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WATER AND SANITATION FOR HEALTH PROJECT

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MEASURING AND EVALUATING DIARRHEA AND MALABSORPTION IN ASSOCIATION WITH VILLAGE WATER SUPPLY AND SANITATION

A Review of the Food Wastage/Sanitation Cost Benefit Methodology Project (Guatemala), Contract AID/csd-2959, by an External Panel of Experts:

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DECEMBER 1981

Prepared for:
Office of Health
Bureau for Science and Technology
U.S. Agency for International Development
Order of Technical Direction No. 19

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The views expressed in this report are those of the expert panel and do not necessarily reflect those of the Water and Sanitation for Health (WASH) Project.

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Panel members wish to express their appreciation to the Water and Sanitation for Health (WASH) Project staff and to acknowledge the excellent arrangements and help extended to the panel by Dr. Raymond B. Isely of the WASH Project. The panel acknowledges the cooperation and assistance of Drs. Morris A. Shiffman, Ronald Helms, Daniel M. Dworkin and Judith M. Dworkin.

Finally general acknowledgement should be given to Guatemalan workers and the people of the two villages who provided the basic work that generated these interesting issues.

PREFACE[1]

The "Food Wastage/Sanitation Cost-Benefit Methodology Project" was funded in 1971 by the United States Agency for International Development. The project was conducted in the field from 1972 to 1976 by the Department of Environmental Sciences and Engineering at the University of North Carolina (UNC) School of Public Health, with a subcontract to the Institute of Nutrition of Central America and Panama (INCAP).

The purpose of the project (see also Appendix A) was two-fold: first, to develop a methodology for examining the relationships between improved environmental sanitation and the waste of food energy due to inefficient absorption of food resulting from intestinal diseases; second, to establish in cost-benefit terms the influence of environmental improvements on morbidity from intestinal diseases and food wastes, and to determine the optimum combination of interventions to enhance food utilization and reduce morbidity.

In order to accomplish these two objectives, an experimental program was initiated in the rural Guatemalan village of Guanagazapa. A second rural village, Florida Aceituna, was selected to serve as a control. The control village was comparable with the experimental village in a variety of measures, including demographic characteristics, morbidity, mortality, water supply, housing characteristics, and dietary habits. However, subsequent examination showed that these communities differed considerably in several important aspects.

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[1] Prepared by Raymond B. Isely, M.D., M.P.H., D.T.M., coordinator of Panel.

The program in the experimental village had three components: improvements in water supply[1] and quality, sanitary improvements and health education. In the control village data collection only was carried out during the four years of the field operation of the project.

The results of the study, published in 1978, indicated important changes in the experimental village in some of the factors potentially affecting disease morbidity. First, the quality and quantity of water used in the experimental village was improved. Second, there were significant gains in knowledge and attitude towards sanitation. Third, a large number of additional latrines were constructed in the experimental village. These results occurred despite the fact that the Health Education component was introduced quite late in the Project, and was therefore not of sufficient length to warrant expecting positive results.

The original data analysis by UNC indicated, however, only minor changes in the experimental village in actual sanitation practices and found no relationship between sanitation practices and improved water supply and morbidity.

A separate analysis of the project data was undertaken by Dr. Daniel Dworkin of the Agency for International Development, Office for Program and Policy Coordination (PPC) and Dr. Judith Dworkin of the University of Arizona, Department of Hydrology in 1980, who compared diarrheal morbidity for children one to seven years old in the two villages. Using a Chi-square test, they report a statistically significant reduction in diarrheal episodes in the experimental village compared with the control village.

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1 Piped water to households constructed by the government of Guatemala.

In order to resolve the discrepancies between the two analyses, the WASH Project, at the request of AID, convened an expert review panel.

Panel members were:

- Lincoln Chen, M.D., Representative for the Ford Foundation in India, Ford Foundation, 320 East 63rd Street, New York, New York 10017.

- Branko Cvjetanovic, M.D., Professor of Epidemiology, Andrijja Stampar School of Public Health, Rockefeller Street 6, 41000 Zagreb, Yugoslavia, formerly Chief, Bacterial Diseases Unit, World Health Organization, Geneva.

- Richard Kronmal, Ph.D., Professor of Biostatistics, University of Washington, Seattle, U.S.A.

- Charles Rohde, Ph.D., Professor of Biostatistics, School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland, U.S.A.

- Robert Suskind, M.D., Professor and Chairman, Department of Pediatrics, University of South Alabama, Mobile, U.S.A.

Panel coordinators were assigned to facilitate the work of the Panel.

- Robert Struba, Ph.D., Epidemiologist, Research Triangle Institute, Research Triangle Park, North Carolina, U.S.A.

- Raymond B. Isely, M.D., Associate Director, Water and Sanitation for Health Project, 1611 N. Kent Street, Arlington, Virginia, U.S.A.

Panel members were each given a complete set of Project reports, a copy of the Dworkin and Dworkin report, and copies of published articles emanating from the Project, which they reviewed before a first meeting on February 9 and 10, 1981. At this meeting a plan of work and strategy were developed and preliminary findings agreed on. At a second meeting of the Panel on May 18 and 19, 1981, interviews were held with Drs. Shiffman and Helms and the Dworkins, and findings were finalized.

The panel findings suggest that certain methodological problems preclude making firm conclusions from the available data, particularly with respect to the initial study hypothesis concerning relationships between water, sanitation, and food wastage. Findings are discussed in detail in the next section.

FINDINGS OF THE PANEL

Introduction and Terms of Reference

The Water and Sanitation for Health Project of the Agency for International Development assembled an External Expert Review Panel that reviewed Project-related documents as well as the Dworkin and Dworkin report and met on 9th and 10th February, 1981. In a subsequent meeting on the 18th and 19th May 1981, the panel met with Dr. Morris A. Shiffman and Ronald Helms of the University of North Carolina, Dr. Daniel M. Dworkin of the Agency for International Development, and Dr. Judith M. Dworkin of the University of Arizona, all of whom helped to clarify points raised in the first meeting.

The panel had as its purpose a review of the findings of the Guatemala Water Supply and Sanitation Food Wastage Methodology Project sponsored by AID from 1972-6 in order to form conclusions on the ability of the data as collected to address the question of the impact of improved water supply and sanitation on diarrheal morbidity.

Panel members critically reviewed the reports of the investigators and interviewed the principal investigators of the Project, Drs. Morris A. Shiffman, and Ronald Helms from the University of North Carolina, as well as Drs. Daniel and Judith Dworkin, and arrived by consensus at the conclusions contained in this report (see References, p. 12).

Project Research Design

The panel felt that the research policy of AID concerning the need to evaluate the health benefits of investments in water supplies and sanitation (AID Health Policy Document, 1980) is

relevant to projects on water and sanitation for health in developing countries and should be pursued.

In general terms the Guatemala project was aimed at developing a methodology to assess the impact of water and sanitation, supported by health education, on the incidence of diarrheal diseases and food wastage caused by malabsorption. The data gathered to test the methodology have also been used to investigate the impact of water and sanitation on diarrheal disease morbidity. It is, in fact, not possible to evaluate the effectiveness of research and evaluation methodologies without assessing their capacity to elucidate valid findings.

For the purpose of documenting the effect of interventions on diarrheal morbidity the study design suffered from two fundamental methodologic defects:

First, the study was based on a comparison of only two villages. Population groups in the study were relatively small. There were significant differences in the two communities (e.g. in socio-economic status and ethnic composition) at the beginning of the study. Neither the changes across time that occurred during the study period but were unrelated to the water intervention (such as population dynamics) nor endemic and epidemic patterns of diarrheal disease were documented sufficiently to permit valid comparisons of the two communities.

Second, in view of the extensive period of implementation of the interventions, the period of observation was too short to evaluate the long-term impact of improved water and sanitation. The data on diarrheal diseases were based only on interviews which were unreliable and of questionable validity.

There was a need to include a larger number of comparable population groups in the study and to select more valid indices and

more reliable methods for measurement of diarrheal diseases. For these reasons, the study lacks both internal and external validity.

Since water, sanitation, and health education were provided as a package over time to a small population group not comparable with the controls, the impact of each of these three components could not be distinguished. As for the impact of the above interventions on diarrheal diseases and ensuing health benefits, health measurements were limited to the incidence of diarrhea and to the degree of malabsorption. The effects of diarrheal diseases on health are in fact more adequately assessed by measuring the nutritional status of children than by attempting to count episodes of diarrhea through interview techniques.

The hypotheses regarding the relationship of water, sanitation and health education to health status were not explicitly presented. The complexity of the interrelationships among various factors was not fully explored. It was assumed that there is a straightforward direct cause-effect relationship between the combined interventions and diarrheal morbidity. Allowance was not made for the possible indirect effect of the interventions on health through socioeconomic development. Thus substantial differences in income which were revealed between the two villages, for example, were neglected rather than examined in detail.

Apparently during the planning stage, insufficient consideration was given to the formulation of hypotheses concerning possible interrelations between various factors in community life and development. This omission contributed to an inadequate research design.

Project Implementation

From a review of the available material the panel could not obtain precise information on whether the Project was implemented

as planned. Changes in the research design were made in the course of implementation that vitiated the comparability of the data collected in the pre- and post-intervention phases. Furthermore, the intervention took place in stages, and only one (self-selected) part of the experimental village was covered by the water supply scheme. Thus the experimental village does not represent a homogeneous group comparable with the control group in any phase of the study.

Two additional implementation practices affect the ability to interpret the data. The quality of water at the source was not maintained at the household level. In addition, the surveillance of diarrheal diseases was limited to only half of the period of observation, e.g., two weeks every month.

The panel took into consideration the fact that there were a number of constraints on implementation. Nevertheless, once a study protocol had been accepted it should have been executed without alterations. If alternatives were necessary because of exigencies in the field, each should have been documented and due attention paid to possible effects on the outcome of the study.

Since at the very outset of the study it was observed that the incidence of diarrhea reported in the project area was approximately 1/10 of those observed in Guatemala as a whole, necessary steps should have been taken to improve reporting. In this way more valid data could have been obtained.

Data Selection and Collection

A single monthly visit was used to collect information retrospectively on incidence of diarrhea during the two weeks preceding the interview. Since the incidence of diarrheal diseases was selected as a major index of the effect of the intervention, the surveillance should have comprised the total period

of observation, in view of variations in endemic incidence and variations in length of episodes over time and the occurrence of occasional outbreaks. The surveillance technique not only does not provide total time coverage but is subject to errors due to reporter's (i.e., usually the mother's) inability to remember accurately "minor" illnesses such as diarrhea in children. Therefore, the information collected on the incidence of diarrhea cannot be accepted at its face value.

The study suffers, as pointed out above, from the inaccuracies caused by the subjective reporting by mothers of the presence or absence of diarrhea among household members. The panel could not obtain evidence that an effort was made to evaluate the validity and reliability of the monthly interview data through more frequent interview rounds, observation, or possibly stool culture data.

The independent variables of water quality and quantity were measured reasonably well but those sanitation variables dependent upon interviews are, in the panel's judgement, of dubious reliability and validity.

There existed a potential for reporting biases on the part of the data collector and the participants in the study. Data were not presented which could measure the degree of bias resulting from interviews of individuals by different data collectors.

The panel felt that there were an excessive number of questions included in the questionnaires, yet the gathering of more objective data such as anthropometry was insufficient and incomplete. This disparity tended to overwhelm the task of data processing, management and analysis.

While collection of data on "hard" indices is essential for meaningful statistical analysis, observations on less quantifi-

able (i.e., less "hard") but relevant processes and events are valuable for the interpretation of the results. Such observations, when and if made, were not adequately recorded and analyzed. For example, in the experimental village only 65 percent of the population was provided with improved water supply, while there is little information as to why the other 35 percent did not receive improved water, and what happened as a result.

Analysis of the Results

The analysis is dependent upon the validity and completeness of the data and the underlying assumptions discussed above.

The UNC group carried out extensive analysis; however, in the view of the panel, the presentation of the analysis is fragmented and incomplete. Displays of descriptive data on diarrheal incidence and prevalence across time, for example, are not given.

The panel is of the opinion that no scientifically justifiable comparisons can be made between the two villages. For this reason and because of the other methodologic weaknesses of this study, no further analysis of the data for assessing the impact of water, sanitation and health education on diarrheal morbidity should be done.

The Dworkin and Dworkin paper entitled, "Water Supply and Diarrhea: Guatemala Revisited," concluded that there was a significant difference between the control and experimental villages in the rate of diarrheal diseases by both age and time period. The analysis is flawed in two major ways. First, the units of analysis shown in the tables are <u>episodes</u> of diarrhea. These episodes are treated as if they were independent observations. However, in the case of these data, the episodes are often in the <u>same</u> <u>individuals</u> at various time periods and thus are

clearly not independent. This treatment of the data could grossly inflate the Chi-square statistics and thus make the associated level of significance meaningless. Second, the Chi-square statistics on which the conclusions were based were calculated incorrectly, since the control village rates were used as expected values. This assumption is faulty since the control village rates are subject to bias and variability which must be considered in the analysis.

In addition, there is sufficient research experience to demonstrate that there is extensive variability between villages in developing countries; therefore "twin city" studies (i.e. single experimental and single control village) cannot be used to make inferences of the strength reported by Dworkin and Dworkin. Also, the above mentioned unreliability of recall data on the incidence of diarrhea prevents meaningful analysis.

Interpretation of the Results

The same data were examined by two groups. The UNC group, which participated in the implementation of the project, articulated some of the flaws of the study design. Because of the fragility of the data collected, they interpreted it cautiously. The investigators interpreted the data simply as an observational study carried out in two villages. They justifiably avoided comparisons between the villages and recognized that fundamental differences existed between the villages at all stages of the study. Any firm conclusions on the effect of the intervention were thus severely limited. The panel considered this strategy appropriate. However, the panel felt that the UNC's interpretation indicating that there was no relationship between water supply and diarrheal morbidity should be modified to indicate that in view of the flaws of the study design and execution it was inconclusive.

As for the Dworkin and Dworkin report, the panel believes that even if the incidence of diarrhea had been shown to be significantly different in the two villages, the difference could not be taken as a definite proof of the effect of the improved water supply alone. For instance, the most common diarrheal pathogens (Rotaviruses and E. Coli) are known to be transmitted through multiple routes, only one of which may be substantially affected by water quality and quantity.

Interpretation of the data on malabsorption and food wastage presented difficulties similar to those encountered in the interpretation of the results for diarrheal diseases. Although the basic aim of the study is of scientific and practical interest, the design and selection of the subjects caused the results to be difficult to interpret. The selection of adult males for the study was inappropriate because of the relatively low prevalence of diarrheal disease in that group. If a population of children, among whom the problem of diarrhea is significant, had been selected, the study might have given more conclusive results on the impact of the interventions on malabsorption. It is understood, however, that studies on children were hampered because of an obligation to adhere to strict ethical and cultural standards.

Nitrogen loss studies were of interest because they documented that Guatemalan males were no different from other adults studied throughout the world, but the significance of this observation in relation to the specific questions asked remains to be determined.

The comparisons made between the reference population and the two study groups of village adults with regard to their dietary intake during the balance studies, demonstrated a sharp difference in the composition of dietary protein. These studies suffered from all of the same problems ascribed to the studies of the incidence of diarrhea. There is therefore no way of

telling whether the differences in non-absorption among these three different groups are due to the intervention or to other confounding variables.

Discussion

Valid studies of the effect of water supplies on health require both proper methodology and study design. The health indices used in this study were not appropriate; there were more indices on the presence or absence of disease than on the presence of positive indicators of health. Irrespective of the indices selected, however, the validity and reliability of those chosen should have been verified. There is a question for example whether the assessment of the incidence of diarrhea is the best way to measure health status or whether weight, height and other anthropometric indices of nutritional status are not more objective and relevant. In addition, in view of the fact that a significant part of the experimental village (35%) did not receive improved water supply, it is questionable whether there was indeed a water and sanitation intervention in a strict sense of the term.

Conclusion

The panel felt that in view of inherent weaknesses of the study, and despite the large investments already expended, it would be preferable to allocate new resources to support well-designed prospective studies rather than to reanalyze the deficient data of the Guatemala study.

Summary and Recommendations

In view of deficiencies in the design and implementation of the Guatemala study, the panel would like to make the following specific recommendations concerning the reporting of the results:

a. The data from this study project should not be used to compare and/or assess the impact of water supply and sanitation on health.

b. The final report by UNC to AID should be revised to indicate that no valid conclusions on the relationship between improvement of water supply and diarrheal diseases incidence can be derived from the results of this study.

c. The Dworkin and Dworkin report uses incorrect statistical techniques and arrives at unwarranted conclusions. Therefore the panel considers that its diffusion as an independent document is not advisable.

d. The information on techniques used in the study, on observational and descriptive aspects of the Guatemala project, on health, education and community development have both scientific and practical value and warrant publication in relevant scientific journals.

e. Should USAID decide for some reason to further analyze the data of the Guatemala study for any reason, the reports on such analyses should be reviewed by UNC principal investigators and by external reviewers prior to their dissemination. This procedure would avoid possible misinterpretations of the results by individuals who had not participated in the study.

In view of the policy significance of the relationship between water supply and sanitation and health the panel submitted the following general recommendations to AID:

a. Invest in high quality research for developing a reliable methodology for documenting and quantifying the relationship between the effect of improvements in water supplies and sanitation (and possibly other relevant inputs) on health;

b. Establish Agency procedures to insure external scientific oversight and guidance for future research activities;

c. Insure that all large investments in water supply allocate part of the resources for monitoring and evaluation of the impact of water supply on health; and

d. Develop a standardized evaluation protocol for all AID-sponsored water supply and sanitation interventions.

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University of North Carolina at Chapel Hill, Institute of Nutrition of Central America and Panama, Methods for the Field Studies: Food Wastage/Sanitation Cost-Benefit Methodology Project, (AID/csd-2959), Guatemala, C.A., Department of State, May 8, 1978. (466 pp.)

Dworkin, Daniel and Judith Dworkin, Agency for International Development, Evaluation Special Study No. 2, Water Supply and Diarrhea: Guatemala Revisited, August, 1980. (35 pp.)

APPENDIX A*

Description of the Project*

1. Project Mandate

The objectives for the study have been summarized by the prime contractor (UNC-CH) as follows:

> The objective of this contract *per se* is to develop, field test and prepare a manual describing a methodology which can be utilized to determine the economic relationship between different levels of improved environmental sanitation and the waste of food energy from (1) inefficient absorption of food in the intestinal tract, and (2) intestinal diseases transmitted under unsanitary conditions. The contractor will (a) establish in cost-effectiveness terms the individual and synergistic influence of various environmental improvements on intestinal disease morbidity and associated food waste, and (b) determine the optimum combination of measures which, under existing economic, social and cultural constraints can most enhance efficient food utilization and reduction in morbidity.

The intervention program in the experimental village included two components: (1) changes in water supply and accessibility and (2) a health education program based on a community development/organization model. Each of these components is described below.

2. Water Supply

Prior to the initiation of the study, the experimental village had an unchlorinated piped water supply serving 13 households.

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* The description that follows was prepared by Kenneth R. McLeroy, Dr.P.H. and Robert Struba, Ph.D. of the Research Triangle Institute and is based entirely on the UNC summary report, as well as on the two background volumes provided by UNC. They are solely responsible for the contents.

During the initial construction phase of the project (1972-1973), water was piped to outdoor spigots in the yards of 103 additional households, many of whom also continued to use a water container in the home. By the end of the study, 61 additional connections had been made, for a total of 164 households (or 65 percent) using the new water system, in addition to the 13 households who continued to be served by the pre-existing unchlorinated water supply system.

Water quality in the distribution system for the experimental village was monitored seasonally. While 97 percent of the 698 samples drawn at the outdoor tap showed no coliform bacteria the quality of water in the household containers was poorer. At the start of the study, 63 percent of the household containers were uncovered, 53 percent were dirty, and in 34 percent of them there were coliform bacteria. These measures showed only minor improvements over the course of the study; however, the number of containers in use in the experimental community decreased over the length of the study as it became more convenient for users to go directly to the faucet in the yard

The control community received water from shallow wells and the river. In 1975, 48 percent of the control community households obtained their water from family wells, 23 percent from neighbors' wells, 9 percent from the river, and 20 percent from unknown sources. The wells were generally hand dug, lacked casings and covers, and had an old automobile tire as a parapet. The river water, used by 9 percent of the households as their main water source, was also used by most of the households in the control village for washing and bathing.

The overall bacteriological quality of water in the control village (Florida Aceituna) was poorer than in the experimental village throughout the study period. Forty-eight percent of the well samples in the control village were satisfactory

(without coliform bacteria), and 41 percent of the water container samples were of satisfactory quality.*

3. Health Education Component

The health education program was initiated midway through the project in April, 1974. The sanitation and improvement programs started in April, 1975. The health education component had five major objectives: (1) reducing fecal contamination in the home and surrounding areas; (2) keeping domestic animals out of the kitchen; (3) promoting the building and use of latrines; (4) improving food and water storage practices; and (5) increasing the use of potable water for hygienic uses.

The health education program used a community development approach. Community leaders were identified, recruited, and trained to carry out the health promotion activities through the formation of peer groups and committees. These groups and committees included: a Community Betterment Committee composed of male leaders; a Homemakers' Club composed of women leaders; a mid-wifery education program; and school teachers.

The Community Betterment committee undertook a variety of programs during the 2-1/2 years that project personnel were present. The committee developed: (1) fund raising activities for improving the health post; (2) a food distribution center; (3) program guidelines for latrines; (4) a community health promotion extension project; and (5) a savings and loan cooperative.

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* These figures are not the same as the ones reported in the Dworkin Paper. Dworkin and Dworkin indicate that none of the water container samples in the control village were coliform free. However, they used a table with longitudinal data collected from 21 sample households in each village. The table used by the Dworkins was developed by UNC as an external quality control for the field-test method of measuring water quality. Forty-one percent of the 875 water container samples from the control village, as measured by the field-test method, were coliform free.

The Homemakers' Club organized several six to eight week courses which met once a week and were open to all community women. Between 60 and 85 women participated in the course on sewing, cooking, child-care, knitting, and home improvement.

An education program recognized by the Guatemalan government for local mid-wives was conducted. The training program stressed hygiene, and provided information on human reproduction, the identification of high-risk pregnancies, and prenatal care.

A school health curriculum that stressed basic hygiene, sanitary behavior, and water and food hygiene was developed. The school health education program plan was developed during a three-day workshop attended by school teachers from the surrounding region.

4. Chronology of the Project

The project was funded in June 1971, and the first year was devoted to project planning and preparation for the field study in Guatemala. The selection of villages took place over a seven-month period, from April 1 through October 31, 1972. From November 1, 1971 through March 31, 1973, the baseline field studies were conducted in the experimental and control villages. Construction of the piped water supply was initiated in August 1972; the first phase was completed in September, 1973. Chlorination was introduced in January, 1974.

Field surveys were conducted from 1972 to 1976. Data management, data analysis, and report preparation were carried out from 1977 to 1978. The Dworkin and Dworkin reanalysis was done separately and at a later date than the UNC analysis (1980).

APPENDIX B*

Data Collection Procedures

A number of indicators were used to assess the impact of the program: morbidity; sanitation; water consumption; knowledge, attitudes, beliefs, and behavior; anthropometric measurements; diet and food consumption; and intestinal malabsorption. The methods of data collection and measurement procedures for the variables are briefly described below.

1. Morbidity

The objectives of the morbidity surveys were to determine the incidence of illnesses in the two communities** (particularly diarrhea and other diseases of the intestinal tract), to correlate disease incidence with the environmental interventions, and to document the presence of bacterial and parasitic intestinal infections.

Morbidity data were collected in each of the two villages through monthly visits to every household by auxillary nurses or specially trained surveyors. Data were provided by a single respondent in the household who was asked to recall incidences of diarrhea or other morbidity among the household members during the previous two weeks. Thus, although monthly surveys were conducted, the household morbidity data covered only a two-week period.

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* The description that follows was prepared by Kenneth R. McLeroy, Dr.P.H. and Robert Struba, Ph.D. of the Research Triangle Institute and is based entirely on the UNC summary report, as well as on the two background volumes provided by UNC. They are solely responsible for the contents.

** Illness was apparently defined as the reporting of symptoms or conditions by the household respondent, or by persons seeking care at the health posts.

Morbidity data were also collected in the health posts in each of the two villages.

Morbidity data collected in both the household survey and the health posts were coded according to the International Classification of Diseases (ICD) using four-digit codes. Each of the home visitors were provided with standardized criteria for those diseases considered most important. In addition, the method of diagnosis was included as part of the ICD code to denote whether the diagnosis was made by reported symptoms or whether the individual was currently ill. Validation of the diagnoses for 10 percent of the homes was made by the physician in charge of field activities who revisited the houses.

According to the study design, parasitologic surveys were originally planned for the early and final stages of the project. However, only two surveys were completed; both were conducted early in the study (1972 and 1973). In each of the two surveys, stool specimens were obtained from 50 to 60 percent of the residents of each of the two villages. Since no data were collected following the introduction of the intervention, the impact of the project on the incidence or prevalence of parasitological diseases is unknown.

2. Anthropometry

Anthropometric surveys of residents of both villages were also to be carried out at the beginning and end of the study. Anthropometric surveys were completed in 1972 and 1973 for 70 to 75 percent of the inhabitants of both villages. However, the survey originally scheduled for the conclusion of the study was not carried out.

During the 1972 and 1973 anthropometric surveys, all households in the two villages were invited to participate. A special emphasis was given to those households with small children. Mea-

sures were taken of weight, height, arm circumference, tricepital skinfold, and head circumference. All measurements were taken by two physicians who had received special training and instruction.

3. Malabsorption Studies

In order to assess the extent of intestinal malabsorption in the two villages, it was necessary to identify an appropriate reference group with whom the rural Guatemalan subjects could be compared. Twenty healthy soldiers born in the rural lowlands of Guatemala, but who had been living during the previous 18 to 24 months near Guatemala City, were selected as the reference group. These soldiers were hospitalized for 29 days and given the normal rural diet. Detailed tests were done for malabsorption.

The same tests were also administered twice a year to 75 percent of the adult males in each of the villages. Based on the results of these tests performed in 1972, 75 adult males from each village were selected for a longitudinal study of malabsorption.* This study included annual testing of the 150 male subjects by giving them a 2,800 calorie standardized diet and comparing calorie, nitrogen, and fat absorption with that of the reference group of soldiers. In addition, the study protocol included anthropometric measurements, parasitological examinations, and stool and urine tests.

4. Dietary and Food Consumption Surveys

The objectives of the dietary and food consumption surveys were to: (1) determine the dietary intake in the two villages; (2)

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* Adult males were selected for the longitudinal study of malabsorption based on their initial scores on the D-xylose absorption test. Twenty-five males were randomly selected from each of the tiercels of scores, that is 25 males from each of the upper, middle and lower thirds of scores.

monitor dietary intake throughout the project; (3) determine and monitor the dietary intake of the 150 males included in the malabsorption studies; and (4) monitor the cost of food items in the local markets. Surveys were conducted annually on a sample of households in the two villages and then on a sample of the 150 males included in the malabsorption studies. Monthly surveys to determine food costs in the local market were also conducted.

The dietary surveys included visiting the household before each meal, weighing the food to be prepared, and determining the kind and weight of food items consumed at each meal by each member of the household. Because of the time-consuming nature of the dietary record method, the measurement of food consumption per household was done for only one day, but a representative sample of households was interviewed on consecutive days of the week.

In 1972, 75 households from each community were selected and studied as part of the dietary and food consumption surveys. During 1973 and 1974, 20 of the 150 original households were studied every four months. During 1975-1976, 30 households were studied every six months.

The dietary record method was also used for the study of the dietary and food consumption patterns of the 150 males included in the malabsorption studies. As with the household dietary and food consumption surveys, 20 of the malabsorption study sample males were surveyed every four months in 1973 and 1974, and 30 every six months from 1975 and 1976. All 150 males were studied for one day in 1972.

Unit prices of each food commonly used by the villages was collected at the local market each month.

5. Sanitation

Annual and monthly sanitation surveys were conducted by field surveyors to document the quality of the home environment. The method of data collection was by observation rather than self-reporting.

A baseline survey of 50 households in each village was completed in 1972. The second annual survey was completed in 1974 based on modifications in the original survey instrument and the sampled households. Variables that were not significant indicators of environmental quality were dropped from the 1974 survey instrument, and the sample was modified to include families of the men in the malabsorption study. Sixty-eight households in each of the two sites were included in the 1974 survey.

Both the 1972 and 1974 surveys included questions on the number and arrangement of rooms, construction items, sleeping arrangements, food protection, storage of items, and latrine construction and use. The survey instruments were revised again for the 1975 and 1976 surveys, but the longitudinal sample was retained.

In addition to the four annual surveys, 26 sanitation and hygienic variables were measured on each of the longitudinal sample households each month.

Water quality in the two villages was assessed using the same longitudinal sample of households. Both source and water container samples were tested on 50 households in each village every four months.

The purpose and volume of water use and consumption were measured each month in both villages. In the control village and in houses without a water tap in the experimental village,

household consumption of water was measured by asking the household informant how often the water container was filled in the past 24 hours, converting the size of the container into standard measures, and computing the total volume of water. The number of persons in the household was used to compute the amount of water used per person per day. For households with a metered supply, the water meter was simply read once a month. The monthly volume was then computed and divided by the number of persons in the household.

6. Health Education

Evaluation of the health education component of the project included assessment of attitude, behavior, and belief changes in the communities as a whole, as well as separate evaluations of each of the health education interventions.

6.1 Community Surveys

The primary objectives of the health education component of the project were to improve household sanitation practices, including hand washing, hygienic food preparation, barring household animals from the kitchen, and building and using latrines. Baseline measures of sanitation practices were obtained in the first annual sanitation survey in 1972. Questions covered: (1) attitudes towards causes, treatment, and control of diarrhea, contagious diseases and illnesses; (2) attitudes towards defecation practices; (3) use of latrines; (4) fly control; and (5) attitudes and practices related to food hygiene.

The 1972 survey was administered to a sample of 50 households in each village. In 1974 a follow-up survey was taken among female heads of household in 134 households in the experimental village and 136 households in the control village. The respondents in the 1974 survey included samples of households in the longitudinal malabsorption and dietary studies.

In 1975, the sample of households was revised to include only households from the longitudinal sample as well as 20 additional households in the experimental village to monitor diffusion of ideas throughout the community. The female heads of household in the 1975 revised sample were interviewed three times a year for the remainder of the study.

6.2 Community Extension Program

The Community Betterment Committee in the experimental village developed a training course for 27 male volunteers who became health promoters. These 27 health promoters were organized into nine three-member teams. Each team organized between five and ten households and met with the households as a group once a week for six weeks. These meetings were devoted to sanitation education on a variety of topics.

Twenty-five households who participated in the community extension program were interviewed in 1975 to appraise health beliefs and attitudes. They were also asked about their attitudes towards the meetings, what they thought of the visual aids, and how they intended to use any of the educational material.

6.3 Latrine Program

Baseline measures of the number and use of latrines were obtained through the 1972 housing survey. In 1975, a program was introduced to increase the use of latrines for households that had one, and to introduce latrines to households without one. A form was filled out and maintained on each household building a latrine in the experimental village. The form contained information on the dates of request by the household and maintenance of the latrine by the appropriate party, building materials used, and the number of persons in the household using the latrine.

6.4 Homemaker's Club

The primary methods for evaluating the homemaker's club were process oriented, including the numbers and type of activities by the club, as well as the extent and frequency of attendance by community members.

6.5 Midwifery Training

Approximately 14 midwives from the experimental village participated in a six-week course in 1976. Oral examinations were administered at the end of the course by representatives of the health ministry. Every midwife attending the course passed the examination.

6.6 School Health Program

Both process and outcome measures of the effects of the school health program were used in evaluating the health education program. Process measures included visits to each teacher once a week to review lesson plans. Records of health classes were also kept, including attendance, student reaction, and materials used. Each classroom was also visited once a week. The health content of lessons and methods of presentation was observed and evaluated.

Two multiple choice examinations were developed--one for grades one through three and the other for grades four through six--and administered at the start and end of each school year in 1975-1976. These examinations served as an additional measure of student/teacher progress towards meeting the objectives of the course, and were used by most of the teachers in calculating student health grades for the year.

7. Summary of Data Collection Procedures

As noted above, three basic samples were used in the evaluation of the water quality and health education components of the project: (1) each village as a whole for annual and monthly cross-sectional studies; (2) a longitudinal sample for determining changes over time; and, (3) separate samples for assessing the results of each of the health education interventions.

The morbidity and anthropometry studies were conducted using the entire populations of the two villages. However, it should be noted that while the information for the morbidity study was collected for all members of the two communities, there was only a single respondent per household, usually the female head.

The longitudinal sample was used for the sanitation, health education, dietary and food consumption, and malabsorption studies. However, the composition of this sample was not consistent during the four years of the study. For example, the sample was revised in 1974 to include the males (and their families) who participated in the malabsorption studies, while some of the original households in the 1972-1973 sample were dropped.

APPENDIX C*

Data Analysis and Results

The original data analysis conducted by the University of North Carolina addressed the effects of each of the program components. The results were published as a single volume of 238 pages.

The Dworkin and Dworkin analysis of the data focused on only a small subset of the total data available from the project. Specifically, the Dworkins examined diarrhea among children one to seven years of age. In order to place the Dworkin and Dworkin reanalysis within the total perspective of the project results, the following discussion will provide a brief overview of the outcomes of each of the project components. Given the volume of data generated by the project, and the extensiveness of the data analyses contained in the UNC final report, this overview will highlight only the major findings.

1. University of North Carolina Analysis

1.1 Equivalence of the Two Sites

Central to any analysis of the UNC/INCAP project data are assumptions about the equivalence of the experimental and control villages. The two villages were initially matched on a variety of criteria, including: (a) demographic characteristics; (b) mortality and morbidity statistics; (c) water supply characteristics; (d) housing and environmental characteristics; and (e)

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* The description that follows was prepared by Kenneth R. McLeroy, Dr.P.H. and Robert Struba, Ph.D. of the Research Triangle Institute and is based entirely on the UNC summary report, as well as on the two background volumes provided by UNC and the Dworking and Dworkin reanalysis. They are solely responsible for the contents.

dietary habits, food consumption, and anthropometric measurements. Initially, a list of 100 eligible communities was prepared. Thirty-six of these communities were identified as acceptable for further screening. The two villages finally selected, Guanagazapa and Florida Aceituna, were identified as the best matches.

Comparisons of the two villages on demographic characteristics indicate similar population size, and age, race, sex distribution. The villages were also similar in their geographic location, vital statistics, morbidity, and mortality. There were, however, important differences between the two villages in family size, income, employment opportunities, and land ownership. In general, the control village had less unemployment, a higher gross income, and more land ownership. The experimental village had a higher proportion of large families, one of the demographic variables found positively related to morbidity.

More importantly, there was considerable in and out migration of residents from both the control and the experimental villages which could dilute the impact of the interventions and confound any subsequent data analysis, particularly when comparisons were attempted between the two villages.

1.2 Quality and Quantity of Water Consumption

Water was piped into the yards of 103 houses in the experimental village between August 1972 and September 1973. By the end of the study, 164 households (65 percent of the total) were using the new water system. Thirteen additional households were still using a previously existing, unchlorinated water source by the end of the study. However, there was only a 24 percent difference between the experimental and control villages in the percentage of household containers with contaminated water (coliform present) over the course of the study. Sixty-five percent of the household containers in the experi-

mental village, and 41 percent of the containers in the control village were uncontaminated with coliform. The number of containers in use in the experimental village, however, declined over the length of the study, making differences in water quality between the two villages inconclusive.

Additionally, no information was provided on the quality of water used by the 35 percent of the households in the experimental village not receiving water from the new system.

The households in the experimental village used 2-1/2 times as much water after the installation of the water system, on the average, as those in the control village. The differences between the two villages in water consumption are probably overestimated, however, since the amount of water used in the control village for washing and bathing at the river was not included in the computations of the amount of water consumed, and residents of the experimental village shifted their washing and bathing practices from the river to the water taps in the yards of their houses.

1.3 Housing Quality and Household Sanitation

Sixteen indicators of sanitation status were selected, including cleanliness of clothing, the covering and protection of food, cleanliness of house and yard, the presence of animals and insects, the use of soap, and handwashing. Improvements in sanitation status in the experimental village, which could be attributed to the interventions, included the use of wooden barriers to exclude animals from the kitchen, the protection of cooked food, the absence of garbage on the kitchen floor, and the removal of trash and garbage from the yard. However, the two latter improvements also occurred in the control community.

1.4 Health Education

The purpose of the health education component of the project was to affect the sanitation variables and to promote adequate use of the potable water system. This section will provide a detailed description of the statistical techniques used in the analysis of behavioral changes, as well as an overview of the effects of the program on attitude changes, use of latrines, animal barriers, and community participation.

In order to assess the effects of the health education component on sanitation behavior, means on each of the 10 sanitation variables were computed, pre- and post-program, for each of the two villages. A 2 x 2 factorial analysis of variance was then performed on each of the ten variables. The results indicate no significant differences as a result of the program in the cleanliness of clothing, the presence of garbage in the patio, the presence of garbage on the floor of the kitchen, and the wearing of shoes by the household informant. Significant differences were observed however in the experimental vs. the control community, comparing pre- and post-program status, in the presence of animal or human fecal material on the floor, the covering and protection of cooked food, and whether the yard was kept swept.

Positive changes in attitudes towards sanitation were clearly observed in the experimental village compared with the control village. To verify this hypothesis, scores on the attitude measures were used to construct a health education scale for the households in the sample. Weighted health education scores for the families--who were interviewed six times between 1975 and 1976--were examined in a multivariate linear model. The six scores for a household over time were treated as six dependent measures, with time considered as a within-subject factor. The results indicate a clear effect of the health education program on the attitudes in the experimental community.

The results of the health education evaluation also indicate an effect of the program on handwashing after urinating or defecating, although bathing frequency was not affected.

During the 1972 cross-sectional housing survey, 32 percent of the households in the experimental community reported having a latrine (n=66) By the end of the field studies, 79 new latrines were installed in the experimental villages. Almost no new construction was observed in the control village. Generally, latrines were found to be well maintained after they were constructed. It was reported that only one household was not using its latrine.

Forty-eight of the experimental village households constructed animal barriers in their homes. Almost none were constructed in the control community. Over 85 percent of the families in the experimental communities participated in at least one of the planned health education programs.

Analysis showed that attitudes toward sanitation, as measured changes on the health education scale, were not associated with sanitation behavioral change (i.e., they were two independent measures of program processes). There was, however, a positive relationship between family participation in the health education activities and sanitation behavioral changes. While the Pearson product moment correlation was significant (.44), it indicates that participation accounted for less than 25 percent of the variance in the behavioral change.

1.5 Malabsorption, Anthropometrics, and Parasitological Study Results

Since the malabsorption studies are not relevant to the controversy surrounding data analysis, they will not be discussed. The anthropometric and parasitological studies were, of course, never completed, and therefore are not included in this discussion.

1.6 Morbidity

Morbidity data were collected monthly in each of the two communities using a two-week recall method. The findings of the UNC staff indicate no significant differences between the two villages in total morbidity over the life of the project.

Diarrhea, skin infections, respiratory illness, and other infectious diseases were also selected for more detailed analysis. Examination of the crude morbidity rates for these four conditions indicates higher rates of diarrhea and other infectious diseases in the control community, and higher rates of respiratory and skin conditions in the experimental community. In both communities, children under seven years of age accounted for 83 percent of all diarrheal episodes, with the higher rates reported in the rainy season.

In order to test the effects of the program on morbidity associated with the four above conditions, general linear and categorical models were used, with a single model being constructed for each condition. These models corrected for some of the differences between the two villages which were unrelated to the project, and which could have potentially confounded the results. Specifically, adjustments were made for month-to-month variability or seasonal differences, age, sex, size of family and village, all of which are believed to affect morbidity.

The UNC findings indicate that the control variables of age, community, season, and size of family were related to morbidity. No sanitation variables were found to be consistently related to morbidity by age or sex. While a few significant findings emerged, the probability of the significant findings occurring approached chance given the number of statistical tests performed. For example, increased water consumption in the experimental village was found to be associated with de-

creased diarrhea and skin infections in children 13-24 months old. This finding, however, did not hold across other age groups.

2. Dworkin and Dworkin Analysis

The Dworkin and Dworkin reanalysis of the UNC data focused on only one disease category, diarrhea. In order to test for program effects, a Chi-square statistic was applied to the age-specific rates in the control and experimental communities. These investigators found significantly different rates in the control and experimental communities for all but two age groups. This difference was attributed to the effects of the program. Other comparisons were made in the direction of the hypothesis under investigation between the control and experimental groups on seasonal variations, water use, and sex, and their effects on diarrheal incidence. All of these comparisons indicated statistically significant differences in the direction of the hypothesis under investigation between the two communities.

APPENDIX D January 14, 1981

WATER AND SANITATION FOR HEALTH PROJECT
Order of Technical Direction Number 19

TO: Mr. James Arbuthnot, P.E.
WASH Contract Project Director

FROM: Mr. Max K. Batavia, P.E. MB
Mr. Victor W.R. Wehman, Jr., P.E., R.S. VWW
AID WASH Project Managers

SUBJECT: Provision of an Expert Panel under WASH Project Scope of Work to Review Guatemala Water and Sanitation/Food Wastage Cost Benefit Methodology Project

REFS:

A) Memorandum 17 November, 1980 - Isely to Batavia and Wehman

B) Previous correspondence involving Howard, Dworkin, Shiffman, Hughes, and others.

C) UNC-INCAP Project Report

D) Guatemala Revisited-Dworkin PPC document

E) Memo McJunkin/Levin on Food Wastage Review and External Evaluation

F) Chanlett and Kawata Final Report Reviews

1. WASH Contractor requested to provide the services of an expert review panel as per scope of work found below.

2. WASH Contractor/subcontractor/consultants authorized to expend up to 80 person days effort over a five (5) month period to accomplish this effort.

3. Contractor to provide a final report by the end of the 5th month of effort.

4. Contractor to coordinate arrangements with AID WASH Project Managers.

5. WASH Contractor should form a panel of five core members plus three consultants to provide as-needed services. The panel members should have expertise and exhibit skills in research experimental design applied to water supply and sanitation in relation to enteric disease in children, and to nutritional impacts on enteric infections, epidemiology as applied to these same problems, and relevant biostatistical analytic and sampling methods. Consultants will supplement the panel with as needed skills and knowledge in sanitary engineering, social anthropology, and economics if as requested by panel and approved by AID WASH Project Managers. WASH Contractor/subcontractor will provide staffing for coordinating the panel activities.

6. WASH Contractor authorized to allow panelists and/or consultants to make up to three (3) trips to Washington for panel meetings, one trip if requested by panel members to Chapel Hill, N.C. to meet with UNC staff and one round trip, if necessary, for 3 of the panelists/ consultants to Guatemala to meet with INCAP personnel to visit communities involved in research design, and other relevant persons. WASH Contractor is authorized to pay salary, travel, per diem and miscellaneous expenses to consultants and UNC project research staff to attend panel meetings if requested and approved by the panel chairman.

7. WASH Contractor to coordinate tasks as follows:

   a. Send packet of all relevant project documents, reports, published articles and correspondence to core panel members and consultants with suggested sections of field reports for individuals.

   b. Ask them to thoroughly read and study pertinent documents and be especially prepared to respond to or lead discussions on project in their areas of expertise.

   c. Convene panel (5 persons) approximately 4 weeks after sending out materials. The project coordinator will serve as the temporary panel chairman until the panel meets and elects their own chairman. At or before the first panel meeting a premanent panel chairman should be selected by the panel members and a course of action charted. Activities should be planned so as to answer the fundamental question:

      "From the data collected by the subject study, what bona fide conclusions(s), if any, can be supported regarding the impact of improved water supply, sanitation and health education (individually or jointly) on diarrheal morbidity. (A corollary question is: Was each intervention really an improvement?) If these questions can be satisfactorily answered after the first meeting of the panel, then no further activities of the panel will be necessary except development of a draft and final panel report. If not, then the panel is asked to recommend activities to resolve this (these) question(s)."

   d. In concert with and with approval of the AID project officer, the contractor will authorize additional activities, if any, as requested by the panel for resources to accomplish their work.

   e. Subsequent activities of the panel will depend upon decisions made at its initial panel meeting at WASH in Arlington, Va. Among operational issues to be decided are:

      (1) Whether to interview relevant persons regarding the conduct of the study and subsequent analyses of data, e.g., Dr. Shiffman, Dr. Dworkin, Dr. Turner, Dr. Helms, et al.

(2) Whether to do any re-analysis of data

(3) Whether a trip to Guatemala is necessary in the panel's opinion or not.

(4) What roles and responsibilities the panel is going to assign to panel members and consultants.

(5) What further meetings are necessary by the panel, if any.

f. The panel chairman will keep the panel coordinator and WASH task manager (Dr. Isely) fully informed of problems, progress, resource requirements, etc.

g. When panel activities have been completed, prepare a final draft report and then after the draft is reviewed by DS/HEA, a final report is due within 30 days.

h. A panel agenda and report will be prepared for each meeting. The panel chairman will be responsible for editorial accuracy of the report. The WASH contractor will provide typing, reproduction and distribution services. The report will not be distributed prior to review by the panel, WASH and DS/HEA. The panel, at its discretion, may also seek reviews from relevant AID/PPC and UNC-INCAP personnel.

8. Suggest WASH Contractor utilize following panel voting members and consultants.

A. Lincoln Chen, Harvard, physician, epidemologist, nutritionist (member)

B. Branko, Cvjetanovic, Zagreb, Yugoslavia, physician, epidemiologist, specialist in enteric infections (member).

C. Alan, Gittelsohn, Johns-Hopkins Univ., biostatistician (member)

D. John Kronmal, Univ. of Washington, biostatistician, nutritionist, gastroenterologist (member)

E. Robert Suskind, Univ. of Alabama, pediatrician, nutritionist, gastroenterologist (member)

F. Mary Elmendorf, self-employed, anthropologist (consultant)

G. Kaz Kawata, Johns-Hopkins Univ., Sanitary/Environmental Engr.(consultant)

H. Abraham, Bekele, self-employed, health economist (consultant) or

Rafat Barokas, self-employed, development economist (consultant)

I. Robert Struba, RTI, epidemiologist, panel coordinator,(non-member/ coordinator of effort)

9. WASH Contractor requested to initiate activity immediately and keep AID WASH project officer informed of progress. WASH task manager requested to keep up to date bi-weekly summary of level of effort expenditures taking place under this OTD. Good luck.

APPENDIX E

PRIME CONTRACT NO. AID/CAD-2959
(Agency for International Development)

STATEMENT OF WORK AND GENERAL OBJECTIVES AS EXCERPTED FROM PRIME CONTRACT NO. AID/CAD-2959 BETWEEN THE AGENCY FOR INTERNATIONAL DEVELOPMENT AND THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

ARTICLE I - STATEMENT OF WORK

For the period hereinafter set forth in the Schedule and in accordance with the level of effort provided in Article IV; the contractor shall provide the staff and facilities necessary to prepare a plan for the development of a methodology to evaluate measures for reducing food waste caused by intestinal disease and to field test that methodology.

A. General Objectives:

The objective of this project is to develop, field test, and prepare a manual describing a methodology which can be utilized to determine the economic relationship between a given level of environmental sanitation and the waste of food energy from (1) intestinal diseases transmitted under unsanitary conditions and (2) inefficient utilization of food energy secondary to intestinal malsorption. The project will (a) establish the significance of the environment on intestinal disease and associated food waste and (b) determine the optimum combination of control measures which, under existing financial, social, and cultural constraints, can enhance the efficiency of food utilization.