodological issues evolving out of the 6 years that the Bureau of the Census has been involved in the present study which we feel are worthy of consideration in planning future AID water supply and related project evaluations. The discussion is organized by major topics.

A. Health Impact Indicators for Water Supply Project Impact Evaluations

A variety of health indicators have been utilized in impact evaluations of water supply/sanitation projects. Most efforts to substantiate health benefits of such interventions examine trends and group differences in the incidence and/or prevalence of diarrheal morbidity. Diarrheal incidence/prevalence is linked to water in that contaminated water provides a primary route of transmission of the responsible pathogenic agents and thus represents a proximate response to inadequate water supply. Other studies have examined differences in infection from specific pathogens. A few studies have looked at the effects of water supply/sanitation regimes on infant mortality rates.

More recently, the use of nutritional status (and more specifically anthropometric indicators) as a primary indicator in water supply impact evaluations has become increasingly common. The theoretical basis for this is a biological pathway linking water-related infections and diarrhea to nutritional status. As such, nutritional status may be viewed as an indicator of the long-term net impact of diarrhea and other water-related gastrointestinal diseases.

There are several methodological advantages in the use of childhood nutritional status as the primary health indicator in water supply project health impact evaluations.[3] A major advantage is in the area of sample

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[1]Silver, Keeve and Warner (1975), pp. 5-10

[2]See Warner (1981)

[3]See Struba and Iseley (1982) and Iseley (1982) for a fuller justification of the use of nutritional status as the primary health impact indicator in such studies.

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size requirements. To the extent that the incidence rates of diarrheal morbidity and other relevant infections are relatively low, large samples are needed to obtain reliable estimates of levels and trends.[4] The sample size requirements for studies focusing on infant and childhood mortality are even large and are made yet worse if cause-specific mortality rates are to be measured. Thus, estimates of health status at a fixed level of precision may be obtained with much smaller samples using anthropometry in comparison with the major alternatives.

Second, anthropometry is in general less prone to measurement bias than are the major alternatives. Measurements of incidence or prevalence rates of diarrhea are subject to potentially large recall and misclassification errors and underreporting. Further, the available evidence suggests that these problems are exacerbated as the length of the recall period increases.[5] Underreporting problems also plague efforts to collect data on infant and childhood mortality. Further, there are often problems in assertaining reliably the specific cause of death in such studies.

Third, there is recent evidence available that certain anthropometric indicators may be as measurably responsive as diarrheal attack rates to changing water and sanitation regimes.[6] This is an important consideration, since it refutes one of the major arguments against the use of nutritional status as a health impact indicator in water supply project evaluations, namely that nutritional status is a nonproximate response to changes in water supply/sanitation and, as such, is prone unacceptably to confounding influences.

While the collection and analysis of anthropometric data are not without problems,[7] the steps required to minimize their adverse effects on the results of health impact evaluations would seem to be more easily contended with than those required to produce equally reliable estimates of levels and trends in childhood health conditions using the major alternative methods.

B. "Intermediate" Variables and Impact Indicators

It is important in health impact evaluations to collect information both on the ultimate health impact indicators and the "intermediate" or "process" variables which measure the short-term responses to the project intervention through which the impact indicators are expected to be influenced. In water supply project interventions, prior research suggests that the important "intermediate" variables include water quality and quantity of water

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[4] In addition to demanding sample size requirements, the difficult logistics and costs of measuring certain types of specific enteric infections are often prohibitive in all but very large studies.

[5] See Martorell et al. (1976)

[6] See Esrey and Habicht (1983)

[7] See Drake et al, 1980 for a discussion of problems and limitations.

consumed, household uses of water, water-related sanitation facilities used, and water-related hygienic practices.

The purposes of collecting such information are:

(1) To provide a basis for attributing observed changes in impact indicators to the project intervention,

(2) To provide information on causal pathways between the project intervention and health, and

(3) To provide a basis for determining the reasons why a project intervention was successful (or, conversely, was not successful).

While collecting information on intermediate variables is critical to understanding the dynamics of the impact of a project intervention, the assumption that impacts can necessarily be inferred from the observation of changes in intermediate variables is a dangerous one. Given that evaluation periods may be too short in which to observe changes in the ultimate impact indicators and considering the relative simplicity of measuring many of the intermediate variables, it is tempting to focus evaluation efforts on changes in the intermediate variables and assume that project impacts will necessarily result.

The Philippines Provincial Water Project, however, provides an example of a case where such an inference would have been unsubstantiated at best, and perhaps misleading. While positive trends in a number of intermediate variables were observed in both study cities (particularly in Bacolod), substantial health impacts were not detected. This is not to say, however, that a positive impact will not emerge eventually, but rather that it is not evident now.

In short, changes in intermediate variables should be viewed as a necessary but not sufficient condition for changes in the ultimate impact indicator(s) to take place. A case could be made, of course, for the use of intermediate variables as the primary indicators in health impact studies given evidence of a correspondence between changes in such variables and in short-term and long-term changes in health conditions. However, the evidence available to date is not sufficiently strong to validate such an approach.

It might be useful in this case to consider a post-evaluation study in the two cities studied in this evaluation. The study would be directed to monitoring further improvements in water-related behavior, sanitation, and health impact indicators. The primary objective of the study would be, of course, to establish a linkage between changes in intermediate variables and long-term health indicators which could be used as justification for future health impact evaluations which monitor only the more easily and unambiguously measured intermediate variables.

C. Use of Experimental or Quasi-Experimental Designs

The Philippines Provincial Water Project experience, as well as recent experiences of other researchers using quasi-experiemental designs in AID

project impact evaluations,[8] suggest that there are methodological problems inherent in the application of such designs in field settings. These problems may severely limit utility of these designs in attributing observed outcomes to project interventions (and thus substantially reduce their cost effectiveness). The problems concern the initial designation of "treatment" and "control" groups and the ability to effectively control and/or account for the exposure of the comparison groups to confounding factors/influences (both endogenous and exogenous to the project intervention) during the evaluation period. More specifically, the following points should be considered:

1) It is virtually impossible to "match" treatment and control groups in nonlaboratory experiments. The primary reason for this is that it is usually necessary to separate the groups geographically, both for ethical reasons and in order to minimize the degree of "contamination" of the control groups. As a result, the experimental groups will typically differ ex ante and undergo compositional changes during the evaluation period in terms of characteristics relevant to the "success" of the project intervention. As a result, a major portion of the analytic effort may be spent attempting to minimize the influences of these factors (to the extent that the differences are quantifiable and have been measured as part of the evaluation study).

2) It is not infrequently the case that the manner in which the project intervention itself is administered compromises the experimental design. Project implementation plans can be changed in response to such factors as political contingencies in the host country, new perceptions of optimal strategies gained through experiences in the initial stages of implementation, new budgetary constraints, etc. To the extent that such changes do not take into account the evaluation design (and in some cases it is neither expedient nor possible to do so), the original evaluation design is compromised. The Philippine Provincial Water Project provides an excellent example of how an experimental design study can be weakened when project implementation does not follow the course anticipated during the design of the evaluation. (In this case, water service improvements were extended into many of the "control" areas.)

3) It is often the case that the experimental groups in experimental design studies are exposed to different exogenous factors during the study period, thus violating a key assumption of such studies (i.e., that the comparison groups are exposed to identical "stimuli" except for the "treatment" whose effects are being measured. This problem is once again due in large part to the need to geographically separate the treatment and control communities. While it is possible to compensate for the effects of exogenous factors through the introduction of

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[8]See Drake et al. (1980), for a discussion of problems encountered in the use of such designs in the analysis of AID Community-Level Nutrition Programs.

statistical controls at the analysis stage, it will not always be the case that the effects of the exogenous factors are known or measurable in any scientific manner. In such a case, the experimental design is compromised and the interpretation of the results becomes ambiguous.

The net result of these problems is that, at minimum, a considerable effort is usually required at the analysis stage to disentangle the confounding factors effecting experimental design studies, although it should be noted that it is not always possible to do so unambiguously.

Given the need to introduce statistical controls at the analytic stage of traditional quasi-experimental design studies, an alternative approach and one with several decided advantages might be to concentrate research on the treatment group only. Rather than evaluate the impact of a project intervention through the comparison of treatment and control groups, an alternative approach would evaluate changes in impact indicators among subpopulations within the treatment population. These subpopulations would vary in terms of duration and intensity of exposure to the "treatment." This approach has several advantages:

1) Since the entire study population is located in the same geographic area, the problem of differential exposure to exogenous factors may be minimized.

2) The compressed study area greatly reduces logistical and manpower requirements for the data collection efforts. This is likely to improve the control over the data collection operations and, in turn, the quality of the data.

3) Since the number of communities be studied is likely to be smaller, sample sizes can be increased and sampling variability in the survey estimates for the "treatment" population reduced.

4) The ability to monitor extraordinary confounding influences during the study period is likely to be greater with a compressed study area.

D. Longitudinal Versus Cross-Sectional Studies

Evaluation studies attempting to measure health impacts of project interventions have traditionally been longitudinal in nature. Assessments of the magnitude of project impacts are usually made on the basis of comparisons of "before and after" project implementation measurements of selected impact indicators. There are a number of compelling reasons, however, for considering alternatives to this traditional approach.

First, high quality longitudinal studies are very expensive to mount, especially when the impact indicators selected require large survey samples for reliable estimates of changes over time and/or when these changes are measured by noninterview techniques (e.g., bacteriological analyses of water or stool samples).

Second, serious problems are often encountered in maintaining a research effort in a developing country over a sufficiently long time period. A variety of factors contribute to this, among them are high rates of personnel turnover (particularly among highly skilled personnel) in the host-country research agency, shifting institutional priorities, and competing obligations. Continuity throughout course of such studies are, however, critical to the success of the evaluation effort.

Third, since it is impossible to foresee the course of future events in a study setting at the outset of longitudinal studies, the very real possibility exists that the study can be compromised and/or its findings rendered inconclusive by events exogenous to the project intervention. These include infrequent catastrophic events such as droughts, floods, or disease epidemics, but can also take the form of the introduction of other development projects which dampen, exaggerate, or otherwise confound the effects of the project intervention.

An alternative to the longitudinal study might be a cross-sectional study in which the primary objective is to measure (at a fixed point in time subsequent to project implementation) the relative well-being of a sub-population exposed to the treatment in comparison to a sub-population not exposed to the treatment, taking differences in other relevant factors into account. In comparison with the longitudinal design where the objective is to measure the extent of change in impact indicators resulting from the introduction of a project intervention, the cross-sectional study seeks to measure the relative benefit of exposure to the intervention (or the relative cost of lack of exposure). The approach described above is similar to the "case-control" methods used in epidemiological research, except that the cases and controls are identified on the basis of survey interviews rather than clinical records.

It is imperative, of course, in adopting such an approach that the survey be carefully designed to ensure that the proper variables are collected so that all important "control" factors can be incorporated into the analysis. However, given the considerable cost savings in comparison with longitudinal designs, a larger investment in the design, execution and analysis of the study can be made and a substantial cost savings will still be realized.

E. Selection of Study Cohorts in Longitudinal Studies

Studies of the health impacts of water supply/sanitation projects typically utilize health indicators for young children (i.e., less than 5 years of age) as the principal outcome measures. The rationale for this is that health indicators for children are quite sensitive to changing water supply/sanitation regimes. In longitudinal studies, however, the selection of cohorts of children to be studied is an important issue with far-reaching methodological implications. There are three major options available:

1. Actual Cohorts - under this option, the same individual children are followed from survey to survey (this is essentially a "panel" design).

2. Synthetic Cohorts - under this option, the same cohort (age group) of children is followed, but not the actual children (e.g., health indicators for a sample of children aged 0 to 4 in one survey round would be compared with those for a sample of children aged 5 to 9 from a survey taken 5 years later).

3. Successive Cohorts - under this option, health indicators for two cohorts of children of the same age range are compared (e.g., health indicators for children aged 0 to 4 in two successive survey rounds).

There are clear advantages and disadvantages of each of the options as concerns survey design and analytic requirements. In terms of required sample size, the use of actual cohorts (i.e., panel designs) becomes problematic where the rate of population mobility is high and it is thus not plausible to follow the original panel of children. In the Philippine Provincial Water Project evaluation, for example, it would have been necessary to more than double the sample size for the Baseline survey in order to retain the prescribed size sample of children for the followup survey under a panel design.

Where the rate of population mobility is high, the use of actual cohorts is generally not feasible. (It would, of course, be implausible to adopt a panel design for project interventions whose impacts require proximity to the project site.)

Panel studies do have an advantage over the use of synthetic or successive cohorts in that since the same children are followed, the "noise" (i.e., sampling variability) that is associated with independent sampling for each survey is minimized. Where synthetic or successive cohort designs are utilized, it is vital that the compositional shifts in relevant characteristics that may be attributable to sampling variability be accounted for (i.e., controlled statistically) in the analysis of the data.

A problem encountered in the use of both actual and synthetic cohorts in longitudinal studies where nutritional status (as determined by anthropometry) is a primary health indicator concerns the natural "aging" process that takes place in children. Children pass through a vulnerable period following weaning, after which there is a natural improvement in nutrition status. In following actual or synthetic cohorts of children across survey rounds in longitudinal studies, there is a very real danger of confusing this natural correction with a beneficial project impact. While procedures have been recommended to address this problem,[9] these procedures are based upon the assumption that the magnitude of this natural correction is independent of initial differences in the characteristics of the experimental groups and of the project intervention. While not an implausible assumption, further research would be helpful in assessing the validity of this approach. Thus, there would seem to be an advantage in the use of successive cohorts of children in that the problem of "aging" is avoided.

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[9]See Drake et al. (1980)

The primary disadvantage of the use of successive cohorts of children is the potential for cohort differences in relevant behavioral and exogenous variables to effect the impact indicators independently of the intervention. Particularly important in this regard are changes in infant and childhood feeding variables and general economic conditions. This problem can be addressed, however, through the introduction of statistical controls into the analyses of changes in impact indicators over time, given that the necessary information was collected during the survey work.

All things considered, a case can be made for the use of successive cohorts of children in longitudinal health impact studies. The required information for statistical control purposes can usually be easily collected along with the health impact indicators and would seem to be a more efficient approach in terms of sampling and analytic complexity than either of the alternatives.

APPENDIX D

Expanded Listing of Physical Improvements to the Water Systems Funded by the Project

The important physical components accomplished for the water improvements of the Cagayan de Oro City and Bacolod City Water Districts are summarized below.

BACCLOD CITY WATER DISTRICT SUMMARY OF PHYSICAL WATER IMPROVEMENTS-PHASE I

As Envisioned (Per Feasibility Study)	As Designed	As Constructed
a. Construction of 5 deepwells with 5,000 gpm capacity. Six of the seven wells will be retained.	a. Construction of 5 deepwells with 6,000 gpm capacity. The existing wells will eventually be abandoned an/or be redeveloped as the need arises.	a. Construction of 9 deepwells with capacity of 5,800 gpm (one well was abandoned due to excessive mineral content).
b. Construction of structures and pumping equipment for each deepwell (4 pumps with electric motors and one with diesel engine).	b. Construction of structures and pumping equipment for each deepwell (4 pumps with electric motors and one with combination electric/diesel).	b. Construction of structures and pumping equipment for 9 wells. Four (4) pumps with electric motor and 5 pumps with combination electric/diesel engine as prime mover.
c. Construction of 10 chlorinators for water treatment.	c. Construction of 5 chlorinators for water treatment.	c. Construction of 9 chlorinators for water treatment.
d. Construction of one 1.5 MG reinforced concrete reservoir. Rehabilitation of existing 1.0 mg. reservoir and 0.35 mg. reservoir.	d. Construction of one 2.6 MG reinforced concrete reservoir and rehabilitation of 1.0 mg reservoir. Construction of Spring Intake Boxes: 2 for Boro-boro and 2 for Bocal-bocal Springs.	d. Construction of one 2.6 MG reinforced concrete reservoir and rehabilitation of 1.0 MG reservoir. Construction of Spring Intake Boxes: 2 for Boro-boro but the size of spring box was increased to cover up other springs, and 2 for Bocal-bocal.

As Envisioned (Per Feasibility Study)	As Designed	As Constructed
e. Installation of 211,500 LM of water mains.	e. Installation of 147,883 LM of water mains.	e. Installation of 116,279 LM of water mains.
f. Construction of Administration bldg., shop building, and parking and storage facilities.	f. Construction of Administration bldg., and shop building.	f. Construction of Administration building.

CAGAYAN DE ORO CITY WATER DISTRICT
SUMMARY OF PHYSICAL WATER IMPROVEMENTS
PHASE I

As Envisioned (Per Feasibility Study)	As Designed	As Constructed
a. Construction of 4 deepwells and a collector well of 300 gpm.	a. Construction of 4 free-flowing type deepwells of 1,230 gpm. capacity and 1 free-flowing deepwell of 960 gpm. capacity. The collector well will no longer be constructed.	a. Construction of 4 wells with a capacity of 1,230 gpm. with pump and one deepwell with a capacity of 660 gpm. with pump.
b. Construction of a structure and pumping equipment of 1,000 gpm for collector well and the deepwells.	b. A booster pumping station is to be constructed as a result of the location of new wells.	b. Construction of booster pumping stations consisting of 4 electric and 1 diesel combination drive of 1,600 gpm, a pumping equipment and a wet well of .25 mg.
c. Construction of 7 chlorinators for water treatment.	c. Construction of 2 chlorinators for water treatment.	c. Construction of 2 chlorinators for water treatment.
d. Construction of 1.0 mg reservoir.	d. Construction of 1.4 mg reservoir.	d. Construction of 1.4 mg reservoir.
e. Installation of 75,060 LM water mains.	e. Installation of 64,610 LM water mains.	e. Installation of 73,191 LM water mains
f. Construction of 2 test wells 130 feet deep and 2 test wells 800 feet deep.	f. Construction of 2 test wells 130 feet deep and 2 test wells 800 feet deep.	f. Construction of 2 test wells 130 feet deep and 3 wells with depth of 306', 335' and 635'.

APPENDIX E

Detailed Tabulations of Changes in Water Related Variables Occurring During the Evaluation Period

This Appendix presents further elaboration of the summary of results pertaining to evaluation period changes in access to and use of water presented in Chapter 4. Tabulations of baseline and followup survey estimates for the comparison groups utilized in the study are displayed (along with a brief discussion) for each of the variables discussed in Chapter 4. The presentation is organized into topical areas as follows:

A. Accessibility and Convenience of Water Supply,
B. Water Consumption and Cost of Water,
C. Water Quality,
D. Household Water Treatment Practices,
E. Sanitary Uses of Water,
F. Sanitary Facilities.

Statistical tests were performed on the findings presented in this chapter to assess the statistical significance of changes observed for project area households and actual water system users in comparison with nonproject area households and nonusers. The results of these tests are indicated in the tables. Where a change for project area households or system users was found to be significant, the level of significance is indicated. Changes which were not significant at the 90 percent level of confidence or above ($p<.10$) are labeled "NS" in the tables. The methodology used in performing the statistical tests is described more fully in Appendix B.

A. Accessibility and Convenience of Water Supply

1. Availability of Water From Main Source 24 Hours Per Day

Although most households reported that water was available 24 hours per day from their main source in the baseline survey, some improvement was observed among project area households and city water user households during the evaluation period (see Table E.1). In Cagayan de Oro, both of these groups reported improvements relative to the nonproject area and nonuser control groups. In Bacolod however, no significant net improvement was observed when comparing project and nonproject area households, but a marginally significant improvement was noted for water system users vis-a-vis nonusers.

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Table E.1 Percent of Households Reporting Water 24-Hour Availablility by Experimental Group and Survey Round

Experimental Group	Survey Round		Level of Significance of Change for "Treatment" Group
	Baseline Survey	Followup Survey	
CAGAYAN DE ORO			
Project Area	90	97	
Nonproject Area	91	80	p<.01
City Water Users	88	97	
Nonusers	93	94	p<.01
BACOLOD			
Project Area	89	95	
Nonproject Area	90	91	NS
City Water Users	87	97	p<.10
Nonusers	90	94	

2. Distance From the House to the Major Water Source

Table E.2 shows that while the average distance from sample households to the main water source declined in the project areas of both cities, there was no significant net decline relative to nonproject area households. A reduction in the average distance to the source for user households relative to nonusers is apparent in Cagayan de Oro, not in Bacolod.

Table E.2. Average Distance (In Meters) From House to Major Water Source by Experimental Group and Survey Round

Experimental Group	Survey Round		Level of Significance of Change for "Treatment" Group
	Baseline Survey	Followup Survey	
CAGAYAN DE ORO			
Project Area	91	44	
Nonproject Area	116	25	NS
City Water Users	84	31	
Nonusers	96	125	$p<.01$
BACOLOD			
Project Area	30	25	
Nonproject Area	50	47	NS
City Water Users	21	11	
Nonusers	38	41	NS

3. Fetching Water

The time that household members spend fetching water is a potential economic impact of improved water systems and is discussed in greater detail in Chapter 5. This section shows that trends in the percent of households fetching water during the evaluation period (see Table E.3). In both cities, the percent of project area households fetching water declined, but increased in the nonproject areas. The same pattern (i.e., a significant reduction among users) was observed when comparing city water users and nonusers.

Table E.3 Percent of Households Fetching Water by Experimental Group and Survey Round

Experimental Group	Survey Round		Level of Significance of Change for "Treatment" Group
	Baseline Survey	Followup Survey	
CAGAYAN DE ORO			
Project Area	69	36	
Nonproject Area	67	81	p<.01
City Water Users	62	29	
Nonusers	73	86	p<.01
BACOLOD			
Project Area	73	55	
Nonproject Area	86	94	p<.01
City Water Users	57	26	p<.01
Nonusers	83	90	

4. Storing Water

Although a substantial percentage of project area and user households continued to store water during the followup survey, there was a significant relative decline in the proportions of project area and city water user households storing water during the evaluation period (see Table E.4).

Table E.4 Percent of Households Storing Water by Experimental Group and Survey Round

Experimental Group	Survey Round		Level of Significance of Change for "Treatment" Group
	Baseline Survey	Followup Survey	
CAGAYAN DE ORO			
Project Area	96	62	
Nonproject Area	100	82	p<.02
City Water Users	95	59	
Nonusers	97	89	p<.01
BACOLOD			
Project Area	93	78	
Nonproject Area	100	96	p<.01
City Water Users	88	66	p<.01
Nonusers	96	92	

B. Water Consumption and Cost of Water

1. Water Consumption

Measures of the amount of water consumed by sample households are available only for the followup survey.[1] These data show that both project area households and user households consumed significantly more water on a per capita basis than did nonproject area and nonuser households (see Table E.5). Table 3.3 (Chapter 3) shows, however, that the average water consumption per active connection remained roughly constant 1978 to 1982.

[1]Partial information on water consumption was collected on the baseline surveys, but was not sufficiently complete to permit valid comparisons with the followup survey data.

Table E.5. Average Monthly Per Capita Water Consumption by Experimental Group

Experimental Group	Average Water Consumption (Gallons)	Level of Significance of Difference Between "Treatment and "Control" Groups
CAGAYAN DE ORO		
Project Area	20.3	
Nonproject Area	8.0	$p<.01$
City Water Users	22.2	
Nonusers	6.1	$p<.01$
BACOLOD		
Project Area	23.6	
Nonproject Area	6.9	$p<.01$
City Water Users	34.0	$p<.01$
Nonusers	10.0	

Source: Followup Survey

2. Cost of Water

The followup survey data displayed in Table 4.9 show that the total amount paid for water and the amount paid per gallon of water was greater for city water users than for nonusers in both cities. Table E.6 shows the evaluation period changes in the amount households paid per gallon of water (in centavos). Interestingly, the cost per gallon paid by households in the project area of Cagayan de Oro decreased by 50 percent, and a significant decline is apparent in comparison with the trend for to the households in the nonproject area.[2] Although the average cost to city water users also decreased, no change is apparent relative to nonusers. In Bacolod, no significant relative changes the cost per gallon cost of water were noted.

[2]There is some concern regarding the accuracy of the baseline survey estimates of the per gallon cost of water. We suspect that the estimates for Cagayan de Oro may be biased upward. If so, this would reduce the magnitude of the apparent change. These estimates should, in any event, be interpreted with caution.

Table E.6 Average Cost per Gallon of Water by Experimental Group and Survey Round (in Centavos)

Experimental Group	Survey Round		Level of Significance of Change for "Treatment" Group
	Baseline Survey	Followup Survey	
CAGAYAN DE ORO			
Project Area	2.7	1.4	
Nonproject Area	0.2	1.0	$p<.05$
City Water Users	2.7	1.5	
Nonusers	2.1	0.8	NS
BACOLOD			
Project Area	0.7	1.1	
Nonproject Area	0.1	0.1	NS
City Water Users	0.5	1.3	
Nonusers	0.7	0.7	NS

C. Water Quality

The data on changes in the quality of water as it reached sample households (i.e., at the point of use) during the evaluation period suggest somewhat different trends in the study cities.[3] In Cagayan de Oro, there is little evidence of a significant improvement in the quality of water at the point of use for city-water users, either on an absolute basis or in comparison with nonusers. Further analyses of changes in water quality by source do not alter this conclusion (see Table E.7).

In Bacolod, a more positive trend is apparent for both the project area and city-water user experimental groups. According to the followup survey estimates, 35 percent of the water samples collected from project area households and 51 percent from actual user households were within national water safety standards. The latter figure represents a highly significant improvement since the baseline survey.

[3]The criteria used in classifying water as safe and unsafe are described in Appendix B.

Table E.7 Percent of Households with Safe Water by Experimental Group and Survey Round

Experimental Group	Survey Round: Baseline Survey	Survey Round: Followup Survey	Level of Significance of Change for "Treatment" Group
CAGAYAN DE ORO			
Project Area	7	13	
Nonproject Area	7	5	$p<.05$
City Water Users	7	13	
Nonusers	6	8	NS
BACOLOD			
Project Area	26	35	
Nonproject Area	0	8	NS
City Water Users	33	51	$p<.01$
Nonusers	18	15	

As noted in Chapter 3, these results are quite different from those obtained by the water districts themselves in their periodic quality checks. Two explanations for the wide discrepancy between the household survey and water district findings with respect to the quality of water are suggested:

1. During the household surveys, the LWUA staff collected water samples directly from the households' immediate source of the drinking water (containers or bottles if drinking water was stored and faucets if drinking water was taken directly from a tap or faucet). This method differed from the water district which consisted of collecting water samples only from faucets and/or other direct sources of water (i.e., pumps and springs.

2. Prior to obtaining the sample, the water district staff disinfected the faucets or taps from which the samples were taken. However, the LWUA staff collected the sample by duplicating the households usuall procedure of obtaining drinking water (which may or may not have involved disinfection).

   In an attempt to resolve the discrepancy, the LWUA's Water Quality Team conducted an independent analysis of water quality in May of 1983 in both cities. The team replicated the water districts'

method of water sample collection so as to minimize the influences that the differences between methods could have had on the results of water analyses.

In Bacolod, the LWUA team obtained results very close to those reported in the bacteriological analyses performed by the water district. In Cagayan de Oro, only a minor deviation from the water district's reported findings was observed. This discrepancy could have been due to the fact that a chlorinator in one part of the city was not operating at the time of the LWUA's independent analysis.

It would thus appear that differences between methods of collecting water samples are the primary causes of differences in bacteriological results. This suggests, however, that sanitary habits of the household with respect to drinking water (e.g., use of unclean faucets and water containers) adversely affect the quality of the water that they use and are largely responsible for the absence of more significant improvements in water quality for city water users during the evaluation period.

D. Household Water Treatment Practices

1. Boiling of Drinking Water

The practice of boiling drinking water increased in both the project and nonproject areas of both study cities during the evaluation period. The incidence of boiling drinking water increased slightly more among the water system users in Bacolod than among the nonusers (see Table E.8).

Table E.8. Percent of Households Boiling Drinking Water by Experimental Group and Survey Round

Experimental Group	Survey Round		Level of Significance of Change for "Treatment" Group
	Baseline Survey	Followup Survey	
CAGAYAN DE ORO			
Project Area	9	27	
Nonproject Area	3	24	NS
City Water Users	9	28	
Nonusers	9	25	NS
BACOLOD			
Project Area	3	15	
Nonproject Area	0	18	NS
City Water Users	3	18	$p<.10$
Nonusers	3	12	

2. Chemical Treatment of Water

Very few households treat water with chemicals (see Table E.9). No significant trends were observed for any of the comparison groups during the evaluation period.

Table E.9. Percent of Households Treating Water With Chemicals by Experimental Group and Survey Round

Experimental Group	Survey Round		Level of Significance of Change for "Treatment" Group
	Baseline Survey	Followup Survey	
CAGAYAN DE ORO			
Project Area	3	1	NS
Nonproject Area	0	3	
City Water Users	Z	Z	NS
Nonusers	6	4	
BACOLOD			
Project Area	Z	0	NS
Non-roject Area	2	2	
City Water Users	0	1	NS
Nonusers	3	3	

Z = less than 1/2 of 1 percent

3. Filtering of Water

The percentage of households filtering drinking water declined in project and nonproject areas of both cities, but more markedly in Cagayan de Oro. The magnitude of the decline was marginally larger among project area households in Cagayan de Oro and significantly larger in Bacolod. There were also highly significant declines in the percentage of city water user households filtering water in comparison with nonusers in both cities (Table E.10).

Table E.10. Percent of Households Filtering Water by Experimental Group and Survey Round

Experimental Group	Survey Round		Level of Significance of Change for "Treatment" Group
	Baseline Survey	Followup Survey	
CAGAYAN DE ORO			
Project Area	45	12	
Nonproject Area	36	14	p<.10
City Water Users	51	11	
Nonusers	36	20	p<.01
BACOLOD			
Project Area	80	62	
Nonproject Area	89	75	p<.01
City Water Users	83	56	p<.01
Nonusers	81	70	

E. Sanitary Uses of Water

This subsection examines the frequency of household use of water for hygienic purposes. Data were collected on the frequency of washing children's hands after toilet use and after playing outside and on the frequency of bathing children.

1. Frequency of Washing Hands After Toilet Use

Survey respondents were asked to indicate the households' usual practice of frequency of children washing hands after toilet use. Responses were coded on the basis of a five category classification - "always," "most of the time," "sometimes," "rarely", and "never." The responses were scored from 1 to 5, where 1 indicates "always" and 5 "never." Averages for these categories are shown in Table E.11. These results are not indicative of substantial project-related changes in either city.

Table E.11. Average Frequency of Washing Hands After Toilet Use Experimental Group and Survey Round*

Experimental Group	Survey Round		Level of Significance of Change for "Treatment" Group
	Baseline Survey	Followup Survey	
CAGAYAN DE ORO			
Project Area	1.14	1.07	
Nonproject Area	1.15	1.02	NS
City Water Users	1.10	1.06	
Nonusers	1.17	1.13	NS
BACOLOD			
Project Area	1.29	1.09	
Nonproject Area	1.34	1.12	NS
City Water Users	1.22	1.06	
Nonusers	1.33	1.12	NS

*See text for explanation of numbers in table.

2. Frequency of Washing Hands After Playing Outside

Information on the frequency of washing children's hands after they were playing outside was collected using a similar scheme as for the previous variable. The averages for each comparison group are shown in Table E.12, where again "1.00" indicates "always" and "5.00" indicates "never." Again, little change was observed in either city during the study period. It should be noted, however, that nonproject area households in Cagayan de Oro, showed a marginally significant improvement comparison with project area households.

Table E.12. Average Frequency of Washing Hands After Playing Outside by Experimental Group and Survey Round*

Experimental Group	Survey Round		Level of Significance of Change for "Treatment" Group
	Baseline Survey	Followup Survey	
CAGAYAN DE ORO			
Project Area	1.23	1.06	
Nonproject Area	1.35	1.02	$p<.10$
City Water Users	1.19	1.05	
Nonusers	1.29	1.08	NS
BACOLOD			
Project Area	1.26	1.09	
Nonproject Area	1.19	1.07	NS
City Water Users	1.19	1.07	
Nonusers	1.28	1.10	NS

*See text for explanation of numbers in table.

3. Frequency of Bathing Children

The average number of times that children were bathed per day appears to have declined somewhat during the evaluation period in both cities (see Table E.14). Similar trends are apparent for both project and nonproject area households and among users and nonusers. As such, no project-related impact is apparent.

Table E.13. Average Number of Times Children Are Bathed Per Day by Experimental Group and Survey Round

Experimental Group	Survey Round		Level of Significance of Change for "Treatment" Group
	Baseline Survey	Followup Survey	
CAGAYAN DE ORO			
Project Area	0.99	0.65	
Nonproject Area	1.12	0.78	NS
City Water Users	1.01	0.66	
Nonusers	0.99	0.65	NS
BACOLOD			
Project Area	1.11	0.92	
Nonproject Area	1.01	0.83	NS
City Water Users	1.13	0.90	
Nonusers	1.08	0.92	NS

F. Sanitary Facilities

This subsection examines the changes in types of sanitary facilities used by households in Cagayan de Oro and Bacolod during the evaluation period. Several of the facilities examined are water-dependent (e.g., flush toilets depend on a reliable piped system), while others provide measures of the adequacy of sanitary conditions in and around the household. The findings are as follows:

1. Use of Flush Toilets

The percentage of households using flush toilets remained fairly constant during the study period. No significant increase in the use of flush toilets was observed among project area or city water user households vis-a-vis their respective comparison groups (see Table E.14).

Table E.14 Percent of Households Using Flush Toilets by Experimental Group and Survey Round

Experimental Group	Survey Round		Level of Significance of Change for "Treatment" Group
	Baseline Survey	Followup Survey	
CAGAYAN DE ORO			
Project Area	72	80	
Nonproject Area	82	93	NS
City Water Users	81	82	
Nonusers	67	69	NS
BACOLOD			
Project Area	58	66	
Nonproject Area	35	44	NS
City Water Users	74	83	
Nonusers	46	46	NS

2. Toilets Located Inside the House

The percentage of user households with toilets located inside the house increased in both cities during the study period (see Table E.15). The relative improvement for project area households was only marginally significant in Bacolod and failed to attain significance in Cagayan de Oro.

Table E.15. Percent of Households With Inside Toilets by Experimental Group and Survey Round

Experimental Group	Survey Round		Level of Significance of Change for "Treatment" Group
	Baseline Survey	Followup Survey	
CAGAYAN DE ORO			
Project Area	25	39	
Nonproject Area	29	42	NS
City Water Users	28	41	
Nonusers	24	28	$p<.01$
BACOLOD			
Project Area	33	49	
Nonproject Area	16	17	$p<.10$
City Water Users	47	66	$p<.02$
Nonusers	24	27	

3. Enclosed Bathrooms

The percentage of households with enclosed bathrooms (i.e., having four walls) increased significantly among project area households during the evaluation period in both cities. In Cagayan de Oro, however, a comparable increase was observed for nonproject area households, resulting in no relative improvement for project area households. The increases for city water users vis-a-vis nonusers were significant in both cities (see Table E.16).

Table E.16. Percent of Households With Enclosed Bathrooms by Experimental Group and Survey Round

Experimental Group	Survey Round		Level of Significance of Change for "Treatment" Group
	Baseline Survey	Followup Survey	
CAGAYAN DE ORO			
Project Area	43	43	
Nonproject Area	49	31	NS
City Water Users	48	46	
Nonusers	41	23	p<.02
BACOLOD			
Project Area	46	53	
Nonproject Area	24	25	NS
City Water Users	60	72	p<.02
Nonusers	35	30	

4. Closed Sewer Systems

In Cagayan de Oro, the percentage of households with "closed sewer" waste water disposal systems appears to have declined during the evaluation period more or less uniformly in each of the experimental groups (Table E.17). In Bacolod, there was little change among project or nonproject area households in terms of the use of closed sewer disposal systems. City water users, however, showed a significant increase in the use of such facilities on both an absolute and a relative basis.

Table E.17. Percent of Households With Closed Sewer Waste Disposal Systems by Experimental Group and Survey Round

Experimental Group	Survey Round		Level of Significance of Change for "Treatment" Group
	Baseline Survey	Followup Survey	
CAGAYAN DE ORO			
Project Area	33	22	
Nonproject Area	46	22	NS
City Water Users	35	23	
Nonusers	35	18	NS
BACOLOD			
Project Area	20	31	
Nonproject Area	11	11	NS
City Water Users	25	45	$p<.01$
Non-Users	17	13	

5. Garbage Collection

The percent of households that had their garbage collected did not change significantly for any of the comparison groups in Cagayan de Oro during the study period. In Bacolod, the percentage of project area and city water user households having their garbage collected by a service declined significantly (see Table E.18).

Table E.18. Percent of Households Having Their Garbage Collected by Experimental Group and Survey Round

Experimental Group	Survey Round		Level of Significance of Change for "Treatment" Group
	Baseline Survey	Followup Survey	
CAGAYAN DE ORO			
Project Area	15	22	
Nonproject Area	0	2	NS
City Water Users	20	22	
Nonusers	9	12	NS
BACOLOD			
Project Area	42	23	
Nonproject Area	3	1	$p<.05$
City Water Users	67	36	$p<.01$
Nonusers	23	7	

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