

AMERICAN CHEMICAL SOCIETY

**FINAL REPORT OF THE INTERNATIONAL FORUM ON  
SUSTAINABLE CONSERVATION OF WATER SOURCES AND  
BASINS AND OPERATION OF SIDEWALK AQUEDUCTS OF  
CHOCONTÁ<sup>1</sup>**

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**Bogota D.C. 2012**

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<sup>1</sup> This report was written by Joan Sebastián Caicedo, Rapporteur.



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## Background

High quality water is crucial not only for drinking, food production, and recreation, but it is also a critical component in the progress and development of a community. A lack of clean water continues to be an impairment to the emerging regions of the world. Rural areas - where having an aqueduct is a symbol of luxury and progress, regardless of water quality - are the hardest hit by shortages.

Only 84.59% of Latin America's population has access to fresh water despite 47% of the world's total water reserves being located in the region. The disparity between supply and access is even sharper when comparing urban areas to rural: in the cities and towns, 92.98% of the population has access to fresh water, while in the rural communities, the number drops to only 61.22%. Colombia is a case study of this inequality. According to 2005 census data, the county seats had 92% water coverage as opposed to the rural areas who had only 55%.

The lack of an easily accessible water supply is not the only problem that rural communities face, however. The quality of water is often below levels considered safe for human consumption. Unsafe drinking conditions in these rural areas are caused by both biotic and abiotic factors and are amplified by anthropological influences. The Universidad Nacional de Colombia surveyed multiple cities, including Tena, in the state of Cundinamarca in which they evaluated rural aqueducts. The study came to the following conclusions:

1. The appropriate infrastructure for water treatment is in place locally. The problem was found to lie in the lack of personnel trained in managing and maintaining the water treatment facilities, which has resulted in levels of turbidity and coliform bacteria above the legal limits.
2. The lifespans of some aqueducts are as long as 40 to 60 years. This has posed a problem in some communities where the current population is significantly greater than what was projected at the time of construction of the aqueduct and the supply cannot meet the current demand.

Water sources which have been tested in rural areas show dangerously high pollution levels, especially in coliform bacteria. These findings indicate that pollution of the water basins is possibly caused by pouring of domestic waste upstream of the water supply points. The scant coverage of sewage networks in Colombia – just 34% in rural areas – forces some inhabitants to dump wastewater directly into freshwater bodies. Livestock activity in the upper portions of the water basins may also be contributing to the pollution.

The city of Chocontá was chosen to use as an example of the problems confronting Colombia's national and regional water supplies. Chocontá faces many of the same problems mentioned above, but also has a set of unique conditions that require a more precise analysis.

Chocontá has twenty-nine rural aqueducts, from which a sample of nine were chosen to be assessed for the study. Of these nine water sources, one had a treatment facility, while the remaining eight only had the structure necessary to supply and distribute the water. The lack of water treatment facilities has been deemed one of the leading obstacles to clean, potable water in rural communities.

Most water intakes use streams or aquifers to supply their water. This poses a risk because each of these sources is vulnerable to pollution generated by livestock and other agriculturally related activities in the surrounding area. While the origins of the pollutants are the same, the methods of how they infect the water supply vary depending on both the amount of time it takes for the water to reach the basin from the moment it falls from the sky and the route by which it travels in between.

Tanneries also contribute to the overall negative water quality in the areas in which they operate. Chocontá is upstream from a tannery waste dumpsite, so the effects in that city are minimal. On the other hand, the tannery represents a significant source of pollution for towns and cities that are downstream, such as Bogota.

Following the analysis of the condition of the water basins, the report will then move on to examine the ecosystems which are supplying the water. Much of the water provided by these aqueducts originates in the moorlands. Increased agricultural activity – particularly that involving grazing livestock – has adversely affected the health of these delicate ecosystems. In addition to the waste from the animals, the moorlands are also being damaged when the native vegetation is stripped to make room for more pastures. The loss of natural plant life leads to an increased rate of soil erosion, which in turn negatively impacts water quality.

To combat these issues, Colombia has developed a series of measures to protect and preserve its hydrological basins. In 2002, Decree 1729 was issued to regulate and protect the basins, which was then strengthened by 2003's Resolution 104. More recently, in 2010, the National Policy for the Comprehensive Management of Water Sources was created as a guide to sustainable management of water resources while balancing their economic use and physical-biotic conservation. Protection of areas deemed important for the generation of water, public utility, and social interests such as the moorlands, aquifer reloading areas, and water foundations were stressed.

As a result, the following aspects will be emphasized:

- Human consumption must remain a priority.
- Prevention and control of basin degradation.
- Continued management of the supply and demand of renewable natural resources.
- Promotion of water saving and efficient water use.
- Getting hydroclimatic management of the basin under government oversight.



Using the community of Chocontá and its water resources as an example, the country of Colombia, in partnership with other worldwide communities, the American Chemical Society (ACS), as part of its Global Innovation Imperatives (Gii) program, along with several other scientific entities and non-governmental organizations (NGOs), will attempt to share and expand knowledge of water management and conservation to encourage innovative solutions.

### **American Chemical Society (ACS)**

With more than 163,000 members, the American Chemical Society (ACS) is the world's largest scientific society and one of the world's leading sources of authoritative scientific information. A nonprofit organization, chartered by Congress, ACS is at the forefront of the evolving worldwide chemical enterprise and the premier professional home for chemists, chemical engineers and related professions around the globe.

### **Global Innovation Imperatives (Gii)**

Global Innovation Imperatives (Gii) is an American Chemical Society (ACS) program with the purpose of creating community and knowledge transfer to stimulate global scientific innovation that meets societal imperatives of the population around the world. Gii promotes creative and innovative solutions to global challenges, such as access to drinkable water, food and health, among others.

The first challenge addressed by the program is water. Drinkable water, for many people around the world, is a scarce resource. The amounts of water necessary to sustain industry are becoming a challenge. Gii's purpose is to provide a platform for the exchange of knowledge to find real solutions in order to improve people's quality of life. To obtain more information about Gii, please visit the website: <http://www.acs.org/gii>.

### **Sociedade Brasileira de Química (SBQ)**

Founded in July, 1977, the Sociedade Brasileira de Química (SBQ) is the main chemistry society in Brazil and its purposes are the development and consolidation of the Brazilian chemistry community, the diffusion of chemistry and of its important relations, applications and consequences for the development and to improve people's life quality.

### **Sociedad Colombiana de Ciencias Químicas (SOCOLQUIM)**

The Sociedad Colombiana de Ciencias Químicas was created in May, 1941. Its purpose is to foster the progress and disclosure of chemistry within the scientific and the industrial framework, create and maintain a favorable environment for chemistry activities in Colombia, cooperate with

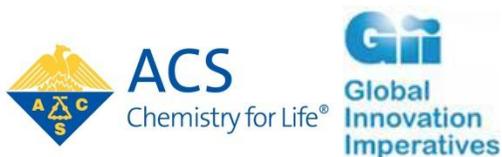


businesses in the application and development of the chemical processes and methods, and to promote the study and research in the chemistry field.

### **Latin American Federation of Chemistry Associations (FLAQ)**

The Latin American Federation of Chemistry Associations (FLAQ) was founded at the VII Latin American Congress on Chemistry held in Mexico City in 1959 and includes 15 associated organizations. Its purposes are: (1) To encourage local setting of chemical associations of professionals on chemistry; (2) to encourage the creation of a code of professional ethics to be adopted by chemistry professionals from Latin America; (3) to promote the exchange among higher education institutions fostering science and technology exchange in order to answer the urgent development issues in Latin America; (4) to encourage the organization of Latin American Congresses of Chemistry; (5) to participate in international meetings on chemistry problems and related topics; (6) to promote the study of chemical problems; (7) to establish committees of works which permanently study Latin American chemistry problems; and (8) to help to spread through the available means the new chemistry knowledge.





## **Justification**

Potable water is an essential amenity of any city or human settlement. Often times, the best availability occurs in cities and other well developed regions, leaving only a small proportion of inhabitants of rural areas with access to clean drinking water. The lack of a clean water supply can be felt even more acutely in communities in high altitude areas. This is the case in Chocontá, where 70% of the population lives in rural areas and the aqueducts lack treatment and service continuity. A major challenge facing the aqueducts in Chocontá is that they are being operated using community resources. This has made it difficult to obtain the proper equipment for water treatment and distribution.

As a result of the poor drinking water conditions, which are widespread throughout the nation of Colombia, the Mayor's Office of Chocontá contacted the American Chemical Society (ACS) through Fundación Nuevos Horizontes Colombianos. The goal was to help solve the municipality's water crisis so that all rural people had access to safe, clean water. The ACS engaged the Sociedad Colombiana de Química (SOCOLQUIM), the Latin American Federation of Chemistry (FLAQ), and the Sociedade Brasileira de Química (SBQ) who then came together with the United States Geological Survey (USGS) and Conservation International (CI). Through site visits and discussion, these organizations established a program that would train local personnel in operation of the plants; would redesign the treatment facilities when necessary; and identify user consumption habits to establish policies that would promote environmental conservation and integrated management of the water resources.

It must be emphasized that the objective of this project was not to solve just the water supply problem in Chocontá, nor should replication of its methodologies be limited Colombia. It is hoped that the experiences, suggestions, and conclusions found herein be used to address similar water resource related issues worldwide.



## 1. Purposes

### General purpose:

To develop a practical and profitable methodology to manage resources that would balance social and ecological demands of water resources.

### Specific purposes:

- To create tools that will increase the awareness and intervention capabilities of the community to ensure the protection of their water resources.
- To draft a proposal that will be: useful for the city of Chocontá; used as an example for other national and international regions with similar conditions; and used to strengthen existing measures in pursuit of the conservation of water resources.
- To structure a methodology that facilitates financing and sustainability of the project to improve water basin conditions.
- To make basic tools for the management and protection of water resources known.



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## 2. Applicable rules

### Water resources and supply

#### **National Policy for the comprehensive management of water resources. 2010.**

**Law 373 dated 1997:** Through which a program for the water efficient usage and saving is established.

**Decree 3930 dated 2010:** Through which Title I of the 9th Law dated 1979 as well as Chapter II of Title VI – Part II – Book II of the Decree-Law 2811 dated 1974 are regulated in terms of water usage and wastewaters, and other provisions are set forth.

**Decree 1575 dated 2007:** Through which the System for the Protection and Quality Control of Water for Human Consumption is established.

**Decree 3100 dated 2003:** Through which taxes are regulated for the direct water usage as a receptor of special pouring and other provisions are also established.

**Decree 1729 dated 2002:** "Through which Part XIII, Title 2, Chapter III of the Decree-Law 2811 dated 1974 on hydrological basins is regulated, and number 12 of Section 5 of the Law 99 dated 1993 is partially regulated and other provisions are issued" POMCA.

**Resolution 1508 dated 2010:** Through which the procedure for the collection of resources coming from measures applied by the Regulatory Commission of Drinkable Water and Basic Sanitation to encourage the efficient usage and protection of drinkable water and to discourage its excessive usage and its corresponding derivation to the National Environmental Fund (FONAM) are set forth.

**Resolution 2115 dated 2007:** Through which the characteristics, basic documents and frequencies of the control and surveillance system for water quality for human consumption are set.

**Decree 2858 dated 1981. Through which Decree 1541 dated 1978 is modified:** Through which Part III of the Book II of the Decree-Law 2811 dated 1974 is regulated: "On non-maritime water" and partially Law 23 dated 1973.

**Resolution 2145 dated 2005:** Through which Resolution 1433 dated 2004 on Sanitation and Pouring Management Plans (PSMV) is partially modified.

**Decree 1323 dated 2007:** Through which the system on water resources information (SIRH) is created.

**Agreement dated 08, 2004 of the Autonomous Regional Corporation (CAR):** Through which the pouring rule of the tanning industry is defined and other decisions are made.



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## Hydrological basins

**Decree 1729 dated 2002:** "Through which Part XIII, Title 2, Chapter III of the Decree-Law 2811 dated 1974 on hydrological basins is regulated, and number 12 of Section 5 of the Law 99 dated 1993 is partially regulated and other provisions are issued" POMCA.

**Decree 1480 dated 2007:** Through which the regulations and intervention of some hydrological basins are a priority and other provisions are issued.

## Related technical documents

### Basin regulations and ecological restoration

**Technical-Scientific Guide for the Regulation and Management of Hydrological Basins in Colombia.** Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM). Second version. 2008.

**Methodological Guide for the Restoration of Ecosystems Based on Vegetation Management.** Ministry of Environment, Housing and Territorial Development. 2003.

**National Plan of Ecological Restoration, Rehabilitation and Recovery of Disrupted Areas.** Republic of Colombia. Ministry of Environment, Housing and Territorial Development. 2010.

### Environmental guides for productive sectors

**Colombian Environmental and Horticultural Guide.** Ministry of Environment, Housing and Territorial Development. 2009.

**Environmental Guide for Potato Crops.** Ministry of Environment, Housing and Territorial Development. (FEDEPAPA) 2004.

**Environmental Guides for the Pesticide Subsector.** Ministry of Environment, Housing and Territorial Development – Industry chamber for crop protection of ANDI. 2003.

**Environmental Guide for the Tanning Industry and Leather Preparation.** Ministry of Environment, Housing and Territorial Development. 2004.

**Environmental Guide for the Sector and Tanneries.** Chamber of Commerce of Bogota, Business Environmental Corporation (CAE), Ventanilla Acercar (Technical and environmental Assistance for the small, medium and large enterprises) and the Technical Administrative Department of Environment (DAMA). 2004.

**Sector Manual on Environment, Environmental Management Project in the Area of Tanneries.** National center of cleaner production and environmental technologies. 2004.

### **Environmental guides for water management**

#### **Guide for the Creation of a Sanitation and Pouring Management Plan – PSMV for the Entities Providers of Sewage Services and its Supplementary Activities in Urban and Rural Areas.**

Autonomous Regional Corporation of Cundinamarca. 2006.

**Environmental Guides for Aqueduct Systems.** Ministry of Environment. 2002.

**Optimization Guide for Wastewater Treatment Systems.** Ministry of Environment, Housing and Territorial Development. 2006.

**Technical Regulations for Drinkable Water and Basic Sanitation Sectors (RAS).** Ministry of economic development. 2000.

**Registry of Creation of Comprehensive Management Plans for Solid Waste.** Ministry of Environment, Housing and Territorial Development – United Nations International Children’s Emergency Fund – UNICEF. 2005.



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### 3. Definition of Problem

Due to a wide range of geographical, geological, and hydrological factors found in the state of Cundinamarca, the city of Chocontá obtains its water from a variety of sources. The most common sources are superficial bodies of water such as rivers and streams. Other typical sources are spring heads, natural underground bodies, and aquifers which offer a supply alternative for the highest regions and in times of drought.

All of these sources are used for various economic activities in the area: farming, watering livestock, industrial uses, and various domestic activities. However, there have been no studies which reveal if the quality of the water is high enough for such activities. Many water sources are exposed to different risk factors such as deforestation, pollution through industrial discharge, illegal settlements, loss of natural vegetation in favor of farmland, and the misuse of agro-chemicals.

The tanning industry in Chocontá is a source of employment within the city and supports many families. The tanners use a low-technical handcraft process which releases byproducts that have a harsh impact on the surrounding environment, including the nearby Bogota River and its tributaries. Nearby Villapinzón has a similar problem. An upstream tannery releases byproducts into the rivers which later on affects the downstream cities, especially in the capital district where the river is used as a primary source of water. Several agencies, including the Autonomous Regional Corporation of Cundinamarca (CAR), have recently intervened to regulate the activities of the tanneries. The new regulations have led to an improvement in the condition of the Bogota River. These have included “end of the pipe” methods such as installing treatment plants. Such methods have proven costly for the tanneries, however, since the installation and maintenance of the required equipment is high. In addition, when the treatment equipment is not maintained properly or on a regular basis, the performance drops considerably.

The tanneries geographic and economic positions make them an important objective in the quest for clean water. The Ministry of Environment is targeting the reduction of pollution generated by offering practical solutions. Suggestions thus far have included the implementation of new technologies, cleaner production, or even cooperating in the construction and management of treatment plants. If the new treatments plants were constructed, the Department of Cundinamarca is in the process of transferring authority of drinkable water treatment plants (PTAP) and wastewater treatment plants (PTAR) to the territory bodies with the proper infrastructure.

Weather is another factor that influences water quality and must be taken into consideration. Chocontá has a seasonal rainfall distribution, with continuous rain during the months of April through November. When rainfall increases there may also be a change in water characteristics. It is essential to consider this aspect when analyzing results. Other data that should be considered



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are the country's exposure to climatic phenomena, such as La Niña and El Niño, which influence the amount of water received and is reflected in supply source measurements.

It is already known that when studying a local or regional problem, such as water resource management, it is important to do so within a context of other significant issues such as climate change and the change of soil usage. The global scientific community informs us that the warming of the climate system is certain, as evidenced by increased global average temperature, the generalized melting of snow and ice, and the increase of the global average of sea level. All of these conditions must be reflected in different laws concerning water quality, including by Decree 1575 from 2007 and Resolution 2115 from 2007, in addition to technical regulations such as the regulation for the drinkable water and basic sanitation sector (RAS).

Water treatment differs in the many cities and small towns across Colombia. Several only use observations of physical conditions such as turbidity, color and total solids without considering very important microbiological factors for the prevention of stomach diseases. In addition, we shall add the lack of knowledge from users, who consider that the water clear appearance indicates it is safe to drink.

As previously indicated, the water lacks the proper treatments to ensure that it is safe for human consumption. This summary is accurate from the perspective of the rural areas, which in contrast to urban areas, shows no evidence of analysis or of purification treatment.

Currently, in the urban areas, the water quality from the drinkable water treatment plant is closely monitored, and the following parameters are analyzed:

- Turbidity
- pH
- Color
- Chlorine levels
- Iron
- Phosphate
- Alkalinity
- Acids
- Manganese
- Nitrites

These parameters partially comply with the environmental rules for drinkable water set in the technical regulations for the drinkable water and basic sanitation sector (RAS 2000), section 104 to 107 and with the legal rules of Decree 1575 of 2007, Resolution 2115 of 2007 and Decree 3930 of 2010.

Furthermore, the city hires a private laboratory, “Maber Soluciones Hidráulicas EU,” to analyze three samples a month. This information can be found in files located in the public services offices. Similarly, the Secretary of Health of Cundinamarca performs physic-chemical and bacteriological controls which determine water characteristics on a monthly and bi-weekly basis, respectively. These results are satisfactory according to the parameters of water quality set forth in Decree 1575 of 2007 and Resolution 2115 of 2007.

The lack of information on water quality is not only limited to surface waters, but also extends to underground water, where little is known. Different factors must be considered with these sources, such as the lack of information on the exact number of water supply wells dug, drilled, cased, and sealed. Entities such as the Government of Cundinamarca, the Instituto Agustín Codazzi (IGAC), CAR, and IDEAM are needed to provide the information necessary for the subsequent analysis of data and to determine the water’s potential to be used as a supply.

Another influential factor on water quality is the sewage system. Proper management of wastewater will show a considerable reduction of pollutants in drinking water sources. In Chocontá, the sewage coverage shows substantial disparity between urban and rural areas. According to the 2005 General Census, the coverage of urban areas is 92%, while rural area coverage is 45%. As a result, communities are forced to use other types of infrastructure such as septic wells, whose existing number is unknown. In an ideal scenario, the construction of the sewage system would be a priority in rural areas, but due to the cost, this development is not feasible. Therefore, expansion in the use of septic wells or the implementation of latrines must be considered. These projects must all be done within the framework of environmental and for environmental education parameters for the communities.

The water sources of Chocontá are exposed to pollution risk factors due to the numerous economic activities performed in the city including agriculture, livestock farming, and industrial undertakings (tanneries). Some of these risk factors from these activities include:

- Incorrect agricultural and livestock practices near water sources.
- Absence of an adequate system for water purification in rural areas.
- Lack of information on water quality and of the different drinkable water sources in the rural areas.
- Unsanitary disposal of domestic and industrial waste into the surrounding bodies of water.
- An increase in soil erosion propagated by deforestation and augmented by severe weather which leads to an increase of solids and turbidity in water sources.

These issues will require attention when structuring a plan regarding water quality, aqueducts, sewage, development and land use, and hydrological basins. It is necessary to use tools including prior studies and databases of outside entities such as the government of Cundinamarca, IGAC, CAR, the Institute of Hydrology, Meteorology and Environmental Studies (IDEAM), and CI which



have information related to the eco-hydrologic, climate, underground water, hydrogeology, design of Plans of Regulation and Management of Basins (POMCAS), and other important aspects. This will assist in diagnosing the current condition of Chocontá's water supply. Likewise, technological tools such as geographic information systems can be used for the analysis of the information gathered. The contribution of the academic sector will be a very important addition, which is why the Universidad Nacional de Colombia will be included through projects such as the inspection, regulation, and modeling of existing basins and sub-basins to suggest follow-up monitoring of the physic-chemical and biological conditions of the sources through the analysis and treatment of the samples in laboratories certified for this activity.

#### 4. Action Plan Proposal

##### Action Plan Procedure

An explanation of the procedures used to draw up the action plan is shown below.



**Expert observations:** Based on field visits and discussions amongst experts, a series of factors that have an impact on the deterioration of water resources were identified.

A succession of references was also established, founded on the identified factors, in order to create a basis for the action plan and its main activities.

**Marking out problems and consulting interested entities:** Based on the factors identified by the experts and on the information gathered as a baseline, the main problems to be addressed by the action plan were identified.

Private and public entities that may possess skills, knowledge, or capacity to address the individual problems should also be consulted.

**Drawing up the action plan:** Taking into account the identified problems, along with the suggestions offered by the panel or experts, a structure for the action plan and its activities was established.



**Implementation of the action plan:** Once the activities and components of the action plan are built, it is possible to establish an adequate implementation sequence, and to identify the different public and private organizations that are to take part.

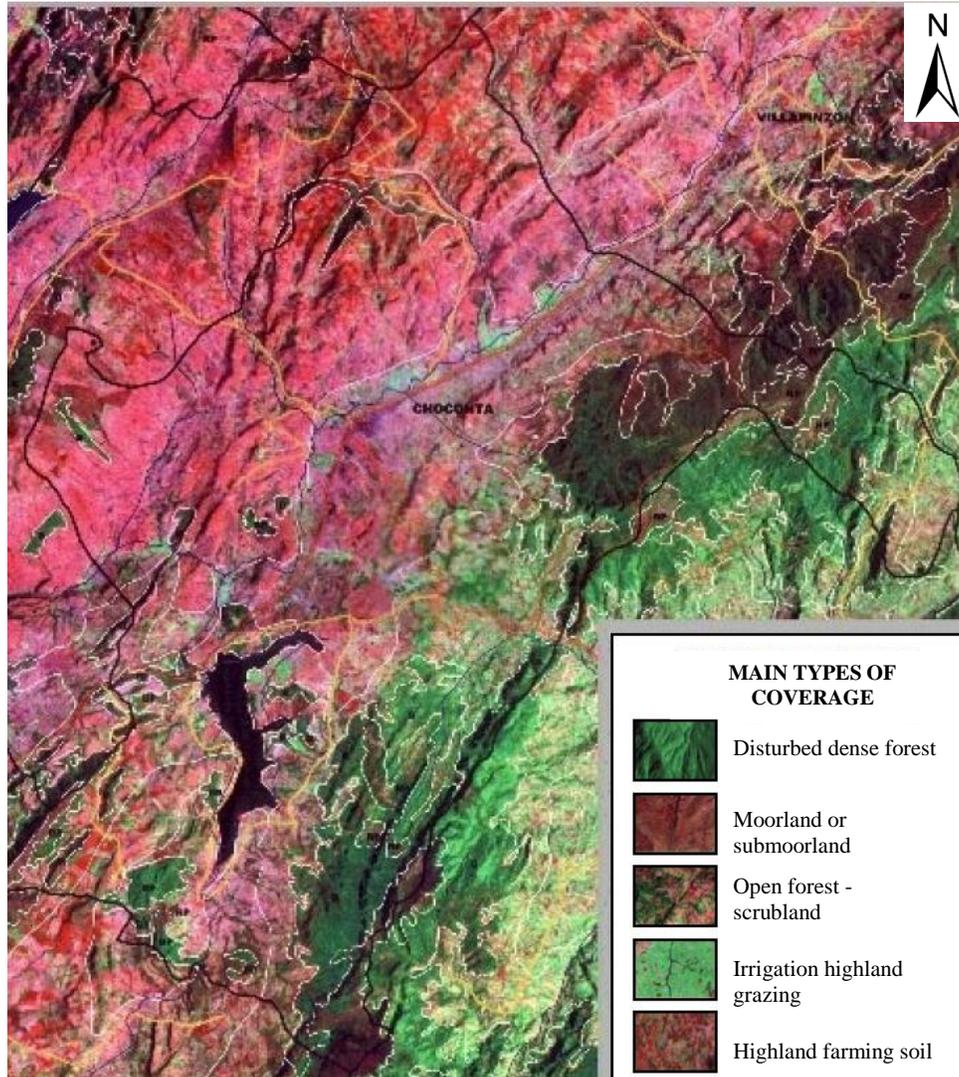
**Evaluation and follow-up:** Given that a project's progress is measured in facts, it is necessary to evaluate the progress made in the outlined activities, using easy-to-understand mechanisms.

#### **4.1. Baseline**

##### **Description of watersheds**

The topographic configuration of the land in the Municipality of Chocontá is defined by two very important watershed systems. The first one is made up by the Cuenca Alta of the Bogotá river, into which the Sisga or San Francisco river, the Tejar river and countless secondary streams and tributary rivers, such as Saucío, Guanguita, Aposentos, Piedra Negra, Turmal – Ratón, and June (Manacá) flow.

The second system is made up of the Machetá river sub-watershed, which corresponds to the Eastern Watershed, into which the waters of the Tócola, Cuchillas, Suralá, and Boquerón streams flow.



Source: CAR February 1995

The Bogotá (or Funza) river, after its source on the Alto de la Calavera, Northeast of Villapinzón, at a height of 3,400 meters, enters Chocontá heading southwest for approximately 30 km, through a narrow valley, and over its course, receives water from the Sisga (or San Francisco) (from the Sisga Reservoir) and Tejar rivers and from the Saucío, Guanguita, Aposentos, Piedra Negra, Turmal – Ratón, June (Manacá) streams, plus countless minor streams that drain directly into the Bogotá river.

The average high watershed and the lower section flow values before entering Chocontá (measured at Saucío station) are 0.879 and 2.551 m<sup>3</sup>/s respectively.

Along its path, the Bogotá River receives contaminated discharge from fertilizers and chemical manures dumped into it, cattle waste, and waste produced by human settlements. Tanneries in Villapinzón and Chocontá also contribute discharged waste into the river.

The most prominent contaminating substance from the leather industry is chrome. Chrome is a toxic substance that is found at alarmingly high concentrations in the Bogotá River. Another element originating from the tanneries is ammoniacal nitrogen. This substance exceeds the limit (1 mg/l) along almost the entire river. Amongst the substances that show a marked quality reduction, is dissolved oxygen, which continues to get worse as the river receives discharge of waste from the city of Bogotá.

At present, the water from the Bogotá River is not suitable to extract neither for human consumption nor for use in irrigation systems due to the high concentrations of heavy metals and fecal coliforms.

Another problem is the deforestation of the river's banks, which has caused a decrease of base flows as a result of the deterioration of aquifer infiltration and recharge processes and overflowing during the rainy seasons. The area that drains its watershed extends for 14,270 hectares.

#### **4.1.1. Identification and location of main water bodies**

##### **Bogotá River**

The Bogotá River is the municipality's primary water source, receiving waters from the Sisga (or San Francisco) and Tejar rivers and from several smaller tributaries, such as the Saucío, Guanguita, Aposentos, Piedra Negra, Turmal – Ratón, and June (Manacá), amongst others. The Bogotá passes through the region to the southeast and is one of the river systems of greatest concern for the area, given the high contamination rate it is subject to and for the limited attention given to the pollution problem thus far.

##### **Sisga River**

The Sisga River is the Bogotá's main tributary, and after receiving several minor streams, flows down from south to north before its waters are dammed to form the Sisga Reservoir.

##### **Sisga Reservoir**

Made from the Sisga River, dammed on a small valley located about 70 km from Bogotá on Carretera Central.

The waters in the reservoir present a low organic load, with low pollution levels. With prior disinfection, the reservoir can be classified as suitable for aquatic life and human consumption, given its physical-chemical and bacteriological.

The growth in farming, numbers of cattle, and the size of human settlements in the area surrounding the reservoir and its tributaries pose a significant degree of risk as the eutrofization and contamination processes could increase.

### **Headwaters**

There are at least 200 headwaters in the entire Chocontá jurisdiction, the source of most being at the Cuchilla del Choque, considered to be river waterway of great ecological importance.

#### **4.1.2. Sources of Contamination**

In the rural areas, the following sources of contamination have been identified:

### **Domestic discharges**

Because of the deficit in the sewage system coverage in rural areas (about 45% coverage), communities are forced to use open-field disposal, thereby contaminating the soil and generating leachates. These end up contaminating both underground and surface water sources through water run-off. Domestic wastewater is often dumped on the ground (66%), in septic tanks (27%), and in some cases directly into natural drainages (7%).

### **Solid waste**

Almost 50% of families in rural areas dump their garbage in open-field sites, sometimes close to water sources; a little more than 15% burn and bury their trash; 12% burn it and then leave it in open-field sites; and 7% bury it.

In this way, the possibility of direct or indirect contamination of water sources caused by inadequate handling of waste is increased.

### **Farming Activity**

One of the main uses of the land in the area is for the cultivation of potatoes and other vegetables. Agrochemical products, including fertilizers and pesticides, are used for all crops. These substances are indirectly potential contaminants of the sources of water due to run-off.

Stock breeding also takes place, mainly with the purpose of producing milk and other dairy products (cheese). Livestock farming close to water sources is a polluting factor as it contributes organic waste which elevates the levels of coliforms.

Most contamination sources can be considered scattered, as they reach the water source via run-off. This indicates that activities upstream have a great impact on the quality of the water downstream. In regards to domestic discharges, they can be considered scattered when treated by

confinement in the ground or dumped in the open air. However, they are considered direct when directly dumped into the water.

It must be noted that each of the sources of contamination described above pose a risk to both aquifers and to surface bodies of water.

#### 4.1.3. Aqueducts

Between 1993 and 2005, the total aqueduct coverage went from 59% to 85.7%, which while a significant increase, was not enough. Expansion of aqueduct coverage was mainly concentrated in rural areas, where it went from 40% to 75%. Meanwhile, in urban areas, there was a very slight increase, which would put universal coverage in the municipality's urban areas within reach, going from 98.3% to 99.2%. According to this data, 25% of rural households and 0.8% of urban households do not have an aqueduct service.

The municipality has twenty-nine rural and one urban aqueduct, which supplies the municipality's center. The rural aqueducts are managed by the users themselves through Community Action Meetings and Local Services Management Meetings. To date, only 19 of these organizations are legally constituted and registered.

At the level of infrastructure and management, aqueducts only have different types of inlets and pipes for transportation. Water purification treatments do not exist except in a few cases where there is some type of filtration treatment that is poorly executed. During the different visits made to nine of the sidewalk aqueduct inlets, the water's physical characteristics were observed, as well as those of their surroundings, particularly at the closest contaminating sources. This was done by means of field observations and based on information from the Chocontá town hall maintenance personnel, as well as from the users of the aqueducts.



### Example 1



Aqueduct name	Saucío
Coordinates	N 5°6'462"
	W 73°39' 967"
Height	2713 masl
Characteristics and surroundings of the water intake source	Water did not present any indicators or traces of contamination. Given the non-existence of treatments, the quality of the water is subject to changes in the weather, which may vary the flow of the source and may collect material along its way, which would ultimately reduce the quality of the water.
Infrastructure	Concrete construction to take in and regulate the flow. Viewers to check the flow.
Problems	There are strawberry fields and cattle close to the inlet, which may affect the quality of the water through run-off.

### Example 2





Aqueduct name	Regional Manaca Cruces
Coordinates	N 5° 6' 078"
	W 73° 43' 421"
Height	2772 masl
Characteristics and surroundings of the water intake source	The water has a bluish color at the point of intake and in the storage tank due to the presence of algae.
Infrastructure	There are two centrifugal pumps to move water to storage tanks inside a shack, for protection. There are also energy counters to control usage.
Problems	The presence of cattle and different crops near the water supply source may directly or indirectly affect the quality of the water in the aqueduct.

### Example 3

This aqueduct has two intake points, explained below

#### First Intake Point





### Second Intake Point



Aqueduct name	Tablón
<b>First Intake Point</b>	
<b>Coordinates</b>	<b>N 5° 9' 780"</b>
	<b>W 73° 39' 855"</b>
<b>Height</b>	<b>2657 masl</b>
<b>Characteristics and surroundings of the water intake source</b>	The first intake point is deep well. It is equipped with a pump, for instances when there is a water shortage at the second intake.
<b>Infrastructure</b>	It has a pumping system and a shack for monitoring and maintenance.
<b>Problems</b>	Close proximity to strawberry fields may lead to contamination problems caused by agrochemicals through infiltration to confined aquifers.
<b>Second Intake Point</b>	
<b>Coordinates</b>	<b>N 5° 10' 472"</b>
	<b>W 73° 40' 232"</b>
<b>Height</b>	<b>2742 masl</b>
<b>Characteristics and surroundings of the water intake source</b>	This is the most used intake out of the existing two. This inlet's intake source is a stream.
<b>Infrastructure</b>	The inlet operates with a centrifugal pump that places the water in a tank close to the pump. There is an unused airing tower in the same place, originally used to treat water that came from the deep well.
<b>Problems</b>	There are farming and livestock farming activities upstream from the inlet, where the slope generates a contamination risk factor through run-off.



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### Example 4



Aqueduct name	Aguas Caliente Parte Alta
Coordinates	N 5° 10' 222"
	W 73°40' 926"
Height	2800 masl
Characteristics and surroundings of the water intake source	The stream used for intake is at an elevated point, which makes transport easier. The location is favorable, as it is away from crops and livestock farming activity areas, which may have affected the quality of the water.
Infrastructure	There is a small structure for water intake along with a piping system that transports the water using gravity.
Problems	Unlike the previous aqueducts, exposure to farming and livestock is absent. This favors optimal water quality at this source. However, due to the absence of treatment, and especially due to the lack of filtering, floods caused by rain, can lead to run-off from fecal matter or an increase in sediments and other types of material to affect the water quality.

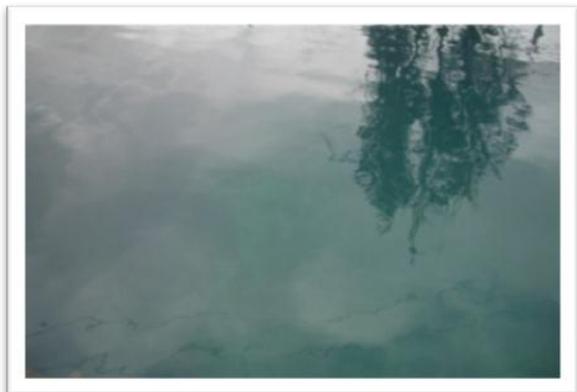


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### Example 5

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<b>Aqueduct name</b>	<b>Aguas Caliente Parte Baja</b>
<b>Coordinates</b>	<b>N 5° 9' 508"</b>
	<b>W 73° 40' 890"</b>
<b>Height</b>	<b>2650 masl</b>
<b>Characteristics and surroundings of the water intake source</b>	During the visit, the water in the storage tank was bluish in color, a lighter color than the one found in Aqueduct 2.
<b>Infrastructure</b>	There is a centrifugal pump that carries the liquid 100 m away from the inlet.
<b>Problems</b>	There are crops and cattle on the stream banks close to the inlet, which may increase the risk of contamination.

### Example 6





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Aqueduct name	Pueblo Viejo Alto
Coordinates	N 5° 12' 443"
	W 73° 41' 684"
Height	2991 masl
Characteristics and surroundings of the water intake source	The inlet corresponds to a deep well. It has a pumping system that carries the water to a storage tank 200 m away before pumping it again later in order to deliver to the users.
Infrastructure	Pumping system and storage tank.
Problems	The users are displeased with the high cost of water delivery, which is due to the double pumping system.



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### Example 7

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Aqueduct name	Hato Fiero Alto
Coordinates	N 5° 9' 508"
	W 73° 40' 890"
Height	3066 masl
Characteristics and surroundings of the water intake source	Given the characteristics of the land, the vegetation present, and the fact that the exact location of the inlet is unknown, it could not be observed. However, it was possible to see the stream that feeds the inlet.
Infrastructure	Could not be observed.
Problems	There are potato crops close to the stream, and the use of agrochemicals could be traced.

### Example 8





Aqueduct name	Guanguita Alto
Coordinates	N 5° 13' 673"
	W 73° 40' 154"
Height	3101 masl
Characteristics and surroundings of the water intake source	The inlet works through gravity, and water is obtained from a stream. The exact point of intake is fenced off and surrounded by native vegetation.
Infrastructure	There is only a PVC piping system.
Problems	One of the problems evidenced in this point was supplied by the person in charge of the inlet's monitoring and maintenance. The issue lies in the fact that cattle invade the surrounding of the stream right before the intake point. This creates a contamination risk for the water used for human consumption. There were also traces of agrochemical residues found in the stream's surroundings.

### Example 9



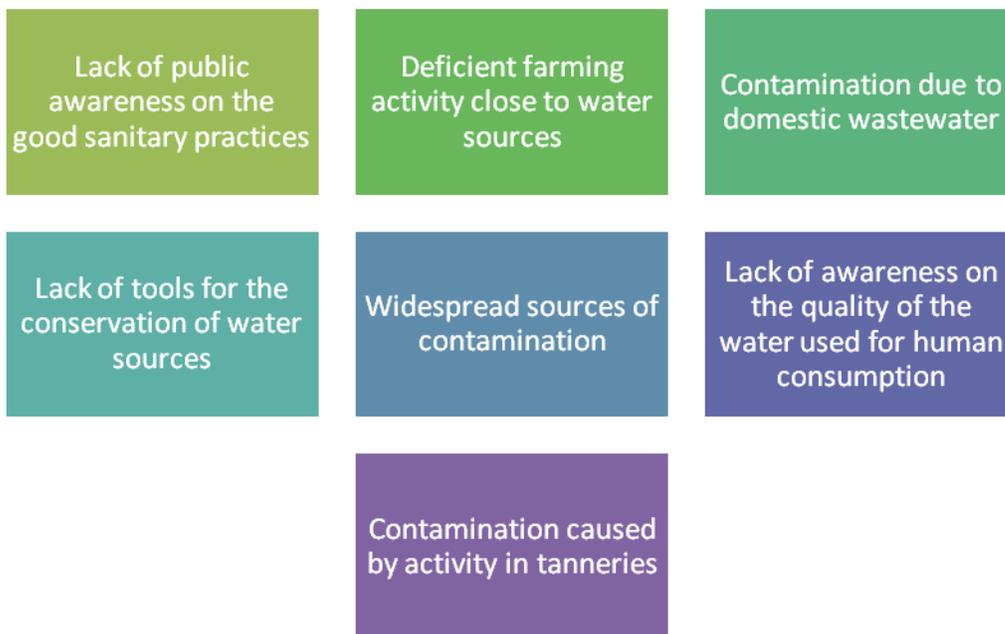


Aqueduct name	Guanguita Bajo
Coordinates	N 5° 13' 476"
	W 73° 39' 525"
Height	2974 masl
Characteristics and surroundings of the water intake source	Intake occurs via a PVC pipe that goes to the treatment plant 100 m away from the inlet.
Infrastructure	There are pumps for the intake and for the distribution of water, and a small treatment plant that has an airing tower, sedimentator, spillway, and a storage tank.
Problems	<p>As in all other observed aqueducts, the water is affected by crops and livestock farming.</p> <p>Other problems found:</p> <ul style="list-style-type: none"><li>• The material of the trays that make up the airing tower is not the best and is rusting. As the water passes it drags rust, deteriorating the quality of the water.</li><li>• The sedimentator has wooden separators which, in time rot and can generate impurities that may be dragged along with pieces of wood.</li></ul>



### Marking out problems

Based on the observations found during the diagnosis of the problem, the previously exposed baseline, and what the experts discussed, it is possible to identify the following problems as those which have the greatest effect on the quality of the water and the watersheds:



Even though the activities of the tanneries are not a direct threat for the intake sources, they do pose a risk for the city of Bogotá, and it is therefore necessary to take steps to eliminate this factor.

These problems form the base to draw up program plans and will be the focus of the activities within the plans.

#### 4.2. Drawing up the action plan

The action plan will focus on the management of the watershed, with the goal of identifying the steps that will be necessary to improve the water quality. The action plan will also look towards the sustainable use of water resources. A step-by-step system was established, starting with the diagnosis of the conditions of the sidewalk aqueducts and their intake sources before finishing with formulation of the action plan and its implementation guide.

The different components of the pilot action plan appear below (***to see the action plan, please go to Appendix 3. Action Plan***).

## Phase 1: Diagnosis

To formulate the action plan, it is essential to draw up a detailed diagnosis of the current condition of the watersheds and the problems they face. It will be necessary to gather and analyze information from primary and secondary sources on the hydro-climatic, ground coverage and use, current pressures and future threats to ecosystems, expansion of the farming, livestock farming and urban borders topics, among others. The efforts to gather information must focus on topics such as the location of inlets, geology, watershed characterization, and the quality of water from streams, headwaters and other sources used for human consumption. Drawing up field diagnostics to keep the information updated should also be considered.

To evaluate the impact that the protection measures have had on the aqueducts, collected information shall be used and analyzed using conceptual or numeric models (for example: WEBMOD, SPARROW, FIESTA, SWAT, RUSLE).

### Activities:

- Gathering of information.
- Development of the chosen model from the gathered information.
- Revision and analysis of the information obtained from executing the models.
- Identification of the areas at higher risk of pollution.
- Calculating the number of people and civilian associations directly affected by the measures to be adopted.

During the execution of this stage, it is essential to work together with different entities such as:

- Competent environmental authorities and universities - essential to obtain, analyze and interpret information.
- Municipal schools and educational entities - participate in gathering field information.
- Industrial sector (tanneries) - their collaboration may encompass anything from supplying information about dumping into the rivers and streams, to collaborating in gathering samples from the water sources close to their facilities.

## Phase 2: Outlining and establishing programs

Using the previously outlined problems, the areas of concern contributed by the group of specialists, and the conclusions of the studies made in the area, a series of programs centered on the identified areas of concern were established.

**Watershed conservation program:** This program seeks to protect and preserve the water sources.

- Generate natural barriers, control erosive processes, and stabilize water courses by advancing restoration and ecologic reforestation.
- To define and establish relief zones near the riverbanks, ravines, and other water bodies to reduce the number of contaminants.

**Program for the prevention and control of industrial contamination on water sources:** This project aims to take the necessary steps to reduce the impact that industries have on water sources. The program focuses especially on the tanning industry, which has the greatest impact on surface waters and causes the most damage of the Bogotá River.

- Training tannery personnel in good manufacturing practices and cleaner production measures such as altering the processing of compounds, modifying hide treatment, and eliminating or substituting contaminating materials.
- Using the information obtained from the diagnosis of the watersheds and from other sources to draw up a water contamination vulnerability map for both underground and surface waters. The project can then identify an appropriate site for possible relocation of the factories, if studies conclude that it is necessary.
- To develop and evaluate an independent plan for the management of tanneries. This will be included in the general diagnosis.
- Establishing an investigative program aimed at reducing the environmental impact caused by tanneries.

In addition to the contaminant load reduction measures, these steps will seek to reduce some expenses both in the production and the treatment of waste. The reduction may be due to the creation of an industrial park where tanneries share the discharge treatment costs, or by implementing good manufacturing practices, which would decrease the consumption of raw materials and energy, thus cutting expenses.

**Program for the prevention of contamination as a result of livestock farming and farming activities:** This program's activities are focused on preventing and reducing the contamination of aquifers and surface waters caused by farming and livestock activities. Since these activities are a source of run-off contamination given their proximity and since they are the most established activities in rural areas, the following activities will be included in this program:

- Training the municipality's rural population in good farming practices in order to reduce the impact on the water resources. Synchronization of the timing and loading fertilizer so as to avoid the transportation of nitrates ( $\text{NO}_3$ ) and other contaminating substances, beyond the radicular area (the area where the plant roots are); the efficient management of agrochemicals to generate a cost reduction for farmers will be emphasized.
- To control those areas with highest farming and livestock influence.

- Carrying out quality control analysis for each water body that may be affected by the previously outlined areas.

**Sidewalk aqueduct strengthening program:** This program seeks to reinforce the administrative and organizational supervision of rural aqueducts, as well as the maintenance procedures. This will be achieved by training the personnel in the proper handling and upkeep of the aqueducts' infrastructure.

Another goal sought by this program is the reduction of direct and scattered dumping associated with domestic activities, as well as spreading information and raising awareness to protect the various water sources.

- To train the neighboring people in the best management practices of sewage.
- Creating a “water school” where members of the community can be trained in the different methods of protecting and conserving water. This “school” may take the form of an instruction and training center for maintenance personnel. The center could train plumbers how to manage and properly care for the sidewalk aqueducts.
- Raising the awareness of aqueduct users which are not yet duly registered, so that they can file with the state commission, and form a sustainable management body for their local aqueduct.

**Program for the prevention of contamination through scattered sources:** In many cases, natural characteristics of the land may facilitate movement and transportation of pollutants, making it difficult to locate the source of contamination. This type of contamination is called “contamination by scattered sources.” In order to control contamination by scattered sources, the program seeks reduce the amount of such possible sources through practical and simple measures, including:

- Carrying out activities to seal perforations in water extraction wells, to avoid the contamination of confined aquifers with leachate toxins from the phreatic surface.
- Identifying the number of septic tanks and the state that they are in. Pinpointing those that pose a risk for aquifers, according to what is established in the proposed diagnosis and previous studies will be made a priority.

**Institutional collaboration program:** This program seeks to strengthen collaboration links between different entities, both state and private. Collaboration will allow for coordinated efforts to implement and follow-up on various programs and actions plans. In addition to cooperation, this program aims to identify different resources which will allow for economic, logistic, and social viability and work together to bring projects before government, private, or foreign entities for funding.

- Carrying out a player analysis which could identify the organizations, institutions, or people who can contribute some kind of resource, on top of the existing ones.



- To prepare and submit projects to entities which may offer financing for the project.

**Water quality follow-up and monitoring program:** This program seeks to generate the necessary tools for monitoring the water quality of the water bodies. These tools will be necessary to maintain up-to-date data and allow the program to monitor the progress made while the project moves through each phase. *(See Appendix 2. Plan for Implementation of the Follow-up and Monitoring Program of Water Quality).*

- Train personnel to perform the sampling.
- Establish a laboratory for the analysis and treatment of samples.
- Evaluate the efficacy of the polluting volume reduction measures.
- Initiate monitoring meetings for the rainy and dry seasons.

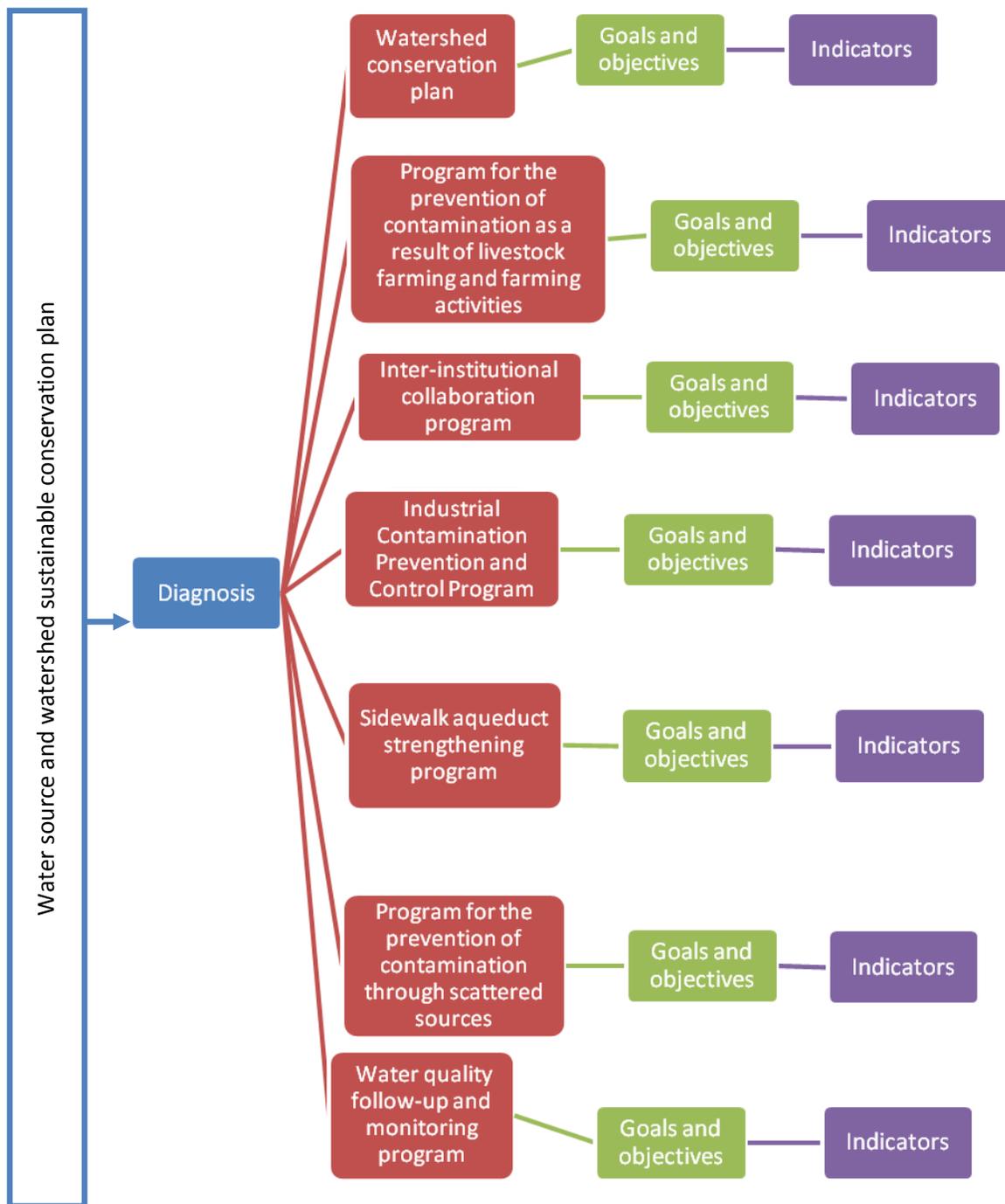
Since program has different focuses, it will be necessary to have different specialists. The programs shall be implemented by the entities that are most experienced in each program's subject *(for a perspective of the entities that are to participate in the different programs, please refer to the action plan).*

An additional factor to take into account is the search for alternative ideas for the monitoring system that are viable from an economic and logistics perspective. The Town Hall will coordinate the organizations and activities. Possible funding sources *(see Funding Sources page 57)*, to supply the necessary resources will be required, because we do not currently have the necessary resources for this program.



### 4.3. Implementation of the action plan

Implementation shall be divided into two phases: 1) diagnosis and 2) program outline and establishment as is shown in the following diagram:





### **Phase 1: Diagnosis**

The goal of this phase will be to obtain as much base information as possible, in order to implement each of the projects.

### **Phase 2: Delimitation and Setting of Programs**

The following stages were established for this phase, to provide guidance in the implementation of the various programs and activities:

#### **Stage 1: Outlining of objectives, goals, and indicators**

The activities established for each program, and the results obtained from the diagnosis, shall both be taken into account for this stage. These two components shall then guide the establishment of objectives and goals, which will in turn be used to formulate indicators; the Coordinating Committee shall carry out this task for each of the programs.

#### **Stage 2: Implementation of activities**

Prioritizing the programs and activities is necessary in order to have guidance in putting the programs into action. This will facilitate the direction of the plan, as well as its funding. **(See Appendix 6. Priority Table)**

Implementation of the plan can begin by putting an emphasis on the prioritized activities. This may be done within the framework of a first initiation project for the execution of the plan. **(See Appendix 7. First Implementation Project).**

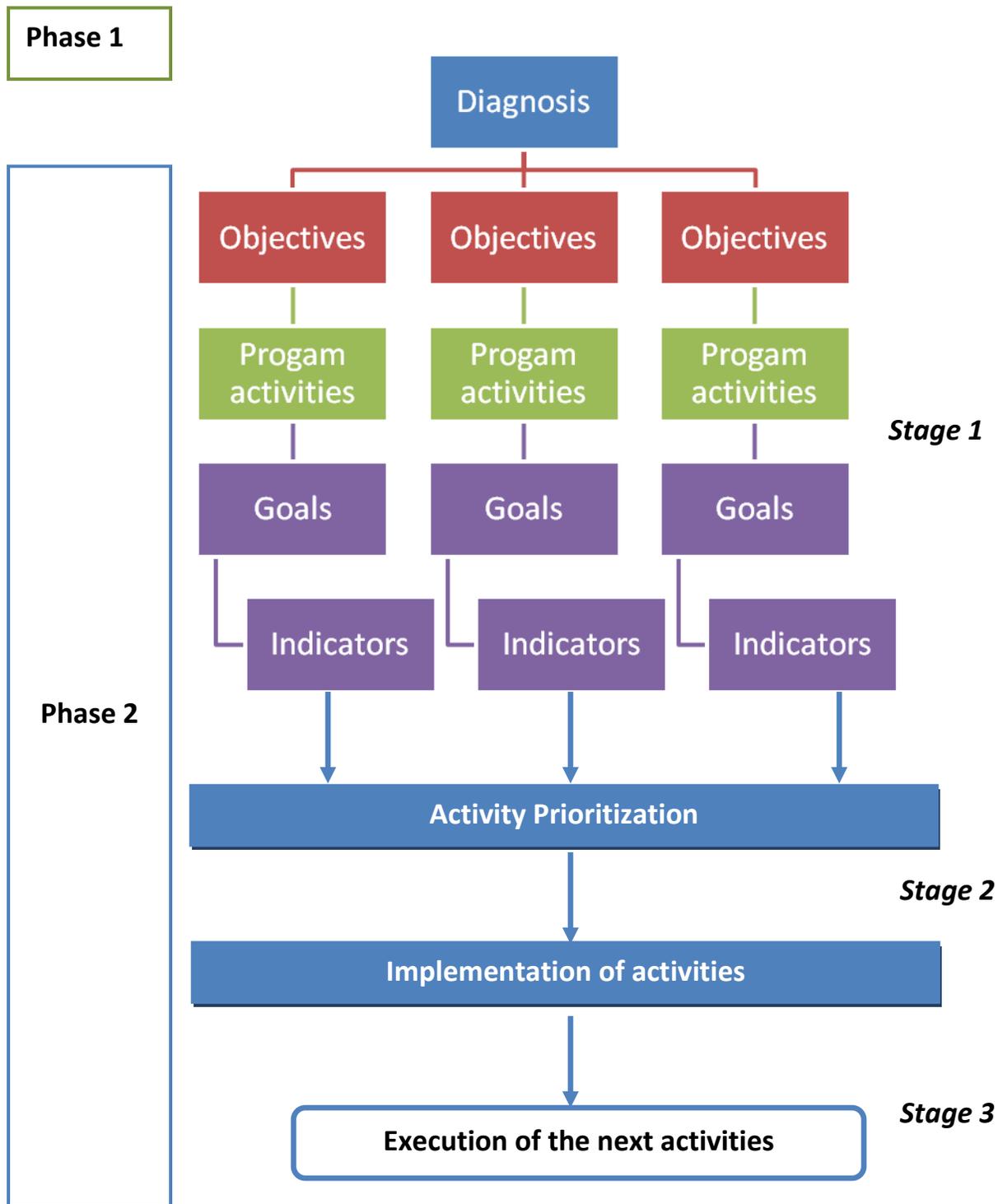
#### **Stage 3: Execution of remaining activities**

The remaining activities shall be executed, taking into consideration their priority level.



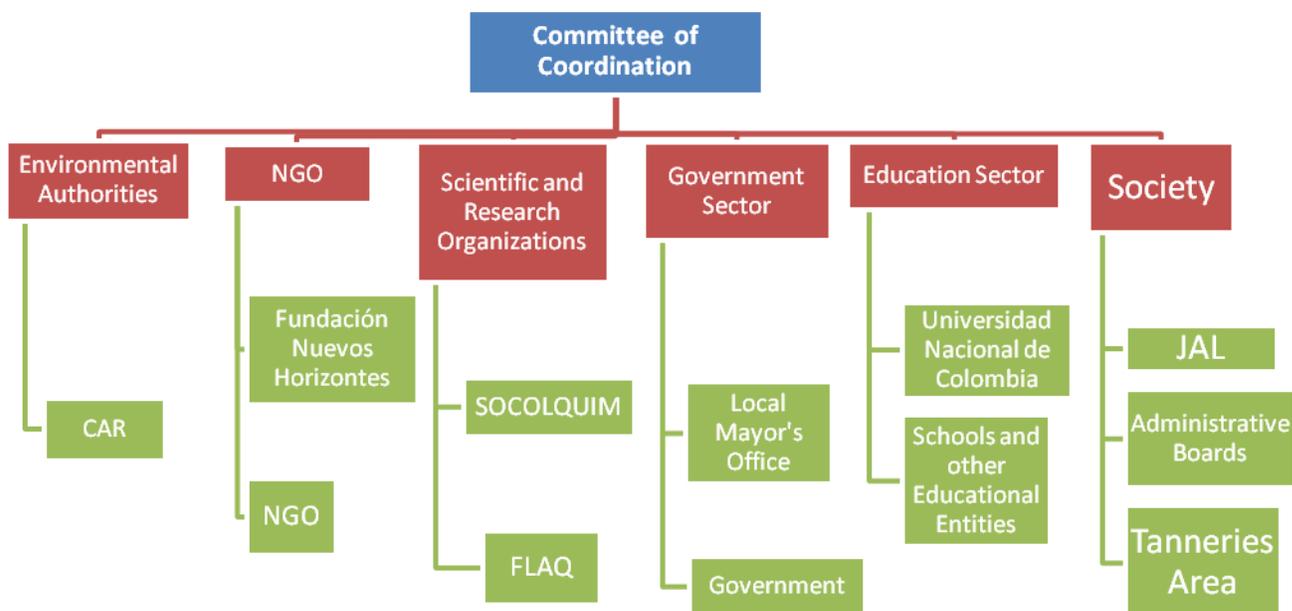
### Implementation diagram

The previously mentioned steps are summarized below.



### 4.3.1. Coordinating Committee

A Coordinating Committee is required to organize the participating entities and maintain the proper implementation and follow-up as set forth by the plan. The Coordinating Committee will be structured as follows:



The Committee will be made up of a representative from each entity.

#### Duties of the Coordinating Committee:

- Perform constant follow-up of programs, projects, and activities.
- Establish improvement measures when required.
- Redirect tasks among the different entities, always taking into consideration their specialty, contributions, and available resources.
- Assure the plan sustainability.
- Reveal the results obtained.
- Develop a schedule consistent with the available budget.
- Prioritize needs and their solutions.



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## Members and Duties

### Environmental Authorities

**Corporación Autónoma Regional de Cundinamarca (CAR):** Given its legal expertise within the framework of environmental protection and its different components, this entity will provide great support during most of the process stages such as:

- Providing information.
- Act as a technical consultant for the committee, as well as the community in general.
- Coordinate its own projects within the different programs and activities presented in this plan.

### Non-Governmental Organizations

#### **Nuevos Horizontes Foundation and Non-Governmental Organizations (NGOs):**

- Submit projects to obtain funds and search for strategic alliances which can contribute to the training and education of the people.
- Once the resources are obtained, lead the design and implementation of the proposed programs, in cooperation with experienced agencies.
- Outline an education plan with the assistance of SOCOLQUIM for the community sensitivity in coordination with competent authorities.

### Scientific and Research Associations

#### **Sociedad Colombiana de Ciencias Químicas (SOCOLQUIM):**

- Outline a community awareness education plan with the assistance of Nuevos Horizontes Foundation and in coordination with knowledgeable authorities.
- Training of people; facilitate the research project administration and management with the assistance of Nuevos Horizontes Foundation and other NGOs.

#### **Federación Latinoamericana de Asociaciones de Química (FLAQ):**

- Facilitate with the Latin American community to help identify and relate the local issues to those abroad.
- Review the results of this project and encourage similar actions in other countries, adapting the recommendations to their specific needs.

## **Government Sector**

### **Municipality**

- Provide financial and logistic resources for plan development where possible.
- Coordinate the search for funds and support from different state entities with the other members of the committee.
- Announce the programs and activities to the community.

### **Cundinamarca Government**

- Finance projects associated with plan implementation.
- Assist in the adoption and implementation of successful initiatives to other municipal districts throughout the nation.

## **Education Sector**

**Universidad Nacional de Colombia and other universities:** Technical support in the different program stages.

**Private and Public Schools:** Student awareness in accordance with the programs developed. These education entities may be involved in field activities such as sample collection.

## **Civil Partnership**

### **Community Action Groups, Sidewalk Aqueduct Boards, Tanneries**

- Assist in collecting information on the sidewalk aqueducts.
- Jointly work together in the implementation of appropriate programs.
- Coordinate and guide the members of the community during the program.

## **Support Entities**

These entities will not be actively associated with the program; however, due to the nature of their business, they may provide information and guidance in specific fields.

**Instituto Geográfico Agustín Codazzi (IGAC):** Providing geographical information.

**Servicio Nacional De Aprendizaje (SENA):** Cooperation in training activities.

**Unidad Municipal De Asistencia Técnica Agropecuaria (UMATA):** Assistance and coordination with the farming industry of the municipal district.



#### 4.3.2. Program Coordination

To achieve a maximum coordination and implementation of the various components of the project, there should be coordination among the entities and other external and ongoing programs.

ACTION AND/OR ACTIVITY	COORDINATION TOOLS	PARTIES INVOLVED
<b>PROGRAM FOR BASIN MAINTENANCE</b>		
<p><b>Advance restoration and ecologic reforestation to generate natural barriers, control erosive processes.</b></p>	<p>National and municipal programs to protect areas of ecologic interest and important water resources which already exist. It will be possible to coordinate with these programs to obtain information and to conduct activities of mutual interest to collectively achieve objectives and goals with an even wider scope.</p>	<ul style="list-style-type: none"> <li>• Municipality of Chocontá</li> <li>• CAR</li> <li>• Cundinamarca Government</li> <li>• IGAC</li> </ul>
<p><b>To delimit and establish mitigation zones near the riverbanks of ravines and other water bodies.</b></p>	<p>Use territorial organization surveys and their updates of environmental zoning, prepared by different local and national entities.</p>	<ul style="list-style-type: none"> <li>• Municipality of Chocontá</li> <li>• CAR</li> <li>• Cundinamarca Government</li> </ul>
<b>PROGRAM FOR PREVENTION AND CONTROL OF INDUSTRIAL POLLUTION ON WATER SOURCES</b>		
<p><b>To train the tannery sector of the municipal district with good manufacturing practices and cleaner production.</b></p>	<p>Include universities and other higher education institutions to establish processes through education and research which could make the tannery sector more environmentally friendly.</p>	<ul style="list-style-type: none"> <li>• Public and private university students who want to develop their graduate projects and for which the sector training is included.</li> <li>• SENA by creating courses certified in good manufacturing practices and cleaner production aimed at industrialists and workers of the leather tanning sector.</li> </ul>



ACTION AND/OR ACTIVITY	COORDINATION TOOLS	PARTIES INVOLVED
<p><b>To prepare a map of superficial and underground water pollution vulnerability with the aim to establish actions for the possible relocation of the sector.</b></p>	<ul style="list-style-type: none"> <li>• Provide inventories of the superficial and underground sources of water in the municipal district of Chocontá (Cundinamarca).</li> <li>• Collect and analyze information related to the condition of water quality.</li> <li>• To have as reference the Territorial Organization Basic Plan (PBOT), the POMCA of the basin of Bogotá River for the possible relocation of the tannery sector.</li> <li>• Space information in relation to hydrological data, zones of environmental protection, flooding risks, soil removal, among others, of the study area.</li> </ul>	<ul style="list-style-type: none"> <li>• Municipality of Chocontá</li> <li>• CAR</li> <li>• IGAC</li> <li>• IDEAM</li> <li>• Cundinamarca Government</li> </ul>
<p><b>Evaluate and develop a management plan for the existing tanneries in the municipal district.</b></p>	<p>A plan may be developed by research projects carried out by advanced students studying in fields such as chemical, industrial, or environmental engineering or other fields which include courses of study matching areas included in the action plan.</p>	<p>Public or private universities or higher education institutions which intend to link by means of research projects.</p>
<p><b>POLLUTION PREVENTION PROGRAM FOR FARMING AND LIVESTOCK ACTIVITIES</b></p>		
<p><b>To train the rural people of the municipal district in good farming and livestock practices with the purpose to diminish the impact generated by these sectors as to water resource.</b></p>	<p>Certified training by programs such as School Environmental Projects (PRAES) and Civil Procedures of Environmental Education (PROCEDA), in which students - as well as residents - will be involved in improving the farming and livestock practices by focusing them on the rational and efficient use of agrochemicals, management of organic waste and the protection of wasteland, woods, and water sources, thus, integrating them as shelter of natural resources of the municipal district.</p>	<ul style="list-style-type: none"> <li>• Nuevos Horizontes Colombianos Foundation</li> <li>• Municipality of Chocontá</li> <li>• SENA</li> <li>• UMATA</li> </ul>
<p><b>Delimitation of existing farming and livestock zones in the municipal district.</b></p>	<p>Survey the people who participate in agricultural activities in the areas, with the purpose of establishing the proximity of water sources to agriculture. Inquiries may be made to see if the agriculture department has related information.</p>	<ul style="list-style-type: none"> <li>• Municipality of Chocontá</li> <li>• UMATA</li> <li>• Department of Agriculture</li> </ul>



ACTION AND/OR ACTIVITY	COORDINATION TOOLS	PARTIES INVOLVED
<p><b>To monitor and analyze the water quality of existing water sources in farming and livestock zones.</b></p>	<p>To update and expand the laboratory capacities in the municipal district to enlarge the range of physical and chemical characteristics to be analyzed. Likewise, analysis shall be conducted in parallel while certifying the correct monitoring in a CAR certified laboratory, if possible.</p>	<ul style="list-style-type: none"> <li>• Municipality of Chocontá</li> <li>• CAR</li> <li>• Laboratories certified in taking water samples and conducting a physical and chemical analysis.</li> </ul>
<p><b>PROGRAM FOR STRENGTHENING OF SIDEWALK AQUEDUCTS</b></p>		
<p><b>To train the neighboring people in the different water bodies in good management practices of sewage water.</b></p>	<p>By means of the above mentioned plans in civil education and PRAES and PROCEDA.</p>	<ul style="list-style-type: none"> <li>• Municipality of Chocontá</li> <li>• Municipal Education Secretariat</li> <li>• SENA</li> <li>• UMATA</li> </ul>
<p><b>PROGRAM FOR STRENGTHENING OF SIDEWALK AQUEDUCTS</b></p>		
<p><b>To create some training space where different community members are trained, in various measures for the maintenance and protection of water, as well as in the instructions of the maintenance staff of different aqueducts (plumbers).</b></p>	<p>This aspect can be coordinated with the support of the municipality and the SENA to train future technicians and technologists who are inhabitants.</p>	<ul style="list-style-type: none"> <li>• Municipality of Chocontá</li> <li>• Nuevos Horizontes Colombianos Foundation</li> <li>• SENA</li> </ul>
<p><b>Submit the sidewalk aqueducts which are not registered to the competent authorities to perform this activity.</b></p>	<p>This process should be carried out by the municipality and the entity charged with the administration of the water resources of the department, such as the CAR.</p>	<ul style="list-style-type: none"> <li>• Municipality of Chocontá (Office or public service company of the municipal district)</li> <li>• CAR</li> </ul>
<p><b>PROGRAM FOR THE PREVENTION OF POLLUTION BY DIFFUSE SOURCES</b></p>		



ACTION AND/OR ACTIVITY	COORDINATION TOOLS	PARTIES INVOLVED
<p><b>To establish which confined wells are used in the activity of underground water extraction and which should be sealed to avoid any potential pollution.</b></p>	<p>To establish a roster of wells, including the updated and existing information of the parties involved, to establish the exposure to pollution of each.</p>	<ul style="list-style-type: none"> <li>• CAR</li> <li>• IGAC</li> <li>• IDEAM</li> <li>• Cundinamarca Government</li> </ul>
<p><b>To identify and evaluate the condition of septic tanks, with the purpose to establish which ones could affect the nearby aquifers.</b></p>	<p>Take into account works and projects present in the sanitation plan and release management of the municipal district.</p>	<ul style="list-style-type: none"> <li>• CAR</li> </ul>
<p><b>PROGRAM FOR COOPERATION AMONG INSTITUTIONS</b></p>		
<p><b>To identify potential parties which may intervene and support, with various types of resources, the development of the project.</b></p>	<p>To determine which entities - public and private, national or international - are interested in contributing to the development of projects, whether in tangible or intangible elements.</p>	<ul style="list-style-type: none"> <li>• Nuevos Horizontes Colombianos Foundation</li> <li>• Non-governmental Organizations</li> <li>• Environment and Sustainable Development Department</li> <li>• Empresa de Acueducto y Alcantarillado de Bogotá</li> <li>• Public and private universities</li> <li>• Environmental programs of European and Asian governments</li> </ul>
<p><b>PROGRAM FOR WATER QUALITY FOLLOW-UP AND MONITORING</b></p>		
<p><b>To train the people of the municipal district in everything related to the water sample taking and analysis.</b></p>	<p>Train the people of the municipal district, especially young high school graduates, at the technical or technological level in relation to water sample taking and analysis.</p>	<ul style="list-style-type: none"> <li>• Institutions of higher education (SENA, public or private universities) which offer this type of program.</li> </ul>
<p><b>To establish a laboratory for the analysis of the water quality of the samples taken from study area sources.</b></p>	<ul style="list-style-type: none"> <li>• Hire a laboratory for the analysis of physical and chemical water samples.</li> <li>• Establish a procedure for the future IDEAM certification with the support of CAR Cundinamarca and its environmental laboratory as well as of the universities which participate in the project.</li> </ul>	<ul style="list-style-type: none"> <li>• Municipality of Chocontá</li> <li>• CAR</li> </ul>



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ACTION AND/OR ACTIVITY	COORDINATION TOOLS	PARTIES INVOLVED
<b>To develop and implement a monitoring plan of water quality with the purpose to evaluate the increase or diminishment of the polluting volume and after implementing the actions and activities presented in the plan.</b>	For the development of the plan, a baseline with the water quality condition of water sources will be taken into account in the study zone. Therefore, we will have the laboratory above mentioned and the information provided by CAR Cundinamarca.	<ul style="list-style-type: none"><li>• Municipality of Chocontá</li><li>• CAR</li></ul>



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## **5. Evaluation and Follow-up**

With the purpose of receiving feedback and achieving continuous improvement, the following tools will be developed:

### **Disclosure of Results**

The results achieved will be disclosed to the people in general. For that purpose, a specific date will be fixed. This event will be held once a year.

### **Follow-up Meetings**

The committee will hold meetings on a quarterly basis to disclose the progress achieved to date. Taking into account observations of members, as well as the outcomes of indicators, these meetings will make changes or improvements to the plan and its different programs.

### **Progress Reports**

For each activity, the delegate entity or agency in charge will deliver a progress report to the Coordinating Committee. This report will be supported by the committee during the follow-up meetings.

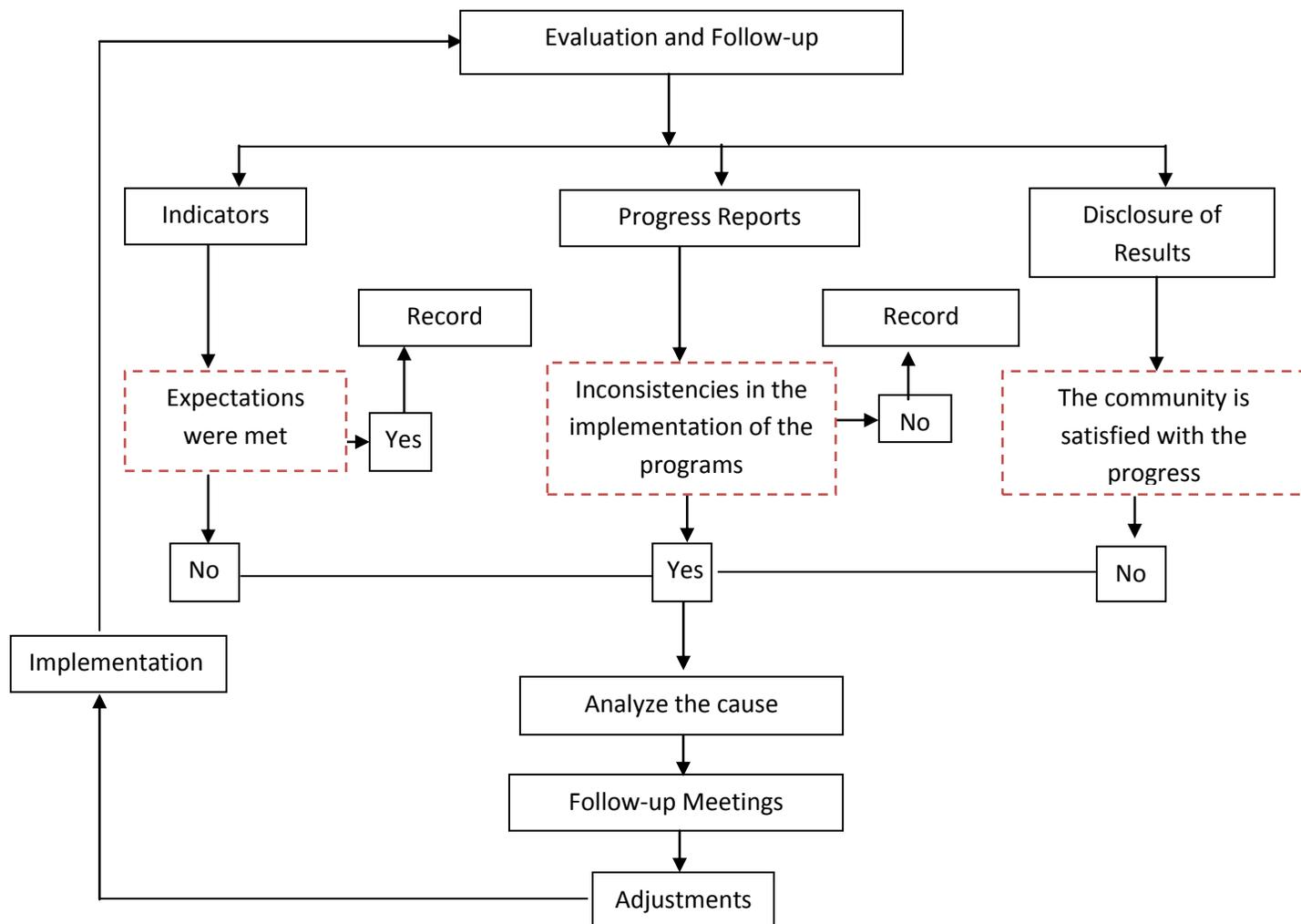
### **Indicators of Each Program**

In addition to the definition of programs and their pertinent goals, indicators will be established to be assessed by the committee members.

### **Improvements and Adjustments**

Before any decision with respect to improvements or adjustments to the activities or programs is made, an analysis must be performed to determine the causes prompting the changes in order to have them approved by the Coordinating Committee.

### 5.1. Evaluation and Follow-up Process





## 6. Financing

Financing of the plan will be the responsibility of the Municipality of Chocontá. This was determined based on the Municipality's established duties as an administrative entity, as one of the program's main beneficiaries, and as one of the interested parties in the plan initiation.

Since the resources of the municipality are limited and due to the plan costs, a well organized financing strategy is necessary for the success of the program. In order to achieve success of each of the suggested activities, the following financing strategy is proposed:

FINANCING STRATEGIES	
Action	Responsible Party
<p><b>1. Diagnosis Execution</b></p> <p>Collect information of the different facets of the municipality which will serve as the basis to determine the costs of different programs for development.</p> <p>Due to the importance of diagnosis in making financial decisions, a list of possible costs has been determined to estimate the resources needed. (<i>See Appendix. 9 Diagnosis Costs</i>)</p>	<p>Universities Schools Municipality Management Boards Communal Action Boards IGAC IDEAM CAR SOCOLQUIM Nuevos Horizontes Colombianos Foundation</p>
<p><b>2. Determine and Identify Partial and Total Costs of Each Program</b></p> <p>The municipality will establish the potential costs with details of the activity and program, based on the diagnosis, baseline, and the participation of each entity.</p>	<p>Coordinating Committee and other participating entities in different programs</p>
<p><b>3. To Specify all Critical Activities to be Developed</b></p> <p>The main activities of each program can be seen in the table priority activities (<i>see Appendix 6. Priority Table</i>), however, these priorities may be modified, provided it is justified and approved by the Coordinating Committee or the entity in charge of that particular activity.</p>	<p>Coordinating Committee</p>
<p><b>4. To Categorize the Activities According to Priority and Cost</b></p> <p>Categories may be established as a means to choose the manner in which each activity is financed, with the estimation of costs and the priority of activities.</p>	<p>Coordinating Committee</p>
<p><b>5. To Establish an Inventory of Potential Financing Sources</b></p> <p>For each financing source, it is necessary to know the different contact procedures and financing requirements.</p>	<p>Municipality of Chocontá</p>
<p><b>6. To Define Potential Financing Sources in Each of the Programs and Activities Proposed</b></p> <p>The origin of the financing will be established for each activity, whether they are from the municipality, another official entity, or external sources - such as foreign entities - taking into account the activity's</p>	<p>Municipality of Chocontá</p>



priority and prior category.	
<b>7. Selection of Financing Sources</b>	Municipality of Chocontá
Choose the most favorable sources, taking into account their financing systems, potential financing costs, and time of resource allocation, among other factors. These will be set by the municipal administration, the Coordinating Committee, and their financial advisors.	

### 6.1. Financing Sources

The main financing sources are:

#### Municipality of Chocontá

The plan execution of the municipal administration will be supported by financial and logistic resources where there are monetary and legal possibilities.

Note that certain activities associated with those proposed in this plan are currently being executed, or will be executed, based on plans such as municipal development and environmental management. This requires the coordination of these activities together with the programs proposed. (*See Appendix 5. Projects Related to the Plan*).

#### State Level

There may be national and local financing sources.

#### Environment and Sustainable Development Department, (FONAM)

The municipality, through the Planning Administrative Department of Cundinamarca (DAPC), may participate in the financing of projects in different areas. These include environmental projects, which may be designed through the methodology established by the DAPC.

#### Sources of International Cooperation

**Inter-American Development Bank (IDB):** This may be the main source of international funds due to past financial backing provided by this agency to project in the region.

It is possible to access the funds of the IDB by submitting a financing proposal through its Water and Sanitation Initiative. Flexible financing is offered in different programs including water quality in parallel to the objectives and activities set out in this plan.

Other potential international sources may be:

- **Corporación Andina de Fomento (CAF)**
- **French Funds for Global Environment**
- **USAID**



- **Bilateral Sources:** As official and non-official organizations of different countries which may provide either technical or monetary cooperation.

All the above international sources may be contacted through the Social Action and International Cooperation Governmental Agency, which also offers advising in the project formulation and search for potential international cooperation sources.

### **Others**

**Research or Academic Entities:** Some entities engaged in academic research may offer financing or assistance in certain studies required. The Universidad Nacional de Colombia which, although it may not offer monetary help, could absorb some costs by research groups or projects being developed that could undertake testing or other parts of the action plan.

**Non-Governmental Organizations:** Whether national or international agencies, some of these organizations may provide financing or technical and logistic cooperation in different fields.



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## Recommendations and Conclusions

- To establish policies and practices which diminish the negative impact caused by the municipal district waters both regionally and nationally.
- To foster the formation community boards for the administration of sidewalk aqueducts.
- To assure the municipal district and its aqueducts (urban and rural) are included in the Water Department Plan (PDA).
- To evaluate the management of aqueducts with untreated water to improve processes and generate practices which would allow the efficient use of water resources.
- To consider the possibility of creating a “water school” to host pilot programs with selected aqueducts.
- To link other entities to the process.
- To encourage best practices for industrial processes with local businesses (tanneries) to obtain green seals of quality. This would create an added value and increase the profitability of their products.
- To encourage the development of common practices for the treatment waste derived from tanneries.
- Consider organizing the tanneries into a single industrial park in order to assure the proper waste treatment and disposal while keeping overall cost low.
- All water supply points must be have protection and natural and/or artificial barriers upstream.
- The inclusion and participation of Universidad Nacional de Colombia including the development of a simple method for the inspection of basin conditions.
- To install meteorological and pluviometrical stations (volume) to have accurate information related to the behavior of different water bodies.
- To take into account large sediment nucleus and flood plains as historic background within the diagnosis studies.
- To include simple, economically sound management practices. These will be vital to the continued maintenance and protection of the water resource, especially if appropriately implemented in the activities of greater impact.
- Work with organizations with funding in place to develop programs and activities that work in concert with their objectives.

## Glossary

**Aquifer:** An aquifer is a water-bearing stratum or geological formation which allows for the flow and storage of underground water through pinholes or crevices.

**Drinking water or water for human consumption:** This water complies with physical, chemical, and microbiological characteristics in the conditions above mentioned in this decree and other rules regulating it, and it is suitable for human consumption. It is used for direct drinking, in the preparation of food, or in personal hygiene.

**Water quality:** The result obtained from comparing the physical, chemical, and microbiological characteristics found in the water, with the contents of the appropriate rules.

**Hydrographic basin:** The area of superficial or underground waters which flow into a natural network with one or several natural beds, continued or intermittent beds which converge in a larger course which, in turn, may flow into a main river, into a natural deposit of natural waters, a reservoir or directly into the sea.

**Water body:** A localized system of natural or artificial origin, over the land surface, made up of physical and biotic elements and water volumes or mass, either contained or flowing.

**Supply source:** Deposit or superficial or underground water course, used in a supply system to people, whether of atmospheric, superficial, underground or marine waters.

**Risk:** Likelihood that an agent or substance produces or generates an alteration to the health as a consequence of the exposure thereof.

**Discharge:** Final discharge into a water body, a sewage system or the ground, of elements, substances or compounds contained in liquid.

**Point discharge:** Made from some conduction means with respect to which the exact discharge point into the water body, sewage system or the ground may be determined.



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## Bibliography

Conferencia de Manejo del Estuario de Bahía de San Juan (Conference of Estuary Management of Bahía de San Juan). Comprehensive Management and Maintenance Plan. San Juan. Puerto Rico 1999.

Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM). Guía Técnico Científica para la Ordenación y Manejo de Cuencas Hidrográficas de Colombia (Technical and Scientific Guide for the Organization and Management of Hydrographic Basins of Colombia). Bogotá 2004.

Ombudsman Office. World Classification of the Water Supply in Colombia. March 29, 2013 [http://www.defensoria.org.co/red/anexos/pdf/11/agua/inf\\_doc\\_resumen.pdf](http://www.defensoria.org.co/red/anexos/pdf/11/agua/inf_doc_resumen.pdf).

National Planning Department, Cundinamarca Government, Social Development Secretariat. Social Agenda for the Extreme Poverty Reduction, Chocontá, Cundinamarca. Bogotá D.C 20011.

Municipal district of Chocontá. Basic Plan for Territorial Organization of Chocontá. Chocontá, Cundinamarca.

World Health Organization (WHO). Regional Report on Evaluation 2000 in the Region of the America. March 29, 2013 <http://www.bvsde.opsoms.org/bvsaas/e/fulltext/infregio /infregio.pdf>.

Peña Guzmán, Carolina. Monitoring Processes of the Water Quality of Bogotá river performed by the Corporación Autónoma Regional de Cundinamarca (CAR). Graduate work to be awarded the degree in Environmental Management. Pontificia Universidad Javeriana. Bogotá 2010.

Pérez Rojas, Julia Andrea. Design of an Environmental Observatory for Tannery Industry. Graduate work to be awarded the degree in Environment and Development. Universidad Nacional de Colombia. Bogotá 2010.

National Planning Department Special Project Group Territorial Technical Assistance Program of Red Unidos. Social Agenda for the Extreme Poverty Reduction. Bogotá 2011.

Municipal Board of Chocontá Development Plan of Chocontá 2008-2011. Chocontá, Cundinamarca. May, 2008.

IPCC, 2007: Climate change 2007. Brief reports. Cooperation to teamwork I, II and III to the Fourth Report of evaluation of the intergovernmental group of experts in climate change [team of main writers: Pachauri, R.K. y Reisinger, A. (Publishing managers)]. IPCC, Ginebra, Suiza, 104 pages.



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## Appendices

### Appendix 1. Assistants and Participants

#### Colombia

Luis Alfonso Acero	Universidad Nacional (UN)
Estibaliz Aguilar Galeano	Universidad Nacional (UN)
Luis Alfonso Caicedo	Sociedad Colombiana de Ciencias Químicas (SOCOLQUIM)
Liliana Ardila Forero	Universidad Nacional (UN)
José Joaquín Fonseca	Universidad Nacional (UN)
Santiago Gómez Cervantes	Nuevos Horizontes Colombianos Foundation
Fabián Parada	Federación Latinoamericana de Asociaciones de Química (FLAQ)

#### United States

Ana María García Flórez	United States Geological Survey (USGS)
Francisco Gómez	American Chemical Society (ACS)
Matthew C. Larsen	United States Geological Survey (USGS)
Leonardo Sáenz	International Maintenance
Richard M.T. Webb	United States Geological Survey (USGS)

#### Brazil

Antonio Salvio Mangrich	Sociedade Brasileira de Química (SBQ)
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Bogotá, D.C. October 19-23, 2012



**Appendix 2. Plan for Implementation of the Follow-up and Monitoring Program of  
Water Quality**



**Delimitation and location of Monitoring Stations of Sample Points**

To be based on the identification of the zones with highest risk of pollution obtained from the diagnosis. Priority to have sampling stations at various points should be given to these areas and to parameters to be analyzed must be established.



### **To establish procedures and protocols**

No preparation of these protocols is required as the IDEAM protocols can be used (see protocols at "<http://institucional.ideam.gov.co/jsp/loader.jsf?lServicio=Publicaciones&lTipo=publicaciones&lFuncion=loadContenidoPublicacion&id=452>") or any other renowned entity. It is essential that the sampling staff is trained in the protocols to be used.

### **Selection and Training of Staff Assigned to Sampling**

The student community can be properly trained to obtain samples and transport them.

### **Monitoring Schedule**

Specific dates and sampling points should be scheduled for the monitoring to guarantee the resources and staff required is in place. All monitoring should be performed in both the rainy season as well as in drought season to account for climate factors.

### **Field Work**

The staff must be trained and have more experience in flow measurement, sample taking, management, transport and quality control.

### **Laboratory Analysis**

Since the PATP laboratory of the municipal district has basic analysis equipment, it may be used as a temporary laboratory to which samples are taken for their subsequent analysis.

### **Record and interpretation of information**

The information obtained should be entered into a database or in specially-designed formats. These records will be used to interpret the data and determine the quality of the water with respect to the national legislation (Decree 1594 from 1984 and Resolution 2115 from 2007). The effectiveness of the measures adopted will be also be evaluated.



### Appendix 3. Action Plan

Program	Activity	Responsible Parties	Period of Time
<b>PHASE: DIAGNOSIS</b>			
	Collection of information.	<ul style="list-style-type: none"> <li>• Universities</li> <li>• Schools</li> <li>• Municipality</li> <li>• Administrating Boards</li> <li>• Community Action Groups</li> <li>• IGAC</li> <li>• IDEAM</li> <li>• CAR</li> <li>• SOCOLQUIM</li> <li>• Nuevos Horizontes</li> <li>• Colombianos Foundation</li> </ul>	5 months
	Estimation of the number of people and civil associations directly affected by the adopted measures.	<ul style="list-style-type: none"> <li>• Universities</li> <li>• Schools</li> <li>• Municipality</li> <li>• Management Boards</li> <li>• Community Action Groups</li> </ul>	1 month
	Preliminary development of model selected from the information collected.	<ul style="list-style-type: none"> <li>• Universities</li> </ul>	3 months
	Model tuning.		6 months
	Revision and analysis of information obtained from the model execution.	<ul style="list-style-type: none"> <li>• Universities</li> <li>• Municipality</li> <li>• CAR</li> </ul>	4 months
	Delimitation of the areas at higher risk of pollution.	<ul style="list-style-type: none"> <li>• Universities</li> <li>• Municipality</li> <li>• CAR</li> </ul>	2 months
<b>PHASE: DELIMITATION AND SETTING OF PROGRAMS</b>			
<b>Set purposes, goals and indicators</b>	To set goals and objectives of programs.	<ul style="list-style-type: none"> <li>• Coordinating Committee</li> </ul>	1 month
<b>Program for basin maintenance</b>	Advance restoration and ecologic reforestation to generate natural barriers, control erosive processes, stabilize water courses, etc.	<ul style="list-style-type: none"> <li>• Universities</li> <li>• Municipality</li> <li>• CAR</li> <li>• Other environmental entities</li> </ul>	15 months



Program	Activity	Responsible Parties	Period of Time
<b>Program for basin maintenance cont.</b>	To delimit and establish mitigation zones near the riverbanks of ravines and other water bodies to reduce the number of contaminants.	<ul style="list-style-type: none"> <li>• Universities</li> <li>• Municipality</li> <li>• CAR</li> </ul>	4 months
<b>Program for prevention and control of industrial pollution</b>	To train the tannery staff of the municipal district with respect to good manufacturing practices and cleaner production.	<ul style="list-style-type: none"> <li>• SOCOLQUIM</li> <li>• Nuevos Horizontes Foundation and NGOs</li> <li>• Industrial sector of tanneries</li> <li>• SENA</li> <li>• Association of tanners</li> </ul>	5 months
	To prepare vulnerability map of both surface and underground water pollution.	<ul style="list-style-type: none"> <li>• Universities</li> <li>• Municipality</li> <li>• CAR</li> <li>• IGAC</li> </ul>	4 months
	To evaluate and develop a plan for the management of tanneries which is integrated to the general diagnosis and subsequently to the action plan.	<ul style="list-style-type: none"> <li>• Universities</li> <li>• Municipality</li> <li>• CAR</li> </ul>	10 months
	To establish a research program aimed at reducing the environmental impact of tanneries.	<ul style="list-style-type: none"> <li>• Universities</li> <li>• Municipality</li> <li>• CAR</li> <li>• Regional tanneries</li> </ul>	20 months
<b>Program for prevention and pollution by farming and livestock activities</b>	To train the rural people of the municipal district in good farming and livestock practices of the study area with the purpose to diminish the impact generated by these sectors on water resources.	<ul style="list-style-type: none"> <li>• Nuevos Horizontes Colombianos Foundation</li> <li>• SOCOLQUIM</li> <li>• UMATA</li> <li>• Community Action Groups</li> </ul>	6 months
	To delimit those areas with highest farming and livestock influence.	<ul style="list-style-type: none"> <li>• Universities</li> <li>• CAR</li> <li>• UMATA</li> </ul>	7 months
	To perform quality analysis to potential water bodies affected by the areas previously delimited.	<ul style="list-style-type: none"> <li>• Universities</li> <li>• CAR</li> <li>• UMATA</li> </ul>	7 months



Program	Activity	Responsible Parties	Period of Time
<b>Program for strengthening of sidewalk aqueducts</b>	To train the neighboring people in the different water bodies, in good management practices of sewage water and of basins.	<ul style="list-style-type: none"> <li>• Nuevos Horizontes Foundation and NGOs</li> <li>• Universities</li> <li>• Management Boards</li> <li>• CAR</li> <li>• SOCOLQUIM</li> </ul>	1 year
	To create a “water school” in which different members of the community can be trained.	<ul style="list-style-type: none"> <li>• Nuevos Horizontes Foundation and NGOs</li> <li>• Municipality</li> <li>• Administrating Boards</li> <li>• SOCOLQUIM</li> </ul>	
	To make the users of aqueducts which are not registered aware in order to perform such process at state entities.	<ul style="list-style-type: none"> <li>• Municipality</li> <li>• CAR</li> <li>• SOCOLQUIM</li> <li>• Nuevos Horizontes Foundation and NGOs</li> <li>• Community Action Groups</li> </ul>	4 months
<b>Program for the prevention of pollution by diffuse sources</b>	To evaluate the number of septic tanks and their condition putting emphasis on those who present risk for aquifers.	<ul style="list-style-type: none"> <li>• Universities</li> <li>• CAR</li> <li>• Community Action Groups</li> </ul>	8 months
	To carry out sealing activities of well perforation for water extraction.	<ul style="list-style-type: none"> <li>• Municipality</li> <li>• CAR</li> </ul>	1 year
	To perform an analysis of parties involved in which possible entities, institutions or persons may be identified who can provide additional resources.	<ul style="list-style-type: none"> <li>• Municipality</li> <li>• SOCOLQUIM</li> <li>• FLAQ</li> <li>• Nuevos Horizontes Foundation and NGOs</li> </ul>	6 months
	To prepare and submit projects to entities which may offer financing for the execution.	<ul style="list-style-type: none"> <li>• Municipality</li> <li>• SOCOLQUIM</li> <li>• Nuevos Horizontes Foundation and NGOs</li> </ul>	19 months
<b>Program for water quality follow-up and monitoring</b>	To train the staff who will perform the sampling.	<ul style="list-style-type: none"> <li>• Universities</li> <li>• CAR</li> <li>• SOCOLQUIM</li> <li>• Schools and Education Entities</li> </ul>	3 months
	To establish a laboratory for the analysis and treatment of samples.	<ul style="list-style-type: none"> <li>• Universities</li> <li>• Municipality</li> <li>• SOCOLQUIM</li> </ul>	7 months

Program	Activity	Responsible Parties	Period of Time
	To evaluate the efficiency of the polluting volume reduction.	<ul style="list-style-type: none"> <li>Universities</li> <li>Municipality</li> <li>SOCOLQUIM</li> </ul>	6 months
	Implementation of monitoring meetings in rainy and dry seasons.	<ul style="list-style-type: none"> <li>Universities</li> <li>Municipality</li> </ul>	1 year
<b>PHASE: EVALUATION AND FOLLOW-UP</b>			
	Disclosure of Results.		During the whole plan implementation
	Follow-up Meetings.	<ul style="list-style-type: none"> <li>Coordinating Committee</li> </ul>	
	Progress Reports.	<ul style="list-style-type: none"> <li>Universities</li> <li>CAR</li> <li>SOCOLQUIM</li> <li>Nuevos Horizontes Foundation and NGOs</li> </ul>	

### Appendix 4. Schedule

PHASE/ PROGRAM	ACTIVITY	MONTHS																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26		
<b>PHASE 1: DIAGNOSIS</b>	Collection of information.	█	█	█	█	█																							
	Estimation of the number of people and civil associations which are directly affected by the measures to be adopted.	█	█																										
	Preliminary development of model selected from the information collected.			█	█																								
	Model completion.										█			█				█				█					█	█	
	Delimitation of the areas at higher risk of pollution.				█	█																							
	Revision and analysis of information obtained from the model execution.						█	█	█	█																			
<b>PHASE 2: DELIMITATION AND SETTING OF PROGRAMS</b>																													
<b>Stage 1: Set purposes, goals and indicators</b>																													
	To set goals, objectives and indicators of programs.																												

PHASE/ PROGRAM	ACTIVITY	MONTHS																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26		
<b>Stage 2: Implementation of activities</b>																													
<b>Program for basin maintenance</b>	Advance restoration and ecologic reforestation to generate natural barriers, control erosive processes, stabilize water courses, etc.																												
	To delimit and establish mitigation zones near the riverbanks of ravines and other water bodies to reduce the number of contaminants.																												
<b>Program for prevention and control of industrial pollution</b>	To prepare a vulnerability map of both surface and underground water pollution.																												
	To evaluate and develop a plan for the management of tanneries to be integrated first with the general diagnosis and then to the action plan.																												
	To establish a research program aimed at reducing the environmental impact of tanneries.																												



PHASE/ PROGRAM	ACTIVITY	MONTHS																									
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
<b>Pollution prevention program for farming and livestock activities</b>	To train the rural people of the municipal district in good farming and livestock practices of the study area with the purpose to diminish the impact generated by these sectors as to water resource.																										
	To delimit those areas with highest farming and livestock influence.																										
	To perform quality analysis to potential water bodies affected by the areas delimited.																										
<b>Program for strengthening of sidewalk aqueducts</b>	To train the neighboring people in the different water bodies in good management practices of sewage water and of basins.																										
	To make users of aqueducts who are not legally registered aware to perform such process at state entities.																										



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PHASE/ PROGRAM	ACTIVITY	MONTHS																										
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
<b>Program for the prevention of pollution by diffuse sources</b>	To evaluate the number of septic tanks and their condition by putting emphasis on those who present risk for aquifers.																											
	To carry out sealing activities of well perforation for water extraction.																											
<b>Program for cooperation among institutions</b>	To perform an analysis of parties involved in which possible entities, institutions or persons may be identified who can provide some sort of resources in addition to those existing.																											
	To prepare and submit projects to entities which may offer financing for the execution.																											
<b>Program for water quality follow-up and monitoring</b>	To train the staff who will perform the sampling.																											
	To establish a laboratory for the analysis and treatment of samples.																											
	To evaluate the efficiency of the polluting volume reduction.																											

PHASE/ PROGRAM	ACTIVITY	MONTHS																										
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
	Implementation of monitoring meetings in rainy and dry seasons.																											
	To evaluate indicators.																											
Evaluation and Follow-up	Disclosure of results.																											
	Follow-up meetings.																											
	Progress reports.																											



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### Appendix 5. Projects Related to the Plan

Plan		Municipal District	
Program	Activity	Associated Activity or Program	Municipal Plans
<b>PROGRAM FOR BASIN MAINTENANCE</b>	To delimit and establish mitigation zones near the riverbanks of ravines and other water bodies to reduce the number of contaminants.	To increase the number of ecosystem hectares for the regulation of the conserved water supply.	<b>2012—2015 Development Plan</b> Environmental Service Program, property of our community  <b>SIGAM*</b>
	Advance restoration and ecologic reforestation to generate natural barriers, control erosive processes, stabilize water courses, etc.	To increase the number of hectares covered by forests and reforested water basins.	
<b>DIAGNOSIS</b>	Collection of information.	Updating of the geographical information system registration.	<b>2012—2015 Development Plan</b>
<b>PROGRAM FOR WATER QUALITY FOLLOW-UP AND MONITORING</b>	To evaluate the efficiency of the polluting volume reduction.	To reduce the risk rate of the water quality for human consumption, IRCA, in accordance with the rules currently in force.	<b>2012—2015 Development Plan</b>

\***SIGAM:** Municipal environmental management system

### Appendix 6. Priority Table

PRIORITY	GRADE	DESCRIPTION
High	1	Basic activity for the implementation of other project actions.
Important	2	Substantial activity which will contribute to the project objectives attainment.
Required	3	Complementary activity which will strengthen the actions set out in the project.

ACTIVITY	PRIORITY	PARTIES WHO WILL BE INVOLVED	BENEFITS	ESTIMATED COST FOR ACTIVITIES OF HIGH PRIORITY
<b>DIAGNOSIS</b>				
Collection of information.	1	<ul style="list-style-type: none"> <li>High Schools</li> <li>The academy (institutions of higher education)</li> <li>Municipal, department and national entities</li> <li>Community organizations</li> <li>Department and National Environmental authorities</li> </ul>	Information required supporting the decision making process, formulation and zoning of future plans and projects necessary for the municipal district development.	\$ 20,000,000
Development of the model selected from the information collected.	2	<ul style="list-style-type: none"> <li>The academy (institutions of higher education)</li> <li>Department and National Environmental authorities</li> </ul>		
Revision and analysis of information obtained from the model execution.	2	<ul style="list-style-type: none"> <li>The academy (institutions of higher education)</li> <li>Department and National Environmental authorities</li> </ul>		
Delimitation of the areas at higher risk of pollution.	2	<ul style="list-style-type: none"> <li>The academy (institutions of higher education)</li> </ul>		

ACTIVITY	PRIORITY	PARTIES WHO WILL BE INVOLVED	BENEFITS	ESTIMATED COST FOR ACTIVITIES OF HIGH PRIORITY
		<ul style="list-style-type: none"> <li>Department and National Environmental authorities</li> <li>Municipal entities</li> </ul>		
<b>PROGRAM FOR PREVENTION AND CONTROL OF INDUSTRIAL POLLUTION ON WATER SOURCES</b>				
<b>Training of the tannery sector of the municipal district with respect to good manufacturing practices and cleaner production.</b>	3	<ul style="list-style-type: none"> <li>The academy (institutions of higher education)</li> <li>Municipal, department and national entities</li> <li>Department and National Environmental authorities</li> </ul>	To improve the manufacturing processes to be environmentally sensitive, focusing on the reduction of residual products (discharge and solid residue).	
<b>Preparation of a map of surface and underground water pollution vulnerability with the aim to establish actions for the possible relocation of the sector.</b>	2	<ul style="list-style-type: none"> <li>The academy (institutions of higher education)</li> <li>Municipal, department and national entities</li> <li>Department and National Environmental authorities</li> </ul>	To establish the areas of Chocontá, Cundinamarca which are prone to be negatively impacted by water pollution in order to implement actions to reduce this problem.	
<b>To develop and evaluate an independent plan for the management of the tannery sector to be included in the general diagnosis.</b>	3	<ul style="list-style-type: none"> <li>The academy (institutions of higher education)</li> <li>Department and National Environmental authorities</li> <li>Municipal entities</li> </ul>	Follow-up of actions aiming at environmental improvement of the manufacturing process of the tannery sector.	
<b>POLLUTION PREVENTION PROGRAM FOR FARMING AND LIVESTOCK ACTIVITIES</b>				
<b>To train the rural people of the municipal district in good farming and livestock practices of the study area with the purpose to diminish</b>	3	<ul style="list-style-type: none"> <li>Municipal, department and national entities</li> <li>Department and National Environmental authorities</li> </ul>	To reduce the negative impact generated by these two rural sectors by instructing efficient	

ACTIVITY	PRIORITY	PARTIES WHO WILL BE INVOLVED	BENEFITS	ESTIMATED COST FOR ACTIVITIES OF HIGH PRIORITY
the impact generated by these sectors as to water resource.			practices of the resources and essentially the approval of the territory such as the water sources and the forests of the municipal district.	
<b>Delimitation of existing farming and livestock zones in the municipal district.</b>	1	<ul style="list-style-type: none"> <li>• Municipal, department and national entities</li> <li>• Department and National Environmental authorities</li> </ul>	To avoid the expansion of these zones in areas of environmental protection such as water sources, woods and wasteland.	\$ 10,000,000
<b>To monitor and analyze the quality of existing water sources in delimited farming and livestock zones.</b>	1	<ul style="list-style-type: none"> <li>• Municipal, department and national entities</li> <li>• Certified laboratories</li> </ul>	To all necessary information in order to establish the qualitative impact generated by these sectors.	\$ 15,000,000
<b>PROGRAM FOR STRENGTHENING OF SIDEWALK AQUEDUCTS</b>				
<b>Training in the domestic discharge management and protection of sources.</b>	3	<ul style="list-style-type: none"> <li>• The academy (institutions of higher education)</li> <li>• Municipal, department and national entities</li> </ul>	To have qualified staff for the water sample taking and thus to guarantee the data obtained.	
<b>To create training for technicians and technologists in protection of natural resources and management of sidewalk aqueducts (treatment of drinking and waste water).</b>	3	<ul style="list-style-type: none"> <li>• The academy (institutions of higher education)</li> <li>• Municipal, department and national entities</li> </ul>	To have staff with sufficient knowledge who live in the municipal district and are interested in the protection of natural resources and who positively own the	

ACTIVITY	PRIORITY	PARTIES WHO WILL BE INVOLVED	BENEFITS	ESTIMATED COST FOR ACTIVITIES OF HIGH PRIORITY
			environmental territory of Chocontá.	
<b>To submit sidewalk aqueducts which are not registered before competent authorities.</b>	1	<ul style="list-style-type: none"> <li>Municipal, department and national entities</li> <li>Department and National Environmental authorities</li> </ul>	To legalize the water collections of the municipal district with the purpose of complying with the currently in force environmental rules.	\$ 10,000,000
<b>PROGRAM FOR THE PREVENTION OF POLLUTION BY DIFFUSE SOURCES</b>				
<b>To establish which confined wells are used in the activity of underground water extraction and which should be sealed to avoid any potential pollution.</b>	3	<ul style="list-style-type: none"> <li>Municipal, department and national entities</li> <li>Department and National Environmental authorities</li> </ul>	To reduce all environmental liabilities caused by confined polluted wells and which lack necessary information for the management.	
<b>To identify and evaluate the condition of septic tanks existing in the study area, with the purpose to establish which ones could affect the nearby aquifers.</b>	3	<ul style="list-style-type: none"> <li>Municipal, department and national entities</li> <li>Department and National Environmental authorities</li> </ul>	To diminish the negative impact on underground water sources close to septic tanks, to establish the condition of them and the actions to be made to solve the issue.	
<b>PROGRAM FOR COOPERATION AMONG INSTITUTIONS</b>				
<b>To identify potential parties who may intervene and support with resources within the development of the project.</b>	1	<ul style="list-style-type: none"> <li>The academy (institutions of higher education)</li> <li>Municipal, department and national entities</li> <li>Department and National</li> </ul>	To obtain financing for the implementation of programs and activities of the project.	\$ 3,000,000

ACTIVITY	PRIORITY	PARTIES WHO WILL BE INVOLVED	BENEFITS	ESTIMATED COST FOR ACTIVITIES OF HIGH PRIORITY
		Environmental authorities <ul style="list-style-type: none"> <li>• Non-governmental Organizations</li> </ul>		
<b>To submit projects to entities which may offer financing for the execution.</b>	2	<ul style="list-style-type: none"> <li>• Research Institutions (Colciencias)</li> <li>• Private company</li> <li>• Non-governmental Organizations</li> </ul>	To obtain sufficient resources for the implementation of social-environmental projects in the municipal district.	
<b>PROGRAM FOR WATER QUALITY FOLLOW-UP AND MONITORING</b>				
<b>To train the people of the municipal district in everything related with the water sample taking and analysis.</b>	3	<ul style="list-style-type: none"> <li>• The academy (institutions of higher education)</li> </ul>	To have qualified staff for the water sample taking and thus to guarantee the data obtained.	
<b>To establish a laboratory for the analysis of the water quality of the samples taken from water sources of the study area.</b>	1	<ul style="list-style-type: none"> <li>• Municipal, department and national entities</li> <li>• Department and National Environmental authorities</li> </ul>	To have the main information source, which shall be certified and have more real and relevant data related to the analysis of water quality of sources in the municipal district.	\$ 25,000,000
<b>To develop and implement a monitoring plan of water quality with the purpose to evaluate the increase or decrease of the polluting</b>	2	<ul style="list-style-type: none"> <li>• Municipal, department and national entities</li> <li>• Department and National Environmental authorities</li> </ul>	To have an information baseline regarding the water quality before and after the project activities.	

ACTIVITY	PRIORITY	PARTIES WHO WILL BE INVOLVED	BENEFITS	ESTIMATED COST FOR ACTIVITIES OF HIGH PRIORITY
<p>volume and after implementing the actions and activities previously described.</p>				
<b>PROGRAM FOR BASIN MAINTENANCE</b>				
<p><b>Advance restoration and ecologic reforestation to generate natural barriers, control erosive processes, stabilize water courses, etc.</b></p>	2	<ul style="list-style-type: none"> <li>• The academy (institutions of higher education)</li> <li>• Department and National Environmental authorities</li> <li>• Municipal entities</li> </ul>	<p>Protection of vital water sources such as the flora of their streams.</p>	
<p><b>To delimit and establish mitigation zones near the riverbanks of ravines and other water bodies to reduce the number of contaminants.</b></p>	1	<ul style="list-style-type: none"> <li>• The academy (institutions of higher education)</li> <li>• Department and National Environmental authorities</li> <li>• Municipal entities</li> </ul>	<p>Identification and future protection of ecological and hydrological importance of the municipal district.</p>	\$10,000,000

### **Appendix 7. First Implementation Project**

For the execution of a first implementation project the main activities of each program have been set out. The activities proposed for this project belong to the activities for the acquisition of basic information, necessary for the decision making process and execution of the other plan actions.

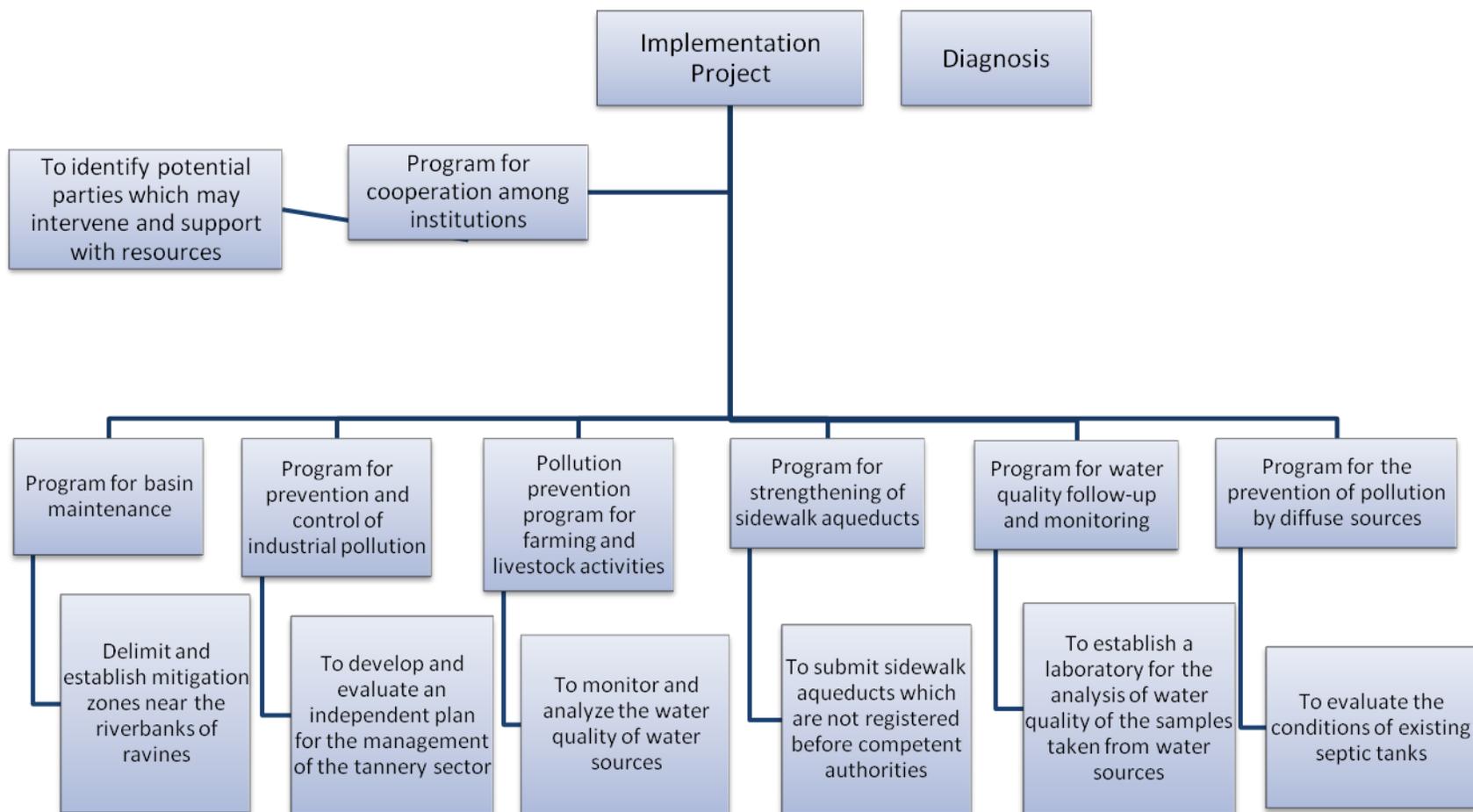
<b>Program*</b>	<b>Activity*</b>
<b>Program For Cooperation Among Institutions</b>	To identify potential parties who may intervene and support with various resources within the development of the project.
<b>Program for Prevention and Control of Industrial Pollution on Water Sources</b>	To develop and evaluate an independent plan for the management of tanneries to be included in the general diagnosis.
<b>Program for Pollution Prevention by Farming and Livestock Activities</b>	To monitor and analyze the water quality of existing water sources in delimited farming and livestock zones.
<b>Program for Strengthening of Sidewalk Aqueducts</b>	To submit the sidewalk aqueducts which are not registered to the competent authorities to monitor their activity.
<b>Program for Water Quality Follow-Up and Monitoring</b>	To establish a laboratory for the analysis of the samples taken from water sources of the study area.
<b>Program for the Prevention of Pollution by Diffuse Sources</b>	To evaluate the number of septic tanks and their condition putting emphasis on those who present risk for aquifers as identified in previous studies.

\*Taken from the priority of activities (*see Appendix 6. Priority Table*)

This project shall be executed after receiving fifty percent of the diagnosis corresponding to the first phase of the plan. The results obtained from the activities of this project should be included in the general diagnosis for the comparison of the new information with the information already acquired.

One of the important activities of this project is to identify potential parties who may intervene and support with resources, as the results obtained may lead to advantages such as quicker and more accurate information with the cooperation of more entities. For such purposes this activity should be the first one to be executed.

### Appendix 8. Activity Schedule



### **Appendix 9. Diagnosis Costs**

Members	#	1 Two-month period (thousand pesos)	2 Two-month period (thousand pesos)	3 Two-month period (thousand pesos)	Total (thousand pesos)
<b>Coordinator</b>	1	\$3000	\$3000	\$3000	\$9000
<b>Students Collecting Information</b>	6	\$6000	\$6000		\$12000
<b>Information Analysis Experts</b>	4			\$8000	\$6000
<b>Secretary</b>	1	\$800	\$800	\$800	\$2400
<b>Documentation and Services</b>	-	\$600	\$600	\$600	\$1800
<b>Model Development</b>	-	\$2000	\$2000	\$6000	\$10000
<b>Total</b>		<b>\$12400</b>	<b>\$12400</b>	<b>18400</b>	<b>43200</b>

#### **Financing**

Financing will be provided by the Municipality of Chocontá and the Cundinamarca Government, which will provide financial and logistic resources according to their capacity. Other entities such as universities, SOCOLQUIM and CAR may provide technical resources and financing in specific studies.