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ENVIRONMENTAL ASSESSMENT WATER AND SANITATION FOR HEALTH AND ECUADOR DEVELOPMENT (WASHED)

WASH FIELD REPORT NO. 287

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1611 N. Kent Street, Room 1001
Arlington, VA 22209-2111 USA

Telephone: (703) 243-8200
Fax (703) 525-9137
Telex WUI 64552
Cable Address WASHAID

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Prepared for
the USAID Mission to the Government of Ecuador
WASH Task No. 067

WASH Field Report No. 287

ENVIRONMENTAL ASSESSMENT

WATER AND SANITATION FOR HEALTH
AND
ECUADOR DEVELOPMENT

(WASHED)

Prepared for the USAID Mission
to the Government of Ecuador
under WASH Task No. 067

By

Robert Hogrefe
and
César Jaramillo

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THE AUTHORS

Robert H. Hogrefe is a civil engineer with the City of Albuquerque Public Works Department. From 1974 to 1978 and 1985 to 1986 he was regional environmental engineer for the State of New Mexico Environmental Improvement Division, and from 1983 to 1985 he served as a U.S. Peace Corps volunteer in Honduras on a Save the Children water and sanitation project. In 1988 Hogrefe was team engineer for the USAId/Honduras Environmental Assessment, coordinated by the Vector Biology and Control (VBC) project: he also carried out another consultancy for WASH: a case study of the Dominican Republic Handpump Manufacture Program for WASH Field Report No. 39: Privatization of Operations and Maintenance of Rural Water Supply Systems."

César Jaramillo Avila is a civil engineer who works as a private consultant on development projects. He has carried out evaluations and assessments for the United Nations, CARE International, and USAID/Ecuador and has been involved with several projects with environmental components for Ecuadorian agencies. Jaramillo, a graduate of Central University of Quito, has attended numerous courses and seminars in the United States.

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Ing. Jorge Castillo, A.I.D. Project Engineer
Lcda. Maria Rivadeneira, A.I.D. Program & Project Officer
Ing. Mònica Brito, IEOS Chief-Division of Environmental Impacts; Directorate of Environment.

ACRONYMS

EA	**Environmental Assessment**
ESPOCH	*Escuela Superior Politécnica de Chimborazo*
ESPOL	*Escuela Superior Politécnica del Litoral, Guayaquil*
GOE	Government of Ecuador
IEE	Initial Environmental Examination
IEOS	*Instituto Ecuatoriano de Obras Sanitarias* (Ecuadorian Institute of Sanitary Works)
IEOS-DNMA	IEOS, *Dirección Nacional de Medio Ambiente* (IEOS, National Directorate for the Environment)
INERHI	*Instituto Ecuatoriano de Recursos Hidráulicos* (Ecuadorian Institute of Hydraulic Resources)
MAG	Ministry of Agriculture and Cattle
MSP/MPH	Ministry of Public Health
NGO	Non Government Organization
O&M	Operation and Maintenance
PVO	Private Voluntary Organization
RWS&S	Rural Water Supply & Sanitation
SOW	Scope of Work
UCETA-IEOS	Appropriate Technology Studies Coordination Unit - IEOS
USAID/LAC	United States Agency for International Development/Latin America Caribbean Areas
WASH	Water and Sanitation for Health Project
WASHED	Water and Sanitation for Health and Ecuador Development

EXECUTIVE SUMMARY

At the request of USAID/Ecuador, the Water & Sanitation for Health (WASH) Project arranged for a two-person team to meet with the USAID Regional Environmental Officer (REMS/SA) and Mission personnel for three weeks in August 1989 to prepare an Environmental Assessment (EA) of rural water supply and sanitation systems under the WASHED Project. This EA was prepared in accordance with A.I.D. Regulation 22 CFR 16.

The team members participated in a scoping exercise in Quito with the Regional Environmental Officer and Mission staff. Interviews were held with key individuals of several Government of Ecuador (GOE) agencies and private institutions. Field visits were made to representative projects for additional insights.

Significant findings of the Environmental Assessment are as follows:

1. The typical physical activities involving water and sanitation projects are usually confined to limited areas and do not represent major intrusions on the environment.

2. However, there is a good potential for increasing the program's sensitivity to environmental concerns relating to the affected watersheds and to the water quality of the community water systems.

3. Surface water supply systems in some locations are vulnerable to contamination and can be safeguarded by protective measures and monitoring.

4. The many institutions involved in environmental promotion and education in the country are a valuable resource on which the project can draw in addressing environmental concerns.

Significant recommendations resulting from this study are as follows:

1. Establish pilot programs in watershed conservation and water quality monitoring, utilizing project components and inter-institutional cooperation for program materials and organizing combined efforts in common work areas.

2. Perform watershed baseline surveys and assessments using the construction module and provincial O&M promoters.

3. Provide flexibility in design criteria to permit selection of more distant spring sources, in lieu of surface sources with filtration treatment plants, if the difference in costs does not exceed 25 to 33 percent.

4. Utilize the appropriate technology component for studies of environmental problems in addition to other subjects.

5. Encourage institutional support for the National Directorate for the Environment of IEOS (DNMA-IEOS). Include the DNMA in studies under the appropriate technology component.

6. Prepare semiannual evaluations to monitor the environmental sensitivity of the WASHED Project. These should be the responsibility of the project coordinator and the three national advisors.

7. Take advantage of resource materials on environmental promotion, education, and training that other institutions, both governmental and nongovernmental, have already developed.

Chapter 1

INTRODUCTION

1.1 Purpose

The purpose of this consultancy was to conduct an environmental assessment (EA) for the Water and Sanitation for Health and Ecuador Development (WASHED) Project, which is a continuation of the GOE-IEOS rural water supply and sanitation program begun in 1982 as a component of the Integrated Rural Health Delivery Systems Project. This report presents the findings and recommendations of the EA, performed in August 1989.

1.2 Scope of Work and Scoping Process

The scope of work (SOW) outlined the following tasks:

1. Conduct a scoping exercise to identify the significant issues to be addressed in the EA. To accomplish this, the team leader will review pertinent project documents and consult with the Regional Environmental Management Specialist, rural development and engineering officers, and representatives of the host country government responsible for implementing the project. The scoping of issues is expected to last three to four days.

2. Prepare a tentative written outline of these issues for review and approval by the Bureau Environmental Officer.

3. Review current GOE criteria for locating water intake structures, latrines, and wells and submit recommendations for improvements.

4. Recommend construction practices to reduce erosion by runoff water from storage tanks, wells, and household connections and eliminate pools of water caused by poor drainage.

5. Visit sites where water and sanitation facilities have been constructed under the Integrated Rural Health Delivery Systems Project (518-0015) and sites where facilities are to be constructed under WASHED, and recommend watershed protection measures for both. Prepare an environmental evaluation of all these sites and an internal review system for inclusion in the overall EA.

6. Assess the status of water quality and recommend appropriate water quality monitoring programs for protection of water supplies.

7. Based on the findings of Tasks 1 through 6 above, and following the procedures detailed in 22 CFR 216.6, prepare an EA for WASHED.

The scoping exercise identified the following significant issues to be addressed in the EA:

Existing RWS&S Systems

- Are these systems having adverse effects because of their location in vulnerable watersheds?
- Is there a viable monitoring system in place (or proposed) to help establish a database for water quality, watershed conditions, and fragile and multi-use watersheds?
- Will future project activities cover the preservation and maintenance of water sources through community and IEOS training, education, promotion, and support?
- What is the nature of regulatory control of water sources and watersheds in Ecuador, and how will this project relate to such controls?

Future RWS&S Systems

- Should the community selection process include the evaluation of watersheds?
- What interagency work is feasible in regard to water quality and watershed management?
- Should an environmental specialist be included in the project or should the roles of the project manager and the three national specialists to be recruited be expanded to include environmental work?
- Should environmental components to enhance water quality and quantity in the project demonstration areas be considered now or in the future? Would this merit a project amendment?
- Should water source selection criteria be modified to include the options of regional multi-community systems and/or spring captures at large distances, wherever possible, as an alternative to surface supplies?
- How can a water quality monitoring program be introduced after system construction? This relates directly to chlorination practices as well.

1.3 Project Description

The goal of the four-year WASHED Project is to improve the health of infants and children in Ecuador, complementing activities under the Child Survival Project. Its purpose is to strengthen IEOS's capability to assist rural communities in eight provinces to install cost-effective, technologically appropriate, safe water supply systems and latrines; use the water and latrines to improve family health; and maintain and improve the systems in the future. Although some project activities will be nationwide, the primary focus will be on eight provinces to test new management, technological, and educational methodologies and to demonstrate what results can be achieved. The provinces, selected according to the scope of the problem and the feasibility of project implementation, are: Imbabura, Pichincha, Cotopaxi, Chimborazo, Azuay, Tungurahua, and Carchi in the Sierra, and El Oro in the Coastal region.

The project consists of five major components--systems construction, hygiene education, operation and maintenance, appropriate technology, and training--and plans the construction of 640 new RWS&S systems, using the decentralized operational module approach which it hopes to institutionalize as a means of construction. The hygiene education component will use mass media and person-to-person health education technologies to change behavior. The operation and maintenance objectives are to establish in IEOS the capability to support the community water boards in maintaining the systems and to strengthen their administrative skills. The appropriate technology component is intended to provide IEOS with the long-term capability to design, manage, and apply research to improve RWS&S technologies and efficiency, and to complete studies to increase the cost-effectiveness of construction and operation. Training activities will upgrade the technical and management skills of IEOS headquarters and field personnel, and introduce new management practices and technical skills called for by project innovations.

The total cost of the project is $22.3 million. A.I.D. will contribute $4.0 million in grants, and $15.7 million, including $1.6 million in ESF local currency funds, will come from counterpart funding. Community contributions through the provision of labor for construction will account for the balance of $2.6 million.

1.4 Threshold Environmental Decision

An initial environmental examination (IEE), prepared in June 1989 by the Regional Environmental Specialist--South America and the Mission Assistant Environmental Officer (see Appendix E), recommended a sampling of water sources for suspected contamination by upstream discharges of pesticides and heavy metals. It also suggested a project modification to include a system to monitor water quality and water use. Neither of these was carried out before preparation of the project paper.

The IEE's recommended negative (i.e., no significant impact) threshold decision was reversed by the Bureau's Chief Environmental Officer for Latin America and the Caribbean (see LAC-IEE-89-98, June 23, 1989). The Bureau's positive (i.e., potential adverse impacts) threshold decision was based on 22CFR 216.2(d), "Classes of Actions Normally Having a Significant Effect on the Environment," that mentions potable water and sewage projects. Therefore, a formal EA is required.

Chapter 2

ALTERNATIVES--INCLUDING THE PROPOSED ACTIONS

2.1 Rural Water Supply and Sanitation Projects Planned

RWS&S systems are usually constructed at preselected locations determined by design criteria, which also influence the degree of environmental intervention. The project's design criteria have been carefully reviewed and have been tested in previously built systems. The project's major proposed physical and program components are presented below in a consistent format followed by alternatives to mitigate potential adverse environmental impacts.

2.2 Proposed Water Supply Sources

2.2.1 Spring Water

According to observations and data gathered, there is a strong preference for the use of spring water and infiltration galleries in the construction of water systems. The communities and IEOS promoters identify the sources and petition INERHI* for the water rights. Prior to the design process, physical and chemical analyses are usually performed.

Reports were received of spring waters that have progressively decreased in volume because the source and watershed are unprotected against the indiscriminate felling of trees and the destruction of vegetation in the process of cultivation. Also, pesticide use is often high.

> ***Alternative #1.*** To prevent contamination, water sources should be surrounded with a fence. This is an important first step in community awareness of the need to protect water quality. Fencing is presently included in implementation.
>
> ***Alternative #2.*** Some systems have a problem with sand carried into the filtration tanks and no means to clean it out. Collection and distribution tanks, and a presedimentation tank if necessary, can correct this problem. Current practice makes use of collection and distribution tanks as sediment collectors. A valved drainage system should continue to be a part of all existing tanks, which should be monitored to ensure that it has been provided.

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* In Ecuador INEHRI (*Instituto Ecuatoriano de Recursos Hidráulicos*), a dependency of the Ministry of Agriculture, has national jurisdiction for water resource allocation and husbandry.

Alternative #3. Spring water might be considered to be of acceptable quality, without the need for chlorination, if reliable periodic bacteriological analyses confirm it is uncontaminated.

2.2.2 Surface Water

Surface water is generally not the first choice of supply, since the quality is usually poorer and costly treatment may be needed. Nonetheless, a significant number of rural communities are served by surface water supplies. A countrywide breakdown of water sources as reported in January 1988, based on partially complete data only but believed to be representative of projects to be built, appears in Table 1.

Table 1
Water Source Breakdown

ZONE	SOURCE %			TREATMENT %	
	WELLS	SURFACE	SPRING	FILTERED	UNFILTERED
Sierra	2	20	78	28	72
Costa	48	52	0	0	100
Oriente	4	58	38	46	54

Source: Memorandum, Jan. 12, 1988, F. Mattson, Engineering Consultant to A. Nassau, World Bank.

It is apparent that in the Sierra, where seven of the eight provinces selected for the project are located, springs are the predominant source of supply. However, if the figure of 20 percent for surface water supplies is applied to the estimated population (320,000) in the project area, about 64,000 people will be served by this source.

Surface water raises the question of filtration treatment. At present, some bacteriological, physical and chemical analyses of raw water are made to determine the need for treatment, but no analyses are made for the presence of pesticides and heavy metals, particularly in water from sources affected by agriculture or mining. Field visits and discussions indicated that these activities are causing increasing contamination above and within the watersheds.

The following alternatives could improve the quality of surface water:

Alternative #1. Although fencing can do nothing to protect the waters feeding the system, it can restrict animal and human entry within reasonable distances of surface water intakes. It is an important <u>first step</u> in promoting water quality preservation in communities. The A.I.D. program now includes fencing; other

programs in Ecuador (e.g., CARE-IEOS) include fencing as a requirement in the agreement with each community. It is of advantage to stress this and other water source protection during initial community promotion work when motivation is high.

Alternative #2. Project selection criteria and design flexibility should consider the comparative costs of providing a surface supply with a filtration plant and reaching higher into a watershed for spring sources. Even if construction costs for spring sources are 25 to 33 percent higher, they may be worth the avoidance of problems associated with filtration treatment plants, which are more difficult to operate and maintain.

Alternative #3. The construction module promoters could include in project selection criteria an assessment of the conditions in a watershed where a potential water source is located. Recommended formats for a watershed survey and a watershed assessment are provided in the Annexes. The information they yield on the causes of contamination could influence community promotion to protect and preserve the water source.

Alternative #4. Chlorination of surface water supplies, at present a design standard, could be modified to apply only to those systems with a greater likelihood of bacteriological contamination. Better monitoring, to be discussed further, could identify which systems need chlorine regularly, periodically, or not at all. The high cost of buying chlorine could be lowered immediately by encouraging bulk purchases by provincial councils for the combined needs of several communities, and later, by building a chlorine factory in the country.

2.2.3 Well Water

As Table 1 shows, wells are most frequent in the Coastal region, where underground water is often the only safe, though expensive, source of supply. Drilled wells with electric pumps are favored over handpumps. Here the operation and maintenance of mechanical and electrical equipment arises, along with long-term depreciation and the eventual replacement of some components.

Alternative #1. The intensive cultivation of bananas, pineapples, and many other crops, along with the concentration of population in many areas, is responsible for contaminating the shallow water table in the Coastal region. Deep aquifers can be considered in lieu of shallow water sources. This alternative again relates to flexibility in project selection criteria and consideration of environmental factors in a given location.

2.3 Watershed Management

The project design does not call for any watershed management activities or promotion, since understandably the project relates to the health sector and child survival, not to natural resources. There are, however, many interrelationships between watershed management and community health, not the least of which are the preservation and protection of potable water supplies for the future. An all too common result of watershed degradation from misuse or overuse is a decline in both the quantity and quality of available water.

This EA uncovered many reports of dwindling supplies in systems already built, and, in some cases, of water dropping to unusable levels at sites selected for new systems. The impact of unrestrained exploitation of watershed resources is obvious, particularly in agricultural and mining areas. The burning of vegetation and uncontrolled grazing that follow population movement to higher elevations where traditional water sources originate can completely change the hydrological characteristics of a given watershed, affecting soil texture and vegetation cover. Runoff erosion is a predictable sequel, compounded by contamination from humans, animals, and pesticides.

Recognizing the close relationship between water supplies and watershed conditions, and the loss of investments, both financial and human, that can occur when water systems fail because of watershed degradation or contamination, many institutions emphasize watershed management through soil conservation and reforestation and promote natural alternatives to chemical pesticides.

> *Alternative #1.* A pilot plan could be inaugurated as part of this project to draw attention to the importance of watershed management and soil conservation. Such a plan is suggested for Tungurahua, where community RWS&S systems are proposed. Interagency cooperation, program promotion, materials, and expertise are available, and IEOS and CARE promoters in this province were enthusiastic about complementing each other's programs to benefit the communities. CARE has mounted a model soil and water conservation project in an area of more than 250 ha. near Ambato, Tungurahua, that has stabilized a highly eroded and degraded segment of the watershed. Agricultural production in the area has surpassed previous productivity many times over--a common result of soil and water conservation programs. The GOE's ministry of agriculture is also working in this area and can be involved in conservation promotion. The Peace Corps has also assisted in introducing conservation techniques, including tree nurseries, that CARE is presently managing with the communities.

Other alternatives relating to watershed management are suggested in the sections on training and education, operation and maintenance, and appropriate technology. Each of these components should have the flexibility to accommodate a pilot program in watershed conservation.

2.4 Water Quality Monitoring

A high percentage of water supplies in the Sierra originate from springs, and bacteriological analyses generally are not performed. However, to ensure water quality, calcium hypochlorite is used for disinfection. Systems depending on surface water usually obtain physical, chemical, and bacteriological analyses, and water is frequently treated via slow sand filters and calcium hypochlorite. However, partially for lack of systematic monitoring, the plants are not operating as originally designed. Only 25 to 50 percent of chlorinators are reported to be in regular use, and this percentage will no doubt decrease once the chlorine donated by IEOS to the communities runs out, obliging the community water *juntas* to purchase it themselves at a high cost.

In the community of La Merced in Chimborazo, some community members were granted loans from funds collected as water tariffs, with adverse effects on the operation and maintenance of the system.

Slow sand filters are designed to improve water quality, but many are not working properly for lack of operation and maintenance training.

> ***Alternative #1.*** A systematic monitoring program could be established to support the operation of surface water treatment plants, providing for the collection of test samples from different parts of the system at different times of the year. This could be effected through interinstitutional agreements between the universities and IEOS under which, for example, a university provides the necessary personnel (perhaps students in their last year of engineering) and test kits and IEOS meets transportation and living costs. All the universities in the provinces visited (Azuay, El Oro, Guayas, Chimborazo and Tungurahua) have the necessary facilities and are willing to collaborate with IEOS for this project.
>
> ***Alternative #2.*** Several governmental institutions, such as the National Fisheries Institute (INP), INERHI, the National Institute for Atomic Energy (INEA), and the Armed Forces-Merchant Marine Directorate, have laboratories which IEOS could use by agreement. The Coastal Resources Program in El Oro has proposed a pilot plan for sampling and water analyses through agreement with IEOS.

2.5 Latrines

Most of the latrines inspected are designed with a hydraulic seal. Families provide an absorption well and complete the rudimentary latrine house with local material.

Generally, latrines are used correctly and operate well. However, absorption well side slopes are unstable and soil permeability is inadequate in some areas. The deterioration of cement latrines causes retention of organic material, bad odors, mosquito breeding, and offensive conditions that discourage community acceptance.

Alternative #1. The following aspects should be considered before starting the construction of latrines:

- A study of soil stability should determine if well walls need to be reinforced totally or partially and the most economical method of doing this.
- Soil permeability tests using small infiltration wells should be performed to ensure that cross-contamination of nearby water wells does not occur.
- Groundwater levels should be checked for contamination.

Alternative #2. A cost-benefit analysis of replacing cement with porcelain latrines, which would eliminate the objections of community users, could be performed.

Alternative #3. Similarly, in the coastal areas, where underground water levels are high, elevated dry latrines should be considered as an alternative. This is an appropriate subject for the appropriate technology component.

2.6 Drainage Measures

Runoff water from intake structures can cause erosion damage or accumulate in stagnant pools if it is allowed to follow its natural course without modification. Overflow from storage tanks is usually directed away from the structure to prevent foundation damage. A small canal may sometimes be provided to direct water in a desired direction to control erosion and accumulation. Simple piping of overflow waters is also effective.

A greater problem is the disposal of household waste water in ditches and depressions, where it stands in unsanitary pools and provides breeding sites for disease-carrying vectors. The problem can be anticipated during water system construction.

Alternative #1. When work crews are digging ditches and making connections, simple cross-ditches or pipes can be installed to connect major drainage depressions along roadways, in yards, and elsewhere. The cost of the additional materials (e.g., 6" diameter PVC pipe, or small quantities of 12"-18" metal culvert pipes) could easily be absorbed by the contingency allowance for each project. The field engineer and promoter could provide the necessary technical guidance and recommend alternative measures as needed.

2.7 Training and Hygiene Education Components

The training and hygiene education components of the project are to be expanded, thereby greatly improving many areas of emphasis. Training is to meet two basic requirements: upgrade the traditional technical and management skills of IEOS staff, and introduce new management and technical skills called for by the project's innovations (decentralized management, hygiene education, appropriate technology, pilot project approaches, and impact education).

IEOS intends to establish a training unit based on the experience gained from this project. Also, training activities will cover local community water board members, provincial-level IEOS staff, health promoters, and rural teachers involved in operation and maintenance and hygiene education. Annual training plans are to be prepared by IEOS for A.I.D. review and approval.

The hygiene education component will address hygiene promotion by continuing the activities of the social marketing program started in August 1989. Also, some 35 of the present IEOS-RWS&S promoters are to be made hygiene promoters with the help of A.I.D. project training funds. Each community water board is to select a female member of the community to serve as hygiene coordinator for the system. A total of $1.082 million in A.I.D. project funds has been dedicated to hygiene education, the largest of the five components.

Training will be given to each IEOS operational module, or construction team (one engineer, three promoters, one administrative assistant), and module promoters will be coordinating promotion in only three communities a year compared with twice that number they were required to handle in past years. (Reference: Final Evaluation--IRHDS--Ecuador, June 1989.)

Appendix G of the project paper provides a detailed training program in some 32 subjects proposed by IEOS for all persons involved in the RWS&S projects, from IEOS national directors to community system operators and water board members. The cost will be covered by $597,000 of A.I.D. funds and $200,000 of GOE funds.

> ***Alternative #1.*** The training and hygiene education components have the flexibility to include elements to help preserve, protect, and enhance many areas of environmental concern. For example, the alternative discussed under Section 2.3, Watershed Management, could use training and education to help establish the pilot program for watershed conservation. Short-term technical assistance could be used to design possible approaches. Also, alternative #3 under Section 2.2.2, Surface Water, could use training in inventories and assessments of watershed conditions. In addition, much material is already available from other sources. For example, CARE, the Peace Corps, and Fundación Natura have strong programs in pesticide controls, soil and water conservation, and environmental education that could be incorporated. Interinstitutional cross-training could be coordinated whenever possible.

The training and hygiene education components could also assist in water quality monitoring, described in Section 3.4. Technical training is needed in slow sand filtration operation that can complement water quality monitoring ability, for

example. Other alternatives for water quality monitoring are discussed in Section 3.9, Appropriate Technology Component.

2.8 Operation and Maintenance Component

The expanded O&M component for the project represents the second largest A.I.D. funding commitment ($825,000) after hygiene education. A new central O&M unit will be established at IEOS headquarters, Quito, and O&M-dedicated centers at the eight provincial offices.

Equipment buildup, including vehicles, workshops, warehouses, tools, and training, is planned in the provinces. Personnel buildup is planned to provide each provincial office with a sanitary engineer, health educator/promoter, administrative assistant, and O&M field promoters.

Each O&M promoter will work in 15 to 20 communities, visiting each community at least four times a year to support the system operators. A great deal more contact is planned through the O&M component, which lends itself to many environmental monitoring and promotion activities.

> ***Alternative #1.*** A complete inventory of the RWS&S systems in the eight project provinces by the O&M centers is programmed for the first stage of the new projects, January 1990 to September 1991. An ideal opportunity exists to include a survey and assessment of the watershed conditions of each water system during this stage. Possible formats are provided in the Annexes of this EA. Baseline data could be obtained at the provincial level for use in future community promotion for water source protection and watershed conservation.

With experience gained from the pilot program in watershed conservation and management (suggested in Section 2.3.), training of the IEOS field O&M promoters could be expanded to cover watershed problems. Again, interinstitutional cooperation could support cross-training and sharing of work in the same areas.

> ***Alternative #2.*** Water quality monitoring would have a logical base at the provincial O&M centers, where portable test kits could be used for periodic monitoring and for response to calls relating to contamination concerns. Sample collection for more sophisticated analyses such as for pesticides and heavy metals could also be obtained during the promoters' regular rounds (i.e., in problem watersheds or where baseline data are desired). The equipment and monitoring plan designs are also possible alternatives under the alternative technology component.

2.9 Appropriate Technology Component

The project is planning to establish a new component in IEOS for studies of appropriate technology that may apply to technical problems encountered in past projects. A.I.D. funds ($787,000) will finance long- and short-term technical

assistance and training and operating costs for the studies. IEOS is to set up a new appropriate technology coordinating unit (UCETA) at its headquarters to work with the provincial offices in identifying priorities for investigation and follow-up studies.

Studies proposed by IEOS are subject to A.I.D. review and approval. Four tentative study subjects are identified in the project paper for budgeting purposes and possible acceptance once detailed proposals have been prepared. Two of the four emphasize water quality and sanitation. The alternative technology component can include alternatives relating to environmental monitoring for the projects.

Alternative #1. A pilot program to establish a well-designed and equipped water quality monitoring system with trained individuals (provincial O&M and construction promoters) could be part of the first two tentative studies or a study by itself. Test kits could be provided at each of the eight provincial O&M centers to analyze microbiological, physical, and chemical parameters. Sampling for pesticides and heavy metals could be part of the monitoring system designed for coordination with other laboratories (e.g., universities, National Fisheries Institute, INERHI).

Seasonal variations in water quality could be covered by an appropriate sampling program coordinated by the IEOS-National Directorate for the Environment (DNMA). Baseline data from the pilot program would serve for important comparisons over time.

The Peace Corps has proposed a study for training provincial IEOS promoters in testing water quality and obtaining important water quality survey data. This proposal could be modified to begin with a pilot study area. Monitoring could complement the first phase of the expanded O&M program, which is to perform an inventory of all water systems in the eight provinces. The initial inventory could include a water quality sampling of some systems. The first stage of the O&M component is scheduled to run from January 1990 to September 1991, which would provide ample time to design a pilot program for a viable water quality monitoring system.

Such a pilot program could begin with surface water supplies, in the eight provinces, for example, expand into the spring water supplies, and then into other provinces, particularly those concerned with the quality of surface supplies.

Alternative #2. Mining activities in the watersheds in the provinces of El Oro and Loja for over 50 years have utilized mercury in gold processing, discharging wastes into the rivers that provide water supplies downstream. Heavy metal accumulation in sediments is suspected along with biomagnification and bioaccumulation. Releases from sediment accumulations during the rainy season are also suspected.

A well-designed sampling and analyzing program in cooperation with existing labs (e.g., ESPOL, Central University) could deliver results at least cost. There is a special need to ascertain the degree of water source vulnerability to the accumulated and ongoing waste discharge in these watersheds. This alternative could be combined with the first alternative as part of the pilot program addressing surface water supplies.

2.10 Project Monitoring and Evaluation

The project calls for a contract project coordinator and three national advisors to monitor project inputs and progress. A midterm evaluation in January 1992 and a final evaluation in November 1993 will assess project performances and goal achievement at these stages.

Alternative #1. Job specifications for the four positions should require semiannual evaluations to assess the environmental sensitivity of the project. Measurement areas for these reports are recommended in Section 5.9.

Chapter 3

AFFECTED ENVIRONMENT--PROPOSED ACTIONS AND ALTERNATIVES

3.1 Project Area

The project area, covering rural communities of 300 to 2,000 people in eight provinces (see Appendix F), is principally in the central Sierra, with the exception of El Oro, which is located in the western Coastal region but also has some higher elevations--in the piedmont between the Sierra and the coast--where intensive mining activities are pursued.

In general, the population is engaged in traditional agriculture, and different provinces may have a dominant crop depending on the conditions that favor growth. For example, Carchi is predominantly a potato-growing area, while a pungent white onion is cultivated in the areas near Ambato in Tungurahua.

There is a general migration into higher elevations approaching the Ecuadorian *páramo* (3,000-4,000 m.), where water sources in the Sierra originate. The environment of the *páramo* is fragile because the shallow fertile soil cover is very susceptible to damage and erosion. Vegetation burning and traditional soil tilling and planting are changing the natural characteristics of the populated *páramo*.

3.2 Water Supply Sources

3.2.1 Spring Water

Springs are generally located at higher elevations, which helps maintain hydrostatic pressure and gravity flow. But their considerable distance from the point of distribution increases the cost of water supply.

> ***Alternative #1.*** Fencing around sources is necessary to prevent human or animal intrusion and any cultivation of the area. The fenced areas should be defined with reference to the water infiltration zones. Fencing is presently included in implementation.
>
> ***Alternative #2.*** Field distribution tanks should permit the easy removal of sediment, and, in some cases, include desanding units. Current designs now generally include this provision. Although earlier versions may not, most communities have qualified personnel who could modify a tank's structure with instructions from the IEOS engineer.
>
> ***Alternative #3.*** Additional bacteriological analyses could be performed under a monitoring plan arranged with IEOS provincial

offices or with the help of the polytechnic universities and institutions (see Section 3.4).

3.2.2 Surface Water

Surface water sources are either in the *páramo* or in the Coastal zone. The former are often in vulnerable areas of watersheds, susceptible to direct contamination from runoff, people, animals, chemicals (e.g., pesticides) and heavy metals (e.g., mercury from gold mining).

Where a surface source is the only one available, it is of critical importance that it be in a protected environment. Multiple use can change a watershed over time, with adverse effects on water quantity and quality.

Alternative #1. Fencing the area, depending on the size and nature of a given water source, would limit direct contamination by minimizing animal intrusion near the water source.

Alternative #2. Flexibility in source selection would permit the choice of a spring in a higher, protected location over a more vulnerable surface water source. The 25 to 33 percent higher construction costs to bring in spring water would be justified by eliminating the need for a surface water treatment plant, and by providing water of superior quality less vulnerable to contamination.

Alternative #3. Watershed surveys and assessments could be performed by construction module promoters during initial investigation of likely water sources. A suggested format is included in the Annexes.

Alternative #4. Modifications in the chlorination of surface water supplies, either with or without filtration plants, could be based on monitoring and observation of watershed practices.

3.2.3 Well Water

Well water sources are generally developed in the Coastal zone, where the groundwater table is high enough to allow pumping within economical limits. These areas are also heavily impacted by agricultural (e.g., banana) production and larger populations.

Alternative #1. Selection of deeper aquifers, where feasible, could replace potentially contaminated shallow aquifers and offer a greater assurance of a potable water supply.

3.3 Watershed Management

Alternative #1. A pilot watershed conservation program could be initiated in Tungurahua using interagency cross-training and shared work areas. The program would promote the protection and conservation of community watersheds through appropriate activities and education. Appendix F lists the first six communities in Tungurahua selected for the project for 1989-1990.

3.4 Water Quality Monitoring

Alternative #1. As part of a monitoring system, the operation of surface water treatment plants should be analyzed and the necessary corrective actions taken.

Students from the polytechnic universities could be employed for water quality monitoring and evaluation of treatment plants under cooperative agreements. Agreements between CARE and the University of Cuenca, and between IEOS and this university are examples. Trained students could also help train members of the communities in sampling, source protection, watershed protection, and operation and maintenance of treatment plants.

A pilot monitoring plan could consider support for the IEOS regional initiative in Azuay under the agreement with the University of Cuenca.

Alternative #2. Following the same reasoning, the environmental directorate of IEOS (DNMA) could coordinate a pilot program for monitoring surface waters, including rivers contaminated by the mines of Portovelo and Zaruma in El Oro. Heavy metals such as mercury, lead, zinc, copper, and cadmium are discharged into rivers used downstream by cities and towns such as Santa Rosa, La Avanzada, Arenillas, and Machala. A pilot program could be executed through participating agreements with ESPOL and the National Fisheries Institute, which has an agreement with PREDESUR (Program for the Development of the Provinces of the South) to monitor the rivers in Loja for the presence of heavy metals and pesticides.

If dangerous levels of these contaminants are found, actions to involve other universities or government institutions with the necessary equipment and laboratories can be considered.

3.5 Latrines

Alternative #1. Studies of subsurface stability, soil permeability, and groundwater level are essential and could be carried out by the IEOS provincial offices in their respective zones.

Alternative #2. Replacing cement latrines with ceramic latrines would apply countrywide.

Alternative #3. The option of dry latrines will affect communities in the Coastal zone. This is a subject for an appropriate technology study of the use of local materials such as sawdust and rice bark.

3.6 Drainage Management

Alternative #1. Water accumulations to be drained by small drainage measures undertaken during water system construction typically would be found within a community. The affected environment would be in the immediate vicinity of dwellings and the downstream natural drainage courses to which the water would be diverted.

The Coastal zone, which lacks gradients, may need more advanced drainage systems. Alternatives to be studied in the appropriate technology component will need to address the problem of poor drainage in the Coastal zone.

3.7 Training and Hygiene Education Components

Alternative #1. These components could help the other environment-oriented pilot programs and foster interagency cooperation and cross-training. This recommendation applies to the pilot project areas for watershed conservation promotion and water quality monitoring. Also to be affected are the agencies (GOE, NGO, PVO) that can provide program materials, cross-training and shared work areas to establish complementary approaches whenever possible. The training and hygiene education activities would assist the construction module and O&M promoters to perform initial watershed surveys and assessments during system inventories and regular promotion work.

3.8 Operation and Maintenance Component

Alternative #1. Watershed surveys and assessments by O&M promoters in the eight project provinces would be performed at the same time as the water system inventories already planned. The surveys and assessments would pertain to existing conditions in the watersheds (sample formats are provided in the Annexes).

Alternative #2. Water quality monitoring and testing by O&M promoters, who need training and equipment, could be limited to a pilot program for surface water supplies.

3.9 Appropriate Technology Component

Alternative #1. Under a pilot program to design, equip, and coordinate a water quality monitoring system headed by DNMA-IEOS, O&M promoters could be trained to perform field tests and to collect samples for tests for heavy metals and pesticides by cooperating laboratories per the monitoring system design.

Also, the Peace Corps can be involved in the training and surveys needed to establish the pilot program in the eight project provinces, covering surface water supplies initially.

As mentioned in Section 3.2.2, Surface Water, bacteriological monitoring can determine whether chlorine for disinfection of water supplies is justified. Monitoring together with watershed observation and assessment for multiple use impacts can provide a rational basis for chlorine use.

Alternative #2. The evaluation of heavy metal contamination in the watersheds of El Oro and Loja would be limited to water sources serving vulnerable communities. Sediment samples as well as seasonal water sampling are necessary.

3.10 Project Monitoring and Evaluation

Alternative #1. The annual evaluation by the four project managers would be based on measurements of progress in certain environmental orientations in all the eight provinces.

Chapter 4

ENVIRONMENTAL CONSEQUENCES

The following outline of the positive and negative aspects of the proposed actions and the alternatives suggested takes into account the variety of factors mentioned in 22CFR Part 216 to allow considerations of the environmental impacts of these actions and alternatives. No duplication is intended from Section 3, where the reader may find more information on each proposed action and alternative, especially of the project components. The direct and indirect effects have been considered along with possible conflicts, conservation potential, and mitigation measures.

4.1 Water Supply Sources

4.1.1 Spring Water

The project as proposed gives priority to spring water as the main water source, according to standard norms and criteria.

POSITIVE ASPECTS:

1. Project feasibility is established according to standard norms.
2. Usually water of very good quality is provided.
3. Spring water intakes are generally easier and more economical to build.

NEGATIVE ASPECTS:

1. Some springs cannot be used because they are too far away.
2. Costs may increase because of long pipelines.

Alternative #1. Provide fencing protection near the source.

POSITIVE ASPECTS:

1. Helps to prevent contamination.
2. Promotes conservation of water resource by the community.
3. Helps to maintain the longevity of the source.
4. Is included in some projects.

NEGATIVE ASPECTS:

1. Costs may increase for water from a distant spring.

2. Community access to the spring may be more difficult.

Alternative #2. Collect and clean sediment in collection and distribution tanks.

POSITIVE ASPECTS:

1. Improves the quality of water delivered by the system.

2. Improves operation.

3. Helps to maintain the system.

4. Is included in some designs.

NEGATIVE ASPECTS:

1. May increase costs.

2. Tanks may not be built according to appropriate design.

Alternative #3. Conduct bacteriological analyses at universities and government institutions.

POSITIVE ASPECTS:

1. Improves monitoring to protect the quality of water.

2. Helps to preserve the health of the community.

3. Optimizes institutional human and financial resources.

4. Makes cost savings possible.

5. Regulates the use of chlorine.

NEGATIVE ASPECTS:

1. Additional costs may be needed for equipment.

2. Additional training is needed for field promoters.

4.1.2 Surface Water

Surface water sources are accepted when necessary, based on standardized norms and criteria.

POSITIVE ASPECTS:

1. Some water quality parameters checked for degree of water quality.
2. Water quantity usually greater if surface streams are combined.
3. Construction costs may be lower than costs needed to reach spring water.

NEGATIVE ASPECTS:

1. Water quality highly vulnerable to contamination.
2. Filtration treatment is usually needed.
3. Operational difficulty may be high with a treatment plant.
4. Chlorination safeguarding may not be adequate because of contaminants (e.g., pesticides) in water.

Alternative #1. Protect water source with fencing where feasible.

POSITIVE ASPECTS:

1. Prevents animals and people from directly contaminating water source.
2. Important first step in community promotion of water source protection.
3. Strategic fencing could be effective and economical.
4. Is included in some project designs.

NEGATIVE ASPECTS:

1. Additional cost of materials and work to a project or the community.
2. Area to be protected may be too large for effective fencing.

Alternative #2. Allow 25-33 percent higher construction cost to justify spring water source instead of surface water source and treatment plant whenever possible.

POSITIVE ASPECTS:

1. Eventual failure of treatment plant could be avoided.

2. Good quality water less likely to be contaminated is provided over a longer time.

3. Fewer operational headaches for communities and IEOS.

4. Greater security of initial investment over the life of the project.

NEGATIVE ASPECTS:

1. Higher costs may eliminate water system construction in other projects.

2. Spring water may not exist in the area.

Alternative #3. Have construction promoters conduct watershed surveys and assessments during initial community selection studies.

POSITIVE ASPECTS:

1. Provides important baseline information of existing watershed conditions and uses.

2. Can be used as basis for watershed conservation promotion in conjunction with water source development.

3. Can foster conservation and preservation of water sources in properly managed watersheds.

4. Makes promotion possible when community motivation to establish a water system is highest.

NEGATIVE ASPECTS:

1. Implies need for pilot approach because of cost constraints in program to provide necessary training and education for promoters and communities.

2. Interinstitutional cross-training and shared work areas may be difficult to achieve.

3. Long-term efforts of conservation practices sometimes needed to see results.

Alternative #4. Modify chlorine practice for surface waters.

POSITIVE ASPECTS:

1. May prevent toxic combinations of pesticides and chlorine in contaminated water.

2. High cost of chlorine prohibitive for some communities.

3. Could be based on periodic monitoring.

NEGATIVE ASPECTS:

1. Bacteriological disinfection may be neglected.

2. Could be wrongly interpreted by other communities to apply to their system too.

3. Changes over time may lower chlorine cost but the practice once modified may be difficult to re-establish.

4.1.3 Well Water

Wells are provided per standard criteria when deemed to be the best source.

POSITIVE ASPECTS:

1. May represent only feasible water source.

2. Water quality may be adequate at present.

3. Project costs are held as low as possible.

NEGATIVE ASPECTS:

1. Shallow aquifers may quickly become contaminated.

2. Many adverse environmental impacts (e.g., pesticides, human wastes) affecting groundwater quality in the Coastal zone.

Alternative #1. Drill wells to reach deeper groundwater of better quality, if feasible, to avoid potentially contaminated shallow aquifers.

POSITIVE ASPECTS:

1. Bypasses contamination in shallow aquifers.

2. Ensures a potable water supply over life of project.

3. May not increase pumping costs.

NEGATIVE ASPECTS:

1. Deeper drilling may not be feasible because of salt water intrusion in areas closer to the ocean.

2. Higher project costs.

3. May increase pumping costs if artesian pressure is not present.

4.2 Watershed Management

Currently, there are no promotion or activities for water source preservation through watershed conservation in projects.

POSITIVE ASPECTS:

1. Project costs not affected.

2. Expertise not available for this kind of project (i.e., IEOS)

3. Too broad a scope for project places the health-related goals of the project in jeopardy.

NEGATIVE ASPECTS:

1. Deterioration of watershed may imperil longevity of water sources.

2. Water quality delivered through projects may be compromised.

3. Potential for interinstitutional work in shared locations not taken advantage of.

Alternative #1. Pilot program to promote watershed conservation for longevity and purity of water.

POSITIVE ASPECTS:

1. Likely success of pilot approach.

2. Fosters interinstitutional cooperation in shared work areas.

3. Motivates promoters of different agencies (e.g., CARE, IEOS) to complement each other's work.

4. Longevity of supply and preservation of water supply enhanced for the pilot area.

5. Possible expansion into other project areas.

NEGATIVE ASPECTS:

1. Commitment of some training and education resources needed to help establish the program.

2. Interagency coordination may be difficult.

3. Long-term efforts in some conservation methods may be needed to produce results.

4. May be difficult to expand outside of pilot area.

4.3 Monitoring Quality of Water

Some physical, chemical, and bacteriological analyses are being performed, according to IEOS. There is no monitoring after the construction is completed.

POSITIVE ASPECTS:

1. Some types of analyses are being programmed.

2. DNMA could implement a monitoring system.

NEGATIVE ASPECTS:

1. There is no monitoring of completed constructions.

2. There is no institutional support for DNMA.

3. Many treatment plants are not working as designed.

4. The health of the community is potentially affected by poor water quality.

Alternative #1. Evaluation of all treatment plants and implementation of a water quality monitoring program under agreements with universities, with a pilot agreement between IEOS and the University of Cuenca, Azuay.

POSITIVE ASPECTS:

1. Could investigate the operational status of treatment plants.

2. Would determine the quality of water being provided.

3. Could help to make necessary adjustments according to needs.

4. Could include training of operators and community water *juntas*.

5. Would optimize institutional cooperation.

6. Would help to preserve the health of the community by maintaining water quality.

NEGATIVE ASPECTS:

1. Project costs may increase depending on type of program.

2. Coordination efforts could fail.

Alternative #2. Program to monitor heavy metals and pesticides, headed by DNMA with the participation of public institutions and universities. Pilot plan in the rivers of El Oro under an agreement between IEOS-ESPOL and/or National Fisheries Institute.

POSITIVE ASPECTS:

1. Would investigate the degree of danger present from heavy metals pollution.

2. Can lead to actions to protect the quality of water for systems.

3. Results would help future studies and designs.

4. Could prevent further pollution.

5. Could establish a standard for optimizing financial resources and interinstitutional cooperation.

NEGATIVE ASPECTS:

1. Project costs may increase depending on nature of program.

2. Interagency cooperation may be difficult.

3. Positive steps to curtail pollution may be difficult.

4.4 Latrines

Project design gives priority to cement latrines with hydraulic seals and partial provision of materials for latrine-houses. Use of traditional latrines in the Coastal zone will be analyzed through the appropriate technology component.

POSITIVE ASPECTS:

1. Cement latrines with hydraulic seals do function.

2. Low costs.

3. Does not support paternalism within the communities.

4. The appropriate technology component may suggest a solution to the problem in the Coastal zone.

NEGATIVE ASPECTS:

1. Materials for the cement latrine wear down. Latrine begins to retain organic material and bad odors and is rejected by users.

2. Cement latrines are not well-accepted.

3. There is no alternative for the coast; therefore the program is not totally implemented.

Alternative #1. Perform studies of soil stability and permeability and groundwater level.

POSITIVE ASPECTS:

1. Could improve implementation of latrine program.

2. Could save work and investment losses due to failure of latrines.

3. Limits contamination.

4. Enhances user acceptance.

NEGATIVE ASPECTS:

1. Some project manpower would be needed.

2. May delay latrine installation.

Alternative #2. Priority on substituting ceramic for cement type.

POSITIVE ASPECTS:

1. Avoids bad odors, mosquitoes, and contamination.

2. Cleaner and safer.

3. Greater acceptance by the community.

NEGATIVE ASPECTS:

1. Project costs will increase.

2. Careful installation needed.

Alternative #3. Where groundwater levels are high, provide dry latrines with elevated chambers.

POSITIVE ASPECTS:

1. Avoids contamination.

2. Permits compost production.

3. Latrines could be used in high groundwater zones.

4. Appropriate technology study may find ways to reduce costs.

NEGATIVE ASPECTS:

1. Increased costs to build this type of latrine.

2. More maintenance work required to function.

3. Requires additional training.

4.5 Drainage Management

Project design calls for small drainage pits near community dwellings.

POSITIVE ASPECTS:

1. Pits do dispose of discarded water effectively and correct standing water problems.

2. Standard community promotion does include education material to encourage building of pits.

NEGATIVE ASPECTS:

1. Community motivation to perform ancillary tasks like drainage pit construction drops after a water system has been provided. In addition, promotion work typically moves on to the next community. In practice, few drainage pits are installed.

2. Lack of pits near dwellings can result in accumulations in natural depressions, ditches along roads, etc., causing contamination, breeding of disease vectors, and other nuisances.

Alternative #1. Small drainage measures undertaken during water system construction.

POSITIVE ASPECTS:

1. Timing this work when motivation is high is far better than attempting it after a water system has been installed. Individual home drainage pits can also be included in water system work, even to the point of making this a prerequisite to receiving the family tap or well.

2. Some drainage materials, e.g., 12" to 18" metal culverts or 6" diameter PVC pipe, could be provided from the contingency allowance for each project.

3. Engineering and promoter expertise available during design and construction can be used for simple drainage measures to

minimize ponding areas. Simple cross-ditching with tubing will be sufficient in many instances.

NEGATIVE ASPECTS:

1. Material and labor costs for some communities may exceed the budget.

2. Downstream impacts of improved drainage are believed to be minimal.

4.6 Training and Hygiene Education Components

Expansion of the training and hygiene education components will enable more direct contacts in the communities for hygiene and health and operation and maintenance. Many innovations will be possible during the life of the project through training programs prepared annually by IEOS. Promoters will have more time to spend in fewer communities because of greater personnel and logistic support.

POSITIVE ASPECTS:

1. Greater likelihood for health program to achieve goals.

2. More community contact to be provided.

3. Annual training plans can adjust to needs.

4. All project components to receive increased training and hygiene education input.

5. Women health promoters to work in hygiene program.

NEGATIVE ASPECTS:

1. No definite environmental concerns identified in the project paper.

2. The large monetary commitment will require close monitoring to prevent waste.

Alternative #1. Utilize training and hygiene education components to help other environment-oriented pilot programs and foster interagency cooperation and cross-training.

POSITIVE ASPECTS:

1. Will provide the funding, flexibility, and opportunity to address environmental concerns.

2. Many other agencies (GOE, NGO, PVO) have good models and program materials and the motivation to share training and hygiene education in environmental areas.

3. Pilot programs are likely to succeed.

4. Annual training plans can adjust to needs.

NEGATIVE ASPECTS:

1. Will require resource commitment from the training and hygiene education components.

2. Interagency coordination may be difficult.

3. May be difficult to expand work beyond pilot programs.

4.7 Operation and Maintenance Component

Project design expands O&M component to build up personnel and equipment at provincial O&M centers. More O&M promoters working in fewer communities will be more effective.

POSITIVE ASPECTS:

1. Greater community contact.

2. Closer monitoring of water system functioning.

3. Improved response to O&M problems.

4. Improved logistical, equipment support.

5. Will complement work of the hygiene/health promoter.

NEGATIVE ASPECTS:

1. No orientation towards environmental concerns mentioned in the project paper.

2. Will require training to address environmental concerns (e.g., watershed conservation promotion).

3. No laboratory equipment planned for water monitoring.

Alternatives #1 & 2. Watershed surveys and assessments to be performed during system inventories in the eight project provinces. Possible equipping of O&M promoters with field lab kits.

POSITIVE ASPECTS:

1. Surveys and assessments can be coordinated with regular water system inventories.

2. Important baseline data can be obtained for future water source/watershed conservation and preservation promotions.

3. Water monitoring plan could be designed to train and equip O&M promoters to perform tests and collect samples for tests run by others.

NEGATIVE ASPECTS:

1. Some training will be needed to ensure watershed surveys and assessments are performed correctly.

2. Maintenance of field lab kits would require annual supply of materials for tests.

3. Follow-up after surveys will be required to address watershed problems and promote appropriate activities.

4.8 Appropriate Technology Component

Investigations of appropriate technology alternatives to serve project needs are planned.

POSITIVE ASPECTS:

1. Four studies have been proposed to cover a wide range of criteria for water system and sanitation projects. Included in these is one on water quality.

2. The appropriate technology component has the flexibility to include other environmental concerns.

3. A.I.D. will review and approve the required detailed proposals to be prepared by IEOS.

NEGATIVE ASPECTS:

1. A specific study of environmental concerns such as water monitoring is not part of the project paper.

2. Studies not relevant to project impacts and needs have been proposed in addition to the four mentioned in the project paper. Elaborate studies with no direct significance must be avoided.

Alternative #1. Pilot program to design, equip, and coordinate a water quality monitoring system headed by IEOS-DNMA.

POSITIVE ASPECTS:

1. DNMA would gain support for a more active role in environmental monitoring.

2. Water monitoring field test kits could be provided to provincial O&M centers along with training to establish a periodic testing/sampling plan.

3. Arrangements could be made with other laboratories for the analysis of samples containing pesticides and heavy metals.

4. Other agencies such as the Peace Corps could participate in establishing a pilot program for water quality monitoring in the project's eight provinces.

5. Initial inventories of water systems could begin monitoring all surface water supplies as a first priority.

6. Chlorination practice can be modified based on bacteriological monitoring results.

NEGATIVE ASPECTS:

1. Funds, training, and materials will be needed from the applied technology component.

2. DNMA will need IEOS support to function.

3. Laboratory test kits will need annual replenishment of supplies.

4. Expansion of the pilot program to other provinces may be difficult.

Alternative #2. Heavy-metal contamination study in the watersheds of El Oro and Loja.

POSITIVE ASPECTS:

1. There is immediate need to determine the degree of contamination by heavy metals in rivers that supply drinking water.

2. Coordination between DNMA-IEOS and other labs, e.g., ESPOCH, ESPOL, National Fisheries Institute, is possible.

3. Sediment studies could identify the seasonal danger of heavy-metal releases into water supplies.

4. This study could be the first step for DNMA to establish the pilot program for water quality monitoring mentioned in alternative #1.

NEGATIVE ASPECTS.

1. An immediate commitment of applied technology resources will be needed.

2. Institutional support for the DNMA is inadequate.

3. Results may indicate the need for a more elaborate study.

4.9 Project Monitoring and Evaluation

Project design calls for midterm and final evaluations, along with regular progress monitoring, by the project coordinator and three national advisors.

POSITIVE ASPECTS:

1. Regular progress monitoring is planned with emphasis on project outputs.

2. Contract evaluations will be very thorough.

NEGATIVE ASPECTS:

1. No monitoring for environmental sensitivity of the project is planned.

2. Evaluations are too far apart to provide annual guidance during the project.

Alternative #1. Semiannual evaluations of the environmental sensitivity of the project provided by the project coordinator and three national advisors.

POSITIVE ASPECTS:

1. A list of 13 areas of environmental sensitivity is suggested as a basis of measurement (see Section 5.9).

2. Semiannual reports can offer guidance for reviews of IEOS annual work plans.

3. Evaluations can serve as reminders to the four project managers to emphasize environmental concerns during each year of the project.

NEGATIVE ASPECTS:

1. Lack of commitment by IEOS to support environmental concerns may hinder success in this area. This particularly pertains to IEOS's support for DNMA.

2. Lack of emphasis by the four project managers may weaken the push for environmental concerns in the project.

Chapter 5

RECOMMENDATIONS

The following recommendations are intended to enhance sensitivity towards environmental concerns associated with RWS&S systems under the WASHED Project.

5.1 Water Supply Sources

5.1.1 Spring Water

1. Fencing discourages cultivation in the spring area and protects the area against chemical contamination. It shows the community the importance of source protection. If provided by the project, fencing should cost about $500 for each site. Communities may be able to provide local materials for less. Fencing is currently included in project implementation and should be encouraged.

2. Collection and distribution tanks with drainage, if properly designed, can be used to collect and dispose of sediment. Current construction incorporates this practice. Tank design should continue to facilitate maintenance of systems through this feature.

3. Bacteriological analyses of water sources are part of current project implementation and are essential before designs are prepared. Results can help modify the water treatment provided and have a direct effect on water quality and the health of the community. The project should continue to promote bacteriological as well as heavy metal and pesticide analyses as part of the system selection process.

5.1.2 Surface Water

1. The project should continue to require fencing of water sources when feasible. A successful example is the IEOS-CARE system at Cuenca in Azuay.

   Costs will vary with the location and the materials used. For example, barbed wire fencing provided to a community would cost about $500. Local materials will cost less.

2. The 25 to 33 percent higher construction cost for utilizing a spring, if available, in lieu of a surface water source with filtration plant should be seriously considered. In the long term, the added expense will be repaid by the avoidance of

operation problems, better water quality, and less likelihood of contamination.

3. Construction module promoters should be required to perform a survey and assessment of the conditions in the watershed where proposed water sources originate, using formats provided in the Annexes. The data can be used to plan community promotion activities for watershed problems. This work can be carried on by the O&M promoters after system construction (see Section 5.7).

4. The project should base the promotion of chlorine use on bacteriological monitoring and observation of watershed conditions. A pilot program to establish a monitoring plan is described in Section 5.8. Nonuse of chlorine should be considered in systems where contamination potential from pesticides is high, e.g., in Carchi, where potato cultivation entails heavy pesticide use. Communities should be encouraged to arrange chlorine purchases through their provincial council to reduce costs.

5.1.3 Well Water

1. The design criteria for wells should consider the feasibility of seeking deeper aquifers, if they have water of good quality, to avoid shallow (less than 30 meters) groundwater with a high potential for contamination. This applies principally to the Coastal zone, where contamination occurs because of agriculture and population pressure.

5.2 Watershed Management

1. A pilot program should be established in Tungurahua to promote community awareness and activities directed toward watershed conservation and protection. The training and hygiene education components can provide needed input as well as coordination with other institutions. CARE has established a model soil conservation and reforestation program covering over 250 ha. near Ambato, and the promoters for CARE as well as IEOS have expressed great interest in working together in common areas. This work should include the rational use of pesticides and of natural alternatives.

5.3 Water Quality Monitoring

1. An inventory and evaluation of the constructed systems should be performed as part of the water quality monitoring program, with emphasis on surface water treatment plants. This will require the analyses of samples taken from different parts of the system at different times of the year. Cooperative agreements with the universities can be arranged. A starting point could be a pilot project in Azuay under an agreement between IEOS provincial offices and the University of Cuenca (Faculty of Engineering).

Several discussions have already been held between A.I.D. and the university.

2. In the mining zones of the country, heavy metals are discharged into the rivers used downstream for water supplies.

Through the appropriate technology component and agreements with public and educational institutions, a water quality and pollutants monitoring program coordinated by DNMA should be considered. The starting point could be a pilot project to monitor the rivers in El Oro, implemented with the Coastal Polytechnical University or the National Fisheries Institute. The institute has an agreement with PREDESUR with similar objectives.

This monitoring program should support corrective actions, where possible, and the development of norms and tolerance ranges, and should provide data for future studies and projects.

5.4 Latrines

1. Soil stability and permeability studies are essential in the areas where latrines will be built, especially in the high groundwater levels of the Coastal region. Small studies following IEOS norms can be carried out by IEOS staff with the support of university students.

This preliminary work will save labor and investments losses from latrine failures caused by collapsing walls, lack of soil filtration, and high groundwater levels that contribute to contamination.

2. The cement latrine should be considered for replacement by the ceramic type with hydraulic seal. The degradation of cement causes the retention of organic material, offensive odors, and mosquito breeding, and results in rejection of the latrine by users.

This change is affordable and will overcome resistance to latrine use.

3. In the Coastal region, where the groundwater level is high, elevated dry latrines with two chambers will prevent contamination and permit compost production if sawdust or rice bark is used instead of water. This is a study area for the appropriate technology component.

5.5 Drainage Management

1. Low-cost drainage improvements within communities to eliminate pools of standing water should be included in the work of IEOS engineers and promoters. The costs of needed materials such as small culverts or pipe should be met from project contingency funds. This work should be undertaken during water system construction, when community motivation is high. Also, each family should be required to provide its own absorption pit for used water as a condition for being given a water tap. (This also can be promoted during system construction.)

5.6 Training and Hygiene Education Components

1. The project should include inputs from the training and hygiene education components to the following pilot programs:

   - Watershed conservation (see Section 5.2)
   - Watershed surveys and assessments (see Sections 5.1.2.3 and 5.7.1)
   - Water quality monitoring (see Sections 5.3.1, 5.3.2, 5.7.2, and 5.8.1)

These inputs should coordinate interinstitutional use of materials and expertise whenever possible. Other agencies (e.g., CARE, Peace Corps, National Fisheries Institute, various universities, Fundación Natura) have expressed interest in a combined approach to environmental problems and education.

5.7 Operation and Maintenance Component

1. The O&M promoters to be placed at the eight new provincial O&M centers should also be trained in watershed surveys and assessments, using the formats included in the Annexes. They should perform these assessments on the existing water systems, complementing the surveys and assessments of the new water systems by the construction promoters.

   The project design calls for a complete initial inventory of all existing water systems within the eight project provinces, providing an ideal opportunity for the surveys and assessments to be performed at the same time. A database can be obtained to guide future promotion and activities relating to water source protection and watershed conservation, especially as an outgrowth of the pilot program recommended in Tungurahua.

2. Water quality monitoring should have a logical base at the provincial O&M centers. Kits could be used for periodic bacteriological testing of samples from the systems. A pilot approach should provide each center with test kits to periodically monitor surface water systems. There is already some effort in this direction but improvement is needed.

   The costs to provide these test kits could be better defined through a small study under the appropriate technology component, but are unlikely to exceed $30-50,000 including sampling and testing for pesticides and heavy metals at other labs during the four project years.

   Surface systems are a small proportion of the total number of existing systems but are the most vulnerable to contamination. Training in testing can be a part of the training and hygiene education components, and equipment can be provided by the appropriate technology component. Surface water monitoring should be part of the water quality monitoring

plan recommended to be developed by the DNMA-IEOS(Section 5.8). This will also include the collection of samples for pesticide and heavy metal analyses coordinated with other labs (see Appendix D). Chlorination practice can be adjusted according to monitoring results and observation of watershed conditions.

5.8 Appropriate Technology Component

1. This component should provide a detailed proposal for a pilot water quality monitoring plan for the eight project provinces. Appropriate test kits should be provided at the provincial O&M centers. The regular water quality analyses performed by IEOS during water source investigation should be combined with periodic monitoring of the systems, particularly the surface water systems. The DNMA-IEOS should be the chief coordinator for the design and implementation of the plan and should be assured of adequate institutional support.

   The pilot plan should arrange for interinstitutional laboratory analyses for pesticides and heavy metals where deemed appropriate. The applied technology component should not finance new laboratories when existing institutions can provide testing services at nominal costs. (See Appendix D for recommended institutions.)

   The Peace Corps has expressed a strong interest in participating in the pilot plan, and could also assist with education, training, assessments, and promotion. (See Section 5.11 for recommendations for Peace Corps involvement.)

5.9 Project Monitoring and Evaluation

1. The job specifications for the project coordinator and the three national advisors should require a semiannual evaluation of the environmental sensitivity of the WASHED Project covering the following areas:

   - Water source fencing by communities per their agreements with IEOS.
   - Progress in establishing a pilot plan for a well-designed water quality monitoring program of surface water supplies in the eight project provinces. This should include interagency (GOE, NGO, PVO, university) activities.
   - Progress in determining the degree of hazardous metals contamination in the watersheds feeding the rivers that provide drinking water in El Oro and Loja.
   - Progress in the watershed surveys and assessments under the system inventories to be performed by O&M promoters.

- Progress in the watershed surveys and assessments of new water systems by construction promoters.

- Progress in the pilot watershed conservation promotion program with participation of the training and hygiene education components, and in interinstitutional cross-training in shared work areas. This should include the use of pesticides and natural alternatives.

- Status of chlorination practices, particularly in surface water systems, based on monitoring of water quality and observation of watershed uses. Extent of provincial council assistance in chlorine purchases.

- In the Coastal region, choice of deeper in place of contaminated shallow aquifers. Also, water quality monitoring of well water.

- Progress of small-scale drainage measures to eliminate standing water undertaken during system construction.

- Design selection flexibility allowing 25 to 33 percent higher construction costs if spring water systems, instead of surface water systems with treatment plants, can be built.

- Provision of ceramic in place of cement latrines.

- Annual reports by IEOS-DNMA of work accomplished, in progress, or planned.

- Appropriate technology studies of environmental problems accomplished, in progress, or proposed.

5.10 Job Specifications for Project Coordinator and Three National Advisors

5.10.1 Project Coordinator

Contract Period: 4 years.

1. Coordinate and help prepare the semiannual evaluations of the environmental sensitivity of the project per the 13 measurement areas listed in Section 5.9 of the A.I.D.-WASHED-EA Report, August 1989.

2. Coordinate the recommended pilot programs for water quality monitoring, watershed conservation, and watershed surveys and assessments by the construction module and O&M promoters. This will require a partial dedication of the training, hygiene education and appropriate technology components and project advisors in these areas.

3. Work with IEOS to ensure that DNMA-IEOS receives the institutional support necessary to function in its intended capacity and to effectively coordinate the pilot monitoring program recommended in Section 5.8.

4. Promote involvement of the Peace Corps, Fundación Natura, CARE, and other organizations in work at shared locations, cross-training, and program materials as these relate to environmental concerns.

5.10.2 National Advisor--Construction

Contract Period: 4 years.

1. Assist in the preparation of the semiannual evaluations of the environmental sensitivity of the project per the 13 measurement areas listed in Section 5.9. of the A.I.D.-WASHED-EA Report, August 1989.

2. Coordinate inputs from the training and hygiene education components to the watershed surveys and assessments by the construction module promoters.

3. Assist in the establishment of the pilot program for water source protection and watershed conservation in Tungurahua with help from the training and hygiene education components. Coordinate interinstitutional cross-training (e.g., CARE, Peace Corps, MAG).

5.10.3 National Advisor--Operation and Maintenance and Appropriate Technology

Contract Period: 3 years

1. Assist in the preparation of the semiannual evaluations of the environmental sensitivity of the project per the 13 measurement areas listed in Section 5.9. of the A.I.D.-WASHED-EA Report, August 1989.

2. Coordinate the establishment of the pilot program for water quality monitoring to be designed by DNMA-IEOS, and encourage IEOS institutional support necessary for DNMA to effectively carry out this program. (See guidelines provided in Sections 5.3 and 5.8 of the A.I.D.-WASHED-EA Report, August 1989..

3. Coordinate inputs from the training and hygiene education components to the watershed surveys and assessments by the O&M promoters. (See guidelines provided in Section 5.7 of the A.I.D.-WASHED-EA Report, August 1989.

5.10.4 National Advisor--Hygiene

Contract Period: 2 years

1. Assist in the preparation of the semiannual evaluations of the environmental sensitivity of the project per the 13 measurement areas listed in Section 5.9 of the A.I.D.-WASHED-EA Report, August 1989.

2. Coordinate the input of the hygiene education component to the pilot program for watershed protection and preservation. Assist in environmental education cross-training with other institutions to support other program work.

3. Seek cross-training and program materials relating to the rational use and safety aspects of pesticides. This will require coordination with the Peace Corps, CARE, MAG, et al.

5.11 Peace Corps Involvement

Possible areas of involvement for the Peace Corps are suggested below. They are not mandatory and are merely suggested for consideration.

5.11.1 Construction Module Component

- Watershed surveys and assessments where water sources are under investigation by IEOS for new projects. Skills needed would relate to soil conservation, natural resources, agroforestry, and environmental engineering.

- Testing for bacteriological water quality. Skills needed would relate to microbiology, sanitary engineering, and chemistry.

5.11.2 Operation and Maintenance Component

- Watershed surveys and assessments of existing systems in the eight provinces as part of IEOS inventories. Skills needed would relate to soil conservation, natural resources, agroforestry, and environmental engineering.

- Helping establish the pilot water quality monitoring system to be coordinated by DNMA-IEOS. Skills needed would be in microbiology, chemistry, sanitary engineering, and training.

5.11.3 Hygiene Education Component

- Education/promotion in the rational uses and safety aspects of pesticides. The Peace Corps and CARE have excellent program materials in this area. Skills needed would relate

to natural resources, education, and health or environmental engineering.

5.11.4 Appropriate Technology Component

- Planning and design of the pilot water quality monitoring program to be coordinated by DNMA-IEOS. Skills needed will be in microbiology, chemistry, and sanitary engineering.

- Evaluation of mining pollution in El Oro. Skills needed would be in environmental engineering, biology, chemistry, and health.

5.11.5 Training

- Watershed conservation pilot program in Tungurahua. Skills needed would be in natural resources, agroforestry, soil conservation, and agricultural engineering.

- Education of IEOS construction module and O&M promoters in performing watershed surveys and assessments. Same skills as above.

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APPENDICES

APPENDIX A

Contacts

APPENDIX A

Contacts

NATIONAL INSTITUTE OF SANITARY WORKS (IEOS)

- Ing. Marco Murillo, Assistant to the Secretary of Environment Sanitation, Quito
- Ing. Marcelo Piedra, Planning National Director, Quito
- Dr. Josè Augusto Rosero, National Director of Environment Quito.
- Ing. Mònica Brito, Toxic Substances Specialist, Quito
- Ing. Patricio Sacoto, Solid Waste Specialist, Quito
- Ing. Olga Fubkova, Air Pollution Specialist, Quito
- Arq. Guillermo Cordero Ortiz, Head of the Province of Azuay
- Ing. Carlos Orozco Solano, Head of the Province of El Oro
- Ing. Iràn Maldonado, Engineer, Riobamba
- Nelson Barragan, Promoter, Tungurahua
- Ing. Xavier Capelo H., Construction Coordinator, Cuenca, Azuay

NATIONAL INSTITUTE OF HYDROLOGIC RESOURCES (INERHI)

- Dr. Hernàn Riofrìo C., Lab Chief, Quito
- Dr. Rafael Armijos, Water Administration Director, Quito.

C A R E

- Dale Harrison, National Director, Quito
- Ron Savage, Director of the Soil Preservation Program, Ambato
- Ing. Hèctor H. Villagràn V., Specialist in the Rational Use of Pesticides, Ambato
- Ing. Joseph Narkevic, Coordinator, Cuenca

- Washington Chapabay, Promoter, Provinces of Cotopaxi and Tungurahua

MINISTRY OF AGRICULTURE

- Ing. Oscar L. Montesdeoca, Chief of the Soil Preservation Division, Quito
- Dr. Luis Arriga, Program and Coast Resources Director, Guayaquil

MINISTRY OF ENERGY AND MINES

- Ing. Nelson Suquilanda Duque, General Director of Environment, Quito

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT, QUITO

- Dr. William Goldman, Chief of the Health Division
- Dr. Fausto Maldonado, Programs, Agriculture and Natural Resources Specialist, Deputy Mission Environmental Officer.
- Dr. Howard Clark, Regional Advisor for Environment Sanitation, South America
- Ing. Jorge Castillo, AID/IEOS, Quito
- Dr. Fernando Ortiz, Agriculture Specialist
- Maria Rivadeneira, Program and Project Development
- Jim Stine, Housing
- Bill Smith, Mission Deputy Director
- Kate Jones-Patron, FHD Deputy
- Bob Mowbry, Chief of Environment Division

FUNDACION NATURA

- Marco Encalada, Executive Director, Quito

NATIONAL FISHERIES INSTITUTE

- Econ. Maria Luisa Jimènez de Cruz, Director, Guayaquil

UNIVERSITY OF CUENCA--FACULTY OF ENGINEERING

- Ing. Marcelo Cabrera Palacios, Dean, Cuenca

NATIONAL ELECTRIFICATION INSTITUTE--Management Unit for the Rio Paute Watershed

- Ing. Florencia Calle Vàsquez, Coordinator, Cuenca

POLYTECHNICAL UNIVERSITY OF CHIMBORAZO (ESPOCH)--Riobamba

- Ing. Bayardo Ulloa, Dean of the Faculty of Agronomy Engineering, Riobamba.

POLYTECHNICAL UNIVERSITY OF THE COAST--Guayaquil

- Ing. Mariano Montaño--Professor and Lab Coordinator
- Ing. David Choes, Chief of the Instrumental Lab

TECHNICAL UNIVERSITY OF MACHALA--Faculty of Chemistry Sciences--Machala

- Dr. Josè Campoverde, Dean
- Ing. Lenin Gordillo, Assistant to the Dean

U.S. PEACE CORPS--ECUADOR

- Jeff Baukin, Training Officer
- Dr. and Mrs. David Auker, Peace Corps Volunteers

APPENDIX B

Field Visits and Interview Summaries

APPENDIX B

Field Visits and Interview Summaries

NOTE: The following summaries are provided to communicate the environmental concerns discussed in this study. It is hoped this information will also facilitate future environment-oriented work involving the USAID Mission by passing along facts learned from various sources. There is a diverse database relating to the environment which makes discovery of data sources and of conclusive evidence difficult. Nonetheless, the information provided herein should give the reader some salient facts and provide some direction for further information if desired.

INTERVIEW SUMMARIES

Dr. Fausto Maldonado, Deputy Mission Environmental Officer, USAID, Quito, Ecuador.

During discussions at the USAID Office in Quito, Dr. Maldonado highlighted many of the known environmental problems in Ecuador, as well as those associated with the WASHED-IEOS water and sanitation projects. In Carchi, for example, WASHED-IEOS water systems are planned in areas presumably vulnerable to pesticide contamination. Many private and governmental agencies are working on problems such as hazardous wastes from mining operations, particularly mercury, and the use of pesticides both in the Coastal zone and in the Sierra. As a founding member of the Fundaciòn Natura (see interview summary), Dr. Maldonado is very aware of the importance of education.

Problems associated with pesticides are exacerbated by uncontrolled, unregulated, and unsafe distribution, handling and application. Hospital staffs often are ignorant of pesticide poisoning symptomatology and treatment, to make matters worse. Analyses of samples taken in major cities such as Guayaquil have also confirmed DDT levels in mothers' milk in excess of minimum tolerance levels.

Also pointed out were the factors of regulatory control in Ecuador. No one agency of the government has a clear mandate to control, monitor, and report findings of contamination. Although there is a congressional commission *Commission de Sanidad Medio Ambiente* (Environmental Sanitation Commission) made up of the heads of many government bodies, the agencies act independently of one another.

The twin governmental agencies of IEOS and INERHI (National Hydrologic Resources Institute) have perhaps the clearest mandates to work in watershed and community water systems. INERHI, for example, has an active major watershed monitoring program modeled on that of the U.S. Geological Service. Periodic reports covering some 80 major watersheds are full of hydrological data and the results of some analytical testing of water quality. IEOS has traditionally worked in

rural and urban water and waste disposal systems with a heavy workload. A small department under IEOS, the National Environmental Directorate, has programs in solid waste, air quality monitoring, toxic substances, and industrial waste monitoring. Unfortunately, lack of program support has hindered much of its work.

Dr. Howard Clark, Regional Advisor Environment Sanitation--South America (Interview in Quito).

Dr. Clark, as the only environmental advisor for South America's USAID Missions, is an invaluable help in any study of this type. Our discussions centered on the work of DIGEMA (Ministry of Mines and Energy), wherein a strongly supported Department of Environment exists under the leadership of Ing. Nelson Suquilanda D. (see interview summary). DIGEMA has focussed on the oil production eastern zone of Ecuador as well as on the coastal mineral extraction and agricultural zones. There is a possibility that DIGEMA may be expanded into a regulatory type institution like the U.S. EPA.

Also of importance is the work of Fundaciòn Natura (see interview summary), an internationally supported nongovernmental organization with a small staff but many active conservation and education-oriented projects. The FN has sponsored the publication of the Ecuadorian Environmental Profile, a seven-volume set released in 1981. An update as of December 1988 contains some 314 pages of essential environmental data.

Another institution soon to be established under USAID sponsorship is the Coastal Resources (*Recursos Costeros*) project, which will focus on impacts in the Coastal zone.

Dr. Clark and Dr. Maldonado completed the Initial Environmental Examination (IEE) for the WASHED Project. Unfortunately, the recommendations for some limited analytical water quality sampling were not carried out. A well-designed water quality monitoring component sensitive to seasonal agricultural and weather patterns is needed to determine such impacts as runoff contamination in watersheds.

Dr. Clark also mentioned the extremely hazardous effects of the use of mercury in the processing of gold. Boiling vats emitting mercury vapors have been observed, along with classic symptoms of mercury poisoning. Studies are now monitoring mercury levels, particularly in children (see field visit interviews in Machala and Zaruma).

Ing. Jorge Castillo, Assistant Coordinator, USAID-IEOS, Quito

In the absence of the WASHED-IEOS Chief Project Engineer, Adalid Arattia, Ing. Castillo provided valuable data as well as coordination with IEOS staff both in Quito and in the field. The in-country manufacture and distribution of chlorine for water disinfection were discussed. An Italian organization will be supporting IEOS to finish the construction of a production facility that will dramatically lower the cost of chlorine which has reportedly risen 5 to 10 times in a few years.

Laboratories in Quito and Guayaquil run the usual tests for bacteriological, physical and chemical parameters, but no pesticide tests appear to be run. Generally, no watershed surveys are performed during community selections of projects, and there were reports of existing water systems that are experiencing declining water supplies because of deforestation.

Some surface drainage construction measures are undertaken at times. Absorption wells are promoted for used water at individual homes. Drainage related problems are a major concern in the Coastal zone, where the groundwater level is high.

The option of regional-type water systems that would serve multiple communities is sometimes considered, as is the flexibility to choose spring water sources, in preference to surface water, where feasible.

Lcda. Marìa Rivadeneira, Program and Project Development Officer, USAID, Quito.

Lcda. Rivadeneira provided invaluable assistance in explaining the development of the project paper, especially the emphasis on appropriate technology studies to foster new approaches to traditional problems and the designs used by IEOS in environmental areas such as water quality monitoring and watershed work. There is a problem in coordinating reports and data generated by the many agencies in Ecuador, and continuity of information and studies are adversely affected as a result. The Fundaciòn Natura is helping to consolidate much data.

IEOS is also proposing programs for water quality control in watersheds and the establishment of a viable monitoring capacity. Recent proposals may be incorporated into the A.T. component.

Ron Savage, CARE, Director of Soil Conservation Projects; and

Hèctor de la Fuente, Assistant Technician, Pesticides Control and Alternatives, Ambato, Tungurahua.

Mr. Savage is an international expert in soil and forestry conservation and management. The team leader for this EA has had personal knowledge of Mr. Savage's work through the CARE Watershed Management Project in Honduras, C.A. (see Reference). Recently, CARE held a seminar in Cuenca for some eight government agencies and CARE personnel addressing the ongoing problems of pesticide misuse and watershed management (see References for minutes).

CARE has focused on water systems, soil conservation, agroforestry and watershed protection in Ecuador for many years in the areas of Cuenca and Ambato. Concerted efforts are being made to promote rational uses of pesticides as well as natural alternatives such as barrier cropping to obviate the need for pesticides.

Population movement into the higher *pàramo* zones of 3,000 to 4,000 m. is affecting watersheds to a degree not known before in Ecuador. Watershed conservation concepts are relatively new to agencies working in water supply development. The impacts of population and agriculture have completely altered

the original environment, changing soil textures (because of cattle grazing and soil compaction), hydrology (greater runoff and erosion), the level of contamination (human, animal, chemicals), and vegetative cover (different species, burning, deforestation). There is a threat of profound degradation of natural resources unless integrated conservation/ protection/management steps are taken.

CARE is exploring the expansion of its program into integrated watershed management cooperation with other agencies. An example is to include irrigation development along with conservation projects.

Also discussed was the high degree of pesticide misuse observed throughout Ecuador. Direct application of unlabeled substances in varying concentrations to green vegetables is common. Many cases of poisoning, some fatal, have been reported. Intensive campaigns are in progress in the CARE work areas to promote the rational use of pesticides and of alternatives.

Ing. Nelson Suquilanda Duque, General Director of Environment, Ministry of Energy and Mines, (DIGEMA), Quito

Discussion with Ing. Suquilanda centered on the agency's investigation of heavy metal contamination and pesticides in the watersheds of Guayas and Esmeraldas, and the mining region of Portovelo in El Oro. DIGEMA is coordinating interagency investigation of impacts on shrimp industries, gold processing methods, mercury in human blood, laboratory calibration confirmation, normative studies for mercury and lead and others. Petroleum development impact regulation has been under the auspices of DIGEMA also.

The role of DIGEMA could be expanded to that of a regulatory agency similar to the U.S. EPA. An environmental regulation under preparation by DIGEMA is soon to be proposed at the national level. DIGEMA has 32 experts in areas ranging from the medical to the geological sciences.

The DIGEMA regional office in Guayaquil keeps most of the records and the results of studies. It concentrates on the Oriente (East zone) because of heavy oil (some 375 oil companies) and gold exploitation activities. A series of informative maps showing the areas of industrial development by province is available from INEMIN, but is not for general distribution.

Lcdo. Marco Encalada, Fundaciòn Natura, Quito

The FN is a virtual clearinghouse of environmental information with a library of some 3,000 references soon to be input into a computerized cross-referencing system for easy retrieval. Its education program, EDMNAT III, is in the process of forming a network for information dissemination at the provincial levels to the secondary schools (*colegios*). Orientations for health and environmental awareness are planned through a series of seminars, and watershed conservation is to be added.

A major effort is also underway to identify industrial pollution and potential options for controls and effluent reductions. Seminars are planned for some 20 to 30 industries including beer, leather, sugar, minerals, and petroleum

refineries. FN's data sources are enriched by inputs from its worldwide support organization. It has published environmental profiles since 1981, with a recent 1988 update.

Interview with Ing. Marco Murillo, Assistant to the Secretary of Environment Sanitation, IEOS, Provincial Office, Quito.

This was a courtesy interview to explain to a high authority of IEOS the reasons for our visit, describe the preliminary contents of the evaluation of the impact of the WASH project on the environment, present a plan of visits for his comments, and request that a representative from IEOS Central Offices be present during these visits.

Meeting at IEOS with:

- Ing. Marcelo Piedra, Planning Director
- Dr. Josè A. Rosero, Environment Director-DNMA
- Ing. Mònica Brito, Environment Division-DNMA

After we had explained the EA to be carried out and asked for collaboration, Dr. Rosero described the following activities under the Environment Directorate (DNMA) within IEOS:

a) The Environment Committees in the Provinces are being put together for the general design of an environmental program.

b) A study to identify toxic pollutants, financed by a real estate tax on industries, is being started as a pilot plan agreed to with the Municipality of Quito.

c) Training agreements with various Universities:

- Technical University of Machala--to measure the amount of mercury in the blood of children in Zaruma and Portovelo, El Oro Province.
- University of Cuenca--to start research on the Mogot Lab kit (portable), in order to obtain a prototype that could be mass produced.
- Central University of Ecuador, Hydrologic Lab--to study the control of hydrographical basins of the Guayas and Esmeraldas Rivers.
- Polytechnological University of Chimborazo (ESPOCH), Riobamba--a general agreement for training involving several faculties, e.g., in Nutrition to develop consumption patterns related to local ecology and environmental sociology; Faculty of Sciences, to study the environment of the basin of the

Pastaza River; Faculty of Zoology, to measure the impact of crops and pesticides in the domestic breeding of cattle.

- Technical University of Babahoyo--participation of women in quality control projects.

d) National Solid Waste Program, through a pilot program in the cities of Babahoyo and Santo Domingo de los Colorados, with sampling of the sewage systems.

e) A water control regulation prepared with other institutions and issued as Law 374 in the Official Registry.

f) The existence of a General Directorate for the Environment within the Ministry of Energy and Mines was mentioned, as well as an Environmental Committee in the CONADE.

Meeting in the Directorate for the Environment at IEOS, with Ing. Patricio Sacoto, Ing. Mònica Brito and Dr. Hernàn Riofrio, Lab Chief at INERHI

It was mentioned that National Law 374 (created in 1976) was not being applied because regulations had just been approved (July 1989) for water quality criteria. Art. 26 opens the possibility of controls of pesticides, biotests, and control of heavy metals.

Technical assistance, training and resources for testing reagents are required to perform lab tests.

Forms to evaluate industrial waste were provided. The program for an air sampling network to determine dusts, sulphurs and gases in suspension was mentioned. Program support is needed to replace old equipment.

Norms and regulations for noise and solid waste will be developed. Project profiles have been developed by this Division to assess the following problems:

- Study of surface and underground water pollution on a national level
- Control and treatment of contaminated water in the Cutuchi and Pumacunchi rivers
- Creation of the position of technical secretary for the interinstitutional committee for environmental protection
- Inventory and control of pollutants program at national level
- Models of water quality program in Poza Honda and the multiple objective project in Daule-Peripa

SUMMARY OF FIELD VISITS--ECUADOR

SUMMARY OF FIELD VISITS--ECUADOR

DATE: August 21, 1989 Quito to Cuenca, Province of Azuay

TRAVEL TEAM: Robert Hogrefe (E.A. Team Leader, WASH)

Cèsar Jaramillo (E.A. Consultant, WASH)

Jorge Castillo (Assistant Project Director, USAID/IEOS)

Mònica Brito (Engineer-Toxic Substances Control, Division of Environmental Health, DNMA-IEOS, Quito)

A.M.: In Cuenca, Province of Azuay

Met with Arq. Guillermo Cordero Ortiz (Provincial Chief, IEOS, Azuay) and Ing. Xavier Capelo H. (Construction Division Head, AID-IEOS Project, Azuay), at the IEOS Provincial Offices. Discussed the inter-agency program planned to be signed by 17 governmental and non-governmental institutions to address and coordinate community projects relating to environmental sanitation and health in the Azuay Province. This project involves IEOS; CARE; the Provincial Council; the Center for Economic Direction for the three Provinces of Azuay, Cañar and Morona Santiago (CREA); Public Telephone, Water and Wastewater for Cuenca (ETAPA); PLAN International; and various municipalities. A significant potential exists to coordinate AID/IEOS WASHED Project work through this agreement.

A new program is also planned through an agreement with the local university and IEOS to provide groups of students to study 10 community water systems to obtain data which IEOS will utilize to develop further work plans to resolve problems. This is another opportunity to address environmental concerns in the watersheds as well (a training course would likely be needed).

Reports exist of water systems failing due to watershed deforestation and resulting erosion. Pesticide applications are not believed to be as great a problem as are animal wastes (principally due to most of the 192 water systems in the province having spring type water sources). About seven water systems utilize surface waters with slow sand treatment plants. Bacteriological tests are taken only at the initiation of projects without any follow-up monitoring (competent laboratories are said to exist at the local university and offices of ETAPA). An agreement does exist to utilize the ETAPA lab; however no system of monitoring is in place. One suggestion is to monitor the seven surface water supplies through the ETAPA lab.

A pending agreement with the Ministry of Agriculture (MAG) will address reforestation needs (this will await the results of the university studies). Chlorine availability is planned to be enhanced through combined purchases at the Provincial Council level. An estimated 52 percent of the 192 water systems in the province are using chlorine.

PM: Visit to Carmen de JADAN, Azuay Province

Here, a surface water source is captured some kilometers above the community and piped to a slow sand filter plant. Some 750 persons are served since project completion this year. Problems were mentioned by Community Water Junta representatives who complained of insufficient water. The system operator indicated filter related problems of plugging and flow restriction. Upon inspection, it appeared that the filters were contaminated by mud and silt, and it was obvious that the biological filter layer had been scraped off. An alternative may need to consider design modifications or water capture at the springs to obviate treatment. Seasonal rains will obviously affect this system with high silt and turbidity loadings. Prefilters may be needed.

PM: (Same day) Visit to Pasto Bamba

Here, three infiltration galleries serve 56 families who regularly pay a tariff of 300 sucres/family/month. No complaints were reported with the system operation. A corn/pasture area was located above the infiltration gallery, with the possibility of direct contamination by infiltration into the water supply. It was agreed that a complete fencing of the water capture area was needed and would be pursued by the community.

The IEOS latrines were inspected at the primary school. The in-country fabricated cement variety of latrine is not popular due to cement surface degradation and sewage retention on the walls, causing odors and offensive conditions. Unfortunately, the in-country ceramic type of latrines run around 8 to 9,000 sucres ($16 to $18) compared to the cement varieties at 2,000 sucres ($4.00). This price difference is not sufficient to justify the use of the poorer quality cement latrines!

DATE: AUGUST 22, 1989--CUENCA

TRAVEL TEAM: Same as Aug. 21, 1989

1. Visit to CARE, Ing. Joseph Narkevic, CARE Coordinator, Cuenca

Ing. Narkevic provided documents related to environmental, sanitation, construction of water and sewage systems, evaluation and follow-up, maintenance and operation activities carried out by CARE.

A draft of the interinstitutional agreement for the planning, design and maintenance of environmental-sanitation works in Azuay was developed with 17 other institutions.

A copy of a community agreement for the construction of a drinking water and sewage system was reviewed. CARE will be responsible for the organization, training and technical assistance to the community, as well as the financial support to purchase construction materials. The community is to provide fencing protection of their water source.

Follow-up visits of the completed projects are planned. We were able to gather information about the workshop, "How to manage hydrologic watersheds to protect drinking water in the Ecuadorian Sierra," financed by CARE.

Visit to the University of Cuenca, Ing. Marcelo Cabrera, Dean of the Faculty of Engineering

Ing. Cabrera stated that the faculty had an agreement with IEOS, under which evaluations of the water treatment plants of Santa Isabel and Paute, including the conveyance of water from the sources, and of sewage systems in Gualaceo and Azogues have been carried out. Both studies have been submitted to IEOS. The evaluation of the water system of Navòn and the design of the treatment plan of Chordeleg will be submitted next October.

The faculty is willing to participate with IEOS in the evaluation of the 192 water systems built in the province, following the terms of the former agreement with CARE for this job.

The investigation of the "Mogot" water test kit will start next October, and will include installation and testing to determine parameters and variables of usage. This will provide guidelines to manufacture the model. The faculty of electricity is studying solar cell appropriate technology to apply to the kits.

There is a request to IEOS to donate equipment to support the Mogot kits.

The faculty will support the possible training for management of watersheds. They have also offered the use of their laboratories, suggesting their expansion instead of creating a new lab at IEOS.

The faculty stated its interest in participating in the Interinstitutional Cooperative Agreement to be signed in the near future. A draft copy was provided for analysis.

They informed us that a course for professionals on operation and maintenance of water treatment plants, sponsored by PAHO, will take place soon.

They requested financial support to buy testing reagents equipment to study underground water sources. They are willing to carry out treatment studies and develop ferrocement norms.

Visit to Ing. Florencio Calle, Chief of the Operation Unit of the basin of the Paute River (INECEL)

The project paper for the management of the Rio Paute watershed is ready. It is expected that the GOE will sign this financial agreement with IDB soon.

An interinstitutional agreement between INECEL-MAG-INERHI and CREA has been signed to execute the project.

The project has two objectives: (1) improve the quality of life of the communities located in the watersheds of the Jadàn, Gualaceo and Burgay rivers through adequate management and preservation of natural resources that will decrease the erosion levels and increase agricultural, forestry and cattle productivity; (2) Protect INECEL's investment in the hydroelectrical project in Paute, Phases A, B and C, to expand the LOP.

Project Components

a. Development and organization of production through owners and through an "aggressive" expansion of actions, which will include follow-up visits and strategically distributed incentives. This will allow:

   - Expansion and increase of agricultural, forestry and cattle production.
   - Preservation of soils and water using small pools.
   - Increase of production to reach a self-maintenance level.

   This component will reach 10,000 owners in the next five years, approximately 22,600 ha. of agricultural and forestry maintenance, and 3,400 ha. of forest.

b. Preservation and management of natural resources in 19 forests, approximately 203,000 ha. of forest and vegetation; exploitation and management of soils in 2,300 ha; small engineering works in streams and beds of rivers, such as 500 ditches and 4,300 meters of fences, including lists and titles of property for the forests.

c. Management of sediments which is included in the second phase of the dredging of the Amaluza impounding study, and training of personnel.

d. Follow-up and evaluation to develop guidelines to measure the impact of the project, related to productivity and preservation of natural resources.

Visit to Mr. Luis Segarra's farm in the watershed of the Jadàn river

We observed the integral management of soils in a demonstration farm where blackberry, sweet-tomato, other fruits of the zone, and some exotic plants and traditional crops are cultivated on level curves (i.e., contour farming).

We also observed reinforced ditches built in the bed of streams to control erosion as well as fences along river edges and streams.

This could be a model of resource management for different zones, with appropriate modifications.

Trip from Cuenca to Machala. Arrival at night.

DATE: August 23, 1989--MACHALA, Province of El Otro

TRAVEL TEAM: Same as August 21.

A.M.: In Machala

Met with Ing. Carlos Orozco S., Chief of the Provincial Office, and discussed work in this province. His office has experienced severe funding constraints to complete projects. The heavy seasonal rains also restrict progress during Feb. to May. Emergency water projects are underway in the watershed area of Rio Amarillo due to contaminated waters from upstream mining and community sewage discharges. A project completion level of six projects/year is believed to be the maximum possible (they were able to complete only two last year).

Success with latrines in the coastal ares has been low due to the need to relocate latrines without drainage capability because of high groundwater and rains. Community collection and treatment sewage systems are being considered. No problems are reported with latrine functioning in the higher areas of the province.

Water quality tests (physical, chemical, bacteriological) are done at the local hospital labs. Passing of raw sewage into water courses is seen as a major problem in the entire province. The Provincial Council is considering regulations to control sewage contamination for the three provinces of El Oro, Loja and Morona Santiago.

A.M.: Faculty of Chemical Sciences, University of Machala

Met with Dr. Josè Campoverde, Dean, and Lenin Gordillo, Assistant Dean, and discussed the mercury study being completed by two students (in coordination with the Central University, Quito). An adult study is being followed with a child study of mercury levels in blood and urine in the areas of Protovelo and Zaruma, El Oro. High levels in the adults were found previously. Student studies are sometimes forwarded to government agencies but little follow-up occurs. IEOS could profit greatly by knowing what university studies are being performed relating to water, wastewater, contamination and other environmental related areas. Pesticide contamination is known to be prevalent but monitoring has been unavailable due to lack of laboratory capability both at this university and at Guayaquil University.

A.M.: Traveled to Community of Torata, El Oro

We traveled with Ing. Orozco, IEOS-Machala, to Torata and inspected a slow sand treatment plant completed in April 1989. Mining activity in the higher watershed area forced movement of the water capture intake higher than planned originally. Presumably, the water source is, for now, beyond the areas of mining in the area. The sediment loading during the rainy season is of concern as plugging of the filter has occurred. No chlorination was being applied even though facilities and chemicals were on-site.

P.M.: Travelled to Areas of Portovelo and Zaruma, El Oro

These areas are heavily impacted from over 50 years of intensive gold mining. Water contamination from gold processing with mercury is flagrant. Results of the adult mercury level study were reviewed at the Provincial Council Office in Zaruma, where 91 adults were sampled. Only 10 adults had blood and urine levels below the norms of 0.003 ppb. (blood) and 0.015 ppb. (urine). Two adults sampled had results of 0.079 (blood) and 0.073 (urine). The children's samples are being analyzed at present at Quito.

All downstream water users are vulnerable to mercury and other heavy metal contamination, especially as accumulated sediment loading travels downstream. No government controls are in place to restrict mercury use and discharge into the water courses (where most of the mineral crushing and processing occurs along the banks).

DATE: AUGUST 24, 1989--GUAYAQUIL

Visit to Dr. Luis Arriaga, Director of the Project to Manage Coastal Resources:

The project is leading an agreement between IEOS, CEDEGE, INERHI, The National Fisheries Institute, the Armed Forces and ESPOL. The objective of this project is to provide surveillance of the quality of water in the Coastal zone especially in shrimp zones. Samples of sediments at four different locations on the coast have been collected. The results did not show the presence of heavy metals such as lead, copper, cadmium, zinc, or chromium.

Waters of the coastal area are considered to be of good quality except the ones of the "Estero Salado" and the Guayas river, which have high ranges of bacteriological contamination which decreases down the river.

In Esmeraldas there is a high incidence of contamination due to oil spilling. The project is sending two technicians from ESPOL to the United States, for a month to be trained (one in analyses of heavy metals and the other in pesticides).

The National Institute of Atomic Energy of ESPOL, and the National Fisheries Institute are reported to have the necessary equipment to analyze heavy metals and pesticides.

Visit to the Polytechnical University of the Coast (ESPOL). Interviews with:

A. Ing. David Choes, Chief of the Instrumental Lab, who is one of the two technicians who will be trained in the United States next October.

   He operates atomic absorption equipment to analyze heavy metals, and has worked with mercury, zinc, lead, copper, chromium and cadmium; results have compared well with those of Rhode Island University.

   Additionally, they have a generator to process mercury and arsenic, as well as a mercury A.A. lamp.

   He will be willing to work in the analyses of heavy metals under an agreement which could finance reagents and two lab assistants.

B. Ing. Mariano Montaño, Chief of the Chromatography Lab, who will be trained in the United States next October.

   He has a gas-chromatograph and a detector which captures electricity to treat phosphated columns for organica.

   He is willing to work in the analyses of pesticides through bio-tests in ocean species as well as in sediments. The labs of the Instituto of "Forence" Sciences and the National Fisheries Institute will complement their work.

He requests support for training, reagent chemicals, special testing-tubes, a place to process the samples before introducing them to the chromatograph, and personnel.

Visit to the National Fisheries Institute. Interview with Econ. Maria Luisa Jimènez, Director.

They already have an agreement with PREDESUR, through the Department of Primary Investigations, Contamination Section, for the sampling of heavy metals in rivers and pesticides in Loja.

They have the necessary equipment and qualified personnel to do the analyses of the samples.

They have signed an agreement with the European Economic Community (CEE) to protect the fishing resources.

They are carrying out a study on nutrients in the mangrove trees zone, specially in Manabi.

They request financial support for per-diem, transportation of personnel and lab reagents.

They expressed a willingness to work together.

Flight to Quito, via TAME, 16H30.

DATE: August 25, 1989 Riobamba, Province of Chimborazo

TRAVEL TEAM: Robert Hogrefe

Cèsar Jaramillo

Mònica Brito

A.M.: Travelled to Riobamba

Met with Ing. Iràn Maldonado, Construction Engineer, IEOS and visited water systems completed under USAID/IEOS Projects in 1988. A regional (for two communities) system at Huasona, San Josè and Huacona, La Merced, was inspected. This is a spring water source system located high in the pàramo above the communities. No apparent problems were seen or reported, outside of a conflict with the lower community reportedly using more water than the upper community. Apparently, the two water Juntas do not meet together to resolve common problems. The IEOS engineer said he never travels to these areas and the promoter only visits every six months. A small trace of chlorine was tested with the ORTHOTOLODINE kit available. A plugged drainage tube at a water service was observed with a water pool accumulated at the base of the service. Little follow-up health promotion or general project promotion (such as to help set up their accounting books) is occurring here.

P.M.: At Colta

This water system collects surface water from multiple small streams that are surrounded by animal grazing pastures. Obvious animal waste contamination occurs, especially during rains. The slow filter plant was inspected next and found to be full of unwashed sand that had been installed originally. The water leaving the plant was of a yellow color due, presumably, to retained clays and chlorine reactions in the water product.

The IEOS engineer indicated he knew nothing of the intended operational concepts of the biological surface filter of the slow sand filter. Neither he nor any of the other engineers or promoters at the province has received any training in the concepts of operation and water treatment. This system alone serves over 600 homes or over 3,000 persons. There are 10 other surface supply-slow sand filter plants in a total of over 130 water systems in this area. Prefilters may be planned for at least the Colta treatment plant to counter heavy sediments.

P.M.: At Escuela Politècnica de Chimborazo, Riobamba

Met with Dean Bayardo Ulloa, School of Agricultural Engineering, to discuss laboratory monitoring program, especially in pesticides. The school is involved with pesticide monitoring; however, those persons responsible for specific projects were unavailable today. Biological natural control of insects is also being studied. CARE is working with some of these research efforts in the provinces (see CARE field visit--Ambato).

DATE: AUGUST 26, 1989--TUNGURAHUA

Together with Mr. Nelson Barragàn, IEOS promoter, we travelled to Haumbalò, Province of Tungurahua to visit the water systems of:

La Florida	293	household	connections
San Josè	133	"	"
Surangay	206	"	"
Segovia	130	"	"
La Merced	80	"	"
Hayrapta	70	"	"
San Antonio	85	"	"
Huambalò	200	"	"

As a sample we visited the tank at la Merced, where we observed that installation is well done and could be complemented with a drainage system in the first reception tank to get rid of solids; similarly, the tank that distributed the water to the different communities has two openings which are located too low block the sedimentation. This tank can be used only if two new holes are opened at a higher level and the other two are closed.

There is enough pressure but insufficient air valves.

The tank drainage at the faucet doesn't work which results in accumulation of water.

"La Moya" is the supply source for all the above mentioned systems and is an important aquifer which can also be used for irrigation. We were able to make the following observations:

- Water is collected through a concrete tank which is located correctly and functions well.
- A distributing tank ends in three reserve tanks, two of which overflowed in 4 lts/sec. The third tank does not supply the communities located below, so it has to be calibrated.
- It was difficult to find data related to water analyses at the source, which is very important because it supplies 10,000 inhabitants of the parish; at the field, iron was found in the water.
- In the higher level of the watershed the original vegetation has been replaced with crops for which pesticides are used. As the depth of the aquifer is ignored, it is essential to

carry out analyses for contamination, including pesticides, at the source.

- The slopes at the basin of the river are steep, requiring a preservation system to manage soils and water because the stream at the source is decreasing.

Together with Mr. Nelson Chapalbay, CARE promoter in Tungurahua, we visited the communities located in the northeast of Ambato: Angahuana, Llantantoma, Calguachico, Calguagrande, Cuillitahua, Ambatillo, Angamarquillo, Pujanza, Cachilrana, and Mogato y Calguachico bajo. CARE is implementing a project to "recover" and preserve the soil in a 250 ha. zone through terraces, ditches, native trees (Yagual, quishuar, pumamaqui, aliso, cedro), bushes (retama, chilca), fruit bushes (blackberry) and traditional crops of the zone.

We visited a nursery where different type of plants are cultivated using alternative agriculture which turns this place into a biointensive garden that uses "compost", green fertilizer, etc. but no chemicals.

We visited another demonstration farm owned by Mr. Josè Tenelema. Here we observed a great soil regeneration job, where the soil was a "congahua" at the beginning but has been turned into a cultivated area of over 1.5 ha., surrounded by trees to protect the crops from the wind as well as from animals. There is also an irrigation system.

The property is a model of what can be done in the Sierra as an incentive to return men to the land. This farmer has not only seeded a variety of plants but also hope for all of us.

APPENDIX B.1.

INTERVIEWS and SITE VISITS FINDINGS

ROBERT HOGREFE/CESAR JARAMILLO

WASHED--ECUADOR--ENVIRONMENTAL ASSESSMENT--AUGUST 1989

EXISTING and FUTURE RWS&S PROJECTS

A. **OBSERVATIONS/FINDINGS:**

1. Spring water supply systems appear to be protected from direct contamination although reports are prevalent of diminishing water output in all areas visited.

2. Multiple uses, vegetation burning and use of pesticides appear to be growing within the watersheds for the projects. It is not known without a more complete survey what percentage of watersheds are experiencing these impacts, only that the trend seems to be growing.

3. No monitoring system exists to determine the actual water quality delivered through the projects. Water samples are usually taken before project initiation, but without any concept of seasonal or multiple watershed use variations. Also, samples are not always taken for complete analyses, e.g. bacteriological.

4. All of the surface water supply systems visited are susceptible to direct runoff contamination from multiple uses (cattle grazing, agriculture and mining). Surface water supplies may represent a small percentage (5-10 percent) of the total number of projects of an area, but do serve an appreciable population (e.g., the surface supply at Colta, Riobamba, supplies 600 homes).

5. No adverse impacts due to latrines were encountered in the Sierra other than the non-popularity of the cement-cast variety. Coastal zone latrine problems continue due to rains and high groundwater table.

6. Very limited support exists at present to monitor for heavy metals and pesticides. Programs are underway to achieve pesticide laboratory capacity at the university level (ESPOCH, ESPOL) and possible capabilities were learned of at several governmental institutions that need to be confirmed, (e.g. MAG).

7. Soil conservation and reforestation work is perceived as critical by many organizations. For example, programs in Azuay (watershed of Rio Paute; (INECEL, MAG, INERHI and CREA) and in Tungurahua (microwatershed within the Ambato basin, CARE) are addressing the long-term need for watershed preservation via the process of conservation.

8. CARE-IEOS water projects require communities to fence their water source. This represents a first step towards water source protection and promotion.

9. Many university studies are undertaken by students who study contamination impacts from sewage, mining, agriculture and other factors affecting environmental health. Insufficient communication of these studies is provided to government institutions. Little follow-up occurs and opportunities are passed up.

10. There is insufficient training of provincial IEOS engineers and promoters in the concepts relating to slow sand filtration.

11. There is no training whatsoever provided to IEOS engineers or promoters concerning watershed protection and conservation.

12. An educational network oriented towards environmental health and sanitation has been started through the Fundaciòn Natura (FN)-IEOS-Ministries of Health and Education. Much educational material is available for environmental promotion work.

13. IEOS and INERHI are the primary government institutions legally responsible for water quality control. The recently passed National Decree No. 2144, Registro Oficial #204, 5 June 89, formally established water quality norms and waste discharge criteria for multiple industries and for potable water.

14. Mercury contamination is occurring in the watersheds of El Oro daily. Many water systems are vulnerable to contamination and no regular monitoring system is in place. IEOS/AID projects of surface water supplies are believed to be vulnerable also.

15. Import restriction of non-EPA-approved pesticides is a national level problem. Agricultural sector users are typically at the mercy of the distribution system which has no regard for the hazards of handling, storage, concentrations, application or consequences of misuse. Disturbing reports are received of pesticide-related poisonings, deaths and injuries. Environmental consequences of biomagnification and bioconcentration in the food chain are suspected.

16. The National Directorate for the Environment of IEOS (DNMA--IEOS) is actively pursuing studies of environmental problems including those relating to water quality. Lack of institutional support by IEOS, a small staff, lack of monitoring ability, lab support and funding severely restrict this important program.

17. Community use of chlorine is estimated to be practiced in 25 to 50 percent of the IEOS projects. High costs and poor results deter its use in treatment plant systems. An unknown danger of pesticide-chlorination combination exists in the surface water supplies seasonally.

18. The appropriate technology component may have a strong potential to foster the development of water quality monitoring work. IEOS has made such proposals along with others (Peace Corps, INERHI).

19. Critically important decisions regarding the location of a water intake are usually made by IEOS promoters in consultation with each community. Watershed factors and water contamination potential, especially in surface supplies, are factors overlooked at times.

20. Past projects have been designed with apparent substandard criteria; for example, low per capita consumption design rates and very high pipeline velocities. Also, system valving design were observed to be inadequate in some systems.

APPENDIX C

Recommendations for Watershed Protection

APPENDIX C

Recommendations for Watershed Protection and Program Material Examples

1. The recommendation to initiate a pilot program in watershed conservation within the province of Tungurahua can utilize program information and training material available from CARE-Ecuador. Some examples are included.

2. Watershed preservation concepts begin with survey and assessments in order to understand existing conditions and to classify appropriate activities. Cross-training to achieve orientations in procedures appropriate for preservation activities is highly recommended.

3. The primary preservation measures are usually initiated through soil conservation practices such as terracing, and contour farming, and water conservation practices such as reservoir and retention structures to hold both soil and water, crop rotation, natural wind barriers, natural insecticide barriers, natural fertilizers, irrigation systems and many others. Reforestation measures are based on soil conservation steps first followed by appropriate selection of native species (a recommended reforestation species list is included in this appendix). Tree nurseries are maintained to optimize growth and seasonal timing for transplanting.

4. Demonstrated results of soil conservation and reforestation methods can communicate more than books or courses can hope to achieve. Ecuador has the good fortune of having a superb model established near Ambato, by CARE and managed by the campesinos who work in the zone. The Peace Corps helped to establish a model tree nursery for the program.

   Results are often dramatic. Conservation has reclaimed land and increased productivity 5 to 10 times that of previous harvests. Campesinos who previously had to work in city factories now have profits from agriculture that allow them to invest in more land to repeat the process. The end result, besides stabilizing the soils and watershed characteristics, is as basic as an improved life for the community.

APPENDIX D

Recommendations for Water Quality Monitoring

APPENDIX D

Recommendations for Water Quality Monitoring

Both the evaluation and water quality monitoring systems at the source, which have been mentioned in section 6.4., are essential and feasible, starting with two pilot projects, one in the Sierra (Province of Azuay) and the other in the Coast (Province of El Oro).

The University of Cuenca is very interested in participating in this pilot project; so are the Provincial Offices who will be the starting point to execute an agreement between 17 institutions working in environmental sanitation together with IEOS. These two institutions have worked together before under other agreements.

Students previously trained could help train the Juntas and systems operators in source protection, operation and maintenance of the treatment plant, chlorine concentration, etc.

In the same way, there is a background of similar works to implement the pilot project in El Oro . The Management of Coastal Resources Project together with ESPOL have performed analyses of heavy metal samples to measure the effects in the production of shrimp.

Similarly, the National Fisheries Institute has signed an agreement with PREDESUR to analyze heavy metals and pesticides in the rivers of Loja.

A study carried out by the Central University of Ecuador, related to the presence of mercury in the blood and urine of the inhabitants of the mining zones of Portovelo and Zaruma, has started many other studies from private and public institutions on the same subject.

There are institutions, besides those already mentioned, that have the capacity and willingness to implement these types of activities. These are: INERHI, Merchant-Marine Institute, Merchant-Marine Directorate, National Institute for Atomic Energy, CEDEGE, Polytechnical University of Chimborazo, and Central University of Ecuador, among others.

The management of the Fishery Resources Program is sending two technicians to the United States to be trained in the analyses of heavy metals and pesticides.

APPENDIX D.1.

PRELIMINARY SURVEY--WATER QUALITY MONITORING

March 30, 1989

Source: Carolyn Auker, US Peace Corps Volunteer, Ecuador

CALIDAD DE AGUA:

o¿Se realizò anàlisis fisico-quìmico? SI ( ) NO ( )

a.Frecuencia del anàlisis:

semanal ( ) mensual ( ) anual ( ) otro ( )

b.Recolectado por: _____

c.¿Dònde realizan los anàlisis? _____

d.Costo del anàlisis: _____

e.¿Utilizan hojas de control? SI ( ) NO ( )

f.¿Mantienen registro de los anàlisis realizados?

SI ( ) NO ( )

o¿Se realizò anàlisis bacteriològicos? SI ( ) NO ( )

a.Frecuencia del anàlisis:

semanal ( ) mensual ( ) anual ( ) otro ( )

b.Recolectado por: _____

c.¿Dònde realizan los anàlisis? _____

d.Costo del anàlisis: _____

e.¿Utilizan hojas de control? SI ( ) NO ( )

f.¿Mantienen registro de los anàlisis realizados?

SI ( ) NO ( )

o Tienen entrenamiento en:

a.Manejo de equipos: SI ( ) NO ( )

b.Anàlisis:SI ( ) NO ( )

oTienen instrucciones respecto a cloraciòn:

oral ( ) escrito ( ) ninguna ( ) otra ( )

o¿Còmo se determina la dosificaciòn del cloro apropiado?

_____

o ¿Por què no hay cloraciòn? Por .... costo ( )

falta de personal ( ) no esnecesario ( ) otro ( )

o Tienen asistencia tècnica de otras organizaciones para resolver:

a. Problemas mecànicos: SI ( ) NO ( )

Organizaciòn _____

b.Problemas con calidad del agua: SI ( ) NO ( )

Organizaciòn _____

c.Educaciòn continua: SI ( ) NO ( )

Organizaciòn _____

oPara el futuro le gustaria tener educaciòn contìnua en:

a. Mantenimiento de equipo: SI ( ) NO ( )

b.Calidad de agua: SI ( ) NO ( )

c.Otro _____

APPENDIX E

Initial Environmental Examination (IEE)

JUNE 1989--WASHED--ECUADOR

INITIAL ENVIRONMENTAL EXAMINATION
Environmental Threshold Decision

Project Location:	Ecuador
Project Title:	WATER AND SANITATION FOR HEALTH AND ECUADORIAN DEVELOPMENT (WASHED)
Project Number:	518-0061
Funding:	grant (approx.) $4,000,000 loan $ (none)
Life of Project:	4 years
IEE Prepared by:	Howard L. Clark, Ph.D., Ecologist, Regional Environmental Advisor (REMS/SA) Fausto Maldonado, Ph.D., Soil Scientist, Assistant Mission Environmental Officer
Recommended Threshold Decision:	Negative (no significant impact)
Comments:	The recommended threshold decision (negative) is conditional, awaiting preliminary study of impacts, if any, of the previous water and sanitation project, which may require an amendment of this IEE. See attached Environmental Review for details.
copy to:	William Goldman, Chief, FHD, USAID/Ecuador
copy to:	Robert Mowbray, Mission Environmental Officer, USAID/Ecuador
copy to:	IEE File

Concurrence with Recommended Threshold Decision:

Frank Almaguer, Director, USAID/Ecuador

LAC Bureau Threshold Decision:

James S. Hester
Chief Environmental Officer
Bureau for Latin America and the Caribbean

Initial Environmental Examination
Environmental Review

WATER AND SANITATION FOR HEALTH
AND ECUADORIAN DEVELOPMENT (WASHED)
USAID/ECUADOR

I. PROJECT DESCRIPTION

The project will assist the GOE to provide potable water systems and latrines to rural communities of less than 2000 inhabitants and, through training and education, will improve water use and hygiene practices. Only 30% of the rural population of Ecuador have access to safe water, only 20% have latrines, and even fewer families understand and apply appropriate hygiene practices. A major goal of the project is to reduce, through water and waste management, the incidence of water-transmitted diseases which are major contributors to infant and child mortality and morbidity in general.

The project will be organized into five components, which are the following:

-- System construction
-- Hygiene education
-- Operations and Maintenance
-- Institutional administration
-- Appropriate Technology system designs.

II. ENVIRONMENTAL REVIEW

A. Previous Project Review

This project is a continuation of major components of the Integrated Rural Health Delivery System Project (Project No. 518-0015), for which an Initial Environmental Examination (IEE) was prepared in November 1980. This IEE concluded that the project would have no significant environmental impacts, and recommended a negative Environmental Threshold Decision. The IEE noted that there could be minor to moderate impacts on the chemical and biological components of aquatic ecosystems and water quality, and that there could be a limited impact from the diversion and altered use of water supplies. Socioeconomic impacts, presumably positive, would result from changes in cultural patterns of water use and hygiene, and from lowered mortality and morbidity rates.

B. Impacts of Previous Activities

We foresee no significant, direct, detrimental environmental impacts

from the activities of the proposed WASHED project, but it is necessary to verify the presumptions and conclusions of the 1980 IEE (based only on project design), by examination of water and latrine systems presently functioning, or abandoned, installed by the previous project. It should be considered that, after almost eight years of installation and use, some unforeseen environmental impacts may be apparent, not only as part of the systems but also in the downstream impacts of waste water discharge and latrine runoff or percolation. Additionally, having water services available, people will likely increase the use of potential pollutants such as household wastes (oil, detergents, cleaning compounds, kitchen organic wastes, etc.) which will be dumped directly into water bodies through the discharge systems. These materials can have significant impacts on downstream water uses.

At the same time, a water system is affected by upstream activities which might alter environmental conditions, as through the discharge of wastes or the alteration or diversion of water supplies, which can change water quality or quantity available to the water system. Deforestation in the upper watershed, for example, can increase erosion and the sediment load of water supplies, as well as changing the seasonal availability of water. Some pesticides can be bound to soil particles and transported downstream in sediments from erosion.

It is necessary to immediately begin a preliminary analysis of these potential impacts, both on the water systems and caused by the water/latrine systems, by sampling (before preparation of the Project Paper) some of the diverse water and latrine systems installed during the IRHDS project. Sampling will be done under the guidance of the USAID/Ecuador Mission Environmental Officer, the Regional Environmental Advisor (REMS/SA) and professional staff of the FHD Division and the IRHDS Project. If a sample of these installed systems shows any unforeseen, potentially significant, environmental impacts, system designs (including operations and maintenance) will be modified in the Project Paper, and during project implementation, to obviate these potential impacts.

If any negative impacts of previously-installed systems are found or suspected, it will be necessary to carry out a more systematic analysis of all systems installed during the IRHDS project, with consideration given to correcting these existing problems under the WASHED project, or by other provision of TA to the relevant GOE agencies. Although negative environmental impacts due to IRHDS project activities are not the direct responsibility of the WASHED project, they are the responsibility of USAID/Ecuador. Particular attention immediately should be given to water systems where there is, or was, upstream mining activity using mercury, or where there is use of particularly toxic or mobile pesticides. If these analyses are determined necessary by the preliminary survey described above or by unforeseen impacts during project implementation, a scope of work for the systematic analyses, and follow-up, with a possible formal Environmental Assessment, will be prepared under guidance of the LAC/DR Bureau Environmental Officer.

C. Toxic Substances

One potentially significant environmental condition, which is not considered in the design and installation of potable water systems in this project, is the possible presence of toxic chemical or other pollutants in water sources. There is increasing use and runoff of toxic pesticides in rural zones throughout Ecuador and, primarily in mountain and piedmont areas of the SW coastal zone, discharge or leaching of heavy-metal mining wastes, particularly mercury. Periodic monitoring for the presence of toxic substances in water is essential to both protect community health and to protect the integrity of ecosystems receiving wastes from water systems and latrines.

The presence of pesticides in water systems can have serious health impacts on water users, particularly children. A recent study (M. Bolanos, X. Santacruz, C. Fazmino, O. Munoz. Dec. 1986. Determinacion de residuos de pesticidas clorados in leche materna. MAG & CONACYT, Quito.) showed significant presence of clorinated pesticides in maternal milk in major Ecuadorian cities, with the average concentrations significantly above the FAO/WHO Maximum Residue Limits (for alpha-BHC, lindane, heptachlor, aldrin, clorodane, and DDT isomers). Dissolved pesticides probably are not removed by the simple water treatment systems recommended and used in this project. It is essential that pesticides and heavy metal analyses be carried out on all water systems concurrently with bacterial and other potability analyses presently included in project design. Because of the permeability of many of the soils and rocks, particularly those of volcanic origin, leaching of toxic substances into the underground water table can occur, so it is necessary to include analyses of water from wells or springs, as well as surface sources. It is important to note that toxic levels of pesticides may be present only seasonally, when there are agricultural or other applications of pesticides; toxic pesticides may flush through a water system in only a few weeks, with substantial (and often unidentified) impacts on community health. Sampling and testing protocols must include these seasonal considerations. The presence of heavy metals from mining activities or other industially-produced toxic pollutants will probably not be as seasonal.

Concentrations of toxic substances in water systems must be reduced (to acceptable levels for community health) by changes in water source, reduction or control of upstream use of pesticides or mining or industrial wastes (which may include leachates from abandoned mines or residues of former mining or industrial activities), or both. This will likely require multi-institutional cooperation with, e.g., the Ministries of Mines and Health, or other institutions.

D. Water Treatment

In the Final Evaluation (April 1989) of the IRHDS Project, it was noted that all water systems visited used chlorine for water treatment. Depending on how and where waste water is discharged, chlorine could have a very significant, negative impact on aquatic ecosystems. This could likely be

significant only if discharge was directly into a small, closed water body (e.g., small pond or lake); discharge with surface runoff and subsequent soil percolation or runoff into a large, moving body of water should have no significant impact because of the rapid volatilization of the chlorine. The evaluation team recommended, for economic reasons, that chlorine treatment be reduced to only those water systems where water quality analyses prove disinfection is needed because of the presence of potential sources of disease. We strongly concur with this recommendation, on the grounds of potential environmental impact, in addition to the economic and operational reasons. The Project Paper must include this recommendation.

III. ACTIONS REQUIRED

1. An examination must be made of a sample of water and latrine systems installed under the previous project, to determine if there were, or are, any negative environmental impacts. Particular attention must be given to waste water and latrine discharges in relation to downstream water uses. Emphasis in sampling should be given to water systems where there is, or was, upstream mining activity using mercury, or where there is use of particularly toxic or mobile pesticides. Recommendations, if any, from this study will be included in the Project Paper and in designs of water and latrine systems during project implementation.

2. If any negative impacts on community health or on ecosystems, resulting from previously-installed water or latrine systems, are found or suspected from the preliminary examination in (1) above, or by unforeseen impacts during project implementation, it will be necessary to carry out a more systematic analysis of all systems, with consideration given to correcting these existing problems under the WASHED project, or by other provision of TA to the relevant GOE agencies. Particular attention immediately should be given to water systems where there is thought to be, or was, upstream mining activity using mercury, or where there is use of particularly toxic or mobile pesticides. If necessary, a scope of work for the systematic analyses, and follow-up, with a possible formal Environmental Assessment, will be prepared under guidance of the LAC/DR Bureau Environmental Officer. These activities may require Technical Assistance in watershed management and in control of toxic substances.

3. Analyses of pesticides and heavy metals (and other toxic substances when there are indications of their possible presence) must be included as part of all preliminary and subsequent analyses for potability of water supplies. Periodic monitoring is necessary throughout the LOP, for pesticides particularly during crop production seasons; heavy metals from mining or other industially-produced toxic pollutants will probably not be as seasonal. Because of the permeability of many soils and rocks, particularly those of volcanic origin, leaching of toxic substances into the underground water table can occur, so it is necessary to include analyses of water from wells or springs, as well as surface sources. If toxic substances are present at any time, in concentrations affecting community health or ecosystems, water systems must be immediately closed and solutions to the origins of the contamination determined through consultation with appropriate GOE agencies or through legal action.

4. Chlorine addition to water supplies will be reduced to only those where it is essential for disinfecting biologically contaminated water, and where potential discharge of treated water will not be into closed bodies of water.

5. Project personnel, with guidance of the Mission Environmental Officer and/or the Regional Environmental Management Specialist (REMS/SA), will monitor changes in water system and latrine design during project implementation to mitigate any possible negative environmental impacts.

6. The hygiene training and education component must include environmental principles essential to the sustainable utilization of water and the rational discharge of wastes from all sources. This should include awareness of the impact of upstream activities (pesticide use, mining, deforestation and other activities leading to erosion and sedimentation, disposal of untreated sewage, etc.) on the community's potable water supplies, as well as the downstream impacts of the community's disposal of wastes.

APPENDIX F

Project Provinces (8) List
and
Country Maps

C U A D R O No. 1

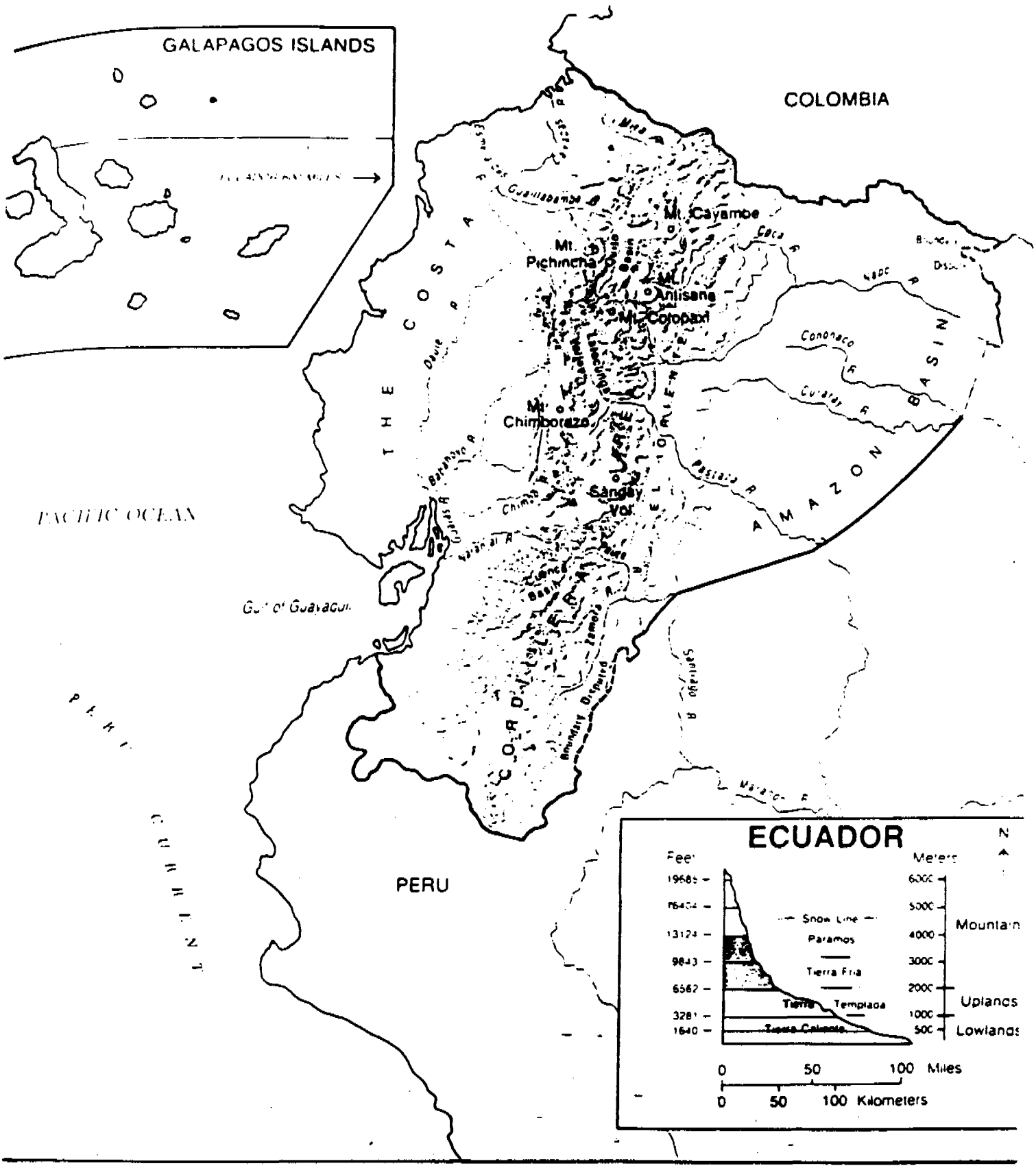
COMUNIDADES CONSIDERADAS PARA LA CONSTRUCCION DE SISTEMAS DE AGUA POTABLE Y LETRINIZACION EN LA PRIMERA ETAPA DEL PROGRAMA ESF JUNIO A DICIEMBRE DE 1989

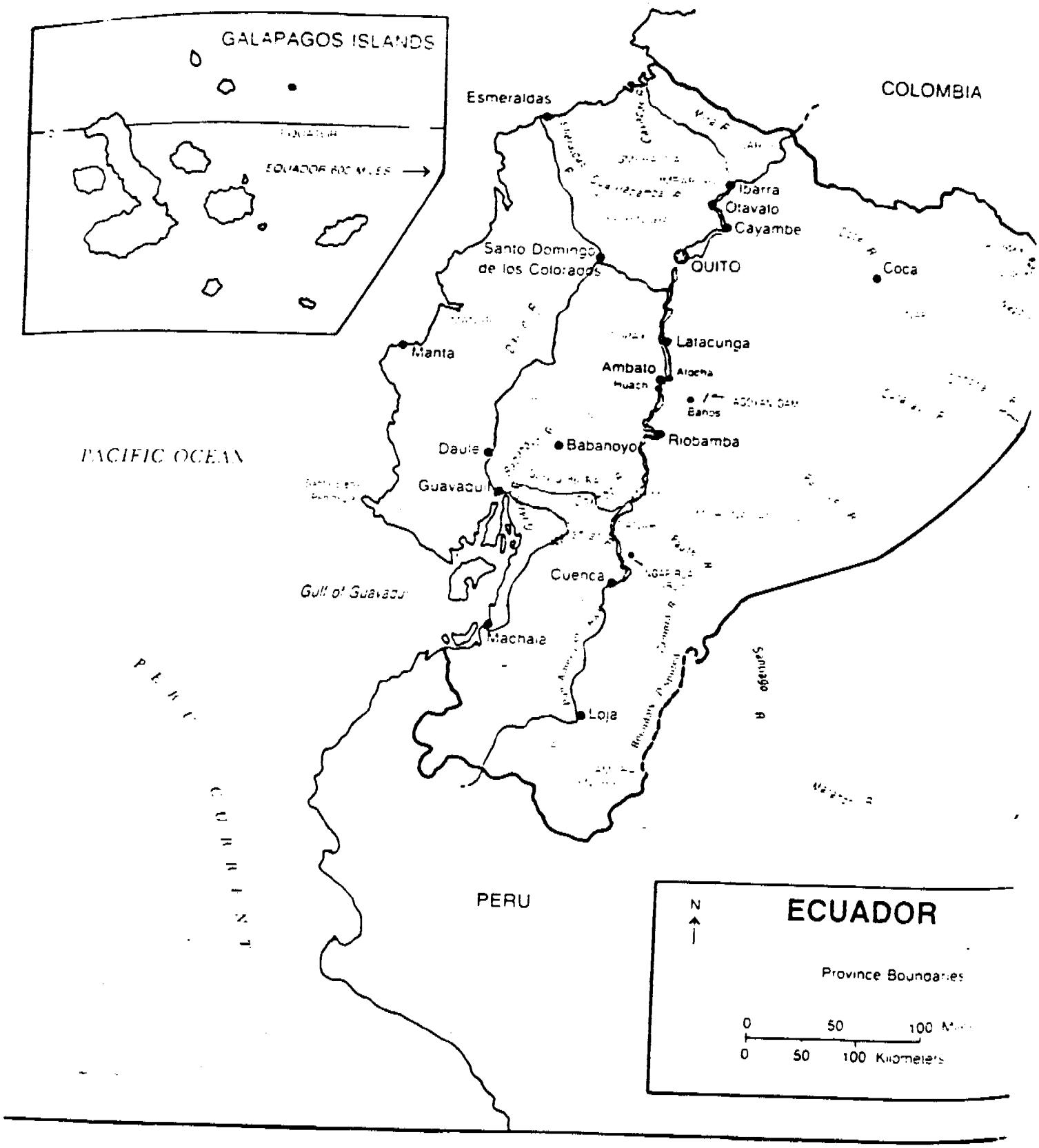
PROGRAMA MODULOS OPERATIVOS

ESF

Provincias	Comunidad		Población Estimada Actual
1.- El Oro	1.1.	Chuva	300
	1.2.	Fátima	500
	1.3.	Cotopaxi-Río Bonito	900
	1.4.	Loma de Franco	600
	1.5.	Minas Nuevas	400
	1.6.	Amarillos	600
2.- Pichincha	2.1.	La Moca-San Antonio-La Libertad	800
	2.2.	Oyambaro-Oyambarillo-La Isla	1,060
	2.3.	Puichig-Sta. Rosa-San Agustín	1,050
	2.4.	Iguiñaro	750
	2.5.	La Aduana-San Carlos	350
3.- Chimborazo	3.1.	San Juan de Trigolima	500
	3.2.	Tutupala-San Francisco	600
	3.3.	Cochapamba	440
	3.4.	Compañía-Cruz Loma	500
	3.5.	Peltetec	300
	3.6.	Calera-Shobol	500
4.- Tungurahua	4.1.	Chambag-Florida	1,050
	4.2.	Miñarica-Verde Sacha	850
	4.3.	Pingue Alto	450
	4.4.	Calamaca	300
	4.5.	Quillán	300
	4.6.	Mirador	200
5.- Azuay	5.1.	Pata Pata	500
	5.2.	Catabiña 1 y 2	500
	5.3.	Caledonea	240
	5.4.	Guashum	520
	5.5.	Sta. Teresita	600
	5.6.	San Antonio de Huentel	360
6.- Imbabura	6.1.	Padre Motilón Chupa	360
	6.2.	Quinta Yuquín	700
	6.3.	Nápoles	200
	6.4.	El Morlán	585
	6.5.	El Milagro-La Carolina	350
	6.6.	La Esperanza-El Abra-San Clemente Chirihuasi	900

Provincia		Comunidad	Población Estimada Ar
7.- Cotopaxi	7.1.	Juigua Yacubamba	1,000
	7.2.	Piedadcita de Calope	330
	7.3.	Matango-Pucará	420
	7.4.	Tingo-Colias	433
	7.5.	San José de la Victoria	420
	7.6.	Tandacato	300
8.- Carchi	8.1.	El Naranjal	360
	8.2.	El Corazón-San Francisco	300
	8.3.	Chután Alto	540
	8.4.	Guamag	600
	8.5.	El Milagro	320
	8.6.	Carrizal	300
TOTAL			24,438


GALAPAGOS ISLANDS
COLOMBIA
PACIFIC OCEAN
PERU
THE COSTA
ORIENTE
AMAZON BASIN
Mt. Cayambe
Mt. Pichincha
Mt. Antisana
Mt. Cotopaxi
Mt. Chimborazo
Sangay Vol.
Guayaquil
ECUADOR
N
Feet
Meters
19685
16404
13124
9843
6562
3281
1640
6000
5000
4000
3000
2000
1000
500
Snow Line
Paramos
Tierra Fria
Templada
Tierra Caliente
Mountain
Uplands
Lowlands
0 50 100 Miles
0 50 100 Kilometers


GALAPAGOS ISLANDS
Esmeraldas
COLOMBIA
Ibarra
Otavalo
Cayambe
Santo Domingo
de los Colorados
QUITO
Coca
Latacunga
Manta
Ambato
Baños
Daule
Babahoyo
Riobamba
PACIFIC OCEAN
Guayaquil
Cuenca
Machala
Loja
PERU
N
ECUADOR
Province Boundaries
0 50 100 Miles
0 50 100 Kilometers

APPENDIX G

Recommendations for Construction Practices to Reduce Erosion and Eliminate Pools of Water Associated with Poor Drainage

APPENDIX G

Recommendations for Construction Practices to Reduce Erosion and Eliminate Pools of Water Associated with Poor Drainage

1. Continue to follow standard norms of directing overflows of water intakes and storage tanks away from structures. Erosion protection measures commonly applied are small rock-lined ditches to dissipate energy, small canals to divert runoff from around structures and into natural drainage courses, and the use of elevated well pedestals.

2. Engineering analyses can be applied to most ponding water areas within communities to effect the most cost-efficient means of drainage. Field engineers and promoters should have in their job description the requirement to analyze community drainage problems and possible solutions during water system construction. Some quantities of materials should be made available during water system construction to apply to drainage measures identified as appropriate and affordable, e.g., 12" to 18" metal culverts, 6" PVC pipe, rock, cement.

3. The following represent low-cost drainage measures that can apply:

   a. Cross-ditching to connect ponding areas where elevations permit to allow positive drainage out of low areas and into natural drainage courses. This is similar to control work for physical control of larval mosquitoes.

   b. Installations of piped drains under roadways to drain road ditches without outlets. Pipelines such as 12" to 18" metal culverts, and 6-inch diameter PVC can be appropriate drain lines for such practice. Pipe should be located to have sufficient slope (average 2 percent grade minimum) and accessibility to be maintained. In some instances, road grades are such that one side of a road only needs to be drained through an underground connection to the other side to continue in natural drainage ways.

c. In some locations construction of small- to medium-sized seepage drain pits, with similar specifications as those for dwelling and well-drainage pits, can be installed in areas of problematic drainage. This is not a method of first choice due to maintenance requirements for longevity of operation.

d. In communities with relatively flat terrain and not much natural drainage, the emphasis should be on the construction of individual drainage pits. In this manner, the dispersed disposal of discarded water can curtail the collections from many families.

e. In extreme cases, absorption wells could be constructed to collect water and allow side-wall absorption (similar to septic tank systems with identical absorption wells in lieu of drain tiles). Absorption wells would not have to be deep--from 5 to 10 feet in depth and 4 to 5 feet in diameter--in order to function adequately. Wells so constructed would need a grate to allow water passage but exclude other material. Longevity of operation would be dependent on the permeability of the subsoils and the degree of annual siltation which will in time require removal.

ANNEX I

ENVIRONMENTAL REVIEW SURVEY FOR A RURAL WATER SYSTEM
AND SANITATION PROJECT OR "WATERSHED SURVEY".

"WATERSHED SURVEY"

Environmental Review Survey for a Rural Community Water System and Sanitation Project

Person _____ Date _____

A. Name and Location of Community

(Note: Provide community profile data per regular MSP or REDS forms)

B. Watershed Factors

1. Present Condition:

	Yes or No	Comments
Excellent: Without erosion and deforestation problems, little human impact, quantity and quality water is excellent, positive stability tendency, natural regeneration occurring.	__	__ _____
Good: With small problems of deforestation and limited human impacts, quantity and quality of water is good, some negative stability tendency, mostly natural regeneration occurring.	__	__ _____
Poor: Much deforestation and erosion, moderate level of human impact, quantity and quality of water is variable, stability tendency is negative, little natural regeneration.	__	__ _____

	Yes or No	Comments
Bad:		
Very bad deforestation and erosion, high level of human impacts, quality and quantity of water is very variable, stability tendency is negative, very little natural regeneration.	__	__

2. Activities in Watershed:

	Yes or No	Comments
Traditional Agriculture:		
Corn and Beans, Sacate	__	__
Production Agriculture:		
Bananas, Coffee, Sugar Cane	__	__
Cattle Grazing	__	__
Forest Harvesting	__	__
Family Dwellings	__	__
No Present Activities	__	__
Other (identify)	__	__

Land Ownership in Watershed (Describe)

Private Lands : _____

National Lands : _____

Undocumented Lands : _____

	Yes	No	Comments
4. Conservation Potential for Watershed and Water Source	__	__	_____
Community Land Rights Established in Watershed			
e.g. legal process —\NERH\	__	__	_____
Reforestation Methods Applicable			
e.g. planting, vegetation conversion	__	__	_____
Protection Methods Applicable			
e.g. fencing	__	__	_____
Management Practices Applicable			
e.g. erosion controls, alternative grazing lands	__	__	_____

Hydrologic Characteristics

a. Duration of Rainy Season: _____

Duration of Dry Season: _____

Duration of Canicula: _____

b. Approx. Precipitation Annually: _____

Approx. Size of Watershed: _____

Approx. Cover of Natural Vegetation, Percentage: _____

c. Sources of Contamination, Describe if applicable:

Dwellings: _____

Pesticides: _____

Fertilizers: _____

Cattle: _____

Erosion: _____

Others: _____

d. Existing Users of Proposed Water Source,

Describe if applicable:

Animal Use, e.g. Cattle:_____

Irrigation Uses:_____

Family Use:_____

Others:_____

e. Water Quality of Water Source

Chemical/Physical:_____

Bacteriological:_____

Pesticide/Hydrocarbons (if suspected):_____

C. Groundwater Factors

1. Present Conditions:	Yes	No	Comments
Low Groundwater Table: (below 40 to 50 m)			
No hand dug wells possible in community; little contamination potential from latrines to water sources	__	__	_____
Moderate Groundwater Table: (4 to 40 m)			
Hand dug wells possible in community, possibility of contamination from latrines	__	__	_____
High Groundwater Table: (0 to 3 m)			
Latrine contamination potential is high without protection measures or special designs, with or without hand dug wells	__	__	_____

2. Seasonal Variation in Groundwater Table

Dry Season: _____

Wet Season: _____

3. Existing Wells in Community

Number: _____

Average Depth: _____

Static Waterlevel: _____

4. Existing Latrines in Community

Number: _____

Average Age: _____

Pit or Surface Type: _____

5. Reports of Groundwater Quality Related Problems (e.g. contamination, teeth problems.)

Describe: _____

6. Records of Tests of Groundwater Quality

Chemical/Physical: _____

Bacteriological: _____

Other: _____

D. Land/Geologic Factors

	Yes or No	Comments
1. Drainage Conditions within Watershed:		
Mountainous: Lands very steep with high peaks and deep valleys, generally high in elevation	__	_____
Rough: Some steep lands and valleys, moderately sloped lands occurring, moderate elevation	__	_____
Undulating: Rolling lands with few steep parts, some gradual slopes, moderate elevations	__	_____
Plains: Mostly flat lands, little natural drainage, low elevations	__	_____
2. Drainage Conditions within Community:		
Mountainous/Rough: Broken up and mostly steep slopes with very defined natural drainage ways	__	_____
Undulating: Some natural drainage due to elevation differences, some flat areas with ponding waters	__	_____

Yes or No | Comments

Flat:

Many flat areas with pending waters,

poor natural drainage __|__|_____

3. Soils:

a. Watershed Soils

1. rocky, little top soils

(less than 30 cm) __|__|_____

2. medium soils (30-90 cm) __|__|_____

3. deep soils (90 cm) __|__|_____

b. Community Soils

1. rocky, little top soils

(less than 30 cm) __|__|_____

2. medium soils (30-90 cm) __|__|_____

3. deep soils (90 cm) __|__|_____

c. Degree of Erosion Evident

1. Watershed erosion, describe:_____

2. Community land erosion, describe: _____

d. Soils Conservation Practices Evident:

1. Watershed practices, describe:_____

2. Community Practices, describe:_____

ANNEX II

ENVIRONMENT ASSESSMENT--REVIEW MATRIX OR RWS&S PROJECTS OR "WATERSHED ASSESSMENT".

"WATERSHED ASSESSMENT"

Environmental Review Matrix

for

Rural Water and Sanitation Projects

Note: Information to be based on a completed Environmental Review Survey.

I. WATERSHED FACTORS

A. Present Condition

Implications and Appropriate Actions

Excellent ☐ Primary actions to take should be preservation oriented, especially community land rights establishment. Watershed restrictions/preservation most feasible techniques.

Good ☐ Preventive measures need emphasis, community land rights, conservation techniques, some reforestation, fencing of defined area to protect water source/watershed.

Poor ☐ Comprehensive approaches needed, inter-agency coordination essential, need for community land rights, reforestation, fencing of water source/watershed; water system longevity in jeopardy.

Bad ☐ Lands may be beyond repair, potential for water system to serve useful life of 20 years very poor, comprehensive rehabilitation may be needed before establishing a water system.

B. Activities in Watershed/Contamination Potential

Heavy Agricultural Use ☐ Danger from uncontrolled chemicals use and pesticides, erosion controls needed, conservation emphasis, water sources highly vulnerable.

Cattle Grazing: ☐ Contamination potential if no fencing containments used, field rotation needed with conservation emphasis to avoid erosion from overgrazed land, water sources highly vulnerable, possibility should be investigated to relocate cattle and retire/preserve watershed areas.

Family Dwelling: ☐ Degree of contamination potential proportional to dwelling densities, emphasis needed on community land rights establishment, conservation practices, fencing watershed and reforestation. Also wastes control e.g. latrines.

No present Activities ☐

Emphasis on community lands rights establishment, conservation/preservation practices, fencing and monitoring by community.

C. Land Ownership in Watershed

Private lands: ☐ Communities may work through Hacienda owners to pay for lands to be reserved or to relocate dwellings. Direct negotiations with land owners needed. Financial costs may be high.

National Lands ☐ Communities must work through IERAC, Instituto Ecuatoriano de Reforma Agraria y Colonización. Negotiations with land dwellers needed to limit activities, establish boundaries, and improve watershed. Negotiated payments may be necessary to restrict watershed lands, IERAC can assist in negotiations. Financial costs should be reasonable.

Undocumented Lands (Terreno Ejidal) ☐ Community must petition local municipal mayor for land rights to protect and conserve watershed. Land dwellers practices can be modified or alternatives sometimes found e.g. relocate cattle grazing lands. Financial costs should be reasonable.

C. Conservation Potential for Watershed and Water Source

Community Land Rights

Established in Watershed ☐

Best potential to effect activity Watershed restrictions and conservation in watershed, fencing protection possible and ability to undertake reforestation program if needed, longevity of water source enhanced, costs usually dependent on land ownership and size of protection area defined as necessary.

Reforestation Methods

Applicable ☐

Emphasis on appropriate species planting, lowest cost alternatives selection, community participation essential, usually represents intensive efforts combining soils conservation techniques and watershed protection measures e.g. fencing, monitoring. Three nurseries may be needed to allow avg. 5 month growth followed by planting and monitoring for min. y years to establish new growths. Can be an expensive undertaking but essential to rehabilitate areas in need.

Protection Methods

Applicable ☐ Emphasis on preventive measures, restricted access, fencing, community monitoring, prohibited activities like cutting, burning and planting, limits on additional dwellings, cattle, grazing. Reasonable costs usually associated.

Management Practices

Applicable ☐ Emphasis on erosion control, soils conservative techniques, possible relocation and rotation of grazing lands, natural fertilizer use and promotion of permanent types of agriculture. Cost dependent on degree of activities undertaken. Where needed, conservation techniques are essential to prevent further watershed deterioration. Also essential to protect long term water quality of water source.

Restricted Water Source

Usage i.e. at the

Source ☐ Community restricted use has best potential to allow physical protection at a water source; fencing possible; minimizes competition for water; longevity dependent on watershed conservation. Overuse e.g. water to be

shared with irrigation or animal watering may compromise community water use.

D. Water Quality Tests

Bacteriological Analyses ☐ Usually most important test to establish potability, tests may indicate human or animal fecal contamination occurring and need for immediate preventive actions, chlorine addition offers disinfection and a degree of safeguarding from recontamination. Continual testing, record keeping and monitoring highly recommended.

Chemical/Physical Analyses ☐ Useful for initial determination of potability, little modification potential if outside boundaries of chemical quality; treatments possible for physical parameter control e.g. filtration, sedimentation techniques. Also useful to perform periodically to monitor water quality changes overtime, impacts form- watershed activities and seasonal variations.

Pesticides/Hydrocarbon Analyses ☐ Useful for baseline determination of potability, especially if chemical applications occurring in watershed; may indicate necessity to control/change practices in watershed. Determinations needed during rainy and dry seasons to understand variations and effects of runoff. Very useful for long term monitoring and contaminant control in sensitive watershed.

II Groundwater Factors - Water Wells & Latrines

A. Water Table	Implications & Recommended Actions.
Low, below 40 or 50 meters ☐	Usually little potential for hand dug wells unless handpump of expensive design is used; little groundwater cross-contamination potential if standard sanitary protection is used at a well e.g. deep well with mechanical pump. Water quality usually stable, low monitoring level necessary.

Moderate, 4 to 40 meters 	Hand pumped wells applicable with normal designs, emphasis needed on proper locating and protection complimentary with proper latrine promotion; contamination potential exists if sanitary protection measures ignored; water quality is vulnerable, continual water quality bacteriological monitoring is needed.
High, 0-3 meters 	Implies need for special designs of latrines to prevent cross contamination in water table; may be impossible for pit-type latrine to function, surface composting latrine types are applicable if maintained & compatible in design with the community. Any water wells need regular bacteriological monitoring & maintenance up-keep to maintain potability.

B. Existing Wells or Latrines in Community

Significant Number Present e.g. multifamily wells and family latrines are common 	Implies need to determine present potential of cross contamination and adequacy of designs in place, may result in design modifications necessary before additional wells/latrines can be safety provided.

Low Number Present e.g. few wells & family latrines ☐	Less potential impact from present wells or latrines, some care needed in locations where present designs are inadequate to protect new installations e.g. avoid wells in vicinity of latrines in high groundwater table areas.

III Land/Geologic Factors	Implications & Recommended Actions.

A. Drainage Conditions in Watershed

Mountainous or Rough Lands

☐ Erosion potential high, soils conservation emphasis needed, watershed management program essential to establish for longevity of a water source; contamination prevention measures are critical, see Section I-C.

☒ Undulating or Flat Lands

☐ Some erosion potential and soils conservation measures needed. Watershed management program essential to establish for longevity of water source; contamination prevention measures are usually less difficult but still essential, see Section I-C.

B. Drainage Conditions In Community

Mountainous or Rough Lands

☐ Soils conservation practices needed, adequate drainage usually not problematic, water wells and latrines need protection from runoff intrusion.

Undulating or Flat Lands

☐ Drainage improvement measures may need attention and possible construction of cross ditching, piping, drainage pits. Recontamination potential is high for standing pools of water; disease carrying vectors can breed also. Emphasis needed also on individual drainage pits at well sites and family water discard locations.

C. Soils

Watershed soils

☐ Rocky
Less than 30cm. Most erosion potential and need for soils conservation techniques and watershed management program; most potential for contamination of water source; may imply need of serious rehabilitation measures in a watershed i.e. if deforestation has occurred, see Sector I-C.

☐	Medium 30-90-cm.	Moderate erosion potential, need for soils conservation to preserve watershed, watershed management program needed to preserve water source longevity, see Section I-C.
☐	Deep 90cm.	Excellent soils with good potential longevity of a water source if watershed protection measures are applied. Most feasible areas to establish new vegetation and soils conservation measures to minimize erosion, see Section I-C.

Community Soils:

☐	Rocky Less than 30cm.	May imply need for surface type-composting latrines. Hand dug wells may be impossible and need for mechanical well drilling. Surface runoff contamination potential is high with need to protect any wells and latrines from intrusions. Used water may need piping to reach absorption areas.
☐	Medium to Deep 30 - 90cm.	Standard latrine designs usually applicable if no high groundwater problems. Hand dug wells also feasible

if water table is no deeper than 30 to 40 meters. Contamination potential less but still imperative to provide protection from runoff intrusions and proper drainage of used waters.