APPENDIX A

NATIONAL PROGRAM FOR THE SURVEILLANCE AND QUALITY CONTROL OF DRINKING WATER

CASE STUDY: “THE COUNTRY”

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INTRODUCTION

Before 1991 the countries of Latin America and the Caribbean focused on the quantity rather than the quality of water for human consumption. The outbreak of cholera in Peru that year was a severe blow to that trend and showed up the poor sanitary conditions of water supply services.

At the "International Conference on Water Quality," sponsored by the Pan American Health Organization and held in Lima, Peru in 1996 at the Pan American Center for Sanitary Engineering and Environmental Sciences, PAHO/CEPIS, one of the recommendations was that the countries of the Region develop programs for the Surveillance and Quality Control of Drinking Water.

A similar request was made to the PAHO by the American heads of state at the Summit Meeting of Santa Cruz de la Sierra in 1996, and to address these needs the Organization drew up a **Regional Program for Improving Drinking Water Quality**, which contained a diagnosis and a specific proposal of action. The diagnosis clearly recognizes that the situation is not the best with respect to the monitoring and control of drinking water quality.

The Regional Program, together with other regional and local initiatives, is a contribution towards satisfying this demand. Also, the Guidelines for the Surveillance and Control of Drinking Water Quality seek to complement the effort by presenting a methodology that can be applied by governments, agencies, public and private companies, and water consumers in general, to help improve the quality of the water supply services.

In this context, The Country has recognized the need for specific action, and has therefore proceeded to draw up its National Program for the Surveillance and Quality Control of Drinking Water.

CHAPTER I

1. Rationale and Diagnosis

1.1 The Country

The Country has an area of 1,500,000 km^2 and is divided into 24 States. It borders with Country 1 to the north, Countries 2 and 3 to the south, Country 4 to the east, and the South Sea to the west. The total population in 2000 was approximately 25.7 million inhabitants, of whom 18.2 million (70.8%) were living in urban areas and 7.5 million (29.2%) in rural areas.

1.2 Distribution of Communities

The number of communities in The Country in 2000 was 65,000, classified as follows: 44,700 remote; 19,300 rural, and 500 urban. For classification purposes, communities of 2,500 inhabitants and over are considered urban communities; from 100 to 2,499 inhabitants are rural communities; while remote communities have up to 100 inhabitants only. Table 1 shows the population breakdown for The Country.

1.3 Population Growth

Based on the population projection published by the National Statistics Institute (NSI), which reveals a sustained growth rate of 2.4% over the past few years, it is estimated that by 2010 The Country will have a population of 32.6 million inhabitants. See Tables 2 and 3 for projections of the country's demographic growth and number of communities between the years 2000 and 2010.

Table 1. Total Population of The Country per Urban/Rural Area, Inhabitants, and Communities

Communities	Number	Population			Type
		Total	Urban	Rural	
Under 50	34,952	650,614	0	650,614	Remote
50 - 99	9,780	780,594	0	780,594	
100 - 199	9,251	1,469,927	0	1,469,927	Rural
200 – 499	7,979	2,735,77	0	2,735,677	
500 – 999	1,955	1,476,257	0	1,476,257	
1,000 – 2,499	593	899,233	282,750	616,483	
2,500 – 4,999	251	843,348	777,323	66,026	Urban
5,000 – 9,999	93	732,111	722,865	9,246	
10,000 – 19,999	42	636,231	636,231	0	
20,000 – 49,999	45	1,632,511	1,632,511	0	
50,000 – 99,999	27	2,129,860	2,129,860	0	
100,000 – 199,999	16	2,697,648	2,697,648	0	
200,000 – 499,000	10	2,704,000	2,704,000	0	
over 500,000	6	6,311,989	6,311,989	0	
Total	**65,000**	**25,700,000**	**17,895,176**	**7,804,824**	

Table 2. Population Growth in The Country (in thousands)

Year	Inhabitants		
	Total	**Urban**	**Rural**
2000	25,700	17,895	7,805
2001	26,319	18,405	7,908
2002	26,952	18,929	8,013
2003	27,601	19,469	8,119
2004	28,265	20,023	8,226
2005	28,945	20,594	8,335
2006	29,642	21,181	8,445
2007	30,355	21,784	8,556
2008	31,086	22,405	8,669
2009	31,834	23,043	8,784
2010	32,600	23,700	8,900

Table 3. Projection of Communities in The Country

Communities	Year					
	2000	**2002**	**2004**	**2006**	**2008**	**2010**
Under 50	34,952	34,962	34,971	34,981	34,990	35,000
50 - 99	9,780	9,824	9,867	9,911	9,956	10,000
100 - 199	9,251	9,300	9,350	9,400	9,450	9,500
200 – 499	7,979	7,983	7,987	7,991	7,995	7,999
500 – 999	1,955	1,964	1,973	1,982	1,991	2,000
1,000 – 2,499	593	594	596	597	599	600
2,500 – 4,999	251	253	255	257	259	261
5,000 – 9,999	93	102	113	124	136	150
10,000 – 19,999	42	50	59	69	82	97
20,000 – 49,999	45	49	54	59	65	71
50,000 – 99,999	27	30	33	37	41	45
100,000 – 199,999	16	17	19	21	23	25
200,000 – 499,000	10	11	12	13	15	16
over 500,000	6	7	7	8	9	10
Total	65,000	65,154	65,309	65,463	65,618	65,774

1.4 Situation of the Water Supply and Sanitation Services

By mid-2000, the activities of the different institutions involved in water supply and sanitation had resulted in a coverage of only half of the total population of The Country. Table 4 shows the extent of the coverage in urban and rural areas.

Table 4. Total Population and Coverage of Water Supply and Sanitation Services in the Year 2000

Population served	Country		Urban		Rural	
	N.°	%	N.°	%	N.°	%
Water supply	**12,724,000**	**49.5**	**10,862,000**	**60.7**	**1,862,000**	**23.9**
Connections	10,112,000	39.3	8,944,000	50.0	1,168,000	15.0
Easy access	2,612,000	10.2	1,918,000	10.7	694,000	8.9
Sanitation	**10,670,000**	**41.5**	**9,627,000**	**53.8**	**1,043,000**	**13.4**
Connections	8,755,000	34.1	7,912,000	44.2	843.000	10.8
Easy access	1,915,000	7.5	1,715,000	9.6	200,000	2.6
Total population	**25,700,000**	**100.0**	**17,895,000**	**69.6**	**7,805,000**	**30.4**

2. Health of the Population

2.1 Indicators

The most sensitive indicator of the population's well-being is the morbidity rate because it provides information about diseases which do not necessarily cause death but which reduce a person's capacity for normal work or school activities and stimulate the demand for health services. Also, unlike the mortality rate, it takes into account the accumulative weakening effect of recurrent diseases.

2.2 Health Care Provided by the Public Health System

In 1999, the health authorities reported a total of 1,052,718 cases of communicable diseases for a set of 51 pathologies submitted to epidemiological recording and monitoring. Roughly half of the cases (48.4%) correspond to under-five-year-olds and two thirds to under-15s.

2.3 Relative Importance of Communicable Diseases

Table 5 lists the six most important diseases in the country, grouped per natural region and infant mortality rate.

Tables 6 and 7 show the incidence and relative importance of the top ten causes of communicable diseases from 1997 to 1999 and the most significant communicable diseases notified by health professionals at the state level in 1998.

From an analysis of the information in Table 6, it can be deduced that the common cold and other acute respiratory infections in 1999 accounted for almost half of the cases (46.1%), followed by gastroenteritis, enteritis and dysentery (24.3% of the cases, showing an upward trend over the past few years). These are followed by helminthiasis (6.5%), malaria (4.5%), respiratory tuberculosis (3.0%), diseases that are preventable with vaccines (measles, whooping cough, tetanus, acute poliomyelitis, and diphtheria) with 5.1%, and typhoid and paratyphoid with 2.0%.

Table 5. Most Important Communicable Diseases in The Country

Region (per 1000 live births and less than one year old)	**Order of most important communicable diseases (1999)**					
	1	**2**	**3**	**4**	**5**	**6**
Metropolitan 55-56	Acute respiratory	Gastroenteritis and dysentery	Tuberculosis	Helminthiasis	Measles	Chicken pox
North 80-83	Gastroenteritis and dysentery	Tuberculosis	Acute respiratory	Measles	Typhoid	Mumps
South 92-96	Gastroenteritis and dysentery	Acute respiratory	Typhoid	Mumps	Helminthiasis	Tuberculosis
Central 103-115	Acute respiratory	Mumps	Gastroenteritis and dysentery	Helminthiasis	Tuberculosis	Typhoid
Coastal 66-73	Acute respiratory	Gastroenteritis and dysentery	Typhoid	Helminthiasis	Tuberculosis	Mumps
Jungle 124-142	Gastroenteritis and dysentery	Acute respiratory	Helminthiasis	Tuberculosis	Typhoid	Measles
Highlands 120-135	Acute respiratory	Gastroenteritis and dysentery	Typhoid	Mumps	Helminthiasis	Tuberculosis
Country	Acute respiratory	Gastroenteritis and dysentery	Tuberculosis	Typhoid	Helminthiasis	Measles

Table 6. Incidence and Relative Importance of the Top Ten Communicable Diseases in Peru (1997-1999)

Diseases	1997					1998					1999				
	Number	%	Order	Rate per 100,000	Reported by professional %	NUMBER	%	Order	R per 100,000	Reported by professional %	Number	%	Order	Rate per 100,000	Reported by professional%
Common cold and other acute respiratory infections	243,133	40.4	1	1,334.0	86.2	299,225	42.4	1	1,599.5	97.7	347,122	46.1	1	1808.2	80.1
Gastroenteritis and dysenteries	152,536	25.3	2	836.9	75.7	203,263	28.8	2	1,086.6	78.8	182,940	24.3	2	953.0	79.9
Helminthiasis	49,518	8.2	3	271.7	82.1	43,628	6.2	3	233.2	85.0	48,653	6.5	3	253.4	84.3
Malaria	20,483	3.4	6	122.4	100.0	28,563	4.1	4	152.7	100.0	33,724	4.5	4	175.7	100.0
Tuberculosis	21,579	3.6	5	118.4	89.7	22,753	3.2	5	121.6	91.8	22,792	3.0	5	118.7	94.7
Typhoid and paratyphoid	23,868	4.0	4	131.0	90.6	21,011	3.0	6	112.3	88.7	15,358	2.0	6	80.0	91.0
Chicken pox	5,421	0.9		29.7	84.7	6,972	1.0		37.3	88.2	13,266	1.8	7	69.1	93.5
Measles	12,708	2.1	8	69.7	84.8	7,619	1.1	10	40.7	79.4	13,099	1.7	8	68.2	89.0
Scabies	9,721	1.6	9	53.3	60.9	10,030	1.4	8	53.6	57.3	12,149	1.6	9	63.3	65.6
Influenza	15,642	2.6	7	85.8	61.4	12,727	1.8	7	68.0	51.1	11,959	1.6	10	62.3	54.8
Whooping cough	8,238	1.4	10	45.2	64.4	7,164	1.0		38.3	63.0	- -	- -	- -	- -	- -
Other salmonella infections	--	- -	- -	- -	- -	8,810	1.2	9	47.1	86.0	- -	- -	- -	- -	- -
Other communicable diseases	39,388	6.5	11 – 51	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
All diseases	**602,235**					**704,914**					**752,718**				

Table 7. Communicable Diseases in the Country per State (1999)

Order of communicable diseases														
State	**Acute respiratory infections**	**Gastro-enteritis and dysentery**	**Respiratory tubercu-losis**	**Typhoid and para-typhoid**	**Measles**	**Helmin-thiasis**	**Mumps**	**Blenno-rrhagia**	**Chicken pox**	**Viral Hepatitis**	**Whoo ping cough**	**Malaria**	**Influenza**	**Tubercu-losis other forms**
State A	1	2	3	7	5	6	8	9	4	10	- -	- -	- -	- -
State B	1	2	4	7	5	3	8		6	9	10	- -	- -	- -
State C	1	2	4	6	7	3	8	9	5	- -	10	- -	- -	- -
State D	10	3	1	2	9	- -	4	7	5	6	- -	- -	- -	- -
State E	1	2	4	7	- -	8	9	- -	5	10	6	3	- -	- -
State F	6	1	2	4	5	- -	3	- -	9	10	8	- -	- -	7
State G	1	2	7	5	- -	4	8	9	6	10	- -	- -	3	- -
State H	1	2	- -	5	10	4	7	6	9	8	- -	3	- -	- -
State I	1	2	7	6	- -	5	4	- -	- -	9	8	3	10	- -
State J	3	2	6	7	- -	1	- -	- -	8	- -	10	4	5	- -
State K	1	2	4	6	7	3	- -	10	8	- -	- -	5	9	- -
State L	2	4	5	8	- -	3	- -	9	7	10	- -	1	6	- -
State M	1	3	6	5	10	4	- -	- -	- -	9	8	2	7	- -
State N	1	3	6	5	10	2	8	7	- -	9	- -	4	- -	- -
State O	1	2	3	4	7	6	9	- -	5	10	- -	8	7	- -
State P	2	4	6	5	- -	3	- -	10	8	7	9	1	- -	- -
State Q	1	3	4	10	- -	2	- -	8	6	9	7	4	- -	- -
State R	1	2	5	5	8	3	- -	10	7	9	6	- -	- -	- -
State S	1	3	7	8	9	4	- -	- -	6	- -	10	2	5	- -
State T	1	2	6	5	7	4	- -	- -	10	8	9	- -	3	- -
State U	1	2	6	5	10	4	7	- -	9	8	- -	- -	3	- -
State V	1	2	3	5	6	4	- -	9	8		7	- -	- -	10
State W	1	2	7	5	4	6	10	- -	- -	8	9	3	- -	- -
State X	1	2	6	4	10	3	- -	- -	8	7	- -	5	9	- -
State Y	1	2	3	4	5	7	- -	9	8	10	6	- -	- -	- -
Total country	**1**	**2**	**5**	**6**	**8**	**3**	**9**	**13**	**7**	**11**	**12**	**4**	**10**	**- -**

3. Preventive Medicine in The Country

3.1 Health Programs

The goals and policies designed and applied in the health sector in recent years have aimed principally at extending the health care system, in particular to cover maternal-child care, preventive health programs, health development in peri-urban and rural areas, and the prevention and control of communicable diseases.

3.2 Investment

Investments made by organizations dedicated to health services (Social Security Institute, Ministry of Health, and the non-public sub-sector) can be grouped as follows:

- Curative medicine (treatment) = Direct health care
- Preventive medicine (individual) = Vaccination, Maternal-Child and Nutrition Programs
- Preventive medicine (mass/public health) = Basic sanitation

The expenditure of the various organizations is shown in Table 8, where it can be seen that approximately 97% of the total expenditure is on health care using curative medicine, that is, medical treatment.

Table 8. Investment in Disease Control on the Part of the Health and Housing Sectors (percentages)

Action	Ministry of health	Social security	Private	Ministry of housing	Total
Health care	93.9	---	---	---	55.5
Vaccination	7.7	---	---	---	1.7
Treatment	85.2	100.0	100.0	---	53.8
Control of communicable diseases	3.9	---	---	---	1.1
Environmental health	2.2	---	---	100.0	43.4

3.3 Public Health

All communicable diseases can be prevented, some more easily than others. The principle of public health action involves setting up barriers at selected points of the cycle of communication of the disease. The means of control employed are usually those of direct health care, vaccination, and environmental control. Environmental control is often the most economic and rational method, and for certain groups of diseases it is sometimes the only feasible method of prevention. Table 9 shows the main means of controlling the principle communicable diseases.

All of these public health programs contribute in one way or another to improving the quality of life of the inhabitants of a country, and the water supply and sanitation programs are at the same time the most significant and those which call for the greatest amount of funding for their implementation, but not for their operation. However, for the greatest possible impact, the water supply and sanitation programs should go hand-in-hand with hygiene education programs.

The main fields identified as having direct impact on the environment because of their contribution to the setting up of barriers against communicable diseases are:

- Water supply
- Sanitation
- Food control
- Collection and disposal of solid waste
- Control of public establishments
- Control of vectors
- Hygiene in the home
- Occupational health
- Air pollution

Once the communicable diseases affecting The Country have been grouped according to the means of control indicated in Table 9, it is then possible to prepare Table 10. Table 10 indicates the impact of the different types of intervention on the control of communicable diseases. Environmental control is found to produce the greatest benefit, providing that it is linked with other programs, mainly hygiene education. Moreover, if we compare investments made by the different institutions in the fight against communicable diseases with the effectiveness of the programs for the control of communicable diseases, it becomes evident that preventive action, especially environment-related, is a highly effective tool for reducing pressure at the curative or treatment level.

Table 9. Incidence of Communicable Diseases in The Country (1999)

Diseases	Total cases	%	Order	Rates per 100,000	Type of control (*)			
					V	T	En	H. Ed
Other acute respiratory infections	222,301	29.5	01	1,157.9			x	x
Gastroenteritis and other diarrheal diseases	174,698	23.2	02	910.0			x	
Common cold	124,821	16.6	03	650.2			x	x
Other helminthiases	47,431	6.3	04	247.1			x	
Malaria	33,724	4.5	05	175.5			x	
Respiratory tuberculosis	21,038	2.8	06	109.6	x			
Typhoid and paratyphoid	15,358	2.0	07	80.0			x	
Chicken pox	13,266	1.8	08	69.1	x			
Measles	13,039	1.7	09	67.9	x			
Scabies	12,149	1.6	10	63.3			x	
Influenza	11,659	1.6	11	62.3	x		x	x

Diseases	Total cases	%	Order	Rates per 100,000	Type of control (*)			
					V	T	En	H. Ed
Mumps	7,844	1.0	12	40.9	x			
Whooping cough	7,145	0.95	13	37.2	x			
Other salmonella infections	6,845	0.91	14	35.7			x	
Viral hepatitis	6,711	0.89	15	35.0			x	
Food poisoning	5,680	0.75	16	29.6			x	
Shigellosis	5,636	0.75	17	29.4			x	
Blennorrhagia	5,285	0.70	18	27.5		x		x
Amebiasis	2,610	0.35	19	13.6			x	
Leishmaniasis	2,410	0.36	20	12.6			x	
Tuberculosis and other forms	1,754	0.23	21	9.1	x			
Yellow fever	1,363	0.18	22	7.1	x		x	
Ancylostomiasis and Necatoriasis (hookworms)	1,222	0.16	23	6.4			x	
Streptococcal angina	1,157	0.15	24	6.0		x		
Late syphilis	1,099	0.15	25	5.7		x		x
Early syphilis	1,091	0.15	26	5.7		x		x
Brucellosis	925	0.12	27	4.8		x		
Lymphogranuloma venereum	650	0.09	28	3.4		x		x
White chancre	571	0.08	29	2.3		x		x
Bubonic plague	454	0.06	30	2.4			x	
Tetanus	404	0.05	31	2.1	x			
Rubella	355	0.05	32	1.8	x			
Anthrax	384	0.05	33	1.8	x		x	x
Barthonelitis	194	0.03	34	1.0		x		x
Meningococcal infections	193	0.03	35	1.0	x		x	
Echinococcosis (hydatid disease)	189	0.03	36	1.0			x	x
Viral encephalitis	165	0.02	37	0.9	x		x	x
Acute poliomyelitis	129	0.02	38	0.7			x	
Diphtheria	127	0.02	39	0.7	x			
Leprosy	87	0.01	40	0.5		x		x
Toxoplasmosis	62	0.01	41	0.3			x	x
Pinta	48	0.01	42	0.3		x		
Congenital syphilis	37	0.005	43	0.2		x		
Human rabies	27	0.004	45	0.1	x			
Trachoma	25	0.003	46	0.1		x		
Exanthematic typhus	25	0.003	47	0.1			x	x
Yaws	21	0.003	48	0.1		x	x	
Chagas disease	12	0.002	49	0.1			x	x
Cholera					x		x	
Smallpox					x			
Total	**752,718**	**100**		**3,920.8**				

** V = Vaccination T = Treatment En = Environmental control H. Ed = Hygiene education.

Table 10. Impact of Means of Control on Human Health

Means of control	Percentage of cases controlled (1)	Complementary control measures (2)				Total	Investment %	Equivalent investment per person
		Vaccination	Treatment	Hygiene Education	Vaccination and hygiene education			
Vaccination	64,999	--	--	--	--	64,999	1.7	26.2
Treatment	1,157	--	--	9,062	--	10,219	53.8	5,265.0
Environmen-tal control	315,553	1584	21	347,864	12,508	677,530	44.5 (3)	59.12
TOTAL	**381,708**	**1584**	**21**	**356,926**	**12,508**	**752,748**	**100.0**	

(1) Controlled by the indicated means of control.
(2) Controlled in conjunction with actions on the environment.
(3) Including control of communicable diseases.

4. Prevention of Diseases by Water Supply

4.1 Impact of the Water Supply on Disease Reduction

The advantage of drinking water supply systems goes far beyond the mere convenience of the supply. Some kind of improvement in the health of populations benefited with safe water supplies is always predictable. The mechanisms whereby water influences human health are complicated. The Ross Institute (School of Hygiene and Tropical Medicine of the University of London) has developed a classification system whereby the mechanism of influence replaces the responsible agent as the principal classifying factor. Table 11 summarizes this classification.

Table 11. Influence of Water on Human Health

Mechanism of influence	Examples	Measures of control
I Waterborne (fecal oral)		Improvement of the microbiological **quality** of the water
a) Classic	Typhoid, cholera, etc	
b) Non-classic	Infectious hepatitis, etc.	
II. Hygiene-related		Improvement in the **quantity** and the **continuity**
a) Skin and eyes	Scabies, trachoma, etc	
b) Diarrheas	Bacillary dysentery, etc	
III Water-based		Protection of consumers Protection of water source
a) Penetration	Bilharziasis, etc	
b) Ingestion	Dracontiasis, etc	
IV Infection through vectors		Channeling the water from the source to the point of consumption
a) Bites	Trypanosomiasis, etc	
b) Reproduction in the water	Yellow fever, etc	

From the above, it is clear that the consumption of water free from fecal waste, besides contributing to the protection of the consumers, also plays a key role in the control of a wide range of hygiene-related diseases. Its contribution to health is made in several ways, for example, the quality of the water has a fundamental influence on classic water-related diseases such as diarrhea, bacillary and amebic dysentery, typhoid, paratyphoid and hepatitis.

In addition, other diseases are influenced by the **continuity** and **quantity** of the safe water supply rather than by the ingestion of the microbes that may be present in the water (**quality**). Such diseases are associated with habits of hygiene and personal cleanliness, and the water contributes directly to their prevention (hygienic handling of food, clean hands, etc).

It is difficult to distinguish the contributions to health improvement made by the different parameters used in water quality assessment, and even more difficult to predict the health impact of a specific activity.

Studies have estimated that good quality drinking water contributes to a substantial reduction of many diseases. In studies carried out in Africa, this degree of reduction has been estimated as shown in Table 12.

Table 12. Estimated Reduction of Diseases by the Supply of Good Quality Water (East Africa)

Disease	Percentage (%) of reduction of disease
Guinea worm	100
Typhoid	80
Schistosomiasis	80
Leptospirosis	80
Gambian trypanosomiasis	80
Scabies	80
Bejel	70
Eye inflammations	70
Non-specific schistosomiasis	60
Bacillary dysentery	50
Amebiasis	50
Non-specific dysentery	50
Gastroenteritis (from 4 weeks – 2 years)	50
Gastroenteritis (over 2 years)	50
Skin and subcutaneous infections	50
Diarrhea in newborn babies	50
Paratyphoid and other Salmonelloses	40
Intestinal schistosomiasis	40
Ascariasis	40
Otitis externa	40
Average	**52**

Table 13 analyzes the impact on communicable diseases of the different measures of control applied in The Country, and it shows that the theoretical impact of environmental control is highly significant. In this reference, it must be understood that the effectiveness of environmental control programs results from multidisciplinary efforts in the technical field as well as in the social and educational areas.

Table 13. Estimated Reduction of Communicable Diseases by Environmental Control Programs and Others

	Water		Hygiene education	Sanitation		Food hygiene	Cases 1984
	Quality	Quantity		Gray waters	Disposal of excreta		
01. Gastroenteritis and other diarrheal infections	Xx	xxx	Xxx	0	xx	xx	174,698
02. Other helminthiases	X	xx	xx	x	xxx	xx	47,431
03. Malaria	0	0	0	x	0	0	33,724
04. Typhoid and paratyphoid	Xx	xx	xx	x	xx	xx	15.358
05. Scabies	0	xxx	xxx	0	0	0	12,149
06. Other salmonella infections	X	xx	xx	x	xx	xxx	6,845
07. Viral hepatitis	X	xx	xxx	0	xx	xx	6.711
08. Food poisoning	0	x	xx	0	xx	xxx	5,680
09. Shigellosis	Xxx	xxx	xxx	0	xx	xx	5,636
10. Amebiasis	X	xxx	xxx	0	xx	xx	2,610
11. Leishmaniasis	0	0	xx	xx	0	0	2,410
12. Yellow fever	0	0	xx	xx	0	0	1,363
13. Ancylostomiasis and Necatoriasis (Hookworms)	X	x	x	x	xxx	xx	1,222
14. Acute poliomyelitis	X	xxx	xxx	0	xx	xx	129
15. Trachoma	0	xxx	xxx	0	0	0	25
16. Exanthematic typhus	0	xx	xx	0	0	0	25
TOTAL							316,016
Percentage							42%
Total number of cases reported in 1986							752,718

xxx : Very significant xx : Significant x : Of little significance 0 : Not significant

5. Surveillance

5.1 Surveillance of the Water Supply

The surveillance of drinking water is an activity distinct from quality control but both compatible with it and complementary to it. Surveillance is a task of investigation, with emphasis on public health, and the institution responsible for it is the Ministry of Health, as stipulated in the Health Code.

Quality control is a routine monitoring activity performed to guarantee that the quality of the water and of the supply service throughout the distribution system up to its delivery in the communities complies with regulations and standards currently in force. The supplier is responsible for quality control.

(PAHO/WHO), in the *Guidelines for drinking water quality*, vol. III, makes a clear distinction between the two activities, as follows:

> *The organizational structures designed to guarantee compliance with the demands of the laws, standards or codes of practice referring to the quality of the drinking water should be such as to facilitate the* ***sharing*** *of the surveillance process between the water supply company and a separate surveillance agency, preferably independent. The former shall be responsible at all times for the quality and safety of the water it produces.*
>
> *The tests and routine monitoring carried out by the water supply company shall be referred to as water quality control tests; not to be confused with the verifications performed independently by the surveillance agency. Both the water quality control tests and the tests performed by the surveillance agency shall be applied to all the types of water available in the community.*
>
> *The surveillance agency shall preferably be constituted at the national level, and shall operate at the central, provincial (regional) and local levels, usually through the health authorities. This surveillance agency shall deal with the aspects of public health associated with drinking water supplies and shall have the general responsibility of guaranteeing that all the systems under its jurisdiction are free from any* ***health hazard****.*

5.2 Surveillance in The Country

Surveillance in The Country was applied only in the capital city. It began in the late 1940s as an activity of the Ministry of Health because of the absence of water quality control in the distribution network on the part of the suppliers. The surveillance program continued in the 50s, was gradually reduced in the 60s, and practically disappeared in the 70s, when the big suppliers began to apply their own very basic quality control programs. The disappearance of the program is attributed to the negligible impact of surveillance activities, since political interference in the management of the water supply systems meant that the Ministry of Health's surveillance unit was prevented from questioning the work of the water supplier, and this led to progressive budget reductions and the loss of the professionals who were responsible for the surveillance work.

The position today is that, in the framework of the Regional Program for the Improvement of the Quality of Drinking Water, subscribed to by The Country, the health authorities have agreed with the representatives of the water suppliers and of the regulatory agency to draw up an overall program setting forth the responsibilities of each of the parties and

the channels of coordination. This will ensure a sound quality control program for both urban and rural areas, and the information produced by the water supply services will be used by the surveillance agency in its evaluation of the risk to human health posed by the drinking water.

6. Legal Framework and Organization

The Sanitary Code of the Ministry of Health stipulates that this Ministry is responsible for the surveillance of drinking water quality. The Ministry has entrusted this task to its Environmental Health Office. In the organizational structure, the Environmental Health Office has a Water Quality Department which is responsible for planning surveillance activities nationwide at the urban and rural levels.

In discharging its surveillance responsibility, the Ministry of Health has promulgated the Standard on the Quality of Drinking Water, which is applicable throughout the country in urban and rural areas. One of the features of the Quality Standard is that it defines two categories of analytical determinations, one obligatory group and one optional, depending on the capacity of the water supply facilities.

The water supply sector, for its part, has a regulatory agency responsible for supervising the water supply agency. This regulatory agency issues directives stipulating the measures to be taken by the suppliers to determine the quality of the water and of the service they are providing.

The suppliers themselves are organized in an association which enables them to negotiate with the regulatory agency so that, for example, any requirements they may be asked to comply with can be implemented gradually and within an agreed timeframe, which will usually be relatively short (within a three-year period).

CHAPTER II

7. National Program for the Surveillance and Quality Control of Drinking Water

7.1 General

This Surveillance Program for drinking water systems has been designed to cover the systems managed by water service agencies which normally operate in urban areas, as well as municipal systems and those managed by rural communities.

At the same time it was decided that the Program for the Surveillance of Drinking Water Quality should include not only the quality of the water itself, but also the quality of the service provided. This information will be valuable in determining the investment needed for the rehabilitation, extension or improvement of the sanitary infrastructure. With reference to the quality of the supply service, this is evaluated using the following indicators: water quality, continuity, coverage, quantity, and cost.

It was also determined that the surveillance and control program would cover the whole water distribution system, from the quality of the treatment plant to the start of the home connection.

In the present case, the surveillance program will determine whether the quality and the health risk fall within the recommendations and standards currently in force, and it will then communicate its findings to the companies or institutions responsible for managing the water supply services, and oblige these to comply with the recommendations and standards.

7.2 Goals of the Surveillance Program

To contribute to an improvement in the health and quality of life of the population with reference to the use of collective water supply systems, by identifying the actions required to improve the quality of the water services.

7.2.1 Specific Objectives

a) To evaluate the physical, chemical and bacteriological quality of the water for human consumption.

b) To determine the risk to human health posed by water supply systems.

c) To quantify regional and national coverage.

d) To determine the degree of continuity of the supply services.

e) To determine the cost of the drinking water.

f) To contribute to programs for the rehabilitation and extension of water supply systems, identifying priority areas for investment, and issuing reports on the basic service characteristics to keep national and regional institutions informed as to where the most serious problems are found.

g) To disseminate at the technical and political levels the results of the Surveillance Program.

h) To identify the hygiene education programs that are required to improve the habits of hygiene of the beneficiary population.

i) To raise people's awareness of the need to demand of the water suppliers reasonably-priced good-quality water in an adequate quantity 24 hours a day.

j) To strengthen the epidemiological surveillance system in order to assess the impact of the Surveillance Program and of the steps taken to improve water quality.

k) To improve the laws, regulations, and standards linked with the conservation and preservation of drinking water quality.

7.3 Policies and Strategies

Considering that the surveillance and control of water quality are not highly developed activities in The Country because of the difficult social and economic situation it is going through, the Program proposes that rational policies be applied in designing solutions and that maximum use be made of existing resources, taking into account the real needs of the people and the availability of the resources.

The obtaining of the results should establish a series of strategies in service improvement, coordination and development of the sectors involved, training of human resources, promotion of the participation of the communities, investment economy, and adequate financing.

7.4 Fields of Action

The Surveillance Program defines two fields of action: a) the water supply system, and b) the quality of the services. The supply system is the physical part of the distribution network including its components, while the quality of the services is represented by aspects of quality, quantity, continuity, coverage, and cost.

Supply system (Physical infrastructure)	Exposed to the least possible risk of contaminating or being contaminated Observation of the quality of the water in all the components of the supply system	
Quality of service	Quality	Fit for human consumption
	Quantity	Sufficient for domestic purposes
	Coverage	Covering the greatest possible number of inhabitants
	Continuity	Available most of the year
	Cost	The minimum necessary

7.5 Scope

In principle, the Program has been drawn up for a ten-year horizon and it includes all collective drinking water supplies delivered by means of home connections, public standpipes, or water tank trucks. In urban areas it covers the whole of the inhabitable area, while in rural areas it covers only those parts served by water supply networks. Thus, for the purposes of drawing up this Program, all communities of more than 100 inhabitants were taken into account.

There are two auxiliary activities that are not regarded as part of the Surveillance Program:

- Authorization for the use of new sources of water for supply purposes; and
- Follow-up of raw water quality at the supply sources.

Authorization for the use of new sources of water for supply purposes is required only during an initial planning stage, and approval is normally given by the health authorities. This is not included among the responsibilities of the surveillance agency.

With regard to the quality control of raw waters at supply sources, specifically of surface waters, those responsible for exploiting them are obliged to keep the competent authorities informed of their quality so that a historic follow-up can be made of their behavior. In this case the competent authorities are the watershed authorities, but it is obligatory that the information be communicated to the health authorities for follow-up.

The fields of surveillance and control of water quality deal with the surveillance and control of:

A. Piped water (components, home connections, and public standpipes)

   a) Disinfected water
   b) Non-disinfected water

B. Water not distributed through pipes (wells, tank trucks, etc.)

   a) Disinfected water
   b) Non-disinfected water

7.6 Hoped-for Results

7.6.1 Impact on the Country's Social Progress and Development

Water is essential for the existence of the human being, and its use improves the quality of life. Water plays an important role in personal hygiene and cleanliness, and thus becomes a fundamental component in attending to the basic needs of the population.

The end goal of the surveillance of water quality is to contribute to improving the general level of health and well-being of the community, and hence to contribute to the social and economic progress of the country.

7.6.2 Impact on Disease Reduction and Control

In The Country there exists a high rate of mortality caused by gastrointestinal diseases and others, linked with the lack of drinking water and/or its low quality.

A combination of a good water supply and education on the subjects of personal hygiene and the proper use of water will reduce the risk of transmission of water-related diseases, and contribute to an increase in life expectancy.

7.6.3 Surveillance and Control Activities

In The Country, water-related diseases and those of fecal-oral transmission are the most significant. In 1999, diarrheal diseases alone accounted for 24.3% of cases of medical treatment of notifiable diseases. (See Table 6)

Thus the surveillance activities will focus mainly on determining water quality, service quality, and level of sanitary risk.

The task of determining water quality mainly involves detecting the presence of biological agents. However, since chemicals also pose certain health risks, they will be included in the water quality assessment.

The quality of the service will be defined by the basic indicators of quality, quantity, continuity, coverage, and cost.

Sanitary Inspection activities will be directed to determining the susceptibility of the system to accidental contamination or contamination induced by external agents.

It is therefore planned to carry out the surveillance and control activities in three basic areas a) the distribution system itself, from the outlet of the storage structures to the home connection; b) water storage structures such as cisterns and distribution reservoirs; and c) outlets from treatment plants or supply sources, which could be feeder mains or storage reservoirs.

7.6.4 Distribution System

In this part of the water supply system the bacteriological quality will be evaluated, as well as a small group of physical-chemical parameters, and this assessment will be complemented with the sanitary inspection of the components that make up the distribution system. In view of the types of supply existing in The Country, two situations are considered:

a) Disinfected water

In systems where the water is disinfected, the analytical determinations to be carried out obligatorily are chlorine residual, turbidity, and pH. The determination of fecal coliforms may be effected less frequently than is recommended in the standard.

b) Non-disinfected water

In supply systems where the water is not disinfected, the determination of thermotolerant coliforms will be obligatory, as will that of turbidity. Bearing in mind the rapid variation in the microbiological quality of the water, these systems will require a high frequency of sampling. Sanitary inspections will also need to be more frequent than in (a).

7.6.5 Reservoirs and Outlets of Treatment Plants

In the feeder mains (the stretch leading directly from the treatment plant or supply source to the storage reservoir or distribution reservoir), in addition to the determinations of chlorine residual and thermotolerant coliforms, special emphasis will be placed on the physical-chemical determinations of an aesthetic nature that affect the acceptability of the water, as well as testing for inorganic and organic elements that affect human health. Table 14 shows the determinations of physical-chemical compounds established in the drinking water quality standard taken into account in planning the surveillance and control program. It also shows the chlorine residual and thermotolerant coliform determinations.

Table 14. Analytical Determinations Stipulated in the Quality Standard

Determinations and Affecting Acceptability	Inorganic Compounds	Organic Compounds
pH	Arsenic	Chlorinated alkanes
Turbidity	Cadmium	Chlorinated ethenes
Color	Chromium	Aromatic hydrocarbons
Hardness	Cyanide	Polynuclears
Chloride	Fluoride	Chlorobenzenes
Total solids	Mercury	Pesticides
Sulphate	Nitrate	Phenols and chlorophenols
Aluminum	Lead	Trihalometanes
Copper	Selenium	Benzene and lower alkylbenzenes
Iron		
Manganese		
Zinc		
Sodium		

Since the presence in drinking water of the inorganic and organic parameters shown in the above table is very infrequent, it is planned to test for them only in the feeder mains and sporadically in the reservoirs. However, depending on the capacity of the testing laboratories, such tests may also be performed in the distribution network. In the event that the quality of the raw water indicates the presence of substances that may affect health or alter the organoleptic quality, or if the water has been treated with unauthorized organic or inorganic chemicals, those responsible for water quality control should measure the affected component frequently.

7.7 The Program's Basic Lines of Action

7.7.1 Surveillance and Control Levels

The surveillance and control program is not only aimed at discovering what is wrong in order to correct the situation, but it also seeks to demand and/or identify the remedial measures that the institutions responsible for the management of the systems need to apply in order to reduce or remove the sanitary risks.

To make the Program for the Surveillance and Control of Drinking Water Services viable, it is planned to implement it in stages. Taking into account the analytical capacity of the laboratories available in the water service companies and in the public health system, the program will be implemented level by level, applying the highest levels of execution to the cities with the largest population that have well-equipped laboratories and the lowest levels to small communities that do not have laboratories.

The surveillance agency and the regulatory agency will bring pressure to bear on those responsible for drinking water quality control so that the number of analytical determinations will gradually increase from year to year.

The basic criteria for setting the surveillance levels were defined based on the availability of human, material, and financial resources. To this effect five levels of surveillance and control have been established, ranging from minimal indispensable actions to the ideal or recommended level.

7.7.2 Recommended Evaluations and Sampling Frequency

To achieve an ideal level of quality control, in the framework of the water quality standard, consensus was reached by the health authorities, the regulatory agency and the representative of the suppliers in the selection of analytical parameters. The analyses to be made and the sampling frequencies have been grouped according to the population size of the localities, which were defined in five categories: a) large cities with populations of over 200,000 inhabitants; b) medium cities with 50,000 to 200,000 inhabitants; c) small cities with 10,000 to 50,000 inhabitants; d) towns with 2,500 to 10,000 inhabitants; and e) rural communities with populations of 100 to 2,500 inhabitants. In addition, the different parts of the water supply system were distinguished: a) outlet from the treatment plants; b) water storage reservoirs, and

c) water distribution network to be defined. Table 15 shows the determinations and sampling frequencies per size of city and per part of the water supply system.

One consideration in designing the analytical programs for each locality may be that in systems which disinfect their waters and serve populations of more than 50,000 inhabitants, the frequency of bacteriological sampling can be reduced providing that chlorine residual determinations be carried out at the most distant points of the distribution network.

In the specific case of the surveillance programs under the responsibility of the health authorities, it is planned to perform the analyses indicated in Table 16. The level of surveillance to be implemented has been defined in keeping with the analytical capacity of the laboratories the authorities have available in the country, and it is roughly estimated that it can correspond to 10% of the analyses performed by the suppliers.

The sampling frequency for bacteriological and physical-chemical determinations in water quality surveillance is shown in Tables 17 and 18.

7.7.3 Sanitary Inspections

The sanitary inspections will be the responsibility of the water suppliers, both public and private, and of the municipal authorities who administer their water supply services. The recommended frequency for these inspections is shown in Table 19. The surveillance authority will be responsible for verifying the quality of the information by means of audits of the inspection units.

Table 15. Number of Determinations per Type of Locality (samples per year)

Determinations	Large cities			Medium cities			Small cities			Towns			Rural		
	Plant	Reserv	Distrib	Plant	Reserv	Distrib	Plant	Reserv	Distrib	Plant	Reserv	Distrib	Plant	Reserv	Distrib
Basic level															
Turbidity	365	365	52	180	48	26	12	12	12		6	6		1	4
pH value	365	365	52	180	48	26	12	12	12		6	6		1	4
Chlorine residual	1460	365	365	180	365	52	52	105	52		26	12		6	4
Thermotoler. coli	365	52	26	180	52	26	52	52	26		6	12		2	4
Affecting organoleptic quality															
Color	52	12	4	24	6	1	4	4			2			0.5	
Hardness	52	12	4	24	6	1	4	4			2			0.5	
Chlorides	52	12	4	24	6	1	4	4			2			0.5	
Sulphate	52	12	4	24	6	1	4	4			2			0.5	
Dissolved solids	52	12	4	24	6	1	4	4			2			0.5	
Iron	52	12	4	24	6	1	4	4			2			0.5	
Manganese	52	12	4	24	6	1	4	4			2			0.5	
Inorganics which affect health															
Arsenic	4	1		4			1			1				0.5	
Cadmium	4	1		4			1			1				0.5	
Cyanide	4	1		4			1			1				0.5	
Chromium	4	1		4			1			1				0.5	
Mercury	4	1		4			1			1				0.5	
Lead	4	1		4			1			1				0.5	
Selenium	4	1		4			1			1				0.5	
Aluminum	4	1		4			1			1				0.5	
Copper	4	1		4			1			1				0.5	
Zinc	4	1		4			1			1				0.5	
Sodium	4	1		4			1			1				0.5	
Nitrate	12	4		12			1			1				0.5	
Fluoride	12	4		12			1			1				0.5	
Organics which affect health															
Chlorinated alkanes	2			0.5											
Chlorinated ethenes	2			0.5											
Aromatic hydrocarbons	2			0.5											
Polynuclears	2			0.5											
Chlorobenzenes	2			0.5											
Pesticides	2			0.5											
Phenols and chlorophenols	2			0.5											
Trihalometanes	2			0.5											
Benzene and lower alkylbenzenes	2			0.5											

Table 16. Analytical Determinations per Level of Surveillance

Piped water	**Level**				
	I	**II**	**III**	**IV**	**V**
Disinfected water					
Feeder main	A	B+A	C+A	D+A	E+A
Distribution	A	B+A	C+A	D+A	E+A
Public standpipe	A	B+A	---	---	---
Non-disinfected water					
Feeder main	B	C	D	E	---
Distribution	B	C	D	E	---
Public standpipe	B	---	---	---	---
Non-piped	**Level**				
	I	**II**	**III**	**IV**	**V**
Disinfected water					
Tank truck	A	B+A	C+A	---	---
Non-disinfected water					
Tank truck	B	B+A	C+A	---	---

Key
A = Chlorine residual
B = Thermotolerant coliforms + Turbidity
C = B + components that affect the organoleptic quality of the water
D = C + inorganic components with health impact
E = D + organic components with health impact

Table 17. Frequency of Bacteriological Sampling per Level (samples per year)

Size of population	**Level**				
	I	**II**	**III**	**IV**	**V**
Rural area 100 – 2,500 inhab	0	1	2		
Towns 2,500 – 10,000 inhab	0	1	2	4	
Small cities 10,000 – 50,000 inhab	0	1	2	4	12
Medium cities 50,000 – 200,000 inhab	1	2	4	12	26
Large cities Over 200,000 – inhab	2	4	12	26	52

Table 18. Frequency of Physico-Chemical Sampling per Level (number of samples per year)

Size of population	Level									
	Surface					Groundwater				
	I	II	III	IV	V	I	II	III	IV	V
Rural area 100 – 2,500 inhab	2					1				
Towns 2,500 – 10,000 inhab	2	4				1				
Small cities 10,000 – 50,000 inhab	2	4	12			1	2			
Medium cities 50,000 – 200,000 inhab	2	4	12	26		1	2			
Large cities Over 200,000 – inhab	2	4	12	26	52	1	2	4		

Table 19. Frequency of Sanitary Inspections per Level

Size of population	Level				
	I	II	III	IV	V
Rural area 100 – 2,500 inhab	0	Every other year	Annually		
Towns 2,500 – 10,000 inhab	0	Annually	Half-yearly		
Small cities 10,000 – 50,000 inhab	0	Annually	Half-yearly		
Medium cities 50,000 – 200,000 inhab	Annually	Half-yearly	Quarterly		
Large cities Over 200,000 – inhab	Annually	Half-yearly	Quarterly		

7.8 Surveillance and Control Programs

7.8.1 General

In drawing up the present Program, two groups of programs have been considered:

a) Operational Programs; and
b) Support Programs.

These programs should be developed jointly by the Ministry of Health and the public and private supply agencies, including the municipal administrations and rural councils responsible for the management of rural systems.

7.8.2 Programs

To meet the goal of improving the quality of life, the Program will conduct a series of surveillance and control activities. Independently of these activities, it is indispensable that investment programs be executed to extend the coverage of the water and sanitation services, and to increase the control of vectors, foodstuffs and public establishments, among others.

The programs designed to help in the application of surveillance throughout the country have been grouped as follows:

7.8.3 Operational Programs

Program 1 Sanitary inspection and assessment of services
Program 2 Analysis of water quality
Program 3 Institutional assessment.

7.8.4 Support programs

Program 4 Institutional development
Program 5 Legal bases
Program 6 Development of human resources
Program 7 Environmental education
Program 8 Environmental epidemiological surveillance
Program 9 Community surveillance
Program 10 Information.

7.9 Operational Programs

7.9.1 Program 1: Sanitary inspection and assessment of services

This program seeks to determine and catalog the risk posed by the water supply facilities in urban and rural areas, and to inform the pertinent institutions of any problems detected, so that corrective measures may be taken to improve the quality of the water service.

The program includes:

a) Census of each of the communities with a water supply service.
b) Evaluation of the facilities in order to catalog and qualify their capacity of response to the Program for the Surveillance and Quality Control of Drinking Water.
c) Sanitary inspection of the water supply systems to determine the risk level of the facilities.
d) Evaluation of health hazard.
e) Assessment of the quality and levels of service.

7.9.2 Program 2: *Analysis of Water Quality*

This program is designed to ensure the good quality of the water for human consumption.

The program includes:

a) Drawing-up and establishment of quality standards
b) Implementation of laboratories
c) Establishment of the sampling system and execution of the water-sampling and testing program.
d) Development of the analytical quality control program.

7.9.3 Program 3: Institutional Assessment

The surveillance agency or the regulatory agency, as the case may be, will be in charge of this assessment program, which seeks to analyze the organization and the physical, economic, and staff resources assigned by the supply agencies to their programs for drinking water quality control.

The program comprises:

a) Institutional organization
b) Operational capacity.

7.10 Support Programs

7.10.1 Program 4: Institutional Development

This program seeks to organize the system for the surveillance of the quality of drinking water services as an element of coordination, supervision and management of the activities and efforts undertaken to determine the risks posed by the different water supply systems, with a view to improving their quality.

The program will be developed through three projects:

a) Institutionalization of the national surveillance system
b) Development of the system for data processing and reporting, notification, and control
c) Strengthening of the executing and coordinating agencies at the regional level.

This latter project should be complemented with the following areas:

c.1) Project management
c.2) Financial management

7.10.2 Program 5: *Legal Bases*

A key to the success of the Surveillance and Control Program is the existence of legal provisions favorable to its execution. To this effect three tasks have been identified:

a) Revision of current laws concerning the rendering of water supply services
b) Promulgation of new legal provisions to make the execution of the Program viable
c) Setting of complementary standards.

7.10.3 Program 6: Development of Human Resources

This activity seeks to train sufficient human resources in the different institutions to ensure that they will be capable of doing the work required of them.

This program comprises:

a) Census of staff assigned to surveillance work
b) Register of national and international institutions that provide training
c) Determination of staff requirements of the surveillance agency and of water supply agencies
d) Training requirements geared to future needs
e) Design and validation of the training modules
f) Design of the national and institutional training program.

7.10.4 Program 7: *Environmental Education*

This program is designed to raise the population's awareness of the positive health impact of good quality drinking water, hygienic disposal of excreta, and other hygienic habits and customs. It involves carrying out individual, group, and mass communication activities. It will also promote the proper use of water and the protection of water resources, through hygiene education programs.

The Program comprises:

a) School education
b) Mass communication by radio and television
c) Training at public health establishments.

7.10.5 Program 8: Environmental Epidemiological Surveillance

Environmental epidemiological surveillance is designed to identify the diseases that are linked with the quality of the water or the quality of water services. This information will make it possible to determine the health impact of water quality and other factors, and it can also be used to identify any remedial actions that need to be taken in the operational, constructional and maintenance procedures of the different parts of the water supply system. It also determines the

impact of the building materials used in the water supply infrastructure and of the chemicals used in treating the water. Finally, it is a tool that will help the sectors involved to set investment priorities that reflect the anticipated impact on public health. The tasks identified are:

a) To revise and extend the list of notifiable diseases, in order to assess the impact of the water quality and the quality of the water supply service on the health of the consumers
b) To develop a system for the evaluation of epidemiological information.

7.10.6 Program 9: Community Surveillance

This program seeks to organize citizens' Surveillance Committees and to encourage the appropriate, active participation of the inhabitants of urban, peri-urban, and rural areas through these committees.

In urban areas, the committees will be responsible for demanding that the suppliers provide safe water of the quality stipulated in the standards or specified by the sanitary authorities. In peri-urban and rural areas, they will be responsible for demanding that compliance be given to the observations made by the sanitary authorities for the improvement of the quality of the water supply service.

The program comprises:

a) Identification of the hierarchies of authorities present in the different regions
b) Design of the system for the participation of the Surveillance Committees
c) Training of the members of the Surveillance Committees.

7.10.7 Program 10: Information

Generally speaking, the data in themselves are of very little value. They need to be validated, carefully stored in a data base, and evaluated to produce information that will be useful to the parties interested in preserving and conserving human health by improving the quality of the services, rehabilitating the systems, or extending the coverage of the water supply.

The information, used in conjunction with the results of the environmental epidemiological surveillance, should also serve to determine the risk to which the users of the water supply service are exposed, and to update standards, rules or other types of regulatory or legal instruments relative to the water supply.

7.11 Options for Implementing Surveillance Nationwide

The options proposed are based on the following premises:

Based on water quality standards, the analyses to be effected and the sampling frequency have already been established.

- The following parties took part in proposing options for the levels of intervention: the health authorities, the regulatory agency and the suppliers. Different levels of compliance have also been established by consensus. For the definition of future levels of intervention, the present situation was taken into account.

- The analytical determinations and the sampling frequencies have been grouped according to the size of the community and the main components of the water supply system.

- During the initial stage, emphasis will be placed on sanitary inspection. The evaluation of the bacteriological quality of the water will gradually be increased, as well as the control of chlorine residual and of the basic physical-chemical parameters.

Table 20 shows the level of the water quality control programs in the year 2000 and the different levels of goals set to the year 2010, giving rise to six intervention options. These goals have been defined bearing in mind the maximum demands indicated in The Country's water quality standard.

Table 20. Present Situation of the Programs for the Control of Water Quality and Options for Future Interventions (expressed as a percentage of compliance with water quality standards)

Size of population	Situation in year 2000	Options to the year 2010					
		1	2	3	4	5	6
Rural area 100 – 2,500 inhab	2	10	20	35	40	50	100
Towns 2,500 – 10,000 inhab	5	20	40	50	60	70	100
Small cities 10,000 – 50,000 inhab	10	35	60	70	75	85	100
Medium cities 50,000 – 200,000 inhab	25	55	80	90	95	95	100
Large cities Over 200,000 inhab	50	75	90	95	100	100	100

In medium cities with 50,000 to 200,000 inhabitants, as well as in large cities with over 200,000 inhabitants, the service providers will have to assume the total cost of drinking water quality control.

CHAPTER III

8. Investment and Costs of Execution of the Surveillance and Control of Drinking Water and of the Water Supply Services

8.1 Criteria for the Determination of Basic Costs

The following criteria were used to determine the cost of implementing the Program for the surveillance and control of the quality of the water and of the water supply services.

Sampling and Sanitary Inspection

The cost of sample collection and sanitary inspections, depending on the size of the population, is shown in Table 21. For rural populations, the calculation includes the per diem expenses of the sampler and the driver, and the fuel and maintenance costs of the vehicles. For urban areas, the calculation includes only the fuel and maintenance costs.

Table 21. Cost per Sample Taken
(in US$)

Size of population	Cost
Rural area 100 – 2,500 inhab	15.00
Towns 2,500 – 10,000 inhab	7.50
Small cities 10,000 – 50,000 inhab	3.50
Medium cities 50,000 – 200,000 inhab	2.00
Large cities Over 200,000 inhab	1.50

Frequency of Sanitary Inspections

The frequency of sanitary inspections was defined based on the size of the population, as indicated in Table 19. The productivity of the inspectors is shown in Table 22.

Table 22. Number of Sanitary Inspections to be Effected per Day and per Inspector

Size of population	Number (days/man)
Rural area 100 – 2,500 inhab	1
Towns 2,500 – 10,000 inhab	2
Small cities 10,000 – 50,000 inhab	4
Medium cities 50,000 – 200,000 inhab	7
Large cities over 200,000 inhab	14

Analyses

Table 23 summarizes the cost per type of laboratory of the physico-chemical and bacteriological analyses included in the surveillance and control program. The details are given in Table 24, where the types and cost of each of the determinations to be applied in the surveillance and control program are indicated, grouped by type of laboratory. Table 25, in turn, shows the cost per year of the determinations for the principal parts of the water supply system (outlet of treatment plant, storage reservoirs, and distribution network) and per size of population. Table 26 shows the details of the global costs taking into account the number of samples to be performed per year as indicated in Table 15.

Table 23. Cost of Determinations per Type of Laboratory

Type of Laboratory	US$
Basic level - Local laboratory	3.60
Intermediate level - Regional laboratory-intermediate Factors affecting organoleptic quality	15.00
Intermediate level - Regional laboratory-high Inorganic components which influence health	80.50
Reference laboratory Organic components which influence health	225.00

Table 24. Determinations and Cost per Physico-Chemical and Bacteriological Analysis

Laboratory	Determination	Cost US$
Local laboratory Basic	Turbidity	0.50
	pH value	0.50
	Chlorine residual	0.10
	Thermotolerant coliforms	2.50
Intermediate level regional laboratory Factors wich affect organoleptic quality	Color	1.00
	Hardness	1.50
	Chlorides	1.50
	Sulphate	2.00
	Dissolved solids	2.00
	Iron	3.50
	Manganese	3.50
High level regional laboratory Inorganics which affect health	Arsenic	5.00
	Cadmium	5.00
	Cyanide	10.00
	Chromium	3.50
	Mercury	10.00
	Lead	5.00
	Selenium	10.00
	Aluminum	7.00
	Copper	5.00
	Zinc	5.00
	Sodium	5.00
	Nitrate	5.00
	Fluoride	5.00
Reference laboratory Organics which affect health	Chlorinated alkanes	25.00
	Chlorinated ethenes	25.00
	Aromatic hydrocarbons	25.00
	Polynuclears	25.00
	Chlorobenzenes	25.00
	Pesticides	25.00
	Phenols and chlorophenols	25.00
	Trihalometanes	25.00
	Benzene and lower alkylbenzenes	25.00

NOTE. It is assumed that the better-equipped laboratories, in addition to conducting the above determinations, perform the analytical determinations of the lower level laboratories.

Table 25. Cost of Determinations per Size of Community and per Year (in US$)

Size of population	Water treatment plant	Reservoir	Distribution network
Rural area 100 – 2,500 inhab	0.00	54.35	14.40
Towns 2,500 – 10,000 inhab	80.50	53.60	37.20
Small cities 10,000 – 50,000 inhab	287.70	212.50	82.20
Medium cities 50,000 – 200,000 inhab	1,522.50	304.50	111.20
Large cities over 200,000 – inhab	3,055.50	822.00	213.50

Table 26. Cost of Analysis per Year and per Type of Locality (in US$)

Determinations	Unit Costs	Large cities			Medium cities			Small cities			Towns			Rural	
		Plants	Reserv	Distrib	Plants	Reserv	Distrib	Plants	Reserv	Distrib	Plants	Reserv	Distrib	Reserv	Distrib
Basic level															
Turbidity	0.50	182.50	182.5	26.00	90.00	24.00	13.00	6.00	6.00	6.00		3.00	3.00	0.50	2.00
pH value	0.50	182.50	182.50	26.00	90.00	24.00	13.00	6.00	6.00	6.00		3.00	3.00	0.50	2.00
Chlorine residual	0.10	146.00	36.50	36.50	18.00	36.50	5.20	5.20	10.50	5.20		2.60	1.20	0.60	0.40
Thermotolerant coliforms	2.50	912.50	130.00	65.00	450.00	130.00	65.00	130.00	130.00	65.00		15.00	30.00	5.00	10.00
Affecting organoleptic quality															
Color	1.00	52.00	12.00	4.00	24.00	6.00	1.00	4.00	4.00			2.00		0.50	
Hardness	1.50	78.00	18.00	6.00	36.00	9.00	1.50	6.00	6.00			3.00		0.75	
Chlorides	1.50	78.00	18.00	6.00	36.00	9.00	1.50	6.00	6.00			3.00		0.75	
Sulphate	2.00	104.00	24.00	8.00	48.00	12.00	2.00	8.00	8.00			4.00		1.00	
Dissolved solids	2.00	104.00	24.00	8.00	48.00	12.00	2.00	8.00	8.00			4.00		1.00	
Iron	3.50	182.00	42.00	14.00	84.00	21.00	3.50	14.00	14.00			7.00		1.75	
Manganese	3.50	182.00	42.00	14.00	84.00	21.00	3.50	14.00	14.00			7.00		1.75	
Inorganics which affect health															
Arsenic	5.00	20.00	5.00		20.00			5.00			5.00			2.50	
Cadmium	5.00	20.00	5.00		20.00			5.00			5.00			2.50	
Cyanide	10.00	40.00	10.00		40.00			10.00			10.00			5.00	
Chromium	3.50	14.00	3.50		14.00			3.50			3.50			1.75	
Mercury	10.00	40.00	10.00		40.00			10.00			10.00			5.00	
Lead	5.00	20.00	5.00		20.00			5.00			5.00			2.50	
Selenium	10.00	40.00	10.00		40.00			10.00			10.00			5.00	
Aluminum	7.00	28.00	7.00		28.00			7.00			7.00			3.50	
Copper	5.00	20.00	5.00		20.00			5.00			5.00			2.50	
Zinc	5.00	20.00	5.00		20.00			5.00			5.00			2.50	
Sodium	5.00	20.00	5.00		20.00			5.00			5.00			2.50	
Nitrate	5.00	60.00	20.00		60.00			5.00			5.00			2.50	

Determinations	Unit Costs	Large cities			Medium cities			Small cities			Towns			Rural	
		Plants	Reserv	Distrib	Plants	Reserv	Distrib	Plants	Reserv	Distrib	Plants	Reserv	Distrib	Reserv	Distrib
Fluoride	5.00	60.00	20.00		60.00			5.00			5.00			2.50	
Organics which affect health															
Chlorinated alkanes	25.00	50.00			12.50										
Chlorinated ethenes	25.00	50.00			12.50										
Aromatic hydrocarbons	25.00	50.00			12.50										
Polynuclears	25.00	50.00			12.50										
Chlorobenzenes	25.00	50.00			12.50										
Pesticides	25.00	50.00			12.50										
Phenols and chlorophenols	25.00	50.00			12.50										
Trihalometanes	25.00	50.00			12.50										
Benzene and lower alkylbenzenes	25.00	50.00			12.50										
TOTAL		**3,055.50**	**822.00**	**213.50**	**1522.50**	**304.50**	**111.20**	**287.70**	**212.50**	**82.20**	**80.50**	**53.60**	**37.20**	**54.35**	**14.40**

Laboratory Equipment

Table 27 summarizes the approximate cost in equipment and instruments of setting up different types of laboratories, and Table 29 contains the breakdown of these costs.

Table 27. Cost of Equipping Laboratories

Level of Laboratory	US$
Basic level - Local laboratory	3,800
Intermediate level - Regional laboratory-intermediate Factors affecting organoleptic quality	39,000
Intermediate level - Regional laboratory-high Inorganic components which influence health	70,500
Reference laboratory Organic components which influence health	323,000

Monthly Salaries and Wages

Table 28 indicates the labor cost considered for the tasks of sampling and data processing.

Table 28. Cost of Staff
(in US$)

Staff	Monthly salary
Professional	1,200
Inspector	300
Driver	200
Secretary	150

Table 29. Cost of Equipping Laboratories per Level of Intervention

Level of laboratory	Basic equipment and instruments	Unit cost US$	Total cost US$
Local laboratory Basic	Portable incubator	3,600	3,800
	Chlorine comparator	50	
	Basic turbidimeter	150	
Intermediate level regional laboratory Factors that affect organoleptic quality	Still	3,000	39,000
	Nephelometric turbidimeter	2,500	
	Spectrophotometer	5,000	
	Analytical balance	8,000	
	Incubator	4,500	
	Stove	2,500	
	Glassware	3,000	
	Reagents	2,500	
	Furniture	5,000	
	Others	3,000	
High level regional laboratory Inorganics that affect health	Evaporating dish	2,500	70,500*
	Fume hood	10,000	31,500
	Glassware	3,000	
	Ion meter	5,000	
	Reagents	3,000	
	Furniture	5,000	
	Others	3,000	
Reference laboratory Organics that affect health	Spectrophotometer UV/VIS	30,000	323,000
	Spectrophotometer A.A.	80,000	
	Gas chromatograph	100,000	
	Analytical balance	8,000	
	Still	3,000	
	Nephelometric turbidimeter	2,500	
	Stove	5,000	
	Incubators	10,000	
	Evaporating dish	2,500	
	Fume hood	10,000	
	Ion meter	5,000	
	Reagents	30,000	
	Glassware	10,000	
	Miscellaneous equipment	10,000	
	Furniture	10,000	
	Others	7,000	

* Including the cost of the intermediate level regional laboratory which performs the determinations affecting organoleptic quality.

Transportation

The cost of each of the vehicles required to support the surveillance tasks is shown in Table 30.

Table 30. Cost of Vehicles
(in US$)

VEHICLE	COST
Four-wheel drive	32,000
Pick-up van	18,000
Motorcycle	2.000

8.2 Cost of the Program

The following factors were taken into account in determining the cost:

a) Population growth according to Census Institute. See Table 2.
b) Number of communities in 2000 and projected to 2010. See Table 3.
c) Population to be served in the coming 10 years. See Table 31.
d) Projected coverage in water supply. See Table 31.
e) Projection of the number of communities to be attended to with water services (2000-2010). See Table 32.
f) Number of localities, components per locality, and total components. See Table 33.
g) Number of physico-chemical and bacteriological samples per year and per size of community. See Table 34.
h) Number of physico-chemical and bacteriological determinations to be analyzed per year and per size of community. See Table 15.
i) Number of sanitary inspections to be performed per year and per size of community. See Table 35.
j) Staff required for carrying out sampling and sanitary inspections, per size of community.
k) Laboratory equipment. See Table 27.
l) Transportation requirements and portable laboratory equipment.
m) Global estimate of the support programs.

Table 31. Projection of the Population to be Served with Water Supply Services (in thousands)

Year	Projected population			Projected coverage (%)			Population to be served		
	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
2001	26,319	18,405	7,908	51.9	63.1	25.9	13,672	11,619	2,047
2002	26,952	18,929	8,013	54.5	65.7	28.1	14,690	12,428	2,250
2003	27,601	19,469	8,119	57.2	68.3	30.5	15,785	13,294	2,474
2004	28,265	20,023	8,226	60.0	71.0	33.1	16,960	14,220	2,720
2005	28,945	20,594	8,335	63.0	73.9	35.9	18,223	15,211	2,990
2006	29,642	21,181	8,445	66.1	76.8	38.9	19,581	16,270	3,287
2007	30,355	21,784	8,556	69.3	79.9	42.2	21,039	17,403	3,613
2008	31,086	22,405	8,669	72.7	83.1	45.8	22,607	18,616	3,972
2009	31,834	23,043	8,784	76.3	86.4	49.7	24,291	19,912	4,366
2010	32,600	23,700	8,900	80.1	89.9	53.9	26,100	21,300	4,800

Table 32. Projection of Communities with Water Supply Services

Communities	Year						
	2000	2001	2002	2004	2006	2008	2010
100 - 199	463	518	579	725	909	1,138	1,425
200 – 499	798	917	1,053	1,391	1,836	2,424	3,200
500 – 999	782	829	879	987	1,109	1,246	1,400
1,000 – 2,499	415	426	438	461	486	512	540
2,500 – 4,999	251	252	253	255	257	259	261
5,000 – 9,999	93	98	102	113	124	136	150
10,000 – 19,999	42	46	50	59	69	82	97
20,000 – 49,999	45	47	49	54	59	65	71
50,000 – 99,999	27	28	30	33	37	41	45
100,000 – 199,999	16	17	17	19	21	23	25
200,000 – 499,000	10	10	11	12	13	15	16
over 500,000	6	6	7	7	8	9	10
TOTAL	**2,948**	**3,194**	**3,468**	**4,116**	**4,928**	**5,949**	**7,240**

Table 33. Number of Localities, Components per Locality and Total Components Present Situation (Year 2001)

Size of population	Number of localities	Components per system			Total components		
		PLANT	RES	NET	PLANT	RES	NET
Rural area 100 – 2,500 inhab	**2,690**	1	1	1	2,690	2,690	2,690
Towns 2,500 – 10,000 inhab	**350**	1	1	1	350	350	350
Small cities 10,000 – 50,000 inhab	**93**	2	2	3	186	186	278
Medium cities 50,000 – 200,000 inhab	**45**	5	15	15	226	677	677
Large cities Above 200,000 – inhab	**17**	10	50	50	168	840	840
TOTAL	**3,194**				**3,619**	**4,742**	**4,835**

Future Situation (Year 2010)

Size of population	Number of localities	Components per system			Total components		
		PLANT	RES	NET	PLANT	RES	NET
Rural area 100 – 2,500 inhab	**6,565**	1	1	1	6,565	6,565	6,565
Towns 2,500 – 10,000 inhab	**411**	1	1	1	411	411	411
Small cities 10,000 – 50,000 inhab	**168**	2	2	3	336	336	504
Medium cities 50,000 – 200,000 inhab	**70**	5	15	15	350	1,050	1,050
Large cities Above 200,000 – inhab	**26**	10	50	50	260	1300	1,300
TOTAL	**7,240**				**7,922**	**9,662**	**9,830**

Table 34. Number of Samples to be Obtained for Water Quality Control
Present Situation (Year 2001)

Size of population	Number of localities	Components per system			Total components			Number of samples per components			Total samples			TOTAL
		PLANT	RES	NET	PLANT	RES	NET	PLANT*	RES	NET	PLANT	RES	NET	
Rural area 100 – 2,500 inhab	**2,690**	1	1	1	2,690	2,690	2,690	0	4	0	0	10,760	0	10,760
Towns 2,500 – 10,000 inhab	**350**	1	1	1	350	350	350	0	12	0	0	4,194	0	4,194
Small cities 10,000 – 50,000 inhab	**93**	2	2	3	186	186	278	0	52	26	0	9,648	7,236	16,884
Medium cities 50,000 – 200,000 inhab	**45**	5	15	15	226	677	677	0	52	26	0	35,213	17,607	52,820
Large cities Above 200,000 – inhab	**17**	10	50	50	168	840	840	0	52	26	0	43,669	21,834	65,503
TOTAL	**3,194**				**3,619**	**4,742**	**4,835**				**0**	**103,484**	**46,677**	**150,161**

Future Situation (Year 2010)

Size of population	Number of localities	Components per system			Total components			Number of samples per component			Total samples			TOTAL
		PLANT	RES	NET	PLANT	RES	NET	PLANT*	RES	NET	PLANT	RES	NET	
Rural area 100 – 2,500 inhab	**6,565**	1	1	1	6,565	6,565	6,565	0	4	0	0	26,260	0	26,260
Towns 2,500 – 10,000 inhab	**411**	1	1	1	411	411	411	0	12	0	0	4,932	0	4,932
Small cities 10,000 – 50,000 inhab	**168**	2	2	3	336	336	504	0	52	26	0	17,472	13,104	30,576
Medium cities 50,000 – 200,000 inhab	**70**	5	15	15	350	1,050	1,050	0	52	26	0	54,600	27,300	81,900
Large cities Above 200,000 – inhab	**26**	10	50	50	260	1,300	1,300	0	52	26	0	67,600	33,800	101,400
TOTAL	**7,240**				**7,922**	**9,662**	**9,830**				**0**	**170,864**	**74,204**	**245,068**

* Samples in the plants are taken by the operators, so there is no cost to the control program.

Table 35. Number of Sanitary Inspections
Present Situation (Year 2001)

Size of population	Number of localities	Components per system		Total Components			Frequency Times/year	Total inspec-tions
		PLANT	RES	PLANT	RES	TOT		
Rural area 100 – 2,500 inhab	2,690	1	1	2,690	2,690	5,380	1	5,380
Towns 2,500 – 10,000 inhab	350	1	1	350	350	699	2	1,398
Small cities 10,000 – 50,000 inhab	93	2	2	186	186	371	2	742
Medium cities 50,000 – 200,000 inhab	45	5	15	226	677	903	4	3,612
Large cities Above 200,000 – inhab	17	10	50	168	840	1,008	4	4,031
TOTAL	**3,194**			**3,619**	**4,742**	**8,361**		**15,163**

Future Situation (Year 2010)

Size of population	Number of localities	Components per system		Total components			Frequency Times/year	Total inspec-tions
		PLANT	RES	PLANT	RES	TOT		
Rural area 100 – 2,500 inhab	**6,565**	1	1	6,565	6,565	13,130	1	13,130
Towns 2,500 – 10,000 inhab	**411**	1	1	411	411	822	2	1,644
Small cities 10,000 – 50,000 inhab	**168**	2	2	336	336	672	2	1,344
Medium cities 50,000 – 200,000 inhab	**70**	5	15	350	1,050	1,400	4	5,600
Large cities Above 200,000 – inhab	**26**	10	50	260	1,300	1,560	4	6,240
TOTAL	**7,240**			**7,922**	**9,662**	**17,584**		**27,958**

In addition, different levels of participation have been planned for the agencies responsible for the control program. In the case of rural populations, it is the Ministry of Health or other pertinent institution that sees to this task, while for the large and medium cities it is the providers of the sanitation service. Table 36 indicates the percentages of participation of each of the institutions involved in the drinking water quality control activities.

Table 36. Percentage of Participation of Institutions in the Drinking Water Quality Control Activities

Size of population	Ministry of health	Supplier
Rural area 100 – 2,500 inhab	100	0
Towns 2,500 – 10,000 inhab	50	50
Small cities 10,000 – 50,000 inhab	10	90
Medium cities 50,000 – 200,000 inhab	0	100
Large cities Over 200,000 inhab	0	100

Also, in defining the participation of surveillance agencies, the level of participation in each of the lines of action was established, as shown in Table 37. No investment in laboratory was considered for the surveillance program, because the Ministry of Health is to enlarge the capacity of the reference laboratory and of the regional laboratories. These laboratories should then support the water quality control tasks and the water quality surveillance work independently.

Table 37. Percentage of Participation of the Surveillance Agency per Line of Action

Lines of action	Rural	Urban
Analysis	3	10
Sanitary inspection	3	10
Sampling	3	10
Laboratory	0	15
Transportation	10	10

The investment required to attend to each of the previously identified options in the period 2001 - 2010 is summarized in Table 38, and it fluctuates between 26.6 and 49.2 million dollars. Tables 39 and 40 show the investment per option that needs to be made by each of the institutions responsible, noting that between 21.7% and 30.6% of the budgeted amount will have to be assumed by the institution responsible for the rural area and small localities, from 70.9% to 62.0% by the providers of the sanitation services, and approximately 7.6% by the surveillance agency itself.

Should it be decided, however, to carry out surveillance only in the large and medium cities, that is, in those areas under the jurisdiction of the providers of sanitation services, the budget would drop by 24%, with an average of 91.3% of the investment corresponding to the suppliers, and 8.7% to the surveillance agency. See Table 41. Tables 42 to 44 give a breakdown of the investments for analysis, sanitary inspection, and sampling, and Tables 45 and 46 specify the investments required for carrying out the control and the surveillance of water quality.

Table 38. Total Cost of the Program for the Surveillance and Control of Water Quality (2001 – 2010)

Item	Options					
	1	2	3	4	5	6
Analysis	16,494,909	1,9484,058	20,745,238	21,559,789	21,850,773	2,3131,701
Sanitary inspection	188,138	281,947	384,172	420,823	483,100	765,184
Sampling	1,613,002	2,129,118	2,475,760	2,625,937	2,811,363	3,573,407
Laboratories	3,409,965	4,414,917	5,449,381	6,518,601	7,628,758	9,163,350
Transportation	2,683,230	3,476,744	4,342,872	5,294,520	6,346,892	8,443,600
Subtotal	24,389,243	29,786,784	3,339,7421	36,419,671	39,120,885	45,077,242
10% Support	2,241,068	2,732,741	3,063,092	3,337,853	3,585,009	4,140,854
Total	**26,630,311**	**32,519,525**	**36,460,513**	**39,757,523**	**42,705,894**	**4,921,8096**
Millions	26.63	32.52	36.46	39.76	42.71	49.22

Table 39. Summary of Investment to Implement the Program for the Surveillance and Control of Drinking Water Quality 2001 – 2010 (in US$)

Line of action	Options					
	1	2	3	4	5	6
Quality control						
Min. of health	5,784,402	6,858,623	8,185,567	9,218,726	10,606,491	15,045,236
Supplier	18,867,345	23,201,533	25,508,443	27,497,654	28,828,608	30,504,155
Subtotal	24,651,747	30,060,156	33,694,010	36,716,380	39,435,100	45,549,390
Surveillance						
Min. of health	226,876	277,189	338,129	395,457	467,637	676,751
Supplier	1,751,688	2,182,180	2,428,374	2,645,687	2,803,158	2,991,955
Subtotal	1,978,564	2,459,369	2,766,503	3,041,143	3,270,795	3,668,706
Total	**26,630,311**	**32,519,525**	**36,460,513**	**39,757,523**	**42,705,894**	**49,218,096**
Millions	26.63	32.52	36.46	39.76	42.71	49.22

Table 40. Summary of Investment to Implement the Program for the Surveillance and Control of Drinking Water Quality 2001 – 2010 (percentage)

Line of action	Options					
	1	2	3	4	5	6
Quality control						
Min. of health	21.72	21.09	22.45	23.19	24.84	30.57
Supplier	70.85	71.35	69.96	69.16	67.50	61.98
Subtotal	92.57	92.44	92.41	92.35	92.34	92.55
Surveillance						
Min. of health	0.85	0.85	0.93	0.99	1.10	1.38
Supplier	6.58	6.71	6.66	6.65	6.56	6.08
Subtotal	7.43	7.56	7.59	7.65	7.66	7.45
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Table 41. Summary of Investment to Implement the Program for the Surveillance and Control of Drinking Water Quality 2001 – 2010 – Urban Areas (in US$)

Line of action	Options					
	1	2	3	4	5	6
Quality control	18,867,345	23,201,533	25,508,443	27,497,654	28,828,608	30,504,155
Surveillance	1,751,688	2,182,180	2,428,374	2,645,687	2,803,158	2,991,955
Total	20,619,033	25,383,714	27,936,817	30,143,340	31,631,766	33,496,110
Millions	20.62	25.38	27.94	30.14	31.63	33.50
Percentage of investment						
Quality control	91.50	91.40	91.31	91.22	91.14	91.07
Surveillance	8.50	8.60	8.69	8.78	8.86	8.93

8.3 Recommended Option

Taking into consideration the investment amount, the country's economy, and the health situation, it is recommended that Option 4 be used. This Option considers 100% of intervention in the large cities, 95% in the medium cities, 75% in the small ones, 60% for the towns and 40% for rural communities, with an investment of 39.8 million dollars. The urban suppliers would assume 69.2% of the investment, the institution responsible for control in rural areas 23.26%, and the surveillance agency 7.7%. The surveillance agency's investment would amount to 3.0 million dollars, that is US$ 300,000 per year.

To ensure the reliability of the control activities, the health authorities should commission an independent institution to audit the work performed by the service providers, and should also demand that the suppliers' laboratories implement analytical quality control programs and start certifying these.

These measures will be conducive to joint efforts on the part of the surveillance agency and the supply agencies, and will translate into savings for the country since they will prevent duplication of efforts on the tasks of drinking water surveillance and drinking water quality control.

9. Origin and Application of Funds

For the surveillance of all the water services and the control of the small water suppliers by the Ministry of Health, which will cost 12,3 million dollars for the ten-year period, the suggested sources and number of funds have been considered.

Table 42. Cost of Analyses per Year and per Option (in US$)

Ministry of Health

Year	Option					
	1	**2**	**3**	**4**	**5**	**6**
2001	8,320	9,833	11,789	12,314	13,666	19,681
2002	11,139	14,664	19,201	20,472	23,605	37,632
2003	14,460	20,613	28,500	30,803	36,248	60,782
2004	18,359	27,892	40,077	43,776	52,186	90,328
2005	22,919	36,752	54,394	59,953	72,129	127,718
2006	28,237	47,483	72,001	80,003	96,927	174,698
2007	34,423	60,430	93,547	104,725	127,593	233,372
2008	41,600	75,993	119,802	135,070	165,339	306,269
2009	49,908	94,640	151,674	172,170	211,609	396,429
2010	59,507	116,919	190,236	217,371	268,121	507,496
Subtotal	**288,873**	**505,220**	**781,221**	**876,656**	**1.067,423**	**1.954,404**
Millions	0.29	0.51	0.78	0.88	1.07	1.95

Supplier

Year	Option					
	1	**2**	**3**	**4**	**5**	**6**
2001	904,282	926,829	933,989	939,015	939,665	942,162
2002	998,757	1,049,184	1,065,458	1,076,954	1,078,445	1,084,184
2003	1,103,103	1,187,691	1,215,432	1,235,157	1,237,722	1,247,616
2004	1,218,351	1,344,483	1,386,516	1,416,599	1,420,523	1,435,683
2005	1,345,639	1,521,974	1,581,682	1,624,694	1,630,322	1,652,100
2006	1,486,226	1,722,896	1,804,320	1,863,358	1,871,107	1,901,140
2007	1,641,500	1,950,342	2,058,296	2,137,082	2,147,453	2,187,720
2008	1,812,997	2,207,815	2,348,021	2,451,015	2,464,613	2,517,500
2009	2,002,411	2,499,278	2,678,529	2,811,064	2,828,616	2,896,992
2010	2,211,615	2,829,219	3,055,559	3,224,003	3,246,378	3,333,689
Subtotal	**14,724,882**	**17,239,710**	**18,127,801**	**18,778,940**	**18,864,843**	**19,198,787**
Millions	14.72	17.24	18.13	18.78	18.86	19.20

Total	**1,5013,755**	**17,744,930**	**18,909,021**	**19,655,596**	**19,932,266**	**21,153,190**
Millions	15.01	17.74	18.91	19.66	19.93	21.15

Table 43. Cost of Sanitary Inspections per Year and per Option (in US$)

Ministry of Health

Year	Option					
	1	**2**	**3**	**4**	**5**	**6**
2001	2,377	2,620	2,885	2,944	3,067	3,498
2002	3,152	3,779	4,477	4,643	4,983	6,214
2003	4,118	5,323	6,701	7,049	7,750	10,380
2004	5,315	7,368	9,782	10,427	11,705	16,692
2005	6,796	10,062	14,020	15,133	17,316	26,165
2006	8,621	13,596	19,816	21,651	25,224	40,278
2007	10,864	18,213	27,706	30,635	36,312	61,183
2008	13,615	24,224	38,405	42,966	51,792	92,004
2009	16,981	32,030	52,863	59,832	73,326	137,279
2010	21,093	42,138	72,344	82,832	103,190	203,585
Subtotal	**92,932**	**159,353**	**248,999**	**278,113**	**334,667**	**597,277**
Millions	0.093	0.159	0.249	0.278	0.335	0.597

Supplier

Year	Option					
	1	**2**	**3**	**4**	**5**	**6**
2001	4,638	4,812	4,870	4,906	4,927	4,984
2002	5,225	5,624	5,759	5,846	5,896	6,034
2003	5,886	6,573	6,812	6,965	7,056	7,305
2004	6,631	7,683	8,057	8,300	8,443	8,843
2005	7,470	8,979	9,529	9,889	10,104	10,706
2006	8,416	10,494	11,270	11,784	12,091	12,961
2007	9,481	12,265	13,330	14,041	14,469	15,690
2008	10,681	14,335	15,766	16,731	17,314	18,995
2009	12,032	16,755	18,647	19,935	20,719	22996
2010	13,555	19,582	22,054	23,754	24,794	27,839
Subtotal	**84,016**	**107,103**	**116,093**	**122,151**	**125,812**	**136,353**
Millions	0.084	0.107	0.116	0.122	0.126	0.136
Total	**176,948**	**266,456**	**365,092**	**400,264**	**460,479**	**733,631**
Millions	0.177	0.266	0.365	0.400	0.460	0.734

Table 44. Cost of Sampling per Year and per Option (in US$)

Ministry of Health

Year	Option					
	1	**2**	**3**	**4**	**5**	**6**
2001	5,875	6,649	7642	7,887	8,453	10,741
2002	7,823	9,730	12,172	12,807	14,227	20,077
2003	10,188	13,699	18,198	19,427	22,096	33,306
2004	13,047	18,774	26,137	28,241	32,697	51,778
2005	16,490	25,224	36,513	39,878	46,845	77,276
2006	20,622	33,380	49,981	55,130	65,583	112,145
2007	25,566	43,644	67,364	75,001	90,238	159,464
2008	31,467	56,512	89,688	100,754	122,499	223,272
2009	38,491	72,585	118,236	133,981	164,510	308,850
2010	46,835	92,599	154,604	176,683	218,993	423,097
Subtotal	**216,402**	**372,796**	**580,534**	**649,789**	**786,141**	**1.420,006**
Millions	0.22	0.37	0.58	0.65	0.79	1.42

Supplier

Year	Option					
	1	**2**	**3**	**4**	**5**	**6**
2001	69,945	72,402	73,191	73,634	73,879	74,450
2002	78,759	84,390	86,240	87,287	87,868	89,233
2003	88,684	98,363	101,616	103,472	104,507	106,951
2004	99,860	114,649	119,732	122,657	124,295	128,187
2005	112,445	133,633	141,079	145,399	147,831	153,639
2006	126,615	155,759	166,231	172,359	175,824	184,145
2007	142,571	181,549	195,868	204,317	209,117	220,708
2008	160,538	211,610	230,789	242,200	248,715	264,531
2009	180,769	246,648	271,935	287,108	295,810	317,056
2010	203,549	287,487	320,418	340,343	351,824	380,009
Su total	**1,263,734**	**1,586,490**	**1707,100**	**1,778,776**	**1,819,671**	**1,918,910**
Millions	1.26	1.59	1.71	1.78	1.82	1.92

Total	**1,480,136**	**1,959,285**	**2,287,634**	**2,428,565**	**2,605,812**	**3,338,916**
Millions	1.48	1.96	2.29	2.43	2.61	3.34

Table 45. Cost of Implementing Quality Control 2001 - 2010 (in US$)

Ministry of Health

Item	Option					
	1	**2**	**3**	**4**	**5**	**6**
Analysis	288,873	505,220	781,221	876,656	1,067,423	1,954,404
Sanitary inspection	92,932	159,353	248,999	278,113	334,667	597,277
Sampling	216,402	372,796	580,534	649,789	786,141	1,420,006
Laboratories	2,571,040	2,737,067	2,932,606	3,162,901	3,434,133	4,129,800
Transport	2,089,300	2,460,676	2,898,065	3,413,200	4,019,902	5,576,000
Subtotal	5,258,547	6,235,112	7,441,424	8,380,660	9,642,265	13,677,487
Support 10%	525,855	623,511	744,142	838,066	964,226	1,367,749
Subtotal	**5,784,402**	**6,858,623**	**8185567**	**9218726**	**10,606,491**	**15,045,236**
Millions	5.78	6.86	8.19	9.22	10.61	15.05

Supplier

Item	Option					
	1	**2**	**3**	**4**	**5**	**6**
Analysis	14,724,882	17,239,710	18,127,801	18,778,940	18,864,843	19,198,787
Sanitary inspection	84,016	107,103	116,093	122,151	125,812	136,353
Sampling	1,263,734	1,586,490	1,707,100	1,778,776	1,819,671	1,918,910
Laboratories	729,500	1,459,000	2,188,500	2,918,000	3,647,500	4,377,000
Transport	350,000	700,000	1,050,000	1,400,000	1,750,000	2,100,000
Subtotal	17,152,132	21,092,303	23,189,494	24,997,867	26,207,826	27,731,050
Support 10%	1,715,213	2,109,230	2,318,949	2,499,787	2,620,783	2,773,105
SubtotaL	**18,867,345**	**23,201,533**	**25,508,443**	**27,497,654**	**28,828,608**	**30,504,155**
Millions	18.87	23.20	25.51	27.50	28.83	30.50

Total

Item	Option					
	1	**2**	**3**	**4**	**5**	**6**
Analysis	15,013,755	17,744,930	18,909,021	19,655,596	19,932,266	21,153,190
Sanitary inspection	176,948	266,456	365,092	400,264	460,479	733,631
Sampling	1,480,136	1,959,285	2,287,634	2,428,565	2,605,812	3,338,916
Laboratories	3,300,540	4,196,067	5,121,106	6,080,901	7,081,633	8,506,800
Transport	2,439,300	3,160,676	3,948,065	4,813,200	5,769,902	7,676,000
Subtotal	22,410,679	27,327,415	30,630,918	33,378,527	35,850,091	41,408,537
Support 10%	2,241,068	2,732,741	3,063,092	3,337,853	3,585,009	4,140,854
Subtotal	**24,651,747**	**30,060,156**	**33,694,010**	**36,716,380**	**39,435,100**	**45,549,390**
Millions	24.65	30.06	33.69	36.72	39.44	45.55

Table 46. Cost of Quality Surveillance 2001 - 2010
(in US$)

Ministry of Health

Item	Option					
	1	**2**	**3**	**4**	**5**	**6**
Analysis	8,666	15,157	23,437	26,300	32,023	58,632
Sanitary inspection	2,788	4,781	7,470	8,343	10,040	17,918
Sampling	6,492	11,184	17,416	19,494	23,584	42,600
Laboratories	0	0	0	0	0	0
Transport	208,930	246,068	289,807	341,320	401,990	557,600
Subtotal	**226,876**	**277,189**	**338,129**	**395,457**	**467,637**	**676,751**
Millions	0.23	0.28	0.34	0.40	0.47	0.68

Supplier

Item	Option					
	1	**2**	**3**	**4**	**5**	**6**
Analysis	1,472,488	1,723,971	1,812,780	1,877,894	1,886,484	1,919,879
Sanitary inspection	8,402	10,710	11,609	12,215	12,581	13,635
Sampling	126,373	158,649	170,710	177,878	181,967	191,891
Laboratories	109,425	218,850	328,275	437,700	547,125	656,550
Transport	35,000	70,000	105,000	140,000	175,000	210,000
Subtotal	**1,751,688**	**2,182,180**	**2,428,374**	**2,645,687**	**2,803,158**	**2,991,955**
Millions	1.75	2.18	2.43	2.65	2.80	2.99

Total

Item	Option					
	1	**2**	**3**	**4**	**5**	**6**
Analysis	1,481,154	1,739,128	1,836,217	1,904,194	1,918,507	1,978,511
Sanitary inspection	11,190	15,491	19,079	20,559	22,621	31,554
Sampling	132,865	169,833	188,126	197,371	205,551	234,491
Laboratories	109,425	218,850	328,275	437,700	547,125	656,550
Transport	243,930	316,068	394,807	481,320	576,990	767,600
Subtotal	**1,978,564**	**2,459,369**	**2,766,503**	**3,041,143**	**3,270,795**	**3,668,706**
Millions	1.98	2.46	2.77	3.04	3.27	3.67

9.1 Sources of Funds

The following have been considered:

National resources

Money from the Public Treasury, from either the national or the regional budget.

Donations

Funds obtained from national or international agencies as non-repayable loans.

9.2 Use of the Funds

- Investments to implement laboratories
  - Central
  - Regional
  - Local.

- Investments for the operations of the Surveillance Program
  - Vehicle
  - Salaries and wages
  - Per diem

- Inputs
- Replacement of equipment.

In the case of control by the suppliers, the cost will be assumed by the supplier and financed by the consumers through the water tariff.

9.3 Execution of the Surveillance Program

9.3.1 Institutional Scheme

The Program will be carried out by the Ministry of Health. The Ministry's Environmental Health Office will be responsible for coordination, administration and supervision at the national level, and its Regional Offices will be responsible at the regional level.

If the goals and objectives are to be met, it is imperative to promote the integrated and well-coordinated cooperation of all the institutions belonging to the sub-sector, such as the National Regulatory Agency and the Regional Regulatory Agencies, as well as the Association of Water Suppliers, in such a way as to optimize the effectiveness of efforts and human, material, and economic resources.

The proposal thus tends to facilitate the execution of the Program because it introduces an element of coordination between the surveillance agencies and the providers of water supply services. It is only logical that this coordination should be the task of the Health Authorities together with the National Regulatory Agency, so that all the efforts and resources involved can be channeled smoothly to accomplish the improvement of water services through the definition of goals. These goals target a reduction of the health risk and the prioritizing of investments for expansion and improvement of the water systems based on the data provided by the activities of surveillance and quality control of the water and the water supply services.

9.3.2 Process of Execution of the Program

The Program design, scheduling, planning of activities and assessment of services, should follow a dynamic ongoing process of planning, execution, assessment, and adjustment, which will cyclically lead to results increasingly closer to the ideal and the necessary.

Guidelines, methodologies, and lines of action will need to be established for the subsequent phases. This is the Health Authorities' job, and they will have to define in detail what should be done, how to do it, and what the desired results are. In this reference, the functions of the surveillance agency within the current public health system are indicated in Table 47. Table 48 summarizes the functions of the regional offices.

9.3.3. Expected Results of the Program

The activities of the Surveillance Program will make it possible to:

- Improve the levels of health and quality of life of The Country's population
- Define:
  (a) The condition of the water supply services,
  (b) Shortcomings in the supply systems from the health-hazard point of view; and
  (c) Condition of services at the home level, in terms of physical components and proper water usage.

The first result will help the Water and Sanitation sector to set priorities for investments in extension of coverage and improvement of the existing systems.

The second group of results will call for close coordination to be established at the national and regional levels between the surveillance agency and the supplying agencies, so that realistic goals may be set to reduce the health risk of the water supply services. The investments contemplated in this reference should be defined by the Water and Sanitation sector taking account of priority criteria on which consensus has been reached by the water suppliers and the Ministry of Health.

Finally, the third result is associated with the planning of hygiene education activities for the population involving mass media campaigns on the proper use of water, care of the water installations in the home and, above all, improvement of the habits of hygiene and sanitary customs.

Taken together, these activities will contribute substantially to improving the health and quality of life of the population, as well as contributing to the country's social progress and development.

Table 47. Functions of the Sanitary Authority

a) Coordinate with the Regulatory Agencies and Sanitation Service Providers regarding the results of their drinking water quality control programs.
b) Identify in each of the regions the communities where surveillance is to be carried out, so that the regions may plan their activities accordingly.
c) Supervise compliance with the control and surveillance programs.
d) Process the data on quality control provided by the suppliers.
e) Periodically report on the situation of the quality of the water supply services.
f) Perform follow-up on activities for the improvement of the quality of the drinking water and of the water supply services.
g) Identify and quantify the needs for human, material, and economic resources for the surveillance work.
h) Identify and formulate training requirements.

i) Periodically review current water supply standards and regulations.
j) Start up the epidemiological surveillance program.
k) Identify steps to be taken to introduce the environmental education program.

Table 48. Functions of the Regional Office for the Surveillance of Water Quality

a) Coordinate quality control activities with the local or regional institutions responsible for managing the water supply services.
b) Register the different communities in its jurisdiction.
c) Plan activities at the regional and local level; quantify investments and commit budget lines for the execution of the surveillance program.
d) Perform the tasks included in the surveillance program (validation of sanitary inspections and water sampling and analysis).
e) Process at the local level the data obtained in its jurisdiction.
f) Notify the institutions responsible for the water supply systems about any observations arising from the surveillance work.
g) Periodically report to the surveillance agency on the quality of the water and of the water supply services.
h) Carry out the planned training, environmental education and community promotion activities.

9.4 Stages of Execution of the Program

Taking into consideration the socioeconomic conditions of the country, it has been decided to execute the Program in two stages. During a first three-year stage, the control programs being carried out by the Sanitation Service Providers in all the capitals of departments will be consolidated, the Ministry of Health reference laboratory and regional laboratories will be implemented, the Definitive Project broken down into departments and provinces will be concluded, and the required funding and material resources will be obtained. During the second seven-year stage, one of intense activity, the program will gradually expand to cover the whole country, beginning with small cities, followed by towns, and finally rural communities.

The stages will include the following actions:

a) First stage (three years)

- Institutionalization of the Program for the Surveillance of Drinking Water Supply Services.
- Setting of goals for the training, environmental education, community, and epidemiological surveillance programs.
- Strengthening of water quality control programs in large and medium cities.

- Planning of surveillance activities for application nationwide.
- Introduction of surveillance work in the country's main cities.
- Creation of database and information flow, notification, and internal control system.
- Passing of the Law for the Surveillance of Drinking Water Services.

b) Second stage (seven years)

- Extension of the Program to cover the whole country.

9.4.1 Assessment and Control

Besides scheduling and execution, the Program management process includes assessment and control. The assessment and control processes will provide feedback on the planning, execution and administration of the surveillance activities. Assessment and control will be based on the policy lines and investments anticipated for the reduction of risk levels in the water supply systems, and will make it possible to adjust cyclically and in a well-coordinated manner the strategies, work policies, and regional and national programs under way.

Guidelines, methodologies, and lines of action will need to be established to serve as a work base for the subsequent phases. This is the Health Authorities' job, and they must define in detail what should be done, how to do it, and what results they hope to obtain.

The processes will be carried out continuously, fed by an efficient system of information at the regional and national level. In this way the scope of the Program will have to be continually adapted to the new conditions arising from the assessments and from the perfecting of the information system.