

**TOWARDS A
HEALTHIER ENVIRONMENT:**

*A Strategy for
Environmental Health
in LDCs*

Office of Health
Bureau of Science and Technology
Agency for International Development

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1. Executive Summary

The objective for global international health programs is "Health for All by the year 2000". If we are to be successful in achieving this broad goal, health programs must begin to focus on preventing the major causes of public health problems. "Health for All" is not a matter of providing treatment for all cases of preventable diseases, but rather, establishing preventive processes, then providing treatment only when prevention fails. An international effort focused on environmental health issues can be considered the most basic form of preventive intervention. The Agency for International Development's Environmental Health Strategy has been formulated within this context and that of broader Agency policy (Appendix A).

Environmental health is defined as encompassing those diseases and health problems that result from environmental conditions or are exacerbated by environmental degradation. Environmental health risks are associated with the following categories: water supply and sanitation; wastewater management; solid waste management; air pollution control; toxic radiological and hazardous waste management; occupational health; injury prevention and control; food hygiene; and vector borne disease control.

This Strategy presents a program objective and an approach to managing environmental health problems. The Strategy consists of two elements: risk assessment and risk management. Specifically, this Strategy addresses the need to be able to measure and characterize the risks, and manage environmental conditions through prevention, control and remediation, in order to minimize health risks.

2. Introduction

Environmental issues are receiving increased technical and political attention. In particular, the detrimental impacts of rapid urbanization and population growth, coupled with industrialization have increased public awareness of environmental issues. These issues include the adverse effects of environmental change on human health. There is increasing recognition that without a healthy population, sound development is not possible.

Most developing countries can expect their populations to double in 20-30 years if current population growth rates continue. Growing numbers of these people are migrating to the cities. This influx, combined with high rates of natural increase among urban residents, is driving urban growth to record levels. This rapid urbanization has several adverse consequences for the environment which impact upon human health. First, urban dwellers consume more resources and generate more wastes than their rural counterparts. Second, rapid growth creates urban sprawl as impoverished families crowd into informal settlements on the periphery of towns. Shanty town and slum dwellers represent on the average 30-60% of the urban population in developing countries (Harpham et al.) Finally, rapid growth overwhelms efforts to provide basic services and curb pollution. Local governments and existing infrastructure become unable to keep up with the demand for adequate and safe water, sanitation facilities, sewerage, and solid waste collection. For example, in Nairobi, Kenya, which has grown by 6% annually since 1985, two in five residents live in shanty towns with no piped water, no sewerage system, and no lighting or access roads.

Environmental degradation affects human health, but the relationship between the two is complex because of the multiple factors involved, their synergistic effect, and different local situations. As a result, there is a paucity of precise data regarding environmental health conditions. Nevertheless, events like the current cholera epidemic in Latin America dramatically illustrate the severity and urgency of environmental health problems.

Cholera, a water-borne disease, was virtually unknown in modern South American history; until the recent outbreak began in Peru. Although cholera had been identified as an Asian, then an African health problem, once the disease was introduced to Latin America, environmental conditions—inadequate water and sanitation supplies—provided the ideal conditions for its rapid spread. As of March 12, 1991, more than 142,000 cases of cholera and 991 deaths had been reported in Peru. Besides the health impact, this epidemic has had enormous impact on the economy of Peru: the first two months

represented a loss of at least 250 million dollars, equivalent to 20% of the planned investment in basic sanitation for 10 years. Thus, the countries of the region are beginning to pay a new debt, an environmental health debt which has been accumulating over the last two decades through neglect of safe water and inadequate sewage and excreta disposal. Without increased attention to these areas of environmental health problems—water supply and sanitation and others described in this Strategy—we can only expect such examples of dire public health problems to multiply.

Everyone's health is affected by the environment. While new concerns are emerging about human health in the urban environment, rural environmental problems persist. Rural water supply and sanitation inadequacies and concomitant health problems have been well-documented. New problems call for attention: increasing concern is being voiced regarding overlooked rural health problems, such as indoor air pollution (Appendix B.4). Many environmental pollution problems are not confined to either rural or urban locations: they know no geographic boundaries. Contaminated water, air, and land resources impact everyone. The problems also touch every social stratum: rich and poor alike eat contaminated foods, drink unsafe water and inhale polluted air. However, a deteriorating environment places the greatest health burden on the poor, and women and children are particularly at risk. In Bombay, India, where one third of the residents live in slums, 70-75% of the women slum dwellers complain of generalized weakness and anaemia; 50-60% suffer from chronic malnutrition, avitaminosis, recurrent gastroenteritis and helminthic infections (Harpham et al.). In São Paulo, infant death rates for enteritis, diarrhea, and pneumonia in the urban periphery (slum dwellings) are twice as high as in the core urban area (Harpham et al.). Consequently, investments in environmental health directly benefit the vulnerable groups which have been of greatest concern in the A.I.D. health portfolio—poor women and children.

2.1 Problem Statement

Environmental health encompasses those diseases and health problems whose origin is environmentally based. These problems range from the direct health impacts of human interactions with the environment, to indirect health impacts of environmental degradation. Many environmental health problems are closely linked to one another, since pollutants, for example, can move from one medium to another. However, it is useful to distinguish nine subsectors of environmental health, comprising:

- Water Supply and Sanitation
- Wastewater Management
- Solid Waste Management
- Toxic and Hazardous Materials Management
- Air Pollution Control
- Occupational Health

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- Injury Prevention and Control
- Vector Borne Disease Control
- Food Hygiene

The importance of particular subsectors varies enormously from one developing country to another. For many countries, the greatest environmental challenge to health is the lack of clean water; in others, intense economic development and industrialization, driven by pressing needs of population growth, have dramatically changed the incidence and prevalence patterns of environmentally-related diseases. Across the developing world, however, the scope of the problem is both large and complex, involving multiple and interconnected causes of many diseases in some sixty developing countries (Table 1).

To reduce morbidity and mortality due to environmental factors, developing countries need first to be able to characterize the problems for their own countries, and assess their magnitude. Bradley et al. have summarized the available literature and found that, in general, data do not exist for most aspects of environmental health in developing countries. The available material, while not comprehensive, clearly establishes the need for current information and data on environmentally-determined health problems.

Developing countries next face a need for means to alleviate environmental health problems. To the extent that technical solutions are called for, the U.S. has much to offer. We already have many of the appropriate technologies and much relevant experience and knowledge. Technical expertise is readily available at various levels of government, in the private sector, and in the not-for-profit sector. What is required is the transfer of this knowledge and, working with host governments, the establishment of policies and regulations that prevent future problems.

Technical interventions alone are not effective in treating environmental health problems, and certainly cannot be sustained, without attention to human resource development, and the institutional and policy framework of the host country. A.I.D.'s assistance must integrate appropriate technical assistance with these social and policy elements. The Office of Health has long experience in several of the subsectors of environmental health: in water supply and sanitation, wastewater management, and solid waste management through the Water and Sanitation for Health (WASH) project and mission-funded programs; and in vector-borne disease control through the Vector Biology Control (VBC) project and mission-funded programs. Elsewhere in A.I.D., the Housing and Urban Development Program focuses on housing and shelter initiatives, which encompass many of these environmental issues.

Table 1

DATA ON ENVIRONMENTAL HEALTH PROBLEMS

Water & Sanitation	◇	Approximately 1 billion people lack safe drinking water and 2 billion lack sanitation (not counting China).
	◇	The ten principal water-related diseases cause 5.5 million deaths per year, and over 28 billion incidences per year.
Wastewater Management	◇	Sewerage connections only reach 14% of the urban population in Africa.
	◇	Surveys of wastewater treatment plants in Mexico and Algeria both showed that over 40% were out of service.
Air Pollution	◇	Over 1 billion people live in urban areas where the level of particulate matter exceeds the WHO chronic and acute guidelines. 96% of GEMS monitoring stations in Asia exceed the WHO guidelines for average particulate matter levels.
	◇	In Mexico City, the highest particulate matter levels are in the Northeast and Southeast, where the low income groups live.
	◇	Studies of the burning of biomass fuels inside homes in Nepal show particulate matter levels several to ten times the WHO guidelines.
Food Hygiene	◇	Current knowledge indicates that 15 to 70% of cases of diarrhea are food borne.
Solid Waste	◇	In many LDCs a large percentage of solid waste remains uncollected - 20% in Bangkok; 30% in São Paulo and 78% in Dar Es Salaam.
	◇	Studies of the health effects of contact with solid waste showed that over 40% of people at dumpsites had gastroenteritis and parasites, 50% had extremity wounds, and 70% had upper respiratory ailments.

Table 1 (Continued)

DATA ON ENVIRONMENTAL HEALTH PROBLEMS	
Vector Borne Disease Control	◇ Malaria is responsible for more than 1 million childhood deaths in Africa, primarily in infants.
	◇ Dengue hemorrhagic fever (DHF) in Thailand in 1987 resulted in 170,000 cases. The cost of an epidemic in Thailand in 1980 was about \$7-10 million.
	◇ Chagas disease, which causes heart damage, enlargement of the liver, spleen and lymph glands and can be fatal, is caused by protozoa which live in mud walls and thatch roofs. It infects an estimated 24 million people in Latin America.
Toxic, Hazardous & Radiological Waste	◇ While data are limited, current information shows that four Sub-Saharan African countries imported over 25,000 tons of hazardous wastes in 1983.
	◇ The National Environment Board of Thailand estimates that hazardous waste generation grew 46% from 1986 to 1991, and is expected to grow an additional 84% in the coming 5 years.
Occupational Health	◇ WHO estimates that there are 2 million unintentional acute pesticide poisonings among workers per year.
Injury Control	◇ In Thailand; more person-years of life are lost from motor-vehicle injuries than from malaria and tuberculosis combined.
	◇ Unintentional injuries are the leading cause of death in Latin America for people aged 1-44 years.

3. Strategy

This Strategy proposes a comprehensive approach applicable to any area of environmental health. It incorporates A.I.D.'s existing capabilities and expands on them, where necessary. Its purpose is to assist host country institutions to establish policies and practices in two principal modes of intervention:

- Risk Assessment
- Risk Management

The specific interventions proposed under the environmental health rubric will consistently be aimed at developing indigenous policies and capacity to institutionalize the health risk assessment and management approach to identifying and resolving environmental health issues. Most frequently, the technologies likely to be required for remediation will be the result of research and development in sectors other than health (e.g., agriculture, industry, shelter), making cooperation and collaboration across sectors essential to success.

The strategy involves characterization of environmental health risks through risk assessment, and implementation of activities to manage (prevention and control) and reduce (remediation) public health risks. The term "risk" refers to the likelihood that a particular condition or event will have an adverse effect, direct or indirect, on human health. Each component of this strategy is discussed further below.

3.1 Risk Assessment

The process of risk assessment involves collecting, analyzing and communicating information for use in policy formulation, decision making and risk management. Since information is the basis for action, the gathering of information on the risks to health posed by changes to the environment is a key component, and first step in this Strategy. With this information, risks can be quantified and compared. Alternative management actions—including no action—for mitigating each risk are identified. The objective is to use risk assessment as a tool for arriving at environmental decisions that will ensure the protection of public health. For environmental public health problems risk assessment must involve analytical expertise from at least the following technical viewpoints:

- demographic
- epidemiological
- bacteriological
- toxicological
- physical and chemical
- behavioral

Various techniques exist for conducting such risk assessments, for example: hazardous inventory analysis, environmental impact assessment, sanitary surveys, and public health epidemiological approaches. In addition, there are new tools for creating and maintaining data bases to aid decision making. The approach needs to be specific to the problem and within the user's (host government's) capability to carry out and maintain. There is, therefore, no universal risk assessment method. In many cases lack of data will require that analysis be truncated in some way.

It is important to note that in this Strategy risk assessment is intended not only as a tool for problem definition, but also as a method for measuring impact. Therefore, risk assessment must be ongoing. A.I.D. has historically focused on measuring input variables, such as, the number of wells drilled for a water project. We need to measure not only the number of wells drilled, but the impact of a new water supply on the whole community: this approach will involve basic, applied, and operational research.

3.2 Risk Management

Once the results of risk assessment have been presented as clearly as possible, the next step in the strategy is risk management. Whereas risk assessment ideally consists of objective, quantifiable determinations, risk management involves such unquantifiable factors as perceptual, cultural, economic, and political influences.

Under risk management there are three components, namely:

- Prevention
- Control
- Remediation

Risk management can focus on changing personal behavior, through education and training; or it can focus on the community level, involving policy, infrastructure and institutional issues. The two are clearly interrelated. For each of the nine subsectors, specific interventions are discussed in Appendix B. The overall approach is presented in this section.

3.2.1 Prevention

The first objective is to prevent environmental deterioration and the consequent risks to health. Prevention implies providing a safe, healthy setting in which to live, as suggested by the title of this Strategy—not simply an absence of specific diseases. Interventions will, for the most part, not be classical medical interventions, such as a vaccine, but rather the provision or maintenance of clean air or water, and therefore may involve technologies like waste and wastewater treatment plants, air filters, smokeless stoves, or

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lead-free gasoline. It could also involve decisions regarding locations of housing or industry. These improvements are best accomplished through policy and regulatory development, institutional development, communication, and education.

3.2.2 Control

All life leaves its impact on the environment: to some extent, a degree of environmental deterioration is inevitable. When environmental problems cannot be prevented, such as the contamination of surface water, control measures must be put in place to treat and reduce the risk. Control is, therefore, an acceptable practice when prevention is not possible. Under other circumstances, the magnitude of an environmental problem demands control measures as a first step. For example, where diarrheal diseases are rampant, control strategies are essential to save lives and reduce the problem to manageable proportions. But control strategies waste valuable resources if they are not supplemented and replaced by preventive measures.

3.2.3 Remediation

Risk remediation occurs as a short-term response to an existing problem, such as a cholera outbreak or a toxic spill. In most A.I.D.-assisted countries, most environmental health problems are preventable and/or controllable, but risk remediation is appropriate in extreme circumstances. Risk remediation is not a primary objective of this Strategy, but should be considered as a step towards control, then prevention.

This Strategy defines the Agency's response to host country needs in environmental health. (Shorn of A.I.D. references in a few sections, it would also serve as an appropriate strategy for either a host country, another donor, or a multilateral agency.) It is guided by A.I.D. policy, and will promote coordination and collaboration across sectors within A.I.D., and with other donors active in environmental health.

The environment is becoming an increasingly appropriate lens for focusing attention upon preventive aspects of international health. Although there may be LCD "Love Canals" to be found and solved, the emphasis here is not on curative measures. The focus of this Strategy is on prevention, to ensure that the net result of development is environmentally, as well as politically, socially, and economically beneficial.

4. Setting Priorities

A.I.D. has been active in environmental health for many years through its water supply and sanitation and vector control programs. However, when considering any expansion, either of existing activities or into new areas, it is important to recognize that resources are limited, and acknowledge the need to "do fewer things better but do them very well". We cannot expand our efforts to every A.I.D.-assisted country, nor is every subsector of environmental health equally relevant to every country's development. The purpose of this section is to present a framework for setting priorities. This framework draws upon information assembled at the Office of Health Environmental Health Workshop (Appendix C) and information provided by Missions (Appendix C).

Choice of countries: Given A.I.D.'s responsibility to work with and serve developing country needs, priority should be given to those host countries whose governments will make a commitment to address environmental health issues over the long term. In addition, country selections should also be made in such a way to maximize A.I.D.'s efforts, by reaching out to Missions which have the capacity on their own staffs to support the commitment to environmental health. Likewise, we must explore opportunities to combine emphasis country efforts, for example, by selecting countries where initial environmental health efforts can be combined with or benefit from other development interventions, such as occur in those countries already designated as Child Survival or Environmental Emphasis countries.

Choice of subsectors: In each country, the selection of most appropriate environmental health subsectors will be based on the following selection process. Clearly, the primary selection criterion is the impact of the problem on human health: here, preliminary risk assessments will be essential. Second, the problem must be amenable to known solutions: that is, we should focus on the most pressing problems for which there are proven remedies or approaches. Third, the costliness of remedies must be considered: we should select critical problems with known solutions that are cost effective. Next, there are some problems which are suited to A.I.D.'s technical expertise, and others which other donors, NGOs, or universities are more capable of addressing. It is important to note that global, regional or local problems may require different approaches, and different combinations of actors. Therefore, we propose a combined approach to priority-setting involving all the components listed above. Finally, we will be active in increasing host country awareness of the health impacts in all relevant subsectors of environmental degradation.

Magnitude of effort: In light of A.I.D. expertise, human health costs, and developing country priorities, A.I.D. will continue to give priority to dealing with health risks related to water supply and sanitation and vector-borne disease issues. Increased effort will also be directed towards wastewater and solid waste management, areas in which A.I.D. has

recently begun to work. Of second but-increasing priority should be identification and resolution of health risks related to air pollution control and toxic and hazardous waste management. In countries in which A.I.D. is a sponsor of urban or industrial development, the third priority areas should be occupational health and injury control. Food hygiene is an important area, primarily for diarrheal disease control, and needs to be addressed, at a minimum, in health education programs related to child survival.

5. Conclusions

Environmental health problems take a very large toll on human health. A number of problem areas affect literally billions of people in the developing world, with the greatest effect on children, the poor, and women. The problems are magnified in rapidly growing urban areas, and will be exacerbated by continued economic development and population growth. The daunting question we face is this: how can human health and well being be sustained and enhanced in an increasingly crowded world?

The Strategy outlines a concentrated, yet broad-based effort by A.I.D. to assist governments and other local institutions in two fundamental ways. The first task is to assess the risks to human health posed by factors in the environment, or by environmental deterioration. Considerably more data need to be collected and assessed, in order to identify environmental subsectors of greatest relevance to an individual country, and to monitor changes over time. The second element of the strategy is to assist host countries in managing these risks, ideally by prevention; but in some circumstances by control and remediation, with a commitment to progress to preventive measures over time.

This Strategy promotes host country institutional and human resource development as the way to achieve sustainable health risk assessment and management. With technical assistance from A.I.D. and the collaboration of other institutions, host countries must develop the capacity to carry out applied and operations research, and maintain the information systems necessary to select environmental health issues of greatest importance. This requires a commitment on the part of host country organizations to recognize and act upon environmental health concerns, and evidence of that commitment will guide A.I.D.'s choices of countries in which to implement this Strategy.

The Strategy describes nine subsectors of environmental health: the choice of subsectors for special effort will depend on the needs and capacities of the host country and the initial risk assessment. A.I.D. will maintain and expand efforts in those subsectors in which A.I.D. has been active for many years. A.I.D. will add or access technical expertise in new sectors where there are strong linkages to "traditional" sectors; or where risk assessments indicate that new threats to health are emerging, particularly where these

threats are associated with environmental changes related to development activities initiated by A.I.D.

This Strategy poses a challenge to A.I.D. The solution to many serious health problems lies outside of the health field, with engineers, town planners, policy makers, industrialists, or educators. The role of the health professional in carrying out this Strategy will be to conduct the risk assessment, and bring that analysis to the attention of the many others involved in decision-making associated with the development process. As an Agency, the role of A.I.D. in carrying out this Strategy will be to foster cooperation across the Agency and with other organizations, to bring multidisciplinary efforts to bear on risk management. While environmental health is a growing concern, A.I.D. has a good opportunity to be a focal point for broad efforts, and to lead the way to a healthier environment.

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Appendices

Appendix A

Agency Policy and Environmental Health

The Administrator has set out a road map for reaching Agency goals and objectives, as defined in his Mission Statement and Initiatives. Environmental health is an important building block in meeting the objectives of the Agency Mission Statement. This Strategy is responsive to health sector and environmental sector policy papers, and is included within the Agency Environmental Initiative.

A.1 Agency Mission Statement

The Administrator has articulated a six point Agency Mission Statement. This section will briefly describe how this Strategy is responsive to each of the six points.

—Support for free markets and broad-based economic growth

Environmental health focusses on pollution control. Experience within the U.S., Japan, and Europe indicates that "environmentally clean" industries are more profitable. It will also put industrial markets on a similar footing. Therefore, investments in pollution control will increase productivity and reduce inefficiencies, thus ensuring the support for free markets and broad based economic growth.

—Concern for individuals and the development of their economic and social well-being

If economic growth occurs, a case can be made that the economic and social well-being of the individual members of the society will also increase. However, the situation in the field is much more complex. Large industrial firms have been allowed to pollute and profit at the expense of the individual, or small-enterprises. If so-called "brown pollution" is controlled, a cleaner environment allow the sustainable growth of other sectors such as farming, fishing, and forestry.

—Support for Democracy

Successful environmental health is primarily a preventive process; therefore, it is most effective when it begins at the community level with individuals. A.I.D.'s

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experience in water supply and sanitation has demonstrated additional benefits beyond the health sector. Rural water projects are often the beginnings of community participation and action at the village level. A community's first experience of the democratic process may occur through the successful participation in and ownership of such a local project. Such activities, therefore, assist to promote democratic reform.

—Responsible environmental policies and prudent management of natural resources

This program is included under the Agency Environmental Initiative (see following section), therefore this program is most specifically responsive to this statement.

—Support for lasting solutions to transnational problems

While this initiative was developed with political problems as its focus, it is not inappropriate to apply it to environmental health problems. Unlike many other health problems, environmental health problems are transnational. Pollution of waterways and the air are issues that cross international borders, therefore pollution control is a transnational issue, and solutions to pollution issues may benefit the populations of many countries.

—Humanitarian assistance to those who suffer from natural or man-made disasters.

Severe environmental degradation through pollution can have catastrophic results. An effective pollution control program to improve public health will reduce the likelihood of some human-caused disasters.

A.2 Agency Initiatives

The Agency currently is focussing on the "Four Plus One" initiatives, the Administrator's road map to development assistance. The following section briefly describes how an environmental strategy is, within the health sector, uniquely responsive to these five initiatives.

A.2.1 The Democracy Initiative

The objectives of the Democracy Initiative are to: strengthen democratic institutions; integrate democracy into the A.I.D. program; reward progress in democratization; and establish rapid response mechanisms to support emerging democratic states. Lessons

learned from the International Decade for Water Supply and Sanitation (1980-90) (Lessons Learned), indicate two important lessons:

- 1) That successful implementations require an initial focus on institutional development at the community, municipal, civil and national level; and
- 2) That community participation, through a democratic process at the village level is crucial to transferring ownership of projects to the community and therefore their successful implementation, operations, and maintenance.

These lessons not only apply to water, but to all the subsectors of environmental health. However, the concept of community may change from a rural village level water committee, to a peri-urban market cooperative, to a trade union, and finally to a large urban area. In all cases there must be participation by citizens and, to be successful, this implies a democratic process. Thus, while health "services" are "purchased" by patients, environmental health "interventions" are "activities" carried out in conjunction with the community (both men and women).

A.2.2 The Business and Development Partnership Initiative

Under the Business and Development Partnership Initiative there are six sub-activities proposed:

- 1) A capital projects fund,
- 2) A business and development network,
- 3) A business advisory council,
- 4) Emerging sectors in development,
- 5) Competitiveness through universities, and
- 6) Business internship for emerging markets.

Environmental health problems which result from environmental degradation can be exacerbated by inappropriate or irresponsible business practices. An increased focus on effective business management should result in improved environmental conditions. Further, it is recognized that there are critical applied and operations research needs for this sector, for which the Agency intends to solicit the assistance of universities and university interns.

A.2.3 The Family and Development Initiative

The Family and Development Initiative argues that the family is the starting point and the catalyst for effective change. The objective is to empower the family as a profit unit through grass-roots organizations and small enterprises to fuel the development process.

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Thus, it is important to invest in the family through education and public health: the family unit is critical to A.I.D.'s objectives. However, for the family unit to be the critical player perceived by this model, minimal conditions must be met, one of which is "good health". Preventable diseases and health risks must not be a burden on the family and therefore a limiting factor. An environmental health strategy focused on prevention is, therefore, pivotal in the well being of the family unit.

A.2.4 The Environmental Initiative

The A.I.D. Environmental Initiative is still being developed. It proposes the following:

- That three criteria be used in selecting critical environmental issues to be addressed:

Ecological
Economic
Public Health

- That the program be active in five subsectors:

Energy
Sustainable Agriculture
Biodiversity and Forestry
Pollution Control
Water Resources

- And, that the program focus on:

Policy Development
Institutional Strengthening
Private Sector.

Of the five subsectors listed above, all but one (biodiversity and forestry) would be classified as high priority according to the criterion of public health. Thus the link between health and environment is central to the proposed A.I.D. environmental initiative. To implement this initiative effectively, it is proposed that the environmental assessment process for all A.I.D. activities (both project and non-project assistance) be strengthened and that a health risk assessment also be required as part of the IEE/EA process.

A.2.5 Towards Strategic Management Initiative

The Management Initiative is focused on streamlining and excellence in the management of A.I.D. operations. A measure of the objective is "To do fewer things and to do them well." In this context, in A.I.D./W within S&T/H, the lead office for environmental health, it is appropriate to consolidate all aspects of environmental health under one umbrella program. At the Mission level this will provide a focused approach to what is now a series of unconnected activities.

Appendix B

Environmental Health Framework

The environmental health framework includes nine subsectors: water supply and sanitation, wastewater management, solid waste management, air pollution control, hazardous materials management, occupational health, injury prevention and control, food hygiene, and vector borne disease. While not exhausting environmental health concerns, this framework is sufficiently comprehensive to cover the major issues. The following section applies the risk assessment and risk management approach for each of the ten subsectors of the Strategy. Each subsector is defined, the environmental health problem characterized, and appropriate interventions outlined.

B.1 Water Supply and Sanitation

Definition: Safe water is water that does not contain microorganisms or chemical substances in concentrations that would cause illness in any form. An adequate water supply is one that provides safe water in quantities sufficient for drinking and for other household purposes so as to make possible the personal hygiene of members of households.

Sanitation refers to the means of collecting and disposing of human excreta and community liquid wastes in a hygienic way so as to not endanger the health of individuals and the community as a whole.

B.1.1 Problem Characterization

Water is an essential ingredient of human life. Everyone alive has a water supply, because without water life is not possible, but not all water supplies are safe. At present 1.2 billion people lack access to safe drinking water. For a large percentage of people in developing countries, their water supply is a river, lake, stream, spring, or well that is a breeding ground or carrier of disease-causing organisms or the home of disease-carrying insects. In recent years, chemical and industrial pollution have also become a threat to the water supply of many people. Water pollution is worsening in many developing countries due to rapid population growth, the lack of waste treatment, and unsafe disposal of toxic wastes. Indeed, the growing volume of untreated toxic wastes could render as much as 1/4 of the world's water supply unsafe for human consumption by the year 2000.

As for sanitation facilities; they are available mainly in established urban areas and generally lacking in most rural areas and urban fringe settlements. Worldwide, three billion people today are without access to appropriate sanitation. The rapid growth of cities has eclipsed efforts to provide adequate sanitation. In Nigeria, for instance, where

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the number of city residents grew by 80% between 1980 and 1990, six in seven houses lack sanitation facilities and dispose of fecal wastes on nearby land or water. Today, untreated human waste—not toxic or radioactive wastes—is the world's most dangerous environmental pollutant.

The lack of safe and adequate water supplies and sanitation in developing countries is associated with many public health problems. Table 2 shows the 37 diseases that are the primary causes of death in the developing world. It is important to note that twenty-one of the diseases listed in Table 2 are water and sanitation related in some fashion. These are printed in boldface type and include:

Diarrheal diseases, which kill 4.3 million people, mostly children, each year.

Malaria, with 150 million afflicted, and 1.5 million deaths.

Filariasis (Elephantiasis), affecting 90 million.

Schistosomiasis, with 200 million affected.

Onchocerciasis (river blindness) affecting 1-5 million.

Dracunculiasis (Guinea worm), which afflicts 15 million.

Water and sanitation are considered primary interventions for prevention for ten of the diseases listed in Table 2; diarrheal diseases, typhoid, schistosomiasis, amebiasis, hookworm, hepatitis A, ascariasis, giardiasis, trichuriasis, and dracunculiasis. The annual death toll from these ten diseases is just under 5.5 million, and the number of cases per year is over 28 billion. Since transmission of many of these diseases is complex and via multiple routes (ingestion and dermal), adequate water supply and sanitation will not prevent all cases of water-related diseases—but it will have a significant effect. Improved water supply and sanitation has made possible a 55% reduction in child mortality (Esrey et al.).

Providing people with an adequate water supply and sanitation reduces morbidity and mortality from many water-related diseases for a number of reasons. Clean water prevents the spread of waterborne diseases, such as common diarrheas and the classic waterborne disease, cholera. Furthermore, increased quantity of and access to water provides the opportunity to improve hygiene—for example, through washing hands and cooking utensils—and prevents the direct spread of pathogens through contamination of food, water, and other objects that may be put in the mouth. Improved water supply and sanitation may lead to decreased contact with unsafe, unimproved water sources and prevent health problems such as schistosomiasis and dracunculiasis. Water-based disease

vectors may be controlled by improving water sources and eliminating breeding sites of insects that carry a variety of diseases, including dengue and malaria. Research has shown that the most effective intervention for selected water related diseases (including diarrheal diseases) is safe excreta disposal, followed by increased water quantity and improved water quality. Therefore, sanitation facilities and health programs which emphasize hygiene education are critical for maximal benefits of a safe water supply to be realized.

Malnourished children, the elderly, and the poor are the highest impact groups. In many developing countries one in four children dies before his or her fifth birthday often due to water-related illness. Many factors affect the degree to which the potential risk posed by a pathogen becomes an actual risk of transmission. These factors can be broken into two groups; personal behaviors and external factors. Personal behaviors which can increase risk are related to hygiene and sanitation habits and include water handling and storage; choice of a water source; sanitation practices; early weaning; and crowded living conditions. External factors include low education; lack of funding for operation and maintenance; level of development; distance to water supply and its cost; and culturally inappropriate technologies.

While health impacts of improved water supply and sanitation have been documented, risk assessment requires further work in monitoring appropriate water quality indicators; determining time savings related to improved water supply; and measuring energy expenditure. In the policy and infrastructure areas, the overwhelming current needs of the water supply and sanitation sector, the projection of future demands from rapid population growth and urbanization, the limited capability of governments to meet even current needs, and reduced funding for development all point to the importance of capacity building within developing countries to address the health problems described above. An indigenous capacity for planning, financing, and implementing water and sanitation projects is necessary for sustainability. Central to capacity building is the development and implementation of policies and national sector plans. The role of the private sector in providing financing and delivering services is a critical element in successful establishment of indigenous capacity. Public expenditures in terms of overall appropriation and allocation levels should be closely analyzed. Cost recovery policies should be developed. Other interventions involve improved hygiene practices; maintenance of the family privy; and modified agricultural practices.

Table 2

**Causes of Death for Individuals of All Ages
- in the Developing World**

Conditions	Number of	Deaths	New
	infected persons		cases
	(thousands per year)		
Respiratory disease (upper & lower)	-	10,000 ¹	15,000,000 ²
Circulatory system	-	8,000	.
(Low birth weight) ³	-	(5,000)	(19,000)
Diarrhea	-	4,300	28,000,000
Measles	67,000	2,000	67,000
Injuries ⁴	-	2,000	.
(Malnutrition) ⁵	-	(2,000)	(5-8,000)
Neoplasms	-	2,000	.
Malaria	2,600,000 ⁶	1,500	150,000
<i>P. falciparum</i>	-	1,350	120,000
Tetanus	-	1,200	1,800
Tuberculosis	1,000,000	900	7,000
Hepatitis B	300,000	800	3,700
Whooping cough	55,000	600	51,000
Typhoid	70,000	600	35,000
Maternal mortality	-	500	.
Meningitis	-	350	1,000,000
Schistosomiasis	200,000	250-500	10,000
Syphilis ⁷	15,000	200	250
Amebiasis (Amebic dysentery)	500,000	70	40,000
Human immunodeficiency virus (HIV)	4,000	50-70	140
South American trypanosomiasis (Chagas disease)	24,000	60	1,200
Rheumatic fever and heart disease	-	52	2,200
Hookworm	800,000	50	1,500
Rabies	35	35	35
Diphtheria	60,000	30	600
Dengue	.	15	48
Hepatitis A	.	14	5,000
Yellow fever	.	9	82
Japanese B encephalitis	.	7	28
Ascariasis	700,000	10	700
Giardiasis	250,000	10	500
Poliomyelitis	150,000	2	220
Leprosy	1,000	1	1,000
Leishmaniasis	1,000	1	1,000
Trichuriasis (Whipworm)	500,000	1	100
Filariasis (Elephantiasis)	90,000	1	1,000
Dracunculiasis (Guinea worm disease)	1,000	1	1,000
Onchocerciasis (River blindness)	1-5,000	1	.
African trypanosomiasis (Sleeping sickness) ⁸	.	1	.
Other ⁹		1-2,000	

¹ 4 million of these deaths occur in children under 5 years old.

² 25 million episodes of acute lower respiratory tract infectious disease and 15 billion episodes of acute upper respiratory tract infectious disease.

³ Low birth weight is the underlying cause of death, although the immediate cause may be respiratory, diarrheal, or other disease; therefore, these deaths have also been counted in the other categories.

⁴ Drownings may be related to water supply conditions.

⁵ Severe malnutrition is the underlying cause of death, although the immediate cause may be respiratory, diarrheal, or other disease, therefore, these deaths have also been counted in other categories.

⁶ This is the population at risk inhabiting infected areas: 365,000,000 live in highly endemic areas.

⁷ Endemic syphilis (pinta and yaws) is water-related.

⁸ Only that caused by *T.b. gambiense* is transmitted by tsetse flies and therefore water-related.

⁹ Deaths of unclear etiology or diseases with relatively small numbers of cases.

Note: - not applicable; * no data.

Adapted from Walsh, 1990

B.2 Wastewater Management

Definition: Wastewater is the liquid wastes from homes and commercial premises, industries, and storm run-off. Wastewater management provides for wastewater collection and includes safe treatment, reuse or disposal.

B.2.1 Problem Characterization

Pathogenic viruses, bacteria, protozoa and helminths pass from the bodies of infected persons in their excreta and are present in wastewater. If the wastewater is discharged, untreated, into surface waters, these pathogens may reach other people via ingestion or dermal contact. In most developing countries wastewater receives virtually no treatment. As a result, surface waters are seriously contaminated. For example, water quality in one river in Jakarta has deteriorated so significantly as a result of untreated wastewater discharge, that the density of fecal bacteria is of the same order of magnitude as that of the human intestine. Not surprisingly, the high incidence of diarrheal disease in Jakarta is partly a result of contaminated water. The health risks presented by wastewater include the diarrheal diseases and other water related disease listed in Table 2 and discussed in Section 1. Those individuals particularly at risk are peri-urban residents, and populations living downstream of major urban centers without wastewater treatment facilities. Others at risk are those already weakened by malnutrition, the poor, aged, and children.

The most effective and reliable strategy for preventing transmission of disease caused by pollution of water resources by human wastes is to collect the wastes from settlements and to provide safe treatment and disposal. Wastewater collection by sewerage is minimal in developing countries. Conventional waterborne sewerage is prohibitively expensive for developing countries and at best is an option only for urban communities. Only 14% of urban populations in Africa are served by conventional sewerage. Furthermore, even where conventional sewerage systems are in place, 90-95% of the wastewater collected is discharged without treatment of any kind. Where treatment facilities are present, many are operating below standards due to operational problems. As an alternative to conventional water-borne sewerage, a range of appropriate on-site sanitation systems need to be developed further. Simplified sewage systems or small bore sewers are options that should be explored. Disposal options which require little or no treatment warrant more investigation. Wastewater reuse for agriculture and aquaculture are two such options already commonly used which present another area of health concerns.

Raw, untreated wastewater is used for crop irrigation and fish production, often illegally and without the approval of health officials, throughout the developing world. Significant disease is associated with these practices. For example, in Santiago, Chile, the

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widespread practice of irrigating vegetables with untreated sewage has been implicated in the unusually high typhoid morbidity rates. In Peru, the same practice is linked to an increased risk of Giardia for farm workers and consumers. The greatest risk of wastewater reuse for irrigation is from helminth infections which are neither detected by conventional microbial monitoring of wastewater quality nor necessarily removed by common treatment processes. Cholera and typhoid can be transmitted by this practice. In fact, food contamination by untreated wastewater irrigation of crops is suspected as a contributing factor in the current South American cholera epidemic. The group of people exposed to the risk of disease are field workers, crop handlers, consumers, and those living near the fields. Aquaculture, the cultivation of fish or aquatic plants for human consumption, animal feed or fish feed, is an increasing area of wastewater reuse in developing countries. Yet, there is little data on health effects related to aquaculture and virtually no guidelines for the protection of human health. Once again, wastewater treatment, while potentially providing the greatest degree of health protection, should be only one of the measures considered in addressing health risks associated with wastewater. Crop restriction; control of wastewater application; exposure control and hygiene promotion are also necessary.

The rapid industrialization which has accompanied urban growth has led to increases in the volume and toxicity of industrial wastewater. Industrial wastewater of concern from a public health perspective is that which contains toxic organic and inorganic compounds which comes from a variety of sources including pesticide, fertilizer, and petrochemical complexes; tanneries; paper and pulp mills; and rubber factories. Both acute and chronic effects on health of contaminants found in industrial wastewater have been documented. The major pathway is through ingestion either directly through drinking untreated water or indirectly by eating food which was irrigated with water polluted from industrial discharges. For certain chemicals, exposure may also occur through skin contact.

Drainage is the movement of excess water from an area by surface or subsurface means. Stormwater run-off is the wastewater most typically associated with drainage structures but leaking water mains, wastewater from washing and bathing, and the sewage from overflowing septic tanks and blocked sewers may also contaminate surface water and constitute health hazards if an adequate drainage system does not exist. The contaminated surface water can infect people in many ways. It can contaminate their hands, their utensils or their drinking water supply. In general, the urban poor who often build on land with drainage problems are at the highest risk for these diseases. More particularly, children are exposed to infection when playing or bathing in surface water. The water related diseases that are often fatal, such as cholera and typhoid fever as well as diarrheal diseases may result from inadequate drainage. Schistosomiasis, often thought of as a rural disease, is often no less prevalent in urban areas where drainage is lacking. Disease borne by mosquitoes also occur as a result of poor drainage. Maintenance of an adequate drainage system depends on an efficient solid waste service, as without one the drains will

soon fill with rubbish. Drainage also involves the cooperation of housing and urban planning and the roads departments.

Personal behaviors which increase risk of disease transmission from wastewater include water handling and storage practices; contact with polluted waters for drinking, swimming, bathing, washing clothes; living near irrigated fields or drains; living on marginal lands; working as a crop worker in wastewater irrigated areas; sanitation practices.

External factors which exacerbate the health risks from wastewater are as follows: For general wastewater, external factors include the absence of adequate wastewater collection, treatment, and disposal services; inappropriate technologies which have become inoperable; inadequate drainage systems; and climatic conditions (flooding). Factors related to industrial wastewater include the degree to which industries are concentrated in a given country; type of industry present; absence or nonenforcement of standards and practices; and lack of pretreatment standards.

Risk management in wastewater touches on the responsibilities of several ministries and government agencies, i.e. health, education, agriculture, public works, urban planning, roads, and water resources, and illustrates the necessity of forming linkages to address the problem. Many interventions are required.

- Education concerning the health risks associated with wastewater.
- Incorporate wastewater management into national water policy plans
- Develop on and off-site appropriate technologies
- Further research on waste stabilization ponds and other wastewater treatment technologies
- Industrial pretreatment/reuse/minimization
- Irrigation coupled with adequate treatment
- Increased attention to drainage problems
- Facilitate the development of local, private sector consulting firms capable of introducing and disseminating pollution control technologies
- Capacity and capability building for monitoring wastewater quality
- Wastewater reuse planning into national water resource and agriculture planning
- Water quality standards realistic for developing countries need to be adopted

B.3 Solid Waste

Definition: Solid waste is the non-aqueous portion of a waste stream. It includes waste products generated by domestic, commercial, and industrial activities.

B.3.1 Problem Characterization

The characteristics of municipal solid waste which themselves present a health hazard are wastes of biological origin carrying a wide variety of pathogens, and toxic (pesticides) or hazardous (flammable, explosive) substances (See Section 5). In the absence of these characteristics, solid wastes have little direct impact on human health at the time of generation. Without proper management, however, the wastes present a health hazard by providing a breeding ground for disease carrying vectors and rodents. For instance, improper solid waste disposal by dumping in urban drainage channels contributes to health problems because this leads to areas of standing water which contributes to vector-borne disease transmission.

Few studies have been conducted to identify and quantify the presence of pathogens in solid waste. Clearly, the greater the amount of contamination of solid waste with human wastes, animal wastes, and diseased animal scraps, the larger the concentration of pathogens and the associated health risks. Contamination by hazardous and toxic materials is discussed in Section 5. Studies have assessed the effect of contact with solid wastes on the incidence of diseases and on morbidity rates of scavengers (people who work on landfill sites). Evidence of respiratory, diarrhea, and skin disease have been detected among Bangkok residents living on or near a landfill. Solid wastes are a particularly significant health risk in large, urban, rapidly growing centers in tropical (wet) developing countries. Human populations most at risk are the poor who live near or scavenge the landfills where solid wastes are deposited. These groups are bitten by rodents and pests which infest the sites, and they are subject to fumes from burning organic materials, chemicals and other hazardous materials found in the dumps. Injuries associated with scavenging or working on the landfills are common.

Personal behaviors which contribute to the health risks include scavenging or collecting solid waste; living on or near the landfill; consuming or re-cycling contaminated material; improper storage, and disposal or re-use of materials taken from the landfill. Other factors constituting risks include the degree of available land and the location of disposal sites or transfer stations; the collection and coverage practices of the agency responsible for solid waste; the absence of policies, standards, and practices on siting and operating landfills; and climatic conditions.

A risk assessment of solid waste would benefit from the following interventions: a rapid analysis method to characterize the solid waste stream in selected developing countries; a multi-national study of the cost of solid waste collection and disposal; a study of health risks associated with unlicensed garbage dumping; and a study of health risks and costs to health care systems of solid waste scavengers and populations living close to landfills.

Risk management options include the following:

- Develop programs to train professional solid waste managers; and promote the development of private sector solid waste management systems;
- Define and implement standards, regulations, and enforcement practices regarding the storage, collection, and disposal of solid waste;
- Introduce waste reduction strategies for industries that are keyed to specific toxic substances, e.g. pesticides;
- Develop facility operating standards to upgrade existing landfills and to open and operate new sites and;
- Support the initiation of highly visible, properly run landfill "demonstration sites" in developing countries.

B.4 Air Pollution Control

Definition: Air pollution is a complex mixture of substances released by both human and natural activities. The major air pollutants of concern include those for which air quality criteria have been established, such as particulate matter, sulfur dioxide, carbon monoxide, lead, nitrogen dioxide, and photochemical oxidants (ozone); and other toxic air pollutants, including benzene, asbestos and metals.

B.4.1 Problem Characterization

Exposure to air pollutants is associated with health effects which range from death at high concentrations to more subtle biochemical, physiological or pathological effects. Air pollutants may be toxic to the respiratory system, central nervous system, reproductive system, heart, and other organ systems. Effects may be short-term or chronic in nature, and may be reversible or permanently debilitating. The likelihood that a pollutant will cause adverse health effects depends on the nature and concentration of the pollutant, the effect of simultaneous exposure to other pollutants, and such factors as the age, sex, and sensitivity of the individual.

Ambient, or outdoor, air pollution is no longer a problem that is limited to the urban areas of industrialized countries. Increasing urban populations in developing countries, accompanied by growths in transportation, energy consumption and industrial activity, contribute to the poor quality of the ambient air in many of the major industrializing cities of the world. An estimated 60 to 80% of the urban population worldwide breathe ambient air of marginal or unacceptable quality (PAHO, 1990).

In general, it is very difficult to quantify adverse health effects of ambient air pollution, except under severe pollution episodes, but the impact may be substantial. Epidemiological information is badly needed. So, too, are indirect measures of health

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risks: information about the sources of air pollutants through emissions inventories, local industrial profiles, records of imports of toxic chemicals, and data on fuel consumption.

As the individual has little control over exposure to ambient pollution, effective risk reduction and management must occur at the policy and infrastructure level. Strategies must be tailored to the needs of a specific area, but should draw on a combination of environmental legislation, pollution prevention, air pollution control devices, transportation interventions, and market incentives. Developed nations offer viable models for regulation which could be appropriate to rapidly urbanizing developing countries.

In contrast, indoor air pollution has special characteristics in poorer nations. Although exposure may occur in the workplace, most exposure is domestic: about half the world's population burns fossil or biomass fuel in the home for cooking and heating (de Koning et al., 1985). Homes may be poorly ventilated, and fuel of low quality. Indoor air pollution is a common phenomenon in rural areas, and also for urban households not connected to public services. It is associated with respiratory disease and cancer in exposed individuals. Air pollution may play an important role in the etiology of respiratory infections, which are responsible for approximately one-third of the deaths in children less than five years old in developing countries.

Studies have shown that in numerous developing country locations, the indoor concentration of air pollutants routinely exceeds levels established in WHO guidelines. Information on the health effects of such exposure comes from a number of studies. Although the health impacts could be more precisely established, there appears to be easily enough evidence to warrant taking action to reduce risk.

Strategies to reduce pollution associated with domestic cooking and heating include: improved cooking stoves and heating units, improved housing and ventilation, cleaner energy sources, and enhanced public awareness. Although most of these strategies fall into the realm of personal behavior, few can be achieved by individual effort alone. Commitment at the community or national level is necessary to support the invention and promotion of "smokeless" stoves, the provision of cleaner fuel, financing for improved housing, and educational campaigns.

B.5 Hazardous and Toxic Materials Management

Definition: In the U.S., hazardous waste has been defined as "a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical or infectious characteristics may 1) cause an increase in mortality or an increase in serious irreversible or incapacitating reversible illness or 2) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported or disposed of or otherwise managed." (Resource Conservation and Recovery

Act). While the definition refers to "solids", it has been interpreted to include liquids and gases as well. The U.S.E.P.A. lists four characteristics of hazardous wastes; ignitability, corrosivity, reactivity, and toxicity. Toxicity is the intrinsic quality of a chemical to produce adverse effects. The term includes teratogenic, mutagenic and carcinogenic effects.

B.5.1 Problem Characterization

Hazardous materials originate from a wide range of commercial, agricultural, and industrial sources. Pesticides, herbicides, fertilizers, heavy metals and solvents constitute the most significant materials in this category. In general, hazardous materials cannot be handled safely and effectively by the existing wastewater treatment or domestic waste disposal systems.

These materials pose dangers to human health when they are released into the environment and ingested, inhaled, or absorbed through the skin. Some hazardous materials may cause explosions or fires. Contact with others may cause corrosion and etching of the skin as well as severe corneal damage. Skin absorption of certain pesticides may cause acute poisoning. Most empty containers for hazardous chemicals can—if not properly disposed of—result in incidents of severe poisoning if left unguarded at materials storage or dumping sites. Children are especially vulnerable. The release of hazardous materials into the environment may result in long-term exposure of the population, causing adverse health effects due to poisoning. The following example although not from a developing country is nevertheless illustrative of this problem.

Water containing a large amount of cadmium was discharged from the Kamioka zinc mine in Japan into a river that was used for drinking water downstream. The river water was also used for irrigating paddy rice. Because of the large amounts of cadmium in the water, used for both drinking and irrigation purposes, the long-term exposure of the local population to this chemical resulted in serious kidney malfunctions in a large percentage of the population. The effects, which were most severe in pregnant women with low calcium intakes, as well as those women suffering from close-spaced births, included de-calcification of the skeleton, multiple bone fractures, invalidity, and death.

Other heavy metals such as mercury and lead have documented adverse health effects. Some organic compounds, e.g. PCBs (polychlorinated biphenyls), dioxins, are also persistent in the environment, tend to accumulate in the food chain, and lodge in fatty tissues in humans. The health significance of this accumulation is still uncertain but experience from accidental high level exposures has shown that these compounds may cause serious effects on human health.

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It is important to note that many health outcomes associated with exposures to hazardous materials have long generation periods. Exposures typically associated with hazardous materials are chronic and low dose. Long latency periods of many exposures make health risks less visible and less urgent relative to other environmental health hazards.

As the hazardous materials move from the point of generation, risk of exposure increases. Those people at highest risk are populations residing close to the sites where hazardous materials are generated or released, or those who reside downstream of discharge points of these materials. Others at risk include people who work with these materials and scavengers. Factors which increase risks to human health include acute accidents, spills and leaks of hazardous materials; intentional, improper disposal of hazardous materials; routine use of hazardous materials; improper handling or transfer of hazardous materials.

Factors affecting the behavior of hazardous materials and their associated health risks include the geology and hydrogeology of the waste disposal site; local climatic conditions; leaching, adsorption/desorption, volatilization and bioaccumulation characteristics of the material; chemical or biological degradability.

The following interventions are proposed:

- Development of country-specific classification systems that rank materials as more or less hazardous
- Development of policies on generating, handling, transporting, and disposing of hazardous materials
- Definition of policies on labeling and handling procedures
- Pollution prevention through materials substitution, process changes, and recycling
- Appropriate treatment and control methods
- Establish technology transfer linkages between U.S. and developing country institutions
- Produce national hazardous waste inventories
- Document transport and disposal methods
- Waste audits in generating firm
- Technology cost assessments
- Development of appropriate information and education programs

B.6 Occupational Health

Definition: Occupational health covers injuries and illnesses which happen in the workplace. Injuries include fractures, sprains, abrasions, burns and fatal falls. Illness may be of a chronic nature, which makes it more difficult to detect and associate with work.

B.6.1 Problem Characterization

Occupational health and safety hazards cause millions of illnesses and injuries throughout the world each year. The toll is especially high in developing countries, where these hazards are often widespread and serious. Occupational illnesses can be divided by cause into four categories:

- 1) **Chemical.** Workers inhale, ingest, or absorb a variety of hazardous chemicals. These include pesticides, which poison an estimated two million workers each year; lead, which damages neurologic, hematologic, and reproductive systems, and which is carried on clothing from the workplace to the home where children are exposed; asbestos, which causes respiratory disease and cancer; and organic solvents, which cause serious neurobehavioural problems that may go unnoticed until they are very advanced.
- 2) **Mechanical and Physical.** Mechanical hazards can induce both acute injuries and so-called cumulative trauma disorders, or repetitive stress injuries. Physical hazards include excessive noise, particularly in mining and manufacturing, which can lead to hearing impairment.
- 3) **Biological.** Hazards include the microorganisms to which laboratory, health care, animal care, slaughterhouse and farm workers are exposed. In many developing countries, workers also face increased exposure to certain infectious agents, such as those which carry malaria or schistosomiasis.
- 4) **Psychosocial.** Psychosocial stress at work, or through rural-urban migration, can lead to a number of diseases, such as peptic ulcers.

Hazardous workplace exposure is generally worse in developing countries for a variety of reasons. Workers are not sufficiently aware of hazards in the workplace. Where poverty and unemployment are high, workers are reluctant to complain of hazards on the job or to refuse to work in imminently dangerous situations. Economic circumstances may focus national attention on the need to industrialize at any cost, including the neglect of worker safety or the acceptance of hazardous materials or industries from developed countries. Shortages of trained staff or spare parts means machinery may not be adequately maintained, or a shortage of needed machinery may lead to the use of machinery in an inappropriate way. Finally, in most developing countries, the majority of the workforce is concentrated in agriculture or in the informal sector of the economy, beyond the reach of the few occupational safety programs which do exist.

Occupational illnesses are under-recognized and under-reported. Initial risk assessment must establish: (1) the occurrence, severity and impact of occupational injuries and

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illnesses; (2) the nature and source of health hazards in the workplace; and (3) the characteristics of workers at risk.

One of the important characteristics of occupational health problems is that they are preventable. Preventive measures fall into two categories: those that focus primarily on the worker and those that focus primarily on the workplace. The former category includes worker training, use of personal protective equipment, medical screening, and administrative measures. These approaches, while important, are generally less effective than those that focus on creating a safer workplace. These include engineering measures, improved ventilation, changed work practices, and substitution of hazardous materials and procedures with safer ones.

Individual workers may not be able to initiate safer practices, or may be discouraged from doing so if the employer does not see occupational safety to be in his or her own best interest. Occupational safety should benefit everyone. Healthier workers mean lower medical expenses and higher productivity, but this relationship may not be appreciated in an environment where there are many unemployed workers ready to replace every worker injured at work, no matter how risky the job. Here, government regulation is desirable. In many developing countries, the responsible government ministries need strengthening before they can carry out their legitimate role: to establish national policy; to generate and enforce safety regulations; to monitor the import, transport and use of hazardous materials; and to promote worker and management awareness and participation.

There are many weaknesses inherent in occupational health in developing countries. These can be grouped in the following five categories in order to describe the problem as well as possible interventions: institutional development of both public and private institutions; human resource development, particularly in the education of workers and managers, health and safety professionals, and policy makers; community participation, which promotes the involvement of both workers and managers in occupational safety; policy development and implementation; and health and management information systems to implement and evaluate programs.

B.7 Injury Prevention and Control

Definition: Injury refers here to unintentional, non-occupational physical harm. As such, this definition excludes not only occupational injuries, but also homicide and suicide.

B.7.1 Problem Characterization

Unintentional injuries are a major cause of morbidity, disability, and mortality worldwide. Although the epidemiology of unintentional injuries varies among and within countries by degree of industrialization and urbanization, and by age, sex, and other characteristics,

the problem is often more serious in developing countries. Morbidity and mortality rates are aggravated by the lack of institutional infrastructure or policies to deal with injury control, by the small number of trained specialists, and by the lack of appropriate information systems.

The sources of injury are diverse. Motor vehicle injuries, which are the leading cause of unintentional injury deaths in developing countries, are increasing sharply. Burns often result from open fires used for cooking and heating, with women, the very young, and the elderly being at greatest risk. Drowning, falls, wounds from animals, injuries from sharp objects, poisonings, and natural and human-caused disasters also cause a heavy burden of morbidity, disability, and death.

Although preventive measures and control strategies vary with the specific type of injury, there are some generic measures which may be taken. In the area of risk assessment, epidemiological data on injury morbidity and mortality, and source of injury can help direct preventive measures. Data on the direct and indirect impact of unintentional injuries may assist policy-makers in allocating scarce resources. And data on people disabled by injury can alert policy makers to the need for rehabilitation services.

In the area of risk reduction, two primary sources of injury, motor vehicle injuries and burns, are categories which demonstrate the diverse strategies which may come into play. In the case of the first, it is tempting to apply the U.S. road safety model, whereas the second case arises largely from situations which are unique to developing countries, and for which we have no easily transferrable model.

Human error, broadly defined, is the leading cause of motor-vehicle injuries, with vehicle deficiencies and environmental problems combined accounting for far fewer injuries. Interventions which have been demonstrated to decrease injuries include: driver training and registration, the availability and use of seat belts, programs which educate drivers not to drive after drinking alcohol, and the design and maintenance of vehicles and roads to minimize the likelihood of crashes.

Many of these interventions rely on the capability of developing country institutions to honestly regulate and license drivers, and to take responsibility for maintaining a safe road system. Individuals or private organizations can be enlisted to support the extensive education needed to change driver behavior.

The U.S. and other developed countries have learned lessons which may be adaptable to developing countries.

The high incidence of serious and fatal burns in developing countries is almost entirely attributable to a developing country phenomenon: the reliance on open or partially open fires for cooking and heating. Measures which can reduce risk include: substitution of

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safe stoves for open flames; the placement of stoves off the floor and on even surfaces; the separation of the cooking and sleeping areas of the house where feasible; and the teaching of burn treatment.

Despite the differences in approach which characterize the interventions in these two areas, there are also common approaches which are broadly useful in reducing or managing the risk of unintentional injury. These include: education about safety hazards, restriction of unsafe substances, training in first aid and emergency procedures, and legislation and policy development to enforce or facilitate the implementation of safety measures.

B.8 Food Hygiene

Definition: Food hygiene refers to the handling, preparation, storage, and disposal practices that prevent or control the contamination of food with pathogens that cause illness.

B.8.1 Problem Characterization

The entire developing world is at risk of food contamination, as is the developed world. Food contamination exists in urban and rural areas, in homes as well in public eating establishments, and is the result of improper food hygiene practices by all segments of the population.

Although the contamination of food by chemicals or toxins through agricultural and industrial practices can have serious health consequences, far more widespread is the contamination of food with the infectious agents which cause diarrhoea. Food becomes contaminated with these pathogens through unhygienic handling, or dirty water and cooking vessels. The storage of food at the wrong temperature can promote the multiplication of the pathogens. And cooking, which could destroy many pathogens, is ineffective if the cooking time is too short, or the temperature is too low.

It has been estimated that between 15 and 70% of episodes of diarrhoea suffered by children are food-borne. Despite the enormous range of this estimate, one can assume that food-borne diarrhoea imposes a significant burden on morbidity and mortality of young children. It is likely that there is also an impact on the elderly, another high risk group prone to be severely affected by food contamination, but very little data is available.

The lack of information about the extent of the problem of food contamination suggests that the most essential interventions are initially in the areas of risk assessment, information gathering, and pilot programs. Epidemiological surveys are needed: experts

concur that even in developed nations, the magnitude of the problem of food contamination is grossly underestimated. Given that, it is not surprising that, in the developing world, no reliable estimates of food contamination exist. Improved information on the health costs of food contamination is a first step in enlisting support for mounting interventions.

Preliminary efforts to prevent or control morbidity or mortality by improving food hygiene practices need to be tested. It is not clear which food hygiene interventions work. In a developing country context, education and training of those involved in the food hygiene system could extend from food preparers to school children. Low-cost, culturally appropriate technical interventions should also be explored. One intervention might be a fuel-efficient refrigerator or cooler to eliminate the improper storage of foods. With scarcity of fuel becoming more of a problem, better and more efficient cooking facilities should be investigated. By contrast, legislative efforts, modelled on developed countries, would be less useful, as they rely on an infrastructure which may not be present. The enforcement of regulations through the inspection of public facilities depends on the requisite education.

Food hygiene has traditionally been the domain of food microbiologists. Thus, pathogen-laden food can be identified, but the social, behavioral, and educational aspects of food hygiene are liable to be ignored. A multi-disciplinary approach is necessary.

If the costs of improper food hygiene practices are large, as believed, then the benefits are also likely to be large if the problem is controlled. Illness is avoided, as well as the consequent loss of income and the time and cost of seeking treatment, but the benefits are more far-reaching than this. Food for export that is contaminated by improper handling may cost industry and government millions of dollars when it is rejected by the importing nation. Furthermore, food hygiene interventions, if innovative enough, may improve the nutrient intake of populations, thereby improving health independent of decreased food contamination.

B.9 Vector-Borne Disease Control

Definition: A vector-borne disease is one in which the infectious agent—such as a bacterium, or a virus—is introduced into the host by another organism, or vector, most often an insect or arthropod.

B.9.1 Problem Characterization

Several hundred diseases are transmitted by vectors. The most common are malaria, schistosomiasis, filariasis, arboviruses (including dengue, yellow fever, and numerous encephalitides), leishmaniasis, and trypanosomiasis.

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In developing countries, where vector-borne diseases are concentrated, they are a major cause of morbidity and mortality. Malaria is responsible for more than one million childhood deaths each year in Africa, and accounts for around half of all hospital and clinic visits. The direct and indirect costs of one case of malaria can exceed the per capita expenditure on health. Egypt estimates that schistosomiasis costs the country \$500 million per year in agricultural productivity. In Nigeria, a single yellow fever epidemic claimed 10,000 lives.

These diseases are naturally associated with the environmental features which affect their vectors: water, vegetation, altitude and seasonality. More recently, however, changing environmental and related factors have contributed to new patterns of disease. Some of the important changes include: (1) changes in agriculture which replace subsistence farming and result in the movement and resettlement of inadequately housed and otherwise unprotected people; (2) development of insecticide resistance, often associated with the use of similar insecticides in agriculture; (3) migration of rural populations to urban slum areas, which produces population densities that favor transmission; (4) deterioration of existing control programs; and (5) lack of foreign exchange for imported commodities.

Although vector-borne diseases are known to be very widespread, risk assessment and decision-making would benefit from more carefully selected information. Because these diseases are intimately associated with environmental change, one would hope to see a coordination of data on land and water use, population shifts, general morbidity and mortality data, and use and efficiency of health care services. What is needed is not necessarily more data, but to use existing data to advance disease control programs and to allocate scarce resources.

Current means of risk reduction and management are as diverse as the diseases they address, but most concentrate on control of the vector. Insecticide treatment has been the primary intervention used against most vectors. However, the overuse of pesticides in areas of intensive cultivation has contributed to widespread insecticide resistance. Now, control programs that depend entirely on insecticides are becoming less effective, and are not sustainable.

Concerns about cost and environmental safety have resulted in a renewed interest in alternatives to chemical control. Integrated strategies now use a combination of complementary interventions, including personal protection and reduction of vector breeding sources through environmental management, biological control and limited insecticide use. The challenge is to select the best parts of existing control strategies, tailored to the local disease situation to maximize efficiency, and minimize danger and cost. Such efforts have to rely on a strong infrastructure and trained personnel who can

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collect and analyze data, and supply the needed commodities: this usually involves a national control program, rather than interventions which originate at the local level.

The cost of controlling and preventing vector-borne disease must be weighed against its tremendous public health and economic benefits. Successful control of these diseases reduces treatment costs, increases economic productivity and school attendance, opens up land for cultivation and resettlement, and helps boost tourism. A successful effort requires training, national planning, coordination between sectors.

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Appendix C

Environmental Health Workshop Summary

In the course of developing this Strategy, the A.I.D. Office of Health (S&T/H) hosted an Environmental Health Workshop to assemble information as input to the strategy. The workshop was organized and conducted by the Research Triangle Institute (RTI). This appendix summarizes the results of that workshop: the complete workshop report is available from the Office of Health.

The workshop was held February 14-15, 1991, in Washington D.C. There were 30 participants, including RTI technical staff, experts from other organizations, and staff from a number of A.I.D. offices. The workshop consisted of a mix of technical presentations, small work group sessions, and plenary discussion sessions.

The technical presentations were based on prepared background papers addressing the nine subsectors of environmental health identified in this Strategy (Occupational Health and Injury Control were considered together in one presentation, and Housing and Shelter issues were also included, although for the purposes of this Strategy, those issues are considered to be the focus of the Housing Office). Additional presentations on "over-arching" technical and policy issues, and the activities of selected other organizations were also offered. The small-group work sessions also dealt with the nine subsectors, identifying associated diseases and other health conditions, characteristics of the health risks, and possible interventions to assess, reduce and manage the risk. This approach led to the emphasis in this Strategy on Risk Assessment and Risk Management, and the small group discussions became the basis for Appendix B of this Strategy, the Environmental Health Framework.

The synthesis sessions examined which problems should be addressed in an environmental health strategy, considered whether the strategy should be focused narrowly or offer a broad menu, assembled information on the priority interventions for each risk area, and identified important issues not addressed in the workshop. These discussions are reflected in the chapter on Setting Priorities.

In January, 1991, the Office of Health sent a cable to all A.I.D. missions in the field, announcing the Environmental Health Initiative, and soliciting input from the missions on a number of points. One of the requests was for the missions to rank the proposed environmental subsectors in order of importance to their host country. The response from missions was large: of the 36 missions which responded, 30 provided a priority ranking.

The results of the mission responses were tabulated and assessed, and compared to information submitted by participants in the Washington workshop. There were important

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regional variations, but, in general terms, missions placed the highest emphasis on traditional areas of A.I.D. intervention. The workshop participants, by contrast, recommended a broad-based approach including attention to newer, "emerging" issues (see Figure 1). The participants suggested that a broad-based strategic approach will be required to understand and deal with environmental health problems, because many of the areas are inter-related, and because different countries and regions have different needs.

In developing this Strategy, A.I.D.'s simplest choice would have been to respond to mission priorities, or alternatively to build the strategy around workshop priorities. However, other options are possible which address both concerns. The report of the workshop presented A.I.D. with three options for increased effort in environmental health (see Table 3). The options are additive: the first option recommends staying with traditional areas of A.I.D. activity, but puts increased effort in areas which are only partly addressed now. This option responds best to mission priorities. The second retains these elements, but adds air pollution and toxic, hazardous and radiological wastes. The third option adds occupational health and injury control, to achieve the most ambitious, broad-based menu recommended by the workshop.

While the broad-based approach is the most comprehensive, it requires the most resources to implement. It was also noted that the three options call different combinations of interventions (see Table 4): for the emerging areas, such as air pollution, more emphasis is required on risk assessment, while the more traditional areas require more emphasis on risk reduction, because these areas are better understood.

The workshop concluded that A.I.D. could make positive contributions by expanding its efforts in the area of environmental health. A.I.D. was urged to build a broad capability, in light of the inter-related nature of environmental health problems, and the different needs of different countries. Whether A.I.D. selects a narrow or broad-based option to respond to this challenge, collaboration with other groups outside A.I.D. will be vital. A broad over-all capability will be required if A.I.D. is to assist missions and countries to collect data and assess environmental health risks, in order to focus efforts on the most critical problems. The risk assessment, comparative risk assessment, and policy dialogue and implementation and capacity-building capabilities must be considered indispensable.

Figure 1

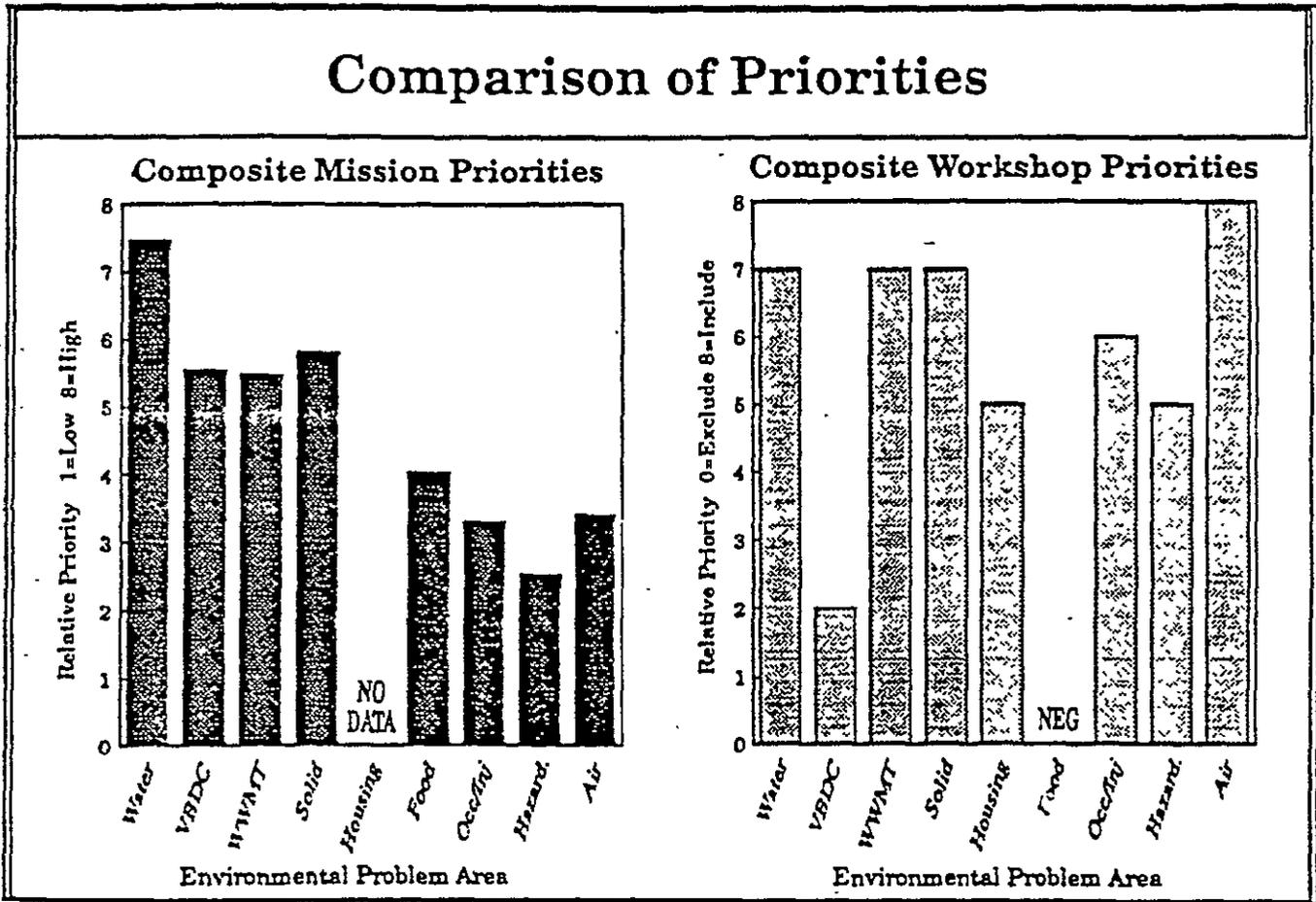


Table 3

FOCUS OPTIONS FOR AID'S ENVIRONMENTAL HEALTH STRATEGY			
	Give Increased Effort in Traditional Areas	Develop a New Focus on Selected Emerging Areas	Offer a Broad-Based Menu
Sustained Effort In	Water Supply and Sanitation Vector Borne Disease Control	Water Supply and Sanitation Vector Borne Disease Control	Water Supply and Sanitation Vector Borne Disease Control
Increased Effort In	Solid Waste Wastewater Management Housing & Shelter	Solid Waste Wastewater Management Housing & Shelter	Solid Waste Wastewater Management Housing & Shelter
Add New Effort In		Air Pollution Toxic, Hazardous & Radiological Wastes	Air Pollution Toxic, Hazardous & Radiological Wastes Occupational Health Injury Control

Table 4

PRIORITY INTERVENTIONS FOR AID'S ENVIRONMENTAL HEALTH STRATEGY			
	Give Increased Effort in Traditional Areas	Develop a New Focus on Selected Emerging Areas	Offer a Broad-Based Menu
For New Areas		Problem Definition Risk Assessment Comparative Risk Assessment	Problem Definition Risk Assessment Comparative Risk Assessment
For Traditional Areas	Policy Development Education/Risk Communication Information Systems Training & Institutional Development Infrastructural Investment	Policy Development Education/Risk Communication Information Systems Training & Institutional Development	Policy Development Education/Risk Communication Information Systems Training & Institutional Development