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# Salvadoran Waters: Working Capital for the Nation

Abt Associates Inc.

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# Table of Contents


Acknowledgements iv

1 Introduction 1

2 Water as Working Capital 2
- 2 1 Basic Concepts for Assessing Water-Related Assets and Liabilities 3
  - 2 1 1 Physical Inventory 3
  - 2 1 2 Scarcity 3
  - 2 1 3 Manmade Capital 5

3 Physical Assessment of Water Resources in El Salvador 9
- 3 1 Surface Water 9
- 3 2 Ground Water 12
- 3 3 Water Production and Demand in El Salvador 12
- 3 4 Water Quality 15

4 Economic Estimates of Health Damages Associated with Water Contamination 21

5 Broader View of Capital Formation 26
- 5 1 Background 26
- 5 2 Incorporating Water Resources into Capital Account of Industry Two Approaches 26
- 5 3 Implications for Capital Formation 32
- 5 4 Investigation of Pollution Prevention Opportunities in El Salvador 32
  - 5 4 1 Environmental Impact Analysis 33
  - 5 4 2 Methodology 34
- 5 5 Implied Priorities for Pollution Prevention Activities in El Salvador 37

6 Balance Sheet of Assets and Liabilities for the Water Sector An Illustration 39
- 6 1 Hypothetical Example for El Salvador in 1998 39
- 6 2 Comparing Water Assets and Liaibilites Over Time 44

7 Special Issue Distribution of Water Resources between Urban and Rural Areas 49

8 Conclusion and Recommendations 50

## Exhibits


Exhibit 1 Available Surface Water Storage vs Flow 6

Exhibit 2 Available Flow vs Usable Portion 8

Exhibit 3 Map Hydrographic Regions of El Salvador 10

Exhibit 4 Hydrographic Regions of El Salvador 11

Exhibit 5 Important Lakes in El Salvador 12

Exhibit 6 Important Aquifers in El Salvador 13

Exhibit 7 Annual Water Statistics, 1995 15

Exhibit 8 Map Total Coliform 16

Exhibit 9 Map Dissolved Oxygen 17

Exhibit 10 Map Biological Oxygen Demand 18

Exhibit 11 Water Body Classification Parameters 19

Exhibit 12 Map Population Density 20

Exhibit 13 Map Rates of Diarrhea 22

Exhibit 14 Incidence of Diarrhea-Related Illnesses, By Age El Salvador, 1994 23

Exhibit 15 Annual Economic Damages Morbidity and Mortality from Acute Diarrhea and Other Water-Related Illnesses 24

Exhibit 16 Annual Economic Damages 25

Exhibit 17 Asset Balances for Major Industries 27

Exhibit 18 Item-by-Item Description, DILUTION Approach 28

Exhibit 19 Asset Balances for Major Industries, Taking Degradation of Water Resources into Account 30

Exhibit 20 Item-by-Item Description, TREATMENT Approach 31

Exhibit 21 Ranking of industries for clean production and energy efficiency 33

Exhibit 22 Ranking of industry sectors using population equivalent loads(1982) 34

Exhibit 23 Ranking of industry sectors using population equivalent loads(1993) 35

Exhibit 24 Ranking of industry sectors using dilution requirement factors(1982) 35

Exhibit 25 Ranking of industry sectors using dilution requirement factors(1993) 36

Exhibit 26 Ranking of industry sectors using dilution requirement factors(1996) 36

Exhibit 27 Ranking of industry sectors using dilution requirement factors(1997) 37

Exhibit 28 Ranking of industry sectors using the treatment method(1997) 37

Exhibit 29 a Balance Sheet for Water Resources and Complementary Capital 41

Exhibit 29 b Balance Sheet for Water Resources and Complementary Capital 42

Exhibit 29 c Balance Sheet for Water Resources and Complementary Capital 42

Exhibit 29 d Balance Sheet for Water Resources and Complementary Capital 43

Exhibit 30 Working Capital in the Water Sector Comparison Over Time 45

Exhibit 31 a Comparison Over Time, Usable Water 47

Exhibit 31 b Comparison Over Time Value 47

Exhibit 31 c Comparison Over Time Damages 48

Exhibit 31 d Comparison Over Time Debt 48

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Given the uniqueness of the study there was no single bibliographic source used as such

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We sincerely hope this study will be useful in future deliberations of the water sector for El Salvador

Greg Michaels Rodolfo Camacho

# 1. Introduction

Freshwater resources figure significantly among the factors that determine the nature and extent of economic development and of improvements in social well-being Preliminary estimates for El Salvador suggest that the potential value of access to water and sanitation for households alone is greater than $200 million per year and possibly much higher Once the value to other sectors of the economy is taken into account, the total value of water resources in El Salvador could be much greater In this respect, the endowment of water resources clearly constitute a very important economic asset for El Salvador Unfortunately, this significance can be missed or understated since these assets and many of the services which flow from them are generally not traded on the market

Given their economic potential, it is important that water resources be managed to achieve maximum social and economic advantages For part of the country's population at least, water resources are indeed being heavily managed Potable water is provided through supply systems to large urban populations that in earlier days would have depended on direct access to surface or groundwater This level of service is the result of investment in manmade capital that complements the available water resources Industry, commerce, and agriculture also take advantage of water supplies to meet their production requirements However, for a large portion of the population, particularly households living in rural areas, water supplies are less reliable and relatively costly because of limited stocks and inaccessibility The complementary investments in manmade capital have been absent in these situations

The other side of the supply of usable water is the removal of waste water Here again, there have been some systematic efforts to collect and manage these water-related wastes However, the coverage of these activities is far less complete than is the case for potable water systems Furthermore, treatment prior to discharge is limited, and at times, nonexistent Because of the resulting contamination, the supply of usable water is reduced further, raising the stakes in the management of water resources These damages represent a degradation of the country's asset base and as a result, a worsening of the conditions for meeting economic and social goals

To make appropriate decisions about how to manage water resources in the country and, in particular, to determine what investments are needed to expand the water-related working capital of El Salvador, it is necessary to examine the linkages between the state of water resources in the country, how they are managed, and the implications of these circumstances for economic and social progress in the country The current paper proposes one way to approach this type of examination Specifically, it introduces an approach that views the water resources of the country as economic assets, differing from other forms of (manmade) capital in origin and maintenance but nonetheless ones that should be managed to maximize their capital value This view should be consistent with a larger effort to maximize the wealth and income of El Salvador in general The companion of assets in such analysis are the associated liabilities Different types of liabilities in the water sector are outlined In short, this paper attempts to establish the framework for a balance sheet of assets and liabilities for the water sector in El Salvador

This report begins with the presentation of basic concepts for evaluating El Salvador's net working capital in the water sector (Section 2) These concepts underly the broader view of capital in the water sector that is proposed in this paper The next three sections provide certain elements of this broader view, based on existing data and estimates Section 3 provides an overview of the physical measures describing the status of water resources in El Salvador Section 4 presents findings of the economic damages imposed on society as the result of water contamination Section 5 presents a sector-by-sector analysis of unmet capital needs for different Salvador industries, based on national economic census information and the estimated costs of addressing certain forms of water pollution from these industries

Since certain imporant information needed to provide a complete version of the broader view of capital in the water sector does not exist, hypothetical examples of balance sheets for assets and liabilities in the water sector are constructed to illustrate possible conditions in El Salvador and what could be learned from developing an actual set of balance sheets on an annual basis Section 6 provides a complete set of hypothetical balance sheets for 1998, examines their implications for the current economic health of the water sector, and makes a comparison with possible past and future trends in the sector

Section 7 discusses a question that deserves separate attention in this economic analysis - rural vs urban benefits from the way that water resources are managed While economic analysis looks for efficient allocation of resources, the distributional aspects of any allocation are also very important This section discusses certain tendencies in the rural-urban competition for water that raise concerns

In Section 8, conclusions and recommendations are presented Of particular note is the recommendation that USAID initiate and coordinate a program of activity to implement the framework of assets and liabilities proposed here

## 2. Water as Working Capital

Net working capital is the difference between current assets and current liabilities Simply put, what remains after liabilities are taken into account is what can be used productively to expand the output of any economic entity, such as a firm When net working capital is sufficiently large, a firm can expand its production and therefore its wealth if it applies that working capital wisely If however net working capital is insufficient, the firm must borrow resources in some way (through debt or equity) in order to stay in business

Similarly, thinking of El Salvador as an economic entity trying to generate wealth for its citizens, the difference between the country's assets and liabilities is an important indicator of its ability to generate wealth In this paper, it is asserted that freshwater resources constitute an important part of El Salvador's portfolio of working capital For this reason, an evaluation is made of the aspects of the country's freshwater resources that can be viewed as <u>assets</u> and the aspects that

can be viewed as liabilities Where feasible, quantitative indications based on actual evidence from El Salvador are considered However, the figures used in this presentation of the main body of this report should be interpreted as *suggestive rather than actual* since data for several key components of the asset-liability balance sheet were not available in El Salvador or could not be estimated within the constraints of the current effort It is expected that this illustrative example will help advance efforts to construct an actual set of balance sheets for the water sector in El Salvador Readers seeking actual data or estimates on the state of water resources in El Salvador should confine their attention to the information provided in the Annexes

## 2 1 Basic Concepts for Assessing Water-Related Assets and Liabilities

Before initiating a review of physical data characterizing the status of water resources in El Salvador (Section 3), it is useful to provide an introduction to the basic concepts which will ultimately be used to interpret the status of water resources from an economic perspective Three particular concepts are considered A physical inventory is an important starting point itself for describing the endowment of water resources And, physical inventories clearly indicate the limits of resources and therefore take a measure of their scarcity However, economic scarcity can be very different from physical scarcity Economic scarcity is one of the most important concepts of an economic perspective of water resources Finally, manmade capital may be the most surprising element of what constitutes assets in the water sector of El Salvador Each of these is discussed in turn below

### 2.1 1 Physical Inventory

An economic assessment of the state of a nation's water resources begins with a basic physical charactization In Section 3, an overview of the flow, distribution, and condition of freshwater resources is provided This overview provides clear evidence of the extent of the nation's water resources but also clearly indicates that pressures are changing the condition of these resources In particular, contamination figures prominently as a signficant pressure on the nation's water resources

### 2 1 2 Scarcity

Given a physical inventory and characterization, it is possible to begin discussing the nature of scarcity in the El Salvador's water resources The concept of scarcity is an essential to an economic assessment since the value of any resource arises from its scarcity Part of the scarcity to be considered here can be attributed to the physical limits of natural processes In the case of water, available amounts are limited by the frequency, quantity, timing, and geographic distribution of rainfall, by the absorptive capacity of the soils and shape of the terrain, and by ambient conditions that affect evapotranspiration However, scarcity in an economic sense also has much to do with the characteristics of water use These are considered below

Some uses of surface water resources, such as boating, may be nonconsumptive In this case,

scarcity still holds but in practice may really come into play only once the number of boaters is enough to create congestion Other uses may be consumptive, or at least extractive Drawing water from surface or ground water sources for human consumption, irrigation, or production creates scarcity and therefore competition for the resource However, scarcity can be even more intricate in these cases A stock of pristine water that is available at the far reaches of the country may for all intents and purposes have zero economic value If the cost of accessing this source exceeds the highest value of the uses to which it could be put if it were transported, then the water has no current economic value for direct use Similarly, rainfall in excess of current consumption needs is not scarce Still, if this excess can be stored and saved for a dryer time, then this excess rainfall takes on economic value

When wastewater is discharged to a receiving surface water body, another form of scarcity is created Up to a point, the water body may be able to assimilate the waste without damaging the plant and animal species that inhabit in or depend on the water Eventually, however, the loadings can be high enough to damage these species This damage could infringe on other uses such as fishing, boating, and other forms of outdoor activity and recreation that are tied to a healthy aquatic ecosystem In this circumstance, these competing uses (discharging waste for assimilation versus water-based occupational and recreational activities) create scarcity There simply is not enough water to satisfy everyone's unconstrained demands

Other serious damages can arise from wastewater discharges beyond the assimilative capacity of a water body When humans draw on this water for consumption without treating it, health problems can arise From fecal contamination, gastroenteric diseases that manifest themselves in acute diarrhea can be induced The morbidity and mortality associated with this acute diarrhea can be substantial Section 4 will provide more details on estimates of water-related health damages that have been made for El Salvador

Beyond fecal contamination, toxic contamination can create more latent damages that manifest themselves only after longer periods of exposure and that may be delayed in their effects Lead contamination of drinking water is one such health threat that could be affecting individuals in El Salvador Exposure of young children to lead can impede intellectual development and therefore affect their productivity once they are adults Estimates of this type of health damage are also presented in Section 4 While it is unknown whether the lead contamination in drinking water that has been identified in El Salvador originated in human activities or not, the theme of scarcity still applies Because these contaminated sources of drinking water are not suitable for consumption, it is necessary to seek other, more suitable sources of drinking water These sources are likely to be less accessible and therefore more costly

The final example of a competing use that helps create scarcity and therefore value in the water resources of El Salvador is hydroelectric power generation Because hydroelectric power depends on impounding surface water flows to create a stock of water to drive power-generating turbines, the quantity of water available for downstream use could be compromised Furthermore, the physical and ecological character of the water bodies upstream and downstream could be changed

markedly Whether and how these changes may have infringed on other uses (such as artesanal and recreational fishing other other water-based activities) is unknown It is also conceivable that the impounded water behind a hydroelectric dam can provide other beneficial services besides power generation - such as open water for boating (that may not have been possible before) and better control of potential floodwaters that would otherwise cause damages downstream

### 2 1 3 Manmade Capital

Focusing on water resources alone provides only a partial picture of assets relevant to the water sector What is missing so far is an inventory of all of the manmade capital which complements the available water resources, and as a result, enhances their value The manmade capital in question includes all of the plant and equipment which facilitates the following

- supply of water to water systems (such as, pipelines, pumping stations, wells, and storage systems),
- distribution of water to individual households, farms, factories, and offices (such as pipes connecting individual users to a municipal system),
- wastewater collection, and
- wastewater treatment

Each of these forms of capital complement water resources differently as will be discussed next

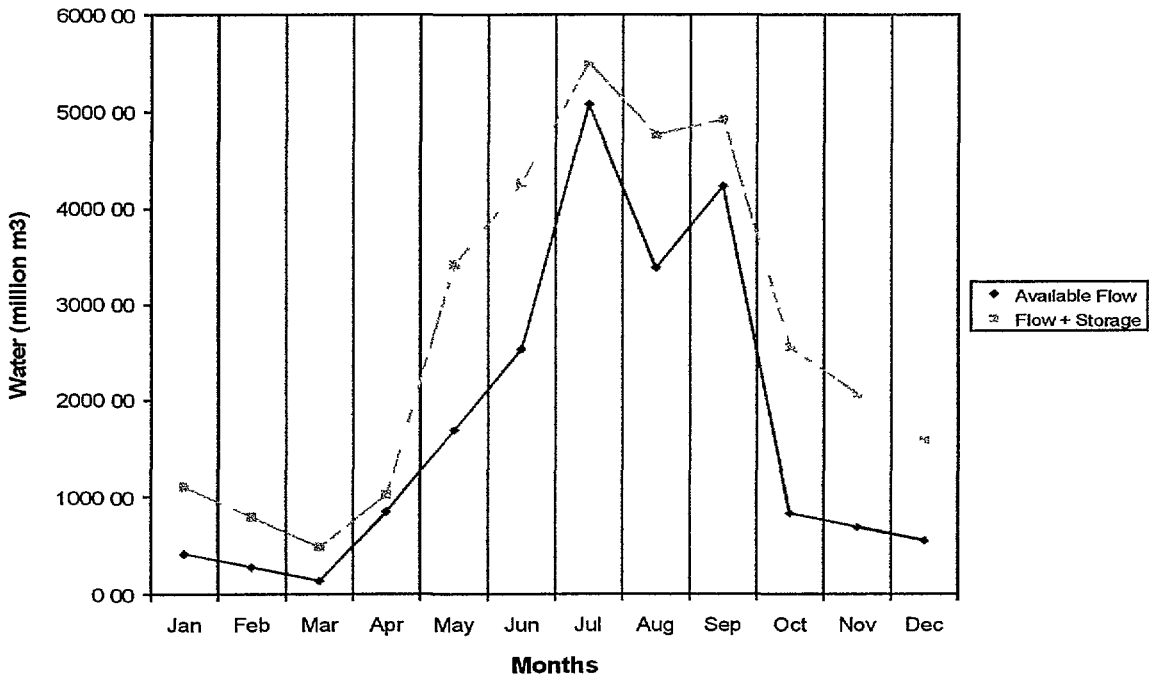
A pipeline that brings water from the Lempa River for use in San Salvador has the potential to raise the value of the Lempa's water resources Using this water to meet drinking water demand in the greater metropolitan area may provide greater economic value than uses in the direct vicinity of the Lempa (such as agriculture) The increased econoimc value of Lempa water is the difference between the values as drinking water delivered to the system in San Salvador (say, 40 colones per cubic meter) and its highest valued alternative use at the Lempa (say, 20 colones per cubic meter) By building the pipeline (at, say, a cost of 15 colones per cubic meter) the water in the Lempa has increased in value by 5 colones per cubic meter

It is also worth mentioning the importance of capital for storage In a country like El Salvador where there are dramatic seasonal fluctuations in rainfall, water storage tanks, holding ponds, and impoundments that add to the natural storage capacity of the country's surface terrain (lakes) and subsurface (aquifers) This storage extends the usable life of rainfall at a given time and thereby evens out the variation in supply and increases the minimum available supply, as shown in the hypothetical example provided in Exhibit 1

The plant and equipment associated with water distribution have a similar effect on the value of actual water resources Because water can be brought to where people are, they do not have to rely on private wells or live directly adjacent to water bodies to obtain their water Since plant and equipment for water distribution facilitate access to more remote water sources, this form of capital

Plant and equipment for wastewater treatment have the potential to complement water resources by protecting them from contamination Whether this potential is realized will depend on whether the treatment is sufficient to render the receiving water body usable for some other purpose Not surprisingly, treating the wastewater sufficiently that the receiving water body can be used as a drinking water source poses one of the highest goals for treatment and accordingly requires significant capital and operation and maintenance expenditures In other words, for the treatment to truly contribute to the value of the receiving water body, a significant investment may have to be made in the treatment capital itself

**Exhibit 1**
**ILLUSTRATION**
**Available Surface Water Storage vs Flow**




Plant and equipment for wastewater collection have a two-edged sword in their relationship to the value of water resources On the one hand, collecting wastewater is essential for any wastewater treatment effort but especially for municipal wastewater which comes from diverse, diffuse, and numerous sources In this regard, manmade capital for wastewater collection can also complement and therefore enhance the value of the water's resources by facilitating the protection that treatment offers

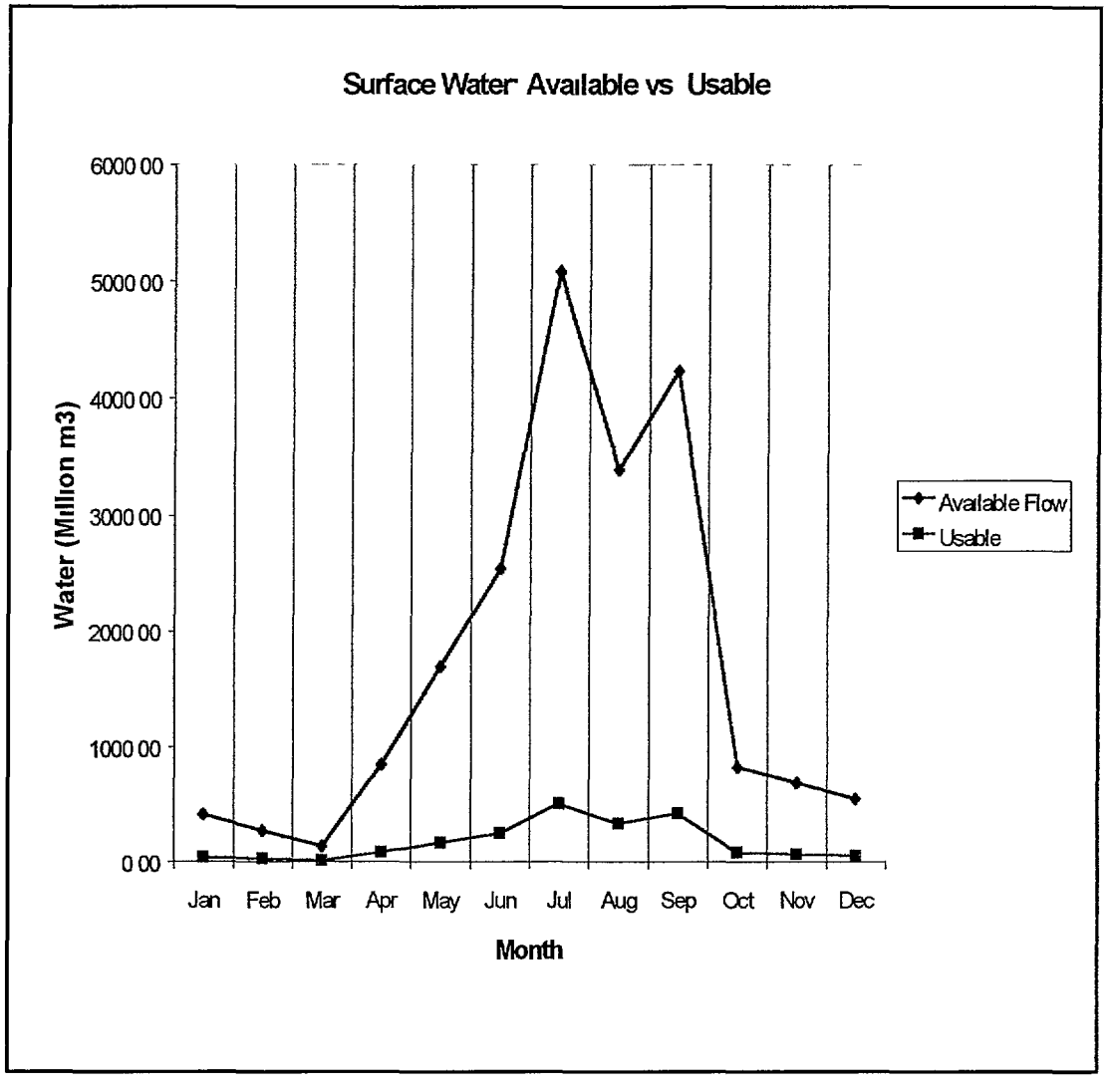
The hypothetical example of Exhibit 2 suggests how contamination can dramatically deplete available water that is usable for drinking water, recreational, and other direct contact uses During the dry season, contamination could easily deplete all of the surface water that would otherwise be

the dry season, contamination could easily deplete all of the surface water that would otherwise be available without contamination Treatment of wastewater discharges or of contaminated water itself can reverse this outcome - partially or entirely, depending on the level of treatment

However, where collection systems exist without treatment or with very limited treatment, as is the case for most wastewater sources in El Salvador, they can actually contribute to the depreciation of the economic value of the receiving water bodies since contamination they facilitate can make the receiving water body unsuitable for human consumption In this case, the collection and discharge equipment takes advantage of the assimilative value of water bodies but the contamination diminishes the drinking water value of the water body at the same time

There is then a tradeoff comparison to be made Whether the collection and discharge equipment is a complementary asset or not will depend on whether the water body's assimilation service is more or less valuable than its provision of drinking water In the case that assimilation is the more valuable service, the equipment is complementary In the alternative case (where providing drinking water is more valuable but this value is being diminished by the discharge), the collection and discharge equipment is not complementary Instead, it results in lowering the value of the receiving water body

**Exhibit 2**
**ILLUSTRATION**




This comparison can change over time For example, if the area adjacent to a water body is sparsely populated and if the wastewater load is small relative to the receiving water body, the assimilation value may easily exceed the foregone drinking water opportunities (if these are even affected) However, as population in the area grows and drinking water demands increase, the opportunity cost of contaminating a nearby drinking water source will grow significantly Then, the drinking water value may readily dominate the assimilative value of the water body With specific reference to El Salvador, the water bodies in the vicinity of San Salvador clearly serve a substantial role in assimilating wastes from the metropolitan area but it remains to be quantified whether assimilation or another use such as drinking water has greater value If the value of drinking water prevails, as many people suspect, then the current system of discharges is driving down the total value of water bodies in the San Salvador area

value of water bodies in the San Salvador area

## 3. Physical Assessment of Water Resources in El Salvador

El Salvador has abundant water resources at its disposal thanks to strong rainfall patterns and the existence of water bodies and aquifer recharge zones that facilitate the longer term storage of water from rainfall The supply of drinking water in El Salvador using groundwater sources has been very important because of the abundance, quality, and low costs associated with its use as opposed to surface water sources Nevertheless, with growth in population and water demand, El Salvador has been obliged to use surface water sources at greater and greater distances from population centers and as a result at higher costs

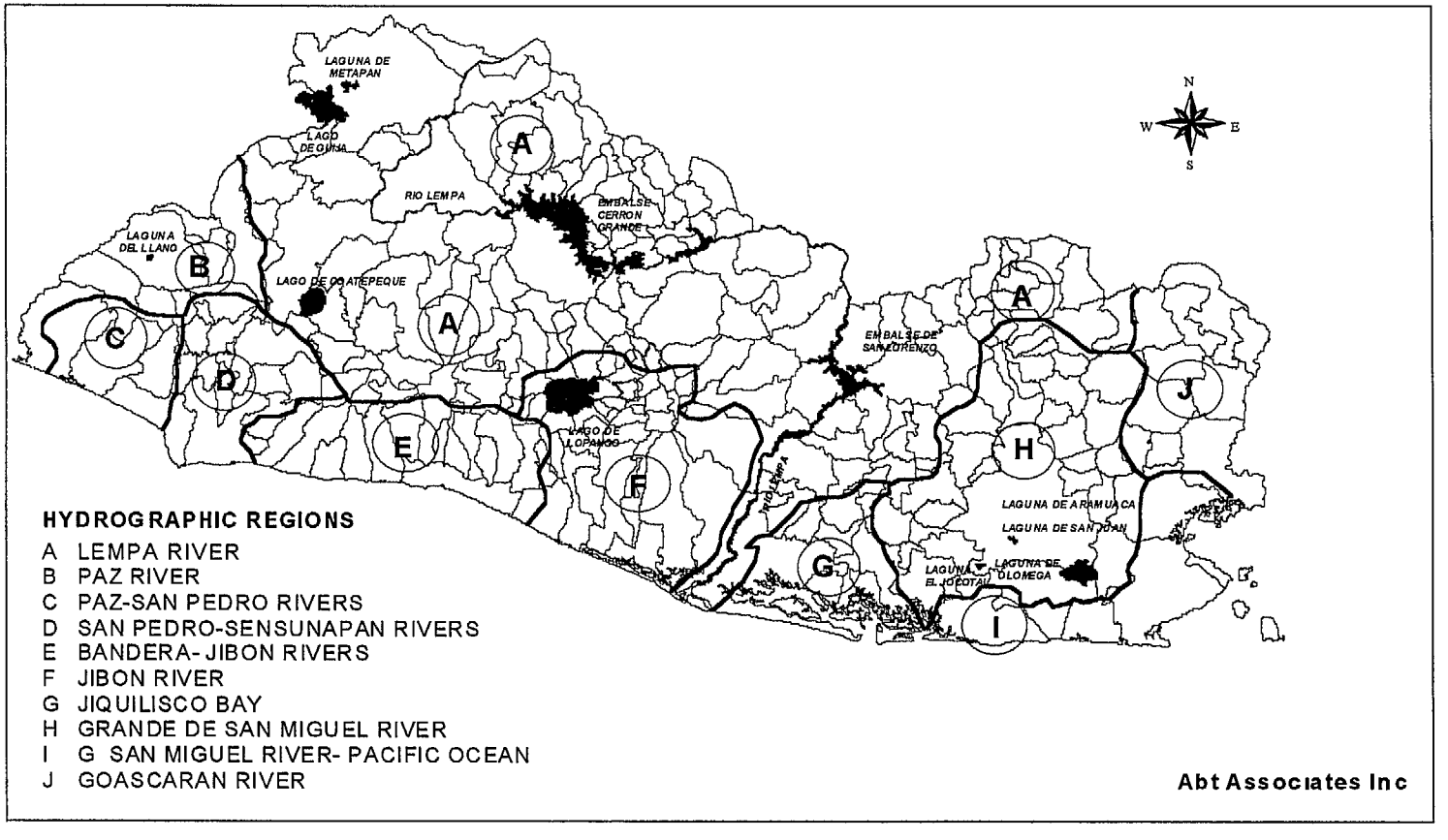
This circumstance applies particularly to the city of San Salvador where it has become necessary to extract surface waters from the Lempa River in order to meet the city's water needs This necessity is attributable primarily to two factors First, the recharge zones of aquifers have been reduced because of urban expansion that affects the quantity of ground water Second, deforestation and poor management of vegetative land cover have led to the compacting of soil which in turn has led to the reduction of water infiltration into aquifers In addition to these two factors, additional contamination of ground and surface water sources is imminent given the poor management of wastes (from industrial, domestic, and other sectors)

In the following sections, descriptions of sources of water in El Salvador and the current state of their quantity and quality is provided

### 3 1 Surface Water

El Salvador comprises ten principal hydrographic regions, as shown in Exhibit 3 The rivers in each of these ultimately all drain to the Pacific Ocean Exhibit 4 provides details on the area of each region and the estimated average surface water flows (runoff) through each region during the rainy and dry seasons Among the hydrographic regions, the Lempa River stands out, with an area of approximately 10,000 square kilometers, which accounts for 70% of the superficial water flow of the country From this exhibit, it can also be seen that 37% of rainfall is embodied runoff while the remaining 63% is lost through evapotranspiration Considering the total drainage area of 30,000 square kilometers (which includes watershed areas in neighboring countries), the average annual rainfall is equivalent to 1,900 mm, of which 700 mm results in runoff

**Exhibit 3**
**Map Hydrographic Regions of El Salvador**



The hydrological regime and availability of water in El Salvador are controlled by two seasons - a dry season from November to April and a rainy season from May to October The rainy season account for 85% of the total runoff volume During the dry season, rivers are fed by ground water sources and some supplies provided by lakes and artificial impoundments El Salvador has at its disposal natural lakes which are fed by rainfall and which can serve as an important source of water Exhibit 5 presents the four largest lakes and their sizes In addition to these natural water bodies, dams and the resulting impoundments constitute important stores of water The largest of these are the Cerron Grande, the 5 de Noviembre, and the 15 de Septiembre impoundments

**Exhibit 4**
**Hydrographic Regions of El Salvador***
**Annual Water Availability**

| *Region* | *Primary River* | *Area within El Salvador ($Km^2$)* | *Rainfall ($Mm^3$)*** | *Volume in Rainy Season ($Mm^3$)* | *Volume in Dry Season ($Mm^3$)* | *Total Volume ($Mm^3$)* |
|---|---|---|---|---|---|---|
| A | Rio Lempa | 10,000 | 33,317 | 12,891 | 2,002 | 14,893 |
| B | Rio Paz/Rio Sonsonate | 925 | 3,051 | 771 | 212 | 983 |
| C | Rio Paz | 674 | 1,281 | 310 | 45 | 354 |
| D | Sonsonate | 875 | 1,736 | 529 | 112 | 641 |
| E | Sonsonate/Jiboa | 1,399 | 2,164 | 643 | 93 | 736 |
| F | Rio Jiboa | 608 | 3,018 | 130 | 39 | 169 |
| G | Jiboa/Lempa | 955 | 1,325 | 260 | 41 | 301 |
| H | Lempa/Rio Grande de San Miguel | 968 | 3,742 | 420 | 95 | 515 |
| I | Rio Grande de San Miguel | 2,356 | 1,385 | 1,021 | 229 | 1,251 |
| J | Goascoran and others | 2,241 | 5,662 | 824 | 58 | 882 |
| Total | | 21,000 | 56,682 | 17,800 | 2,925 | 20,725 |

* Source Ventura (1993)

** Source Plan Maestro y Aprovechamiento de los Recursos Hidricos El Salvador 1992 Documento Básico No 14 Resumen General sobre Recursos y Demandas

**Exhibit 5**
**Important Lakes in El Salvador**

| Water Body | Area (Km2) |
|---|---|
| Lago de Ilopango | 70 5 |
| Lago de Guija | 44 1 |
| Lago de Coatepeque | 24 8 |
| Laguna de Olomega | 24 2 |

## 3.2 Ground Water

Ground water constitutes one of the principal sources of drinking water for El Salvador Recharge of ground water supplies is facilitated by the prevalence of volcanic soils which permit the percolation of rainfall Recharge areas are located in San Salvador, Santa Ana, San Vicente, Usulatan, San Miguel, and Conchagua in La Union The associated aquifers are located in alluvial deposits and pyroclastic soils The alluvial deposit zones include areas located along the Lempa River, in San Salvador, and in the coastal zones of the departments of La Paz, Usulatan, Ahuachapan, Sonsonate, and La Union The pyroclastic deposit zones include areas that surround the Ilopango and Coatepeque lakes and the Laguna del Llano Exhibit 6 lists the principal aquifers and pertinent measures of their recharge tendencies

From this exhibit, it can be observed that the recharge of these aquifers reaches on average a level of 1 4 billion cubic meters per year Of this amount, 40% corresponds to aquifers linked to the Lempa River In general, the majority of the soils of El Salvador have a limited capacity for infiltration, which is reflected in high levels of runoff during the rainy season and in low levels of runoff during the dry season because of the low base flow coming from ground water sources (Estrada, 1993)

## 3.3 Water Production and Demand in El Salvador

Despite the abundance of water demonstrated in this profile, El Salvador has entered a critical period where the security of the country's supply is significantly threatened Growing demand, contamination, and poor land uses put existing water supply sources and their quality at risk Exhibit 7 summarizes the production, consumption, and theoretical demand for water in El Salvador in 1995 Based on a typical per capita requirement of 165 liters per person per day, the implied demand for water is 303 million cubic meters, an amount which cannot be satisfied by the annual produrction of 239 million cubic meters Worsening matters is the fact that only 163 million cubic meters is actually accounted for as consumption, implying a loss of 32%

The figure for the implied demand for water may appear small relative to the available water resources cited earlier but this view ignores the difficulty of attaining water of good quality at reasonable costs Not only are surface waters generally unavailable without treatment but ground water resources are vulnerable, as indicated elsewhere in this report Furthermore, the implied demand for water is expected to grow substantially For example, by the year 2000 it is anticipated that the annual implied demand for water in San Salvador will reach 315 million cubic meters (ANDA, 1991) To satisfy this demand would require more than doubling the production of potable water from the Lempa River, the North Zone, and other AMSS sources

**Exhibit 6**
**Important Aquifers in El Salvador**

| *Aquifer* | *Location* | *Recharge Area ($Km^2$)* | *Recharge (millions of $M^3$ per year)* |
|---|---|---|---|
| **Hydrographic Region A** | | | |
| Singüil | Volcan Singüil | 80 | 10 |
| Texistepeque | Rio Texis | 40 | 10 |
| Santa-Ana | Macizo Volcánico Santa-Ana | 200 | 90-100 |
| Aguilares | Agulares-Rio Acelhuate | 140 | 40 |
| Coatepeque | Oeste Lago Coatepeque | 60 | 30-40 |
| San Salvador Group | | | |
| South Sector | Santa Tecla | | |
| West Sector | Valle Zapotitan | | 112 |
| North Sector | Quezaltepeque-Nejapa | 130 | 100-110 |
| East Sector | Area Metropolitana de San Salvador | 160 | 42 |
| Ilopango North | Lago Ilopango | 38 | Limitado |
| San Vicentre | Ladera Norte Volcan San Vicente | 100 | 55 |
| Aluvión Río Lempa | Rio Lempa | | ND |
| Subtotal | | 948 | 489-519 |
| **Hydrographic Region B** | | | |
| Atiquizaya | Departamento de Ahuachapán | 250 | 114 |
| Chalchuapa | Volcán Singüil | 30 | 9 |
| Planicie de Omoa | | ND | ND |
| Subtotal | | 280 | 123 |
| **Hydrographic Region C** | | | |
| Costero Paz | Acajutla | 100 | 124 |

| *Aquifer* | *Location* | *Recharge Area ($Km^2$)* | *Recharge (millions of $M^3$ per year)* |
|---|---|---|---|
| **Hydrographic Region D** | | | |
| Volcánico Izalco | Volcán Izalco | 75 | 55 |
| Valle de Sonsonate | Valle de Sonsonate | 200 | 108 |
| San Julián | San Julián | 55 | 41 |
| Subtotal | | 330 | 204 |
| **Hydrographic Region E** | | | |
| La Libertad-Comalapa | La Libertad Costa del Pacifico | | 30 |
| Balsamo | Desembocadura del Rio Jute | ND | ND |
| Renderos | | ND | ND |
| Subtotal | | | 30 |
| **Hydrographic Region F** | | | |
| Libertad-Lempa | Zona Costera Libertad, Desembocadura del Lempa | 400 | ND |
| San Vicente | Laderas del Norte y Noreste-Volcan San Vicente | ND | ND |
| Ilopango | Lago Ilopango | ND | 20 |
| Total | | 400 | 20 |
| **Región Hidrológica G** | | | |
| Lempa-Usulutlán | Zona Costera del rio Lempa y el Dep Usulutlan | | 100 |
| **Región Hidrológica H** | | | |
| Volcánico Usulutlán | Usulutlán | | 100 |
| Cuenca Jocotal | San Miguel | 92 | 45 |
| Valle de Olomega | Zona de la laguna de Olomega | 100 | ND |
| Quelepa | Zona Norte Volcán San Miguel | | 30 |
| Chapeltique | Valle de Chapeltique | 200 | 60 |
| Total | | 392 | 235 |
| **Región Hidrológica I** | | | |
| La Unión | Golfo de Fonseca | ND | ND |
| **Region Hidrologica J** | | | |
| Valle Este Pasaquina | Departamento de Morazán | 30 | ND |
| TOTAL | | 2,480 | 1,325-1,355 |

Key ND = No Data

**Exhibit 7**
**Annual Water Statistics, 1995**

| *Parameter* | *Water (Million m³)* |
|---|---|
| Production | |
| Lempa River | 31 5 |
| North Zone | 42 1 |
| Other AMSS | 70 8 |
| Central Region | 31 4 |
| Western Region | 38 8 |
| Eastern Region | 23 9 |
| Total | 239 3 |
| Consumption | 163 2 |
| Implied Demand | 303 4 |

Source ANDA Comportamiento de Variables e Indices de Acumulados 1995

## 3 4 Water Quality

The high level of water contamination in El Salvador has been documentedwell in the last ten years Contamination from household, muncipal, and industrial wastewater, from solid wastes, from sedimentation, and from agricultural activities have rendered the majority of rivers in the country unusable for many purposes Although limits in available data make it difficult to quantify the extent to which each of these activities contributes to this ubiquitous problem, it is possible to provide a snapshot of the magnitude and distribution of this contamination using measures taken in various locations Exhibits 8, 9, and 10 respectively provide measurements of total coliform (a measure of human and animal waste contamination), of dissolved oxygen (a measure of the absence of organic contamination), and biological oxygen demand (a measure of nutrient contamination) Exhibit 11 presents a classification system for categorizing rivers for different uses Class 4 riversare the highest quality and Class 1 the lowest A simple comparison of the indicated measurementss with the classification system highlights the extent and magnitude of contamination in the country Exhibit 12, which highlights differences in population density in the country shows that much of this contamination originates in densely populated areas (urban) and is destined to more sparsely populated areas (rural) The distributional implications of this phenomenon are considered later in this paper

**Exhibit 8**
**Map Total Coliform**

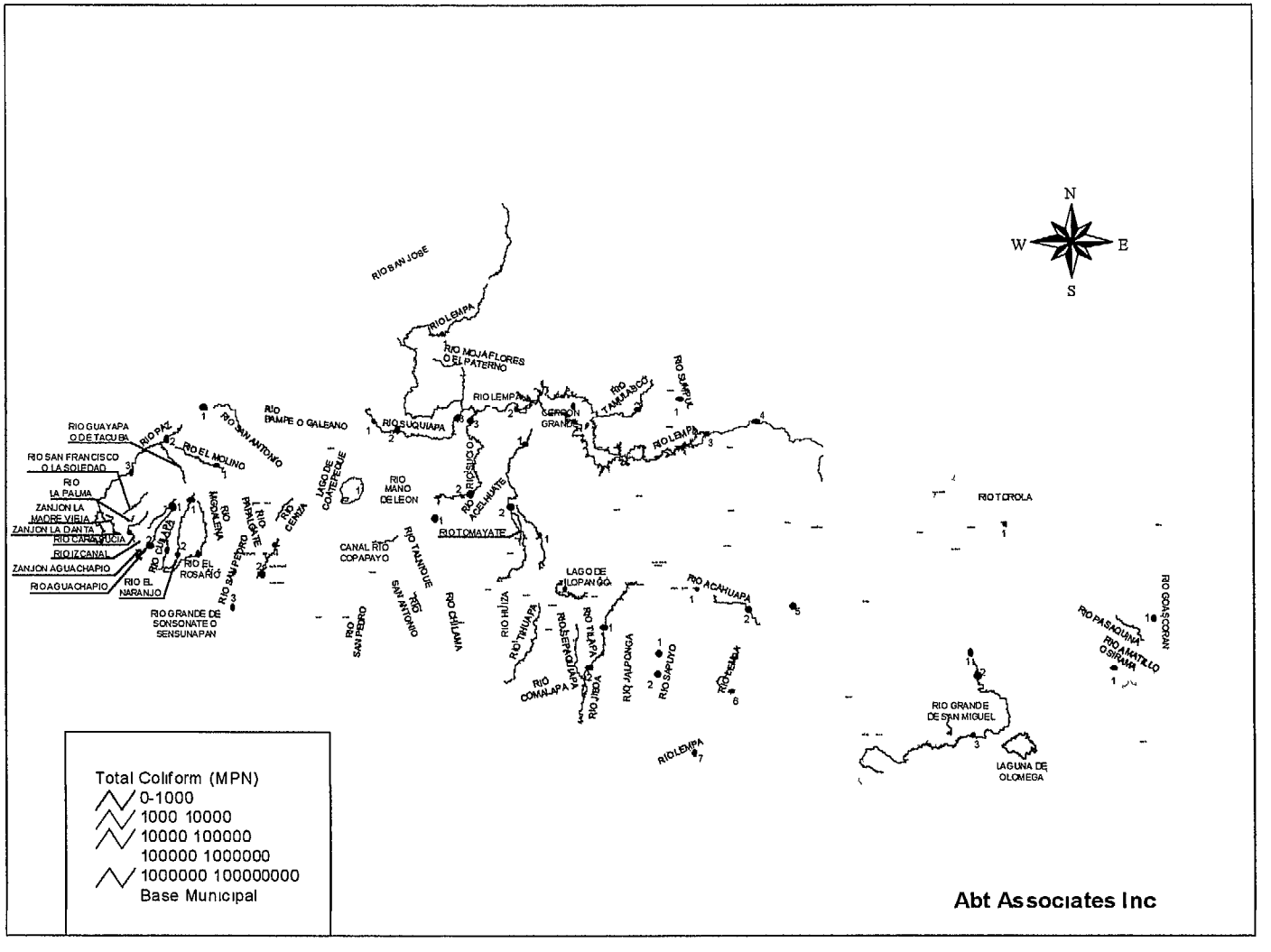


**Exhibit 9**
**Map Dissolved Oxigen**

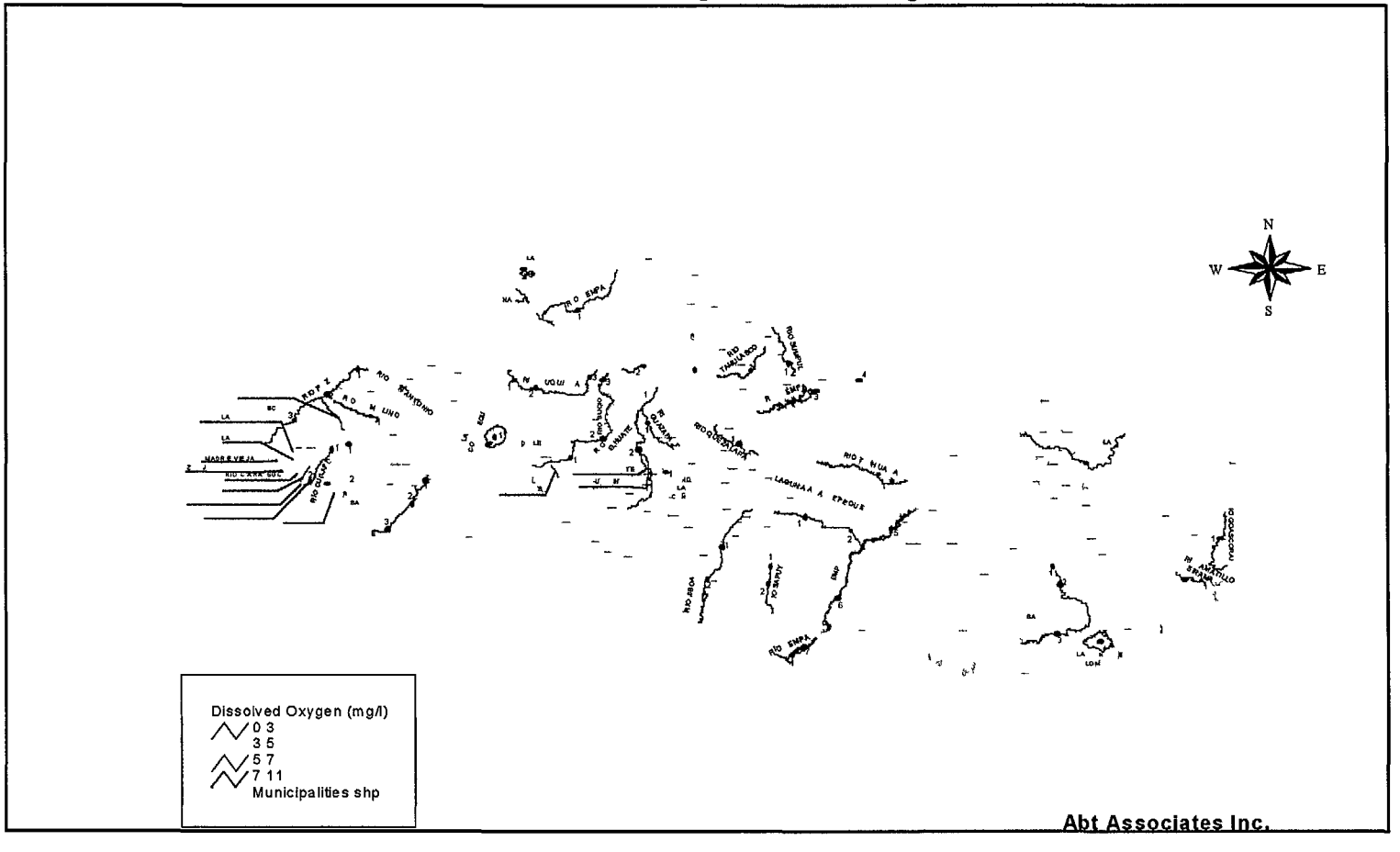


**Exhibit 10**
**Map Biological Oxygen Demand**

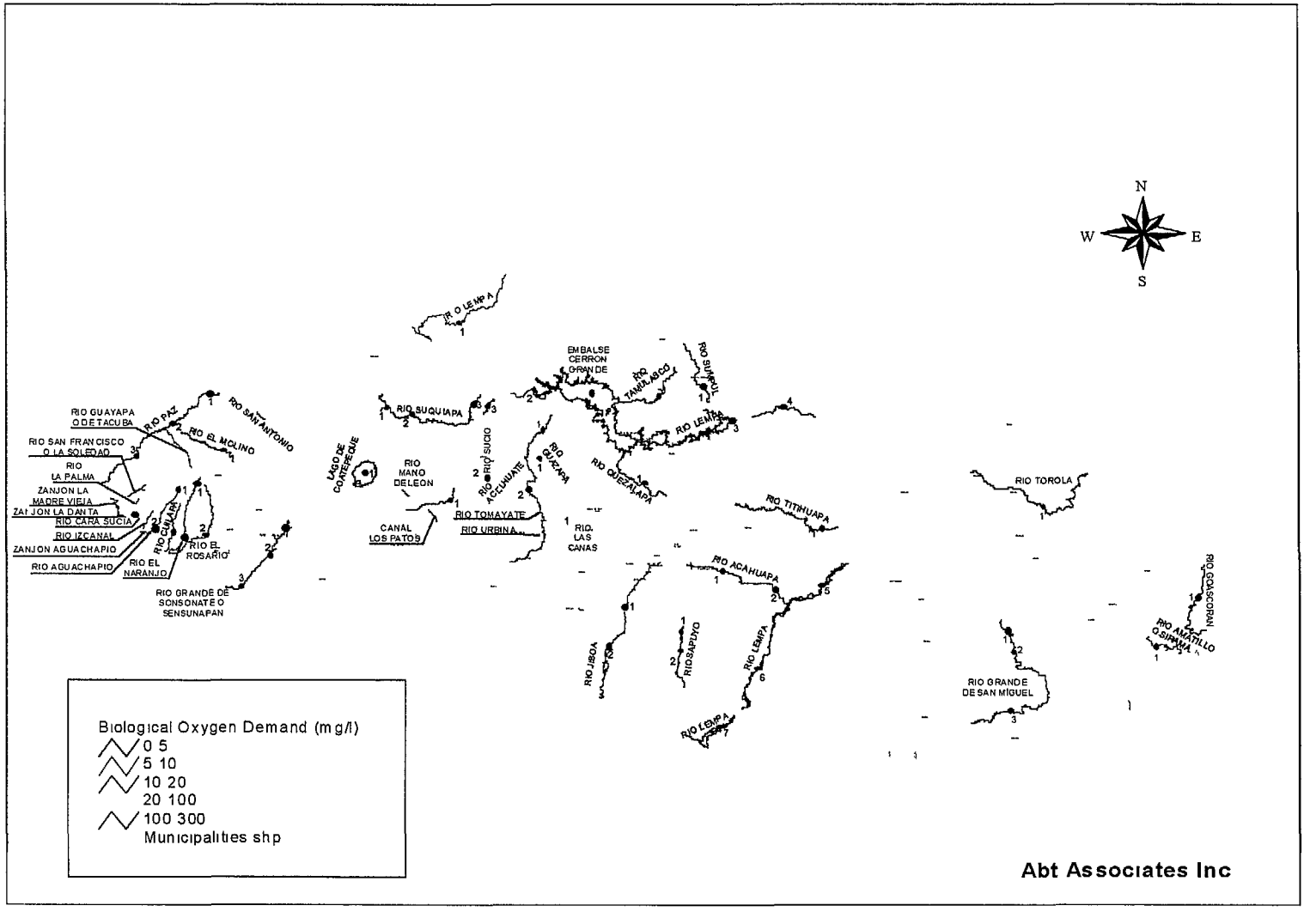
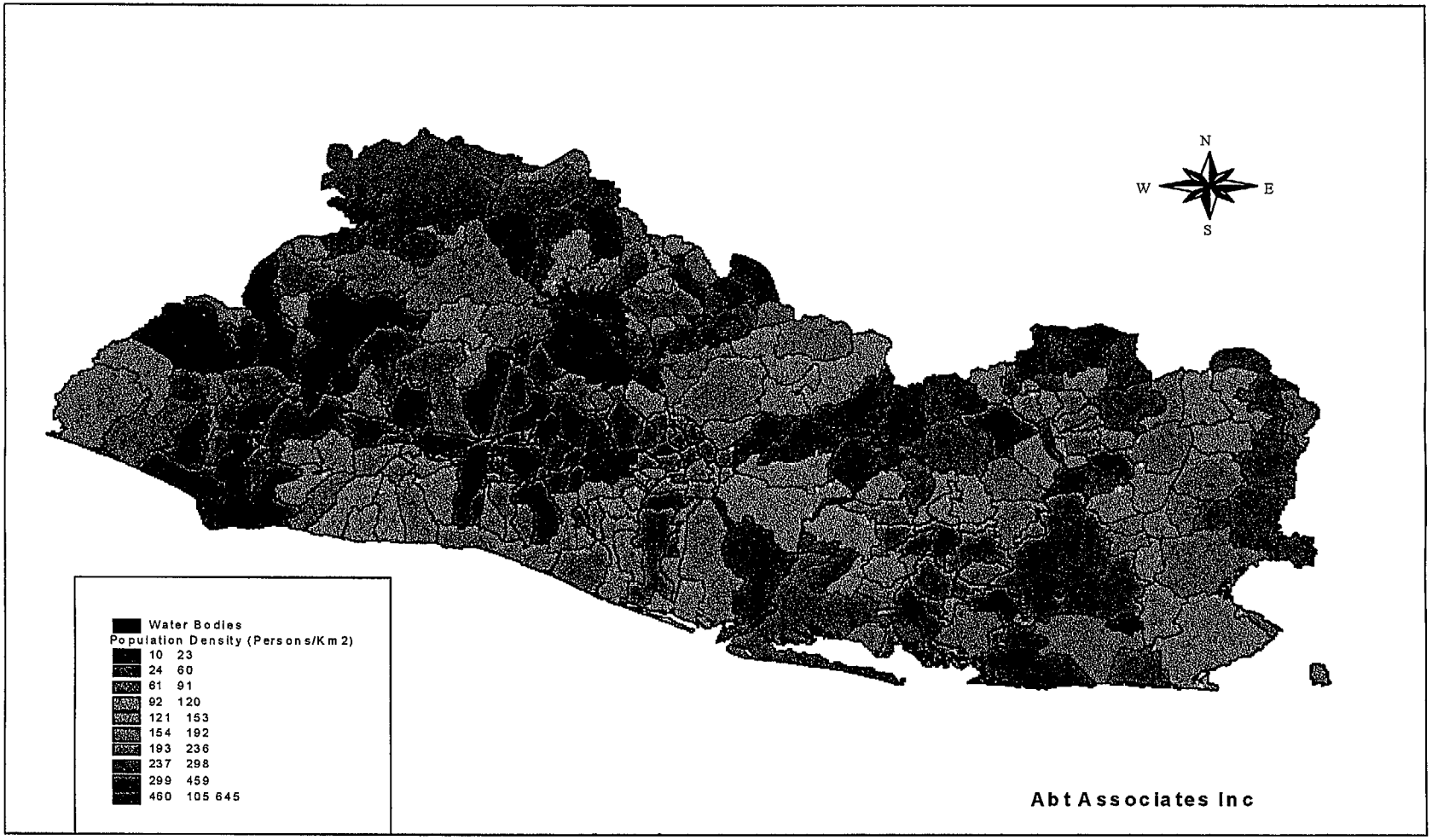


**Exhibit 11**
**Water Body Classification Parameters**

| Parameter | Units | Permitted Use | | | |
|---|---|---|---|---|---|
| | | Class 1 | Class 2 | Class 3 | Class 4 |
| Coliformes Totales | Count/100ml | <1250 | <1250 | <20,000 | <20,000 |
| Dissolved Oxygen | mg/l O2 | >6 | <5 | >4 | >2 |
| BOD5,20oC | mg/l O2 | 3 | 5 | 10 | 15 |

**Exhibit 12**
**Map Population Density**



## 4 Economic Estimates of Health Damages Associated with Water Contamination

The previous section provided extensive evidence on contamination of water resources in El Salvador Given this physical evidence, the next step of analysis focuses on the economic significance of this contamination The approach taken is to estimate the costs imposed on users from having to rely on water sources of compromised water quality Specifically, two types of contamination are considered, as manifested by their impacts on human health and development The first type is fecal and other contamination which result in acute cases of diarrhea and other water-related gastrointestional illnesses The second type is lead contamination, which can impede the intellectual development of young children

Exhibit 13 provides an overview of the incidence of acute diarrhea cases per 1000 people in different areas of El Salvador Because this information is compiled at a very gross level of detail (at the department level), it is not possible to draw rigorous links between incidence of diarrhea and exposure to contaminated water resources Still, it suggests possible variation across the country and, more importantly for this analysis, linkages between water contamination and the incidence of diarrhea

To construct national estimates of the economic damages generated by diarrhea and other water-related gastrointestinal diseases, the economic costs arising from the incidence of debilitating and occasionally fatal effects of these diseases are calculated In Exhibit 14, age-specific statistics for El Salvador on morbidity and mortality from these diseases are presented Having these statistics by age is important since measures of foregone productivity (caused by the incidence of disease) vary by age

For morbidity, economic output is lost for each day that an economically active individual is incapacitated by illness In this analysis, it was assumed that only individuals who are 15 to 64 years of age are economically active Consequently, only morbidity incidence for the age cohorts in this range are estimated Furthermore, it was assumed that the associated morbidity is serious enough to incapacitate each individual by the equivalent of two full work days The economic consequences of morbidity are than calculated as follows

- The product of all morbidity cases (101,688) is multiplied by the number of work-days lost (2) and then divided by the assumed number of work days in a year (250) This calculation generates an estimate of "work-years" lost to morbidity
- Using information from a 1994 Salvadoran government survey of household income, the per capita annual income of economically active household members was calculated ($1725)
- Multiplying the estimates of work-years lost by per capita annual income of economically active household members generates an estimate of productivity lost ($1 4 million)

**Exhibit 13**
**Map Rates of Diarrhea**
**(Cases per 1000 People)**

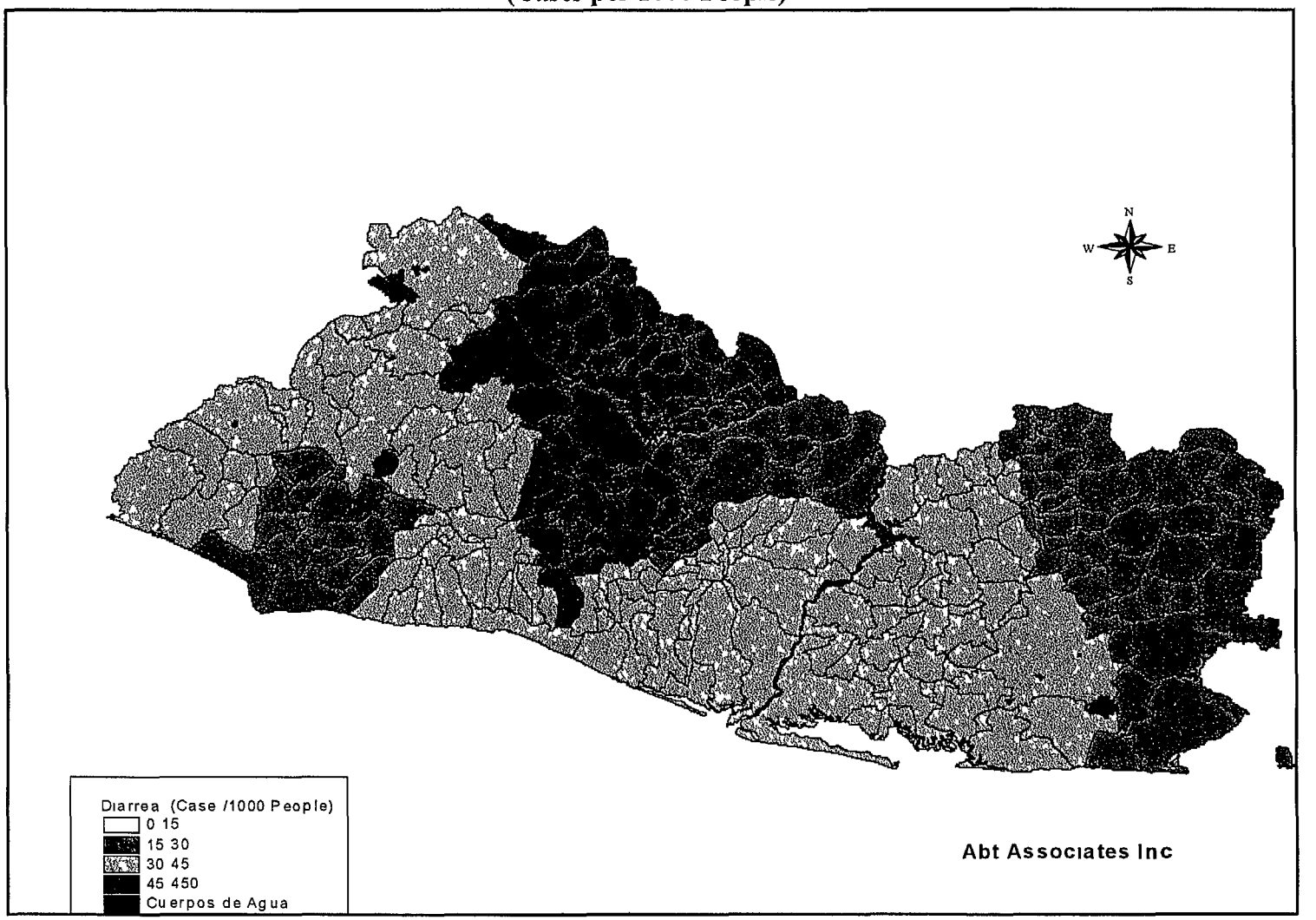


**Exhibit 14**
**Incidence of Diarrhea-Related Illnesses, By Age**
**El Salvador, 1994**

| Age Cohort | Morbidity | Mortality |
|---|---|---|
| Less than 1 Year | NA | 328 |
| 1 to 4 Years | NA | 141 |
| 5 to 14 Years | NA | 28 |
| 15 to 44 Years | 63824 | 64 |
| 45 to 64 Years | 37864 | 98 |
| 65 Years and Older | NA | 234 |
| TOTAL | 101688 | 893 |

NOTE Morbidity was estimated for certain age cohorts using information from the Ministry of Health and from the "Anuario Estadistico de Consulta Externa." "NA" indicates that morbidity was not estimated for the associated age cohort (since members of the cohort were assumed to be out of the labor force and their morbidity were not assumed to productivity losses) Mortality data were obtained from "Salud Publica en Cifras 1995 "

For mortality, economic output is also lost for each work year foregone by the death of any individual who is currently working or will work in the future Again, it was assumed that individuals who are 15 to 64 years of age are the economically active members of society at a given point in time However, while foregone productivity was calculated only for the year of incidence of morbidity, in the case of mortality, foregone productivity extends into the future and as such is calculated for all future years that a given individual would have worked. Future productivity losses carry less weight in the estimates of economic damages since they are discounted by 3% per year (the assumed social rate of time preference) Based on this approach, the economic consequences of mortality are than calculated as follows, <u>for each age cohort</u>

- Lifetime income for an average individual in the age cohort is calculated Lifetime income is considered the present value of annual income expected in the year of death and all future years For the current year, the same estimate of individual annual income was used ($1725) To reflect potential economic growth, annual income and, correspondingly, foregone productivity were assumed to grow by 4 5% per year As a result, the assumed income in the year 2 was $1725*(1 045), and so forth in future years
  Offsetting this growth in future income is the economic concept of discounting, which holds that future income is worth less today than today's income A social rate of discount of 3% was applied Accordingly, the present value of income lost in year 2 would be

$1725*(1 045)/(1 03)

For example, an infant (less than 1 year of age) who dies is assumed to lose 50 years of future productivity that would have begun in 14 years had the infant survived For that infant's lost 15th year, this income would have been greater by the growth factor ($1 045^{14}$) but this income must also be translated into its present value by a discount factor ($1/1 03^{14}$) The subsequent must be similarly increased and discounted The sum of all of these discounted future years' income is the estimated lifetime income foregone by an infant who dies

- Foregone lifetime income for a typical individual in the age cohort is multiplied by the number of deaths in that cohort from diarrhea and water-related gastrointestinal diseases

Making these calculations for all age cohorts results in an aggregate estimate of $88 6 million in economic damages from mortality associated with water-related gastrointestinal illness Exhibit 15 provides a summary by cohort of economic damages based on morbidity and mortality

**Exhibit 15**
**Annual Economic Damages**
**Morbidity and Mortality from Acute Diarrhea and Other Water-Related Illnesses**

| Age Cohort | TOTAL (US$) |
|---|---|
| Less than 1 Year | $54,106,053 |
| 1 to 4 Years | $22,596,074 |
| 5 to 14 Years | $4,055,258 |
| 15 to 44 Years | $6,155,552 |
| 45 to 64 Years | $1,781,682 |
| 65 Plus | $813,367 |
| | |
| TOTAL | $89,507,987 |
| | |
| Per Capita Damages (Total Damages/Total Population) | $16 66 |
| Per Capita damages as Percent of Per Capita Income | 2 24% |

Lead contamination of drinking water is the second type of contamination for which economic damages are calculated This analysis was motivated by a study conducted by the Universidad Centro Americana (UCA) and FIAES This study found high levels of lead in wells in the Sucio/Opico aquifer which supplies approximately one-sixth of the drinking water for the San Salvador metropolitan area All 19 samples exceed the USEPA standard of 15 ug/l The concentrations ranged from 20 to 800 ug/l, and averaged approximately 150 ug/l In the midst of

high environmental contamination, even these findings stand out.

Among other effects, exposure to lead among children from infancy through age 7 can limit intellectual development (as measured by "foregone IQ points') Based on research in the United States, it is estimated that lifetime income is 2 18% lower for each IQ point lost as the result of a child's exposure to lead As result, for this one effect of lead contamination and for this single site, the estimated annual economic damages are $118 million It is unknown whether this level of contamination exists anywhere else within El Salvador but lead is present in other drinking water sources Because contamination in excess of the USEPA standard for lead has been identified in the past in other drinking water delivery systems and because other detrimental effects from lead exposure (such as, increased risk of mortality from high blood pressure) have not been explicitly included, it is very possible that the estimated economic damages presented here constitute a conservative estimate

Exhibit 16 provides a summary of the total economic damages calculated in this analysis Given rough estimates of willingness to pay for access to clean water and sanitation that have been cited for El Salvador, these estimated economic damages seem credible Based upon studies conducted in other Latin American countries, households have indicated a willingness to pay at least 1% of income to pay for access to clean water Applied to El Salvador, the resulting aggregate willingness to pay is $395 million (of which, $97 million is based on rural households, $298 million on urban) Clearly, Salvadoran households would be willing to pay to avoid a lot of the problems associated with water (and many of which have not quantified in dollar terms in this analysis)

In conclusion, an economic perspective adds yet further motivation for concern about the misuse of water resources in El Salvador The motivation is even greater once a longer term view is taken Capitalized over a ten period, annual economic damages of this level would justify an investment of at least $1 8 billion dollars to eliminate them This finding provides a good impetus for the discussion of taking a broader capital perspective of water resources presented in the next section

**Exhibit 16**
**Annual Economic Damages**

| Impact from Water Pollution | Annual Economic Damages |
|---|---|
| Diarrhea and Water-Related Gastrointestinal Disease | $89 million |
| Lead Contamination (One Site Only) | $118 million |
| TOTAL (Based on Partial Inventory of Impacts) | $207 million |

# 5. Broader View of Capital Formation

## 5 1 Background

The aim of this presentation is to put water contamination into a recent economic context in El Salvador The usual means for comparing the environmental impacts of different polluting industries is to look at their discharges in physical terms (such as amount of material discharged or the change in water quality as a result of these discharges) This comparison is indeed provided in a subsequent section of this memo However, the objective of considering environmental impacts in an economic light is to attempt to view the social implications of these physical effects In this case, social significance is measured in economic terms

To put the impact on water resources into an economic context, these resources are characterized as economic assets which needed to be maintained by ongoing expenditures, by additional investments, or both In particular, these water resources are treated as if they were actually assets of the polluting industries and therefore could be compared with the level of capital formation being undertaken by those industries As a result, it was possible to find an industry that appeared to be on a real growth path (as the result of exhibiting positive net capital formation in terms of conventional economic accounting) would more accurately be viewed as losing ground once the deterioration of its water assets was taken into account

## 5 2 Incorporating Water Resources into Capital Account of Industry Two Approaches

The economic value of environmental deterioration was estimated using the potential costs of each industry to protect its water resources Two approaches for estimating such costs were considered One approach was to estimate the costs of each industry's diluting its waste loads prior to discharge such that deterioration of the receiving water body would be minimized or effectively eliminated This approach would required the acquisition of uncontaminated water to dilute the waste load Of course, acquiring this water from a water system source, such as ANDA, would come at a cost It was assumed that this cost would be approximately equal to what ANDA charges on average for the water it supplies The second approach focused on the waste load itself To avoid deterioration of the quality of the receiving water body, the wastes would be treated first to reduce or eliminate the pollutant discharge The treatment chosen was a combination of primary and biological treatment that could be provided by a central treatment plant. These two approaches were chosen because they are reasonable alternatives for addressing the problem and because estimated unit costs were readily available It should be noted though that these approaches to estimating the opportunity costs could be supplemented through other potential solutions In particular, the set of solutions offered by a pollution prevention review stand out

The asset balances constructed for several Salvadoran industries based on these two approaches are presented in the following pages (Exhibits 17 and 19) The findings from these applications are used in a subsequent analysis to help draw conclusions about where a demonstration effort on clean production might be focused in El Salvador To facilitate interpreting these tables, an item-by- item description of the components of these tables is provided in Exhibits 18 and 20

**Exhibit 17**
**Asset Balances for Major Industries**
**Taking Degradation of Water Resources into Account**
**DILUTION Method**

| Industry | Number of Facilities | Value Added | Dilution Requirement | Value Added per Mm3 of Dilution Water | Gross Capital Formation | Costs of Dilution Water | Gross Capital Formation, Net of Dilution Costs | Capital Stock | Capital Stock, Net of Dilution Costs |
|---|---|---|---|---|---|---|---|---|---|
| | | ($US1000) | (Mm3/year) | ($US1000) | ($US1000) | ($US1000) | ($US1000) | ($US1000) | ($US1000) |
| Food Products | 360 | $343,202 | 6,480 | $52 96 | $58,800 | $740,571 | ($681,771) | $197,291 | ($543,280) |
| Textiles | 305 | $212,368 | 2,593 | $81 92 | $20,227 | $296,286 | ($276,059) | $195,237 | ($101,049) |
| Tanneries | 20 | $8,376 | 170 | $49 27 | $9 | $19,429 | ($19,419) | $133,346 | $113,917 |
| Chemical Products | 160 | $255,604 | 1,920 | $133 13 | $16,384 | $219,429 | ($203,044) | $83,769 | ($135,660) |
| Coffee Processing | 93 | $62,098 | 6,475 | $9 59 | $15,978 | $740,014 | ($724,036) | $245,587 | ($494,427) |
| Metals & Metal Products | 213 | $266,754 | 2,130 | $125 24 | $7,059 | $243,429 | ($236,370) | $328,887 | $85,459 |
| Wood Products | 139 | $12,121 | 5,213 | $2 33 | $835 | $595,714 | ($594,880) | $274,942 | ($320,772) |
| Paper | 161 | $98,526 | 6,038 | $16 32 | $21,638 | $690,000 | ($668,362) | $309,550 | ($380,450) |
| Sugar Processing | 9 | $73,438 | 649 | $113 20 | $4,156 | $74,143 | ($69,986) | $7,617 | ($66,526) |
| | | | | | | | | | |
| TOTAL | 1460 | $1,332,489 | 31,666 | | $145,087 | $3,619,014 | ($3,473,927) | $1,776,227 | ($1,842,788) |

**Exhibit 18**
**Item-by-Item Description**
**DILUTION Approach**

| *Item* | **Description** |
|---|---|
| *Industry* | The industry categories were constructed from economic sectors defined by the 1993 Economic Census in El Salvador These sectors correspond with varying degrees of reliability to the sectors for which we have pollution discharge information In certain cases, sectors that appeared as individual categories in the Census were aggregated in order to correspond to industry classification applied in other reports we referenced For example, food products encompass three categories in the Census fabrication of food products, elaboration of food products, and beverages It is believed that this aggregation was necessary and appropriate In other cases, the Census categories were more aggregated than those in our other information sources This was the case with industry sector designated as paper In the Economic Census, paper production, products, and printing appear as one category Lacking any means of disaggregating this sector, it was necessary to treat this entire sector as having a pollutant profile similar to that of the paper production sector alone Because the different paper sub-sectors may have very different pollution profiles, a bias may be introduced by applying one pollution profile to all sub-sectors No information is available which would permit determining the direction or magnitude of such a bias |
| *Number of facilities* | Self explanatory This information was taken from the Economic Census |
| *Value Added* | This figure is an estimate of the economic surplus generated by an industry net of labor, capital and materials costs This information was taken from the Economic Census |
| *Dilution Requirement* | These industry-specific estimates were drawn from the UCA/FIAES January 1997 report, Investigacion Aplicada Sobre el Impacto Ambiental de la Contaminacion del Agua en las Cuencas de los Rios Sucio, Acelhuate, y Cuaya (Table No 4 23) |
| *Value Added per Mm3 of Dilution Water* | Calculation based on estimates of value added and dilution requirement |
| *Gross Capital Formation* | While no detailed documentation of this figure was available, it was interpreted as an estimate of the monetary value of new, durable plant and equipment acquired by the industry in the year of the Census or of investments to maintain existing plant and equipment during the Census year This information was taken from the Economic Census |
| *Costs of Dilution Water* | A cost of 1 colon per cubic meter of water as assumed This figure was converted into dollars using an exchange rate of 8 75 colones per dollar The resulting unit cost was applied to the amount of water needed to meet the industry's dilution requirement |

| *Item* | **Description** |
|---|---|
| *Gross Capital Formation Net of Dilution Costs* | This figure illustrates what the investment flow of the industry sector might look like if the water resources contaminated by the industry's discharges were also counted explicitly as part of the industry's assets In this respect, it provides an estimate of capital formation net of water resource depreciation (but not other forms of depreciation since these are not available from the Census) A negative number implies that the investment in this particular year was not sufficient to offset the deterioration of the industry's assets (including water resources) and as a result that the industry is on a path of decline rather than growth |
| *Capital Stock* | While no detailed documentation of this figure was available, it was interpreted as an an estimate of the value of the existing plant and equipment held by the firm (or, in other words, the accumulated net capital formation of the firm) This information was taken from the Economic Census |
| *Capital Stock Net of Dilution Costs* | This measure provides a way to evaluate the scale of the deterioration in an industry's water assets By comparing the depreciation of water assets (measured in terms of dilution costs or treatment costs) to the value of remaining capital stock, one can get a sense of the relative size of the economic depreciation associated with water discharges A negative number indicates that the depreciation associated with the water assets of the industry is greater than the value of all other capital stock In other words, every year, the industry is using up more in water resources than it has available to it in the form of other capital stock |

**Exhibit 19**
**Asset Balances for Major Industries**
**Taking Degradation of Water Resources into Account**
**TREATMENT Approach**

| Industry | Number of Facilities | Value Added | Treatment Costs | Gross Capital Formation | Gross Capital Formation, Net of Treatment Costs | Capital Stock | Capital Stock, Net of Treatment Costs |
|---|---|---|---|---|---|---|---|
| | | ($US1000) | ($US1000) | ($US1000) | ($US1000) | ($US1000) | ($US1000) |
| Food Products | 360 | $343,202 | $18,456 | $58,800 | $40,344 | $197,291 | $178,835 |
| Textiles | 305 | $212,368 | $8,039 | $20,227 | $12,188 | $195,237 | $187,198 |
| Tanneries | 20 | $8,376 | $2,603 | $9 | ($2,593) | $133,346 | $130,743 |
| Chemical Products | 160 | $255,604 | $29,394 | $16,384 | ($13,009) | $83,769 | $54,375 |
| Coffee Processing | 93 | $62,098 | $19,855 | $15,978 | ($3,877) | $245,587 | $225,732 |
| Metals & Metal Products | 213 | $266,754 | $32,609 | $7,059 | ($25,550) | $328,887 | $296,279 |
| Wood Products | 139 | $12,121 | $16,830 | $835 | ($15,995) | $274,942 | $258,113 |
| Paper | 161 | $98,526 | $19,493 | $21,638 | $2,145 | $309,550 | $290,057 |
| Sugar Processing | 9 | $73,438 | $27,612 | $4,156 | ($23,455) | $7,617 | ($19,995) |
| | | | | | | | |
| TOTAL | 1460 | $1,332,489 | $174,889 | $145,087 | ($29,802) | $1,776,227 | $1,601,337 |

**Exhibit 20**
**Item-by-Item Description**
**TREATMENT Approach**

| *Item* | **Description** |
|---|---|
| *Treatment Costs* | Treatment costs were estimated by using municipal wastewater treatment costs as a reference point First, it was necessary to determine the population that would typically generate the equivalent amount of waste (in terms of BOD and solids) We obtained facility-specific estimates for each industry for these population-equivalent loads from the 1982 U N Development Program (UNDP/PNUD) report "Plan Maestro de Desarrollo y Aprovechamiento de los Recursos Hidricos, El Salvador, Documento Basico No 14 " Population-equivalent loads for an entire industry were derived by aggregating these facility-specific estimates across all facilities in an industry The resulting population benchmark multiplied by their expected wastewater flow per day (assumed to be 200 gallons/day/person) provided the estimated aggregate flow of waste that had to be treated each day The total treatment costs were based on applyng a combination of low-dose chemical primary and biological treatment to this wastestream The annual unit costs of this treatment is approximately $1,100 per million gallons of wastewater treated per day (from the 1993 National Research Council book "Managing Wastewater in Coastal Urban Areas") |

Note Only the unique item ("Treatment Costs") that does not also appear in the DILUTION approach is described here Otherwise, identical terms in the TREATMENT approach have the same origin and explanation "Gross Capital Formation, Net of Treatment Costs" and "Capital Stock, Net of Treatment Costs" are exactly analagous to their counterpart terms in the Dilution approach The only difference is that industry-specific treatment costs have been substituted for dilution costs

## 5.3 Implications for Capital Formation

Two approaches have been examined for implementing a broader view of capital formation that considers water resources as a form of capital The first approach assumes that the harmful effects of pollutant discharges can be mitigated through dilution This approach would be very expensive and require enormous quantities of water (equivalent to approximately 60% of the country's annual rainfall) Though this approach is infeasible, it does illustrate an imporant point In order to satisfy water needs, you will have to look harder and harder and go further to obtain usable water from "natural" sources Such a task would of course imply the need for substantial investments Accordingly, this finding underscores the judgment that there is insufficient investment by industry in its use of water resources

The second approach considered here suggests a form of investment that could be more economically feasible Still, the results from applying this approach also underscore the basic point of the broader view of capital formation suggested here, which is that the capital needs of the industries considered are much greater than ordinary capital accounts would suggest

To remedy the shortcomings of current capital accounting, it is recommended that an effort be made to treat water resources like other important assets The ultimate aim would be to determine the asset value of water resources to different sectors (such as, households, commerce, industry, agriculture, government, and power generation) An important step in this direction would be to develop more detailed industry-specific and sector-specific information on water use and wastewater generation and discharge A second step would be to estimate the value of these services from water resources

Once estimated, the asset value of water resources could be integrated into a wider economic policy context As an example of such an application of this broader view of capital formation, an attempt is made in the following section to use estimates of wastewater control costs to understand priorities in potential pollution prevention activities with Salvadoran industry

## 5 4 Investigation of Pollution Prevention Opportunities in El Salvador

In 1997, a joint effort by AID, its global pollution prevention project (EP3) and the Instituto Centro Americano de Investigacion y Tecnologia Industrial (ICAITI) of El Salvador investigated opportunities for implementing pollution prevention activities in Salvadoran industry The EP3/ICAITI team evaluated 8 industrial sectors for their potential for implementation of a clean production and energy efficiency project in El Salvador [1] In an initial review, the team judged each sector's potential in terms of four sets of parameters and a fifth parameter to capture other, industry-specific considerations Each of these sets of parameters were assigned a range of index values The

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[1] Environmental Pollution Prevention Project and the Instituto Centro Americano de Investigacion y Tecnologia Industrial 1997 Evaluation of Seven Industry Sectors in El Salvador for Participation in a Clean Production and Energy Efficiency Program Draft Report. April 17

four sets of parameters and their associated range of index values were

- clean production and energy efficiency opportunities (0-3),
- economic importance of the sector and chance for replicability (0-3),
- propensity of the plant management to implement recommendations (0-2), and
- team's experience in other Latin American countries (0-2)

The scores assigned by the team to each sector according to the individual criteria and the resulting aggregate score are presented in the following table

**Exhibit 21**
**Ranking of industries for clean production and energy efficiency**

| Sector | Opportunities | Economic | Management | Experience | Other | TOTAL |
|---|---|---|---|---|---|---|
| Metal | 1 | 1 | 2 | 1 | 0 | 5 |
| Paper | 2 | 2 | 2 | 2 | 0 | 8 |
| Coffee | 2 | 3 | 2 | 1 | 1 | 9 |
| Printing | 1 | 1 | 2 | 1 | 0 | 5 |
| Tanneries | 3 | 2 | 2 | 2 | 1 | 10 |
| Sugar Cane | 2 | 2 | 2 | 1 | 0 | 7 |
| Textiles | 3 | 2 | 2 | 2 | 0 | 9 |
| Dairy | 2 | 1 | 2 | 2 | 0 | 7 |

By their approach, the team found tanneries, coffee processing and textiles to be the best candidates for a demonstration project on clean production and energy efficiency

### 5 4 1 Environmental Impact Analysis

As the EP3/ICAITI team acknowledged, no specific consideration was given in their ranking scheme to the potential environmental impacts of the plants considered in the industries that were evaluated We have attempted to fill this gap with the results of our own analysis of the water discharges of these and other Salvadoran industries, as reported below Despite the lack of accurate data to quantify the environmental impacts on water for each industry sector, we were able to evaluate potential impacts to water contamination based on available information from different studies and data bases for the industries in El Salvador The sources used in this analysis included

- Plan Maestro de Desarrollo de los Recursos Hidricos (PNUD, 1982)
- Evaluacion de Ecosistemas Acuaticos Contaminados (Rubio, 1993)
- Investigacion Aplicada sobre el Impacto Ambiental de la Contaminacion del Agua en las Cuencas de los Rios Sucio, Acelhuate y Cuaya (UCA-FIAES, 1997)
- Inventario de Industrias suministrado por el ANDA (1996)

### 5 4 2 Methodology

Characterization of industrial effluents from the sources mentioned above were used to rank the industry sectors based on the potential impacts to water quality using three methods (1) population equivalent loads (i e industrial discharges expressed as number of people that produces an equivalent discharge of contaminants), (2) required dilution flows to minimize impacts on the water quality, and (3) treatment requirements

(1) Ranking of industry sectors using population equivalent loads

**Exhibit 22**
**Ranking of industry sectors using population equivalent loads (1982)**

| *Ranking* | *Industry* | *Number of Facilities* | *Industrial loads (Equivalent Population)** |
|---|---|---|---|
| 1 | Coffee | 211 | 2,123,357 |
| 2 | Sugar Cane | 11 | 1,590,718 |
| 3 | Maguey (Henequen) | 4 | 694,535 |
| 4 | Distilleries | 3 | 193,808 |
| 5 | Tanneries | 14 | 85,872 |
| 6 | Dairy | 10 | 24,162 |
| 7 | Textiles | 19 | 23,604 |
| 8 | Meat Processing | 42 | 18,435 |
| 9 | Paper | 2 | 11,414 |

*Source PNUD (1982)

**Exhibit 23**
**Ranking of industry sectors using population equivalent loads (1993)**

| *Ranking* | *Industry* | *Number of Facilities* | *Industrial loads (Equivalent Population)** |
|---|---|---|---|
| 1 | Coffee | 31 | 1,409,982 |
| 2 | Sugar Cane | 10 | 1,110,628 |
| 3 | Distilleries | 4 | 193,319 |
| 4 | Tanneries | 8 | 108,642 |
| 5 | Maguey(Henequen) | 2 | 68,600 |
| 6 | Textiles | 18 | 30,303 |
| 7 | Meat Processing | 27 | 20,759 |
| 8 | Dairy | 7 | 15,326 |
| 9 | Paper | 2 | 11,414 |
| 10 | Cement | 7 | 9,441 |
| 11 | others | 1 | 2,275 |
| 12 | Soaps | 3 | 435 |

*Source Rubio (1993)

(2) Ranking of industry sectors using dilution requirement factors

**Exhibit 24**
**Ranking of industry sectors using dilution requirement factors**

| *Ranking* | *Industry** | *Number of Facilities** | *Water Demand for Dilution (Mm3)*** |
|---|---|---|---|
| 1 | Coffee | 211 | 14,691 |
| 2 | Distilleries | 3 | 900 |
| 3 | Sugar Cane | 11 | 793 |
| 4 | Maguey (Henequen) | 4 | 567 |
| 5 | Meat Processing | 42 | 244 |
| 6 | Dairy | 10 | 180 |
| 7 | Textiles | 19 | 162 |
| 8 | Paper | 2 | 75 |
| 9 | Tanneries | 14 | 2 |

*Source PNUD (1982)
**Water demand calculated using dilution factors from UCA-FIAES (1997)

**Exhibit 25**
**Ranking of industry sectors using dilution requirement factors**

| *Ranking* | *Industry** | *Number of Facilities** | *Water Demand for Dilution (Mm3)*** |
|---|---|---|---|
| 1 | Coffee | 31 | 2,158 |
| 2 | Distilleries | 4 | 1,000 |
| 3 | Sugar Cane | 10 | 721 |
| 4 | Meat Processing | 27 | 157 |
| 6 | Textiles | 18 | 153 |
| 7 | Dairy | 7 | 126 |
| 8 | Maguey (Henequen) | 2 | 125 |
| 9 | Paper | 2 | 75 |
| 10 | Cement | 7 | 69 |
| 11 | Soaps | 3 | 3 |
| 12 | Tanneries | 8 | 2 |

*Source Rubio (1993)
**Water demand calculated using dilution factors from UCA-FIAES (1997)

**Exhibit 26**
**Ranking of industry sectors using dilution requirement factors(1996)**

| *Ranking* | *Industry** | *Number of Facilities** | *Water Demand for Dilution (Mm3)*** |
|---|---|---|---|
| 1 | Distilleries | 11 | 3,300 |
| 2 | Food | 179 | 3,222 |
| 3 | Coffee | 42 | 2,924 |
| 4 | Paper | 14 | 525 |
| 5 | Metal/Plastic/Glass | 40 | 400 |
| 6 | Textile | 44 | 374 |
| 7 | Other | 52 | 260 |
| 8 | Chemical Products | 45 | 225 |
| 9 | Wood | 1 | 38 |
| 10 | Paint | 7 | 35 |
| 11 | Meat Processing | 5 | 29 |
| 12 | Farm | 2 | 12 |
| 13 | Tanneries | 12 | 3 |

*Source ANDA (1996)
**Water demand calculated using dilution factors from UCA-FIAES (1997)

**Exhibit 27**
**Ranking of industry sectors using dilution requirement factors(1997)**

| *Ranking* | *Industry** | *Number of Facilities** | *Water Demand for Dilution (Mm3)*** |
|---|---|---|---|
| 1 | Food Products | 360 | 6,480 |
| 2 | Coffee | 93 | 6,475 |
| 3 | Paper | 161 | 6,038 |
| 4 | Wood Products | 139 | 5,213 |
| 5 | Textiles | 305 | 2,593 |
| 6 | Metals & Metal Products | 213 | 2,130 |
| 7 | Chemical Products | 160 | 1,920 |
| 8 | Sugar Processing | 9 | 649 |
| 9 | Tanneries | 20 | 170 |

*Source USAID Green Project/Abt Associates, March 17 (1997)

3) Ranking of industry sectors using the treatment method

**Exhibit 28**

| *Ranking* | *Industry** | *Number of Facilities** | *Treatment Costs ($US1000)*** |
|---|---|---|---|
| 1 | Metals & Metal Products | 213 | $32,609 |
| 2 | Chemical Products | 160 | $29,394 |
| 3 | Sugar Processing | 9 | $27,612 |
| 4 | Coffee | 93 | $19,855 |
| 5 | Paper | 161 | $19,493 |
| 6 | Food Products | 360 | $18,456 |
| 7 | Wood Products | 139 | $16,830 |
| 8 | Textiles | 305 | $8,039 |
| 9 | Tanneries | 20 | $2,603 |

*Source USAID Green Project/Abt Associates, March 17 (1997)

## 5 5 Implied Priorities for Pollution Prevention Activities in El Salvador

In the analysis presented here, the potential waste burdens discharged to water bodies by different Salvadoran economic sectors have been estimated These estimates are intended to complement the findings of the EP3/ICAITI team by considering the environmental impacts of different Salvadoran industries These industries are candidates for pollution prevention activities

# 6. Balance Sheet of Assets and Liabilities for the Water Sector: An Illustration

## 6 1 Hypothetical Example for El Salvador in 1998

The following exhibits present a hypothetical example of a "balance sheet" of assets and liabilities embodied in water resources and complementary capital in the water sector in El Salvador in 1998 This exhibit is divided into four parts The first three parts (Exhibits 29 a, 29 b, and 29 c) respectively present assets embodied in water resources, liabilities associated with the use of water resources, and assets and liabilities embodied in manmade capital in the water sector The final exhibit for 1998 (Exhibit 29 d) provides a composite picture of the net worth of the assets and liabilities associated with water resources and manmade capital This net worth is intended as a measure of the "working capital" available in the water sector in El Salvador

In Exhibit 29 a, a profile of water resources for each of the country's ten hydrographic regions is presented Water resources are the primary form that assets take in the water sector In this example, only the annual flow of surface water resources are tallied This inventory takes two forms - the amount of available annual flow and the amount of annual flow that is usable (which means, by assumption, that the quality if sufficient for consumption) The definition of "usable" could take many forms but here it is taken to be indicative of a wide range of consumptive uses Consequently, for the water to be deemed usable, it must be of a suitable quality to satisfy typical human consumption, industrial, and agricultural needs As such it represents a portion of the total available water (assumed to be 31%) which implies that the remaining 69% of the available water is too contaminated for any consumptive use

The average unit value (colones per cubic meter) is meant to capture a generalized value for the uses cited above This value varies for different hydrologic regions since willingness to pay and the cost of accessing the water can vary by region While many of the figures presented in the table are on the same order as their counterparts in the real world, it is very important to note that this is a hypothetical example It is intended to illustrate what could be learned if such a balance sheet were actually constructed

The price (unit value) of surface water flow varies across hydrographic regions Such variation could derive from differences in accessibility and quality For example, in regions E and F and portions of region A, water resources are more accessible to urban populations where water can presumably be applied to higher valued uses In the remaining regions, it is assumed that the access for urban populations are currently infeasible and instead rural uses constitute the highest valued use Information from an assessment of willingness to pay for water in rural areas suggests that unit values are lower in rural areas Consequently, in this illustration, the unit values are correspondingly lower in rural than in urban areas As indicated later in this report, differences in the valuation between urban and rural areas could be an important component of the distributional problems that affect the water sector in El Salvador

In this illustration, the current total value is constructed to be approximately 10 billion



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colones (approximately $1 2 billion) Of this total, 80% derives from surface waters in the Rio Lempa region, as would be expected given its large physical endowment of surface water and its relative proximity to population centers

By comparison, the damages imposed on Salvadoran society by contamination of surface water resources are more important Exhibit 29 b presents an illustration of the damages to human health and to industrial and commercial output that derive from water of poor quality The "damages" component represents the flip side of water as a provider of services Instead of representing services provided, "damages" represent services foregone Liabilities arise because the current state of water resources imposes costs (damages) on society The damages to human health include the economic costs such as morbity and mortality associated with acute diarrheal disease and other water-related diseases as well as impediments to intellectual development in children that derive from exposure to lead contamination [2] The damages to industrial and commercial output include the increased costs of production (such as having to purify water prior to use) and reductions in the quality of products that result from using water containing contamination or of inferior quality

In this example, the total damages amount to 12 billion colones (approximately $1 4 billion) These damages exceed the asset value of surface water resources by 20%, implying a negative net worth This example illustrates the importance of how water resources are managed in the country To the extent it is possible to avoid the effects of contamination (such as by the treatment of liquid wastes or the development of other sources of water), it will be feasible to increase the value of water resources

Investments in complementary capital can make this improvement possible, adding to the asset base in the water sector Complementary capital provide the means for accomplishing this improvement, by providing access to additional sources (such as groundwater or more distant and as yet uncontaminated surface water) or reducing contamination directly (such as wastewater treatment facilities at industrial or municipal discharge sites) As illustrated in Exhibit 29 c, this improvement comes at the price of additional debt Nonetheless, as long as wise investments are made such that the capital involved (3 billion colones) return greater value than they cost (2 94 billion colones), this element of the water sector will have a positive net worth. In this example, the net value is indeed positive for each type of capital and accordingly for all manmade capital (0 06 billion) colones) but small

Exhibit 29 d presents an aggregate picture of assets and liabilities based on the hypothetical examples given in Exhibits 29 a through 29 c The bottom line is that the sector would be considered insolvent if it were audited as a private enterprise since its liabilities exceed its assets A positive balance in investments in manmade capital (0 06 billion colones) only offsets a small portion of the capital deficit which exists in the water resources component of the sector (-1 99 billion colones) The overall deficit of 1 93 billion colones implies that the water sector is reducing the economic well-being of El Salvador rather than contributing to its growth

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[2] Separately in this report, these types of damages are also estimated using actual data.

While the results in Exhibit 29 d are hypothetical, they are consistent with the findings of an analysis of specific key Salvadoran industries with respect to capital formation, provided elsewhere in this paper This analysis integrates wastewater treatment into the calculation of overall capital formation to provide a more complete view of the impact of economic production on the state of Salvadoran water assets This example underscores the need for additional investment in the water sector in El Salvador Appropriate capital investments can increase the volume of usable water resources (and therefore their value) and thereby reduce the damages imposed on the country by contaminated water This possibility is considered in the next section

**Exhibit 29 a**
**ILLUSTRATION**
**Balance Sheet for Water Resources and Complementary Capital**

**Assets Embodied in Water Resources**

| Hydrographic Region | Available (million m3) | Usable (million m3) | Water Price (colones/m3) | Value (billion colones) |
|---|---|---|---|---|
| A | 14,893 | 4,542 | 1 72 | 7 83 |
| B | 983 | 300 | 1 08 | 0 32 |
| C | 354 | 108 | 1 08 | 0 12 |
| D | 641 | 196 | 1 08 | 0 21 |
| E | 736 | 224 | 2 00 | 0 45 |
| F | 169 | 52 | 2 00 | 0 10 |
| G | 301 | 92 | 1 08 | 0 10 |
| H | 515 | 157 | 1 08 | 0 17 |
| I | 1,251 | 382 | 1 08 | 0 41 |
| J | 882 | 269 | 1 08 | 0 29 |
| | | | | |
| TOTAL | 20,725 | 6,321 | 1.58 | 10.01 |

## Exhibit 29 b
## ILLUSTRATION
## Balance Sheet for Water Resources and Complementary Capital

### Liabilities Linked to Water Resources

| Hydrographic Region | Available (million m3) | Usable (million m3) | Health Damages (billion colones) | Industry & Commerce (billion colones) | Total Damages (billion colones) |
|---|---|---|---|---|---|
| A | 14,893 | 4,542 | 5 61 | 3 02 | 8 62 |
| B | 983 | 300 | 0 37 | 0 20 | 0 57 |
| C | 354 | 108 | 0 13 | 0 07 | 0 20 |
| D | 641 | 196 | 0 24 | 0 13 | 0 37 |
| E | 736 | 224 | 0 28 | 0 15 | 0 43 |
| F | 169 | 52 | 0 06 | 0 03 | 0 10 |
| G | 301 | 92 | 0 11 | 0 01 | 0 17 |
| H | 515 | 157 | 0 19 | 0 10 | 0 30 |
| I | 1,251 | 382 | 0 47 | 0 25 | 0 72 |
| J | 882 | 269 | 0 33 | 0 18 | 0 51 |
| | | | | | |
| TOTAL | 20,725 | 6,321 | 7.80 | 4.20 | 12.00 |

## Exhibit 29.c
## ILLUSTRATION
## Balance Sheet for Water Resources and Complementary Capital
## Assets and Liabilities Associated with Manmade Capital

| Plant & Equipment | Value (Billion Colones) | Outstanding Debt (Billion Colones) |
|---|---|---|
| Water Supply/Watershed Protection | 1 2 | 1 18 |
| Water Distribution | 0 9 | 0 88 |
| Wastewater Collection | 0 45 | 0 44 |
| Wastewater Treatment/Pollution Prevention | 0 45 | 0 44 |
| TOTAL | 3 | 2 94 |

**Exhibit 29 d**
**ILLUSTRATION**
**Balance Sheet for Water Resources and Complementary Capital**

**Aggregate Picture of Assets and Liabilities**

| Hydrographic Region | Value (Billion Colones) | Damages (Billion Colones) | Net Value (Billion Colones) |
|---|---|---|---|
| A | 7 83 | 8 62 | (0 79) |
| B | 0 32 | 0 57 | (0 25) |
| C | 0 12 | 0 21 | (0 09) |
| D | 0 21 | 0 37 | (0 16) |
| E | 0 45 | 0 43 | 0 02 |
| F | 0 10 | 0 10 | 0 01 |
| G | 0 10 | 0 17 | (0 08) |
| H | 0 17 | 0 30 | (0 13) |
| I | 0 41 | 0 72 | (0 31) |
| J | 0 29 | 0 51 | (0 22) |
| | | | |
| SUBTOTAL, Water Resources | 10 01 | 12 00 | (1 99) |
| | | | |
| | Value | Liabilities | Net Value |
| SUBTOTAL, Manmade Capital | 3 00 | 2 94 | 0 06 |
| | | | |
| | Value | Liabilities | Net Value |
| TOTAL | 13.01 | 14.94 | (1.93) |

## 6 2 Comparing Water Assets and Liaibilites Over Time

To appreciate the potential insights that can be gained from constructing an economic balance sheet for the water sector more fully, it is useful to compare examples contructed for a larger time frame These hypothetical examples illustrate the changing nature of

- physical endowments,
- amount of usable water,
- unit value of water resources,
- total value of water, and
- investments in manmade capital in the water sector

Examples for a ninety-year period have been constructed which provide snapshots every thirty years (including the hypothetical example for 1998 already presented) in order to capture the potential state of the water sector at different stages of the country's development In Exhibit 30, a hypothetical comparison of changes in working capital over a ninety-year period (1938-2028) is presented to illustrate the economic significance of both protecting existing water resources as well as investing in manmade capital in the water sector These examples are presented in graphical form in Exhibits 31 a through 31 d

The first major observation to draw from this comparison across time is that even though gross assets in the water sector grow dramatically during these ninety years, liabilities also grow dramatically (and during the current period, more than assets) The dramatic growth in liabilities is consistent with what many people already perceive in El Salvador - the ubiquitous nature of contamination in surface water This view is supported by information provided in the characterization of water resources presented in this study What Exhibit 30 also shows is that assets are having to grow substantially to offset this contamination For example, were it not for the capital purchased with the 2 94 million colones (represented by the level of debt as of 1998), the damages associated with El Salvador's water sector could have been much worse and the amount of usable water much lower

The relative combined effect of the changing levels of assets and liabilities is captured in the estimates of net working capital for the period 1938 to 2028 Through 1968, this hypothetical example shows that the country is still ahead, generating growing levels of net working capital From 1968 to 2028, the situation reverses itself once (reflecting inadequate protection of water resources) and then again (reflecting greater efforts to protect water resources and/or to make provisions to obtain substitutes for contaminated sources) This second reversal comes at the price of high investments in manmade capital, which are 66% of total assets in the water sector by 2028 (or nearly 14 times greater than in 1938)

**Exhibit 30**
**ILLUSTRATION**
**Working Capital in the Water Sector. Comparison Over Time**

| | 1938 | | 1968 | | 1998 | | 2028 | |
|---|---|---|---|---|---|---|---|---|
| ASSETS | | | | | | | | |
| | Usable Flow | Value | Usable Flow | Value | Usable Flow | Value | Usable Flow | Value |
| | (milln m3) | (blln colones) | (milln m3) | (blln colones) | (milln m3) | (blln colones) | (milln m3) | (blln colones) |
| Water Resources | 20,725 | 5 00 | 12,642 | 12 00 | 6,321 | 10 00 | 7,921 | 20 00 |
| Manmade Capital | | 0 15 | | 0 60 | | 3 00 | | 24 00 |
| | | | | | | | | |
| Subtotal, Assets | | 5 15 | | 12 60 | | 13 01 | | 44 00 |
| % Manmade | | 2 9% | | 4 8% | | 23 1% | | 54 5% |
| LIABILITIES | | | | | | | | |
| | | Value | | Value | | Value | | Value |
| | | (blln colones) | | (blln colones) | | (blln colones) | | (blln colones) |
| Damages | | 1 50 | | 3 00 | | 12 00 | | 12 00 |
| Debt | | 0 08 | | 0 45 | | 2 94 | | 22 80 |
| | | | | | | | | |
| Subtotal, Liabilities | | 1 58 | | 3 45 | | 14 94 | | 34 80 |
| % Debt | | 4 8% | | 13 0% | | 19 7% | | 65 5% |
| NET WORTH (Working Capital) | | | | | | | | |
| | | Value | | Value | | Value | | Value |
| | | (blln colones) | | (blln colones) | | (blln colones) | | (blln colones) |
| Net Total | | 3.58 | | 9.15 | | (1.93) | | 9.20 |

This constructed example, despite its hypothetical nature, conforms well with a phenomenon that seems to be operating in El Salvador Water no longer comes easily from nature Instead, significant interventions through management and through capital investments are needed to replace lost water resources Because pressures from an already strained system of water resources (e g , through increased contamination and increased demand) are likely to increase with population and economic growth in the country over the next few decades, the likelihood of depreciating the existing water resource assets seems very high

To offset this depreciation, it will be necessary to make additional and substantial investments in plant and equipment that provide access to usable water and will at least limit the growth of contamination In Exhibit 30, invesments in manmade capital are assumed to have risen to 24 billion colones (from 3 billion in 1998) and correspondingly, the value of water resources have increased and damages imposed on society by contamination have declined As a result, in 2028, the water sector is no longer insolvent since it has a positive net worth of 9 2 billion colones and is contributing to the economic welfare of the country

Exhibits 31 a through 31 d help illustrate the individual trends that underlie the overall phenomena highlighted above In particular, the following observations are highlighted

- The physical quantity of water declines precipitously from 1938 to the year 2000, when a small turnaround begins as the result of proportionately greater wastewater treatment and control from that year forward (Exhibit 31 a)
- Despite the decline in the physical quantity of usable water, the value of these resources grows during part of the period (1938 to 1968) and only declines slightly from 1968 to 2000 Implicit in this example is the assumption that the real marginal value of water grows enormously over this period (from about 0 2 colones per cubic meter in 1938 to 2 4 colones in 2028) because of the growth in demand (Exhibit 31 b)
- The value of damages increases with contamination (from 1938 to 1998) but levels off after contamination begins to be abated after 1998 The required reduction in contamination will have to be substantial since it is likely that the marginal value of damages will continue to rise with economic growth (deriving in part, for example, from the rising value of foregone productivity attributable to water-related morbidity and mortality is worth more) (Exhibit 31 c)
- Offsetting the depletion and deterioration of water resources is possible but it comes at a price El Salvador will have to incur debt to be able to make the necessary investments in wastewater treatment and control Accordingly debt rises throughout the ninety-year period (Exhibit 31 d)

To conclude this comparison of hypothetical asset balances across time, it is useful to underscore one more phenomenon In 1938, water resources contributed 97 1% of the value of assets in the water sector (and manmade capital, 2 9%) In 2028, water resources constituted only 45 5% (even though they were four times more valuable than they had been in 1938) It is evident that nature has become secondary as a store of wealth in this sector There is something at least a little bit hopeful in this outcome, which is, that proper investments can in theory restore at least part of the value lost through exploitation of natural resources Whether these investments will be made

is a separate question But that question could be answered at least roughly with the ongoing construction of actual asset balances for the water sector, like that presented here, using actual data, estimations, and inferences about the different components

**Exhibit 31 a**
**ILLUSTRATION**
**Comparison Over Time**
**Usable Water**

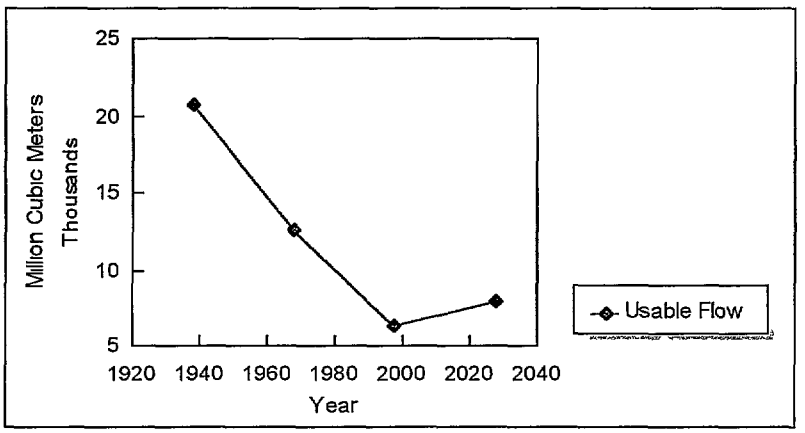



**Exhibit 31 b**
**ILLUSTRATION**
**Comparison Over Time**
**Value**

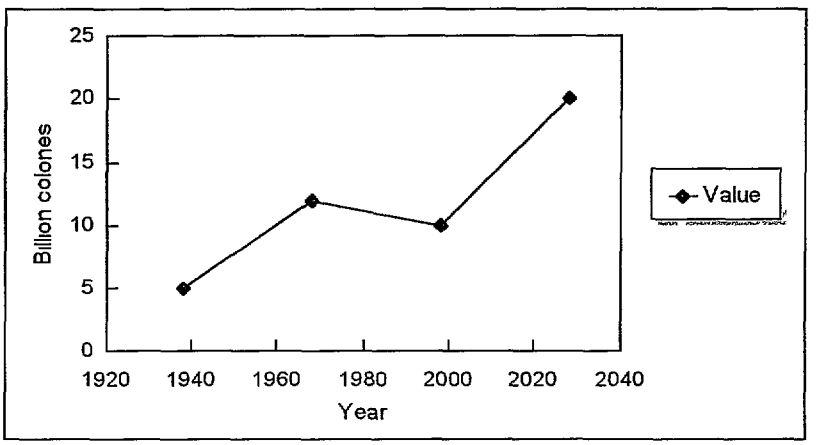


**Exhibit 31 c**
**ILLUSTRATION**
**Comparison Over Time**
**Damages**

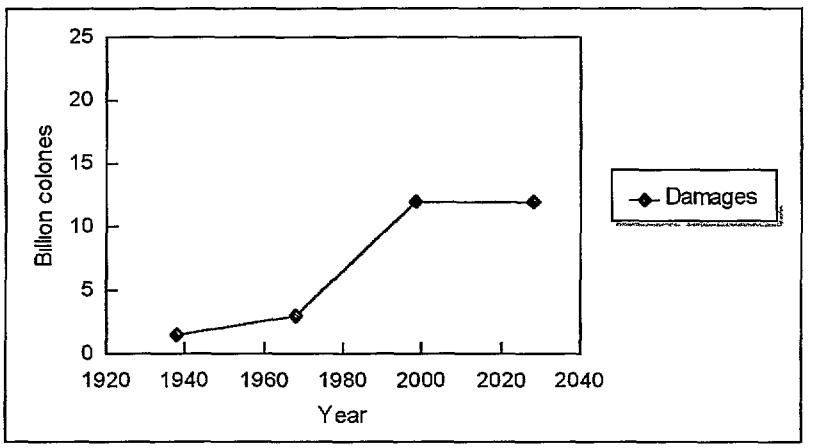
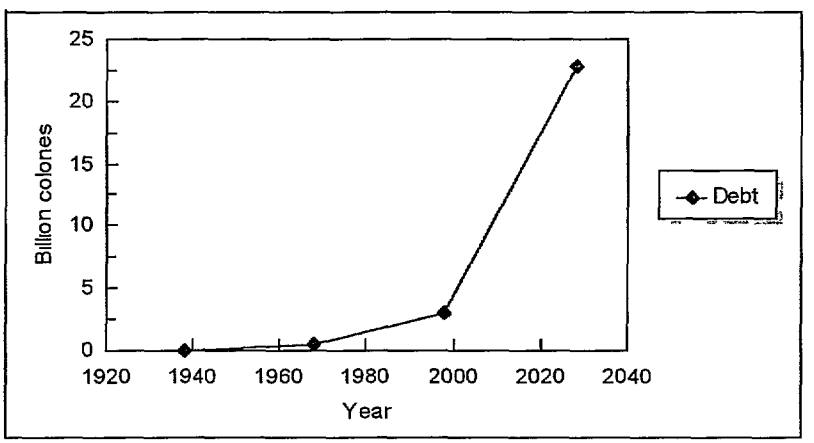



**Exhibit 31 d**
**ILLUSTRATION**
**Comparison Over Time**
**Debt**



## 7. Special Issue: Distribution of Water Resources between Urban and Rural Areas

One issue that has filtered through several of the analyses conducted for this paper but that has not received direct attention is the distributional aspect of water use and degradation in El Salvador While the allocation of water resources may not have been managed in full recognition of the value of water resources, this is not to say that the value of water resources has been completely ignored On the contrary it appears that many decisions about the allocation of public water resources have been engineered to benefit urban populations For example, as local ground water resources have become depleted in the greater metropolitan area of San Salvador, more distant sources of drinking water have been sought, in the rural areas of the country At the same time, much of the industrial, municipal, and household wastewater generated in the country is discharged from major population centers downriver to rural areas of the country

Together these two tendencies constitute a phenomenon that raises concern about who is benefitting and who is losing with the current allocation of water resources in the country - valuable water resources are being imported into urban population centers, from which contaminated water is being exported The ultimate balance between these two tendencies and its distributional implications deserve further evaluation As of 1994, about 45% of the country's population, or 2 4 million people, lived in rural areas In 1992, 48% of the rural population did not have reliable access to clean water Clearly, any detrimental impact on rural areas carries great social significance

One of the challenges in considering the rural-urban distributional implications of water allocation in El Salvador is that the urban areas can back up their demand for water with significant economic resources Given current income distribution, an estimated 75% of the potential buying power for water resides in urban areas (based a rough estimate of willingness to pay as a constant 1% income regardless of location)

Nonetheless, the rural areas stand to gain from improvements in water resource management and allocation and may have sufficient economic resources to pay for some of these improvements Already, water acquisition is an expensive proposition in rural areas One estimate has suggested that costs on the order of 4 to 7 colones per $m^3$ (in 1988), or, $1 30 to 2 29 per $m^3$ (in 1996) By comparison, average cost of water in US is $1 22 per 1000 gallons (in 1994) This circumstance suggests that the savings made possible by investments in cost-effective means to provide better and more reliable to access to clean water may pay for themselves Using the same willingness to pay calculus cited above, rural households without access to clean water may be willing to pay as much as $47 million per year for access to clean water

These and other factors need to be weighed in the design of future investments in water resources and their distribution between rural and urban water needs

## 8. Conclusion and Recommendations

Implicit in this report is the assumption that achieving economic growth and development in a sustainable way is a desirable goal In this respect, income should be generated for the citizens of El Salvador without driving down the value of the nation's wealth More preferred would be the case where greater income could be generated in tandem with an increase in the wealth of the country

To pursue this goal, it is necessary to have a very clear understanding of the concepts of true income and wealth Where nonmarket resources are concerned, national tallies of income generation have been notoriously deficient For several years, addressing this general shortcoming has been the domain of environmental and natural resource accounting efforts in industrialized countries and developing countries alike One particular approach to this task has been codified in the United Nations' System for Integrated Environmental and Economic Accounting (SEEA) While the current paper does not explicitly present its findings in this context, the findings could indeed contribute to an effort to construct national economic and environmental accounts for El Salvador And, United Nations authorities involved in the development and application of the SEEA have expressed to the AID/Abt project team a readiness to collaborate with Salvadorans in an effort to produce an initial version of this integrated accounting approach for the Salvadoran economy

One of the most important lessons to be drawn from the collected experience of trying to implement environmental accounts is the difficulty of trying to assess the size and economic value of stocks of environmental and natural resources Not surprisingly, this difficulty coincides with the fact that the management of these resources is very poorly pursued in most countries in the world Not knowing much about the state of these resources also goes hand-in-hand with ambiguities about who "owns" and can effectively control the resources No one organization or individual knows enough about what is happening to the resource Accordingly, to protect and enhance these resources, it is fundamental to make a systematic and persistent effort to fill this gap in understanding

The management of water resources is a very good example of these problems Freshwater resources are usually not well controlled The water itself typically comes from "somewhere else" (such as rainfall or from remote sources upstream or underground) And once the water resources are used, they are sent yet "somewhere else " This scenario plays itself out in El Salvador at the most individual level (a single household or producer) and all the way up to the most aggregate level conceivable - the entire country The latter case offers a compelling example A significant portion of El Salvador's main watershed (of the Lempa River) is supplied by water that originates outside th country (in Honduras) Furthermore, the Lempa and other major rivers discharge to the Pacific Ocean In short, El Salvador does not have full control of its water sources or the fate of its discharges

Recognizing what is being lost by incomplete, and possibly deficient, management of the water resources of the country is an essential prerequisite for identifying ways to protect the country's water assets The pressures on freshwater resources are so large in El Salvador and

growing at such a substantial rate that it raises doubts about the real net benefits that individual water projects will actually be able to realize in the future When an individual water project can be implemented within a well-orchestrated national system of water resource management, it is much likelier to succeed than if it takes place in circumstances where water use and management is rapidly changing If the entire picture of what is happening to the collective water resources is either not understood or not taken into account, it is easy to imagine how a specific water project could be encroached upon by other larger factors For example, a project to draw drinking water from the Lempa watershed could certainly fall short of its original goals in the future if the Lempa watershed itself is not protected

This paper has suggested that taking an economic view of water resources and their associated complementary capital offers a useful means to assess how well these are being managed in El Salvador In particular, it is recommended that an effort to evaluate the nation's freshwater resources as a portfolio of net working capital be undertaken At a minimum, a preliminary set of balance sheets for the present water sector would be established using actual data, estimations, and inferences about the different components Preferably, this assessment of the current status quo could be compared with projections made for assets and liabilities in the water sector at points in the future Such a comparison of the present with the future circumstances could provide guidance for current and near-term decisions about investments in the water sector of El Salvador, at the national level and at the level of individual projects

In the current effort, actual data and estimates could be compiled for certain elements of an assessment of the assets and liabilities in the water sector (such as the overall water balance, estimates of human health damages, and estimates of net working capital for selected, important industrial sectors), further work is clearly required It is important to note that these balance sheets were constructed to illustrate how they could provide insights into the current status of the nation's wealth was embodied in water resources and complementary capital Although they are consistent with a general understanding of the factors that affect assets and liabilities in the water sector in El Salvador, certain parts of the presentation are conjectural To construct a complete set of actual estimates of the asset and liabilities figures presented here will require additional data collection and estimation The following provides is a brief overview of the associated data needs

First, the asset value of water resources will require information on the economic demand for water (willingness to pay) by different types of users (e g , households, industry, agriculture) in different locations and socioeconomic circumstances This information provides a better basis for establishing the asset value of water resources Second, estimates of the supply costs of using different water resources (from surface and ground water souces) are required in order to estimate the net economic value of these resources, which will serve as the basis for estimating their asset value These supply costs could include the possibility of obtaining water from more remote surface or ground water sources as well as the possibility of treating more accessible water that is contaminated Third, a better accounting of complementary capital that is already in place in the public and private sector is needed as well as the level of indebtedness associated with this capital

Admittedly not all of this information will be available in a first iteration of trying to

implement the concept of assets and liabilities proposed here Nonetheless, it is anticipated that certain data gaps can be filled through estimation and imputation In the end this approach will provide at least a basic picture that is useful in its own right as a rough indicator of the long-term economic prospects of the water sector Furthermore, the experience of composing this basic picture should be instructive for determining the types of actual data that need to be collected in the future

What is being proposed here is not a one-time effort but the beginning of a regular activity that can be conducted at the micro and macro level to inform public and private economic decisions about the use of water resources in El Salvador Consequently, the next steps that are taken to implement a broader view of assets and liabilities in the water sector should be designed to facilitate a longer-term effort, to the extent feasible This objective suggests the importance of involving Salvadoran counterparts in the public and the private sectors who have an interest in environmental and economic priorities as well as individuals familiar with implementing environmental and resource accounting at the national level (such as officials from the United Nations involved with the development of its protocol for such accounts) in the final design and implementation of such a framework The effort could also benefit from the participation of donor and lender representatives and technical staff since they too are concerned about the health of water resources and its relationship to economic and social welfare in El Salvador

Because of its current focus on water as a vehicle for many of its development objectives in El Salvador, USAID appears to be well positioned to take the lead in putting together the type of consortium that is needed to undertake the next steps in the activities proposed here To succeed, these activities will require both technical assistance as well as constructive advice on generating public and private interest in the economic health of water resources In each of these areas, USAID can serve both as a contributor as well as a possible coordinator