

## **SYNOPSIS**

### **The Study on the Sustainable Groundwater Development for Bogotá Plain**

Study Period: December 2000 - February 2003

Recipient Agency: Bogotá Water Supply and Sewerage Company

#### **1 BACKGROUND TO THE STUDY**

In Bogotá Plain, with a population of 7 million, the capital city of Colombia, Bogotá D.C., and its neighboring cities are located. The population in the plain is estimated to increase to 9 million in 2015 because of migration from local towns and rural areas as well as natural increase. Public water supply in the metropolitan area depends on surface water sources. New stable water sources, however, will be necessary to correspond to future population increase and industrial development. Further, alternative water sources for emergency supply have to be urgently developed to avoid social disorder. Against the background described above, new groundwater development was expected. There are Quaternary and Cretaceous aquifers in Bogotá Plain, and development of these aquifers could contribute to stable water supply in ordinary and emergency situation. However, suitable sites and available potential for new groundwater development were not clarified. In addition to this, groundwater conservation is urgently necessary in the central part of Bogotá Plain, where in recent years groundwater is highly used.

#### **2 OBJECTIVE OF THE STUDY**

The objectives of the Study, targeting the whole area of the Bogotá Plain, are as given below:

- To evaluate potential of groundwater in Bogotá Plain.
- To investigate the current situation of the environment related to groundwater
- To formulate a sustainable groundwater development plan.
- To conduct technical transfer programs for the counterpart personnel in the course of the Study

#### **3 OUTLINE OF THE MASTER PLAN**

##### **3-1 Planning Policy**

Planning policy of groundwater development and conservation were set based on socio-economical and natural condition as well as current water supply and future water demand.

##### **(1) Groundwater Development**

Currently, water supply for metropolitan area depends on surface water, and the total volume of the current water supply is 15m<sup>3</sup>/s. By replacing part of water resource from surface water to groundwater, water supply in case of both ordinary and emergency cases could be more stable. In addition to this, water environment could be improved and new economical benefits could be produced.

##### **a) Area for Water Supply by Groundwater**

Currently, water supply to Bogotá City and neighboring cities are carried out through three water supply systems. Among them, water supply system from Chingaza Dam (Chingaza System) is vulnerable to natural disasters. Therefore, in this plan, new water supply by groundwater is proposed for the area where water supply is difficult when Chingaza System is suspended. Moreover, groundwater instead of surface water should be used for water supply of ordinary as well as emergency cases in above proposed area to increase stability of water supply.

#### **b) Volume of Water Supply**

For ordinary water supply, volume of water to be supplied is evaluated based on water demand of the proposed area mentioned above in the year target of 2015. Also in cases of emergency, groundwater should be produced to meet water demand of the proposed area. In addition to this, more groundwater should be produced to provide water to as wider areas as possible, as far as groundwater potential is available.

#### **c) Sites of Groundwater Development**

Mountain area located in the east of Bogotá City (Eastern Hills of Bogotá Plain) has high capacity of groundwater development (more than  $2\text{m}^3/\text{s}$ ). However, groundwater has not yet been fully developed in this area. This area is conveniently located beside the eastern parts of Bogotá City, where water supply is difficult when Chingaza System is suspended. Considering situation mentioned above, Eastern Hills of Bogotá Plain was proposed as optimum sites for new groundwater development.

### **(2) Groundwater Conservation Plan**

#### **a) Goal Setting**

Projects for groundwater conservation should be implemented in areas where large volume of groundwater is currently used. Project of groundwater conservation will enable the current groundwater use to be continued sustainably.

#### **b) Project Area for Groundwater Conservation**

Groundwater resource should be conserved in Eastern Hills, where groundwater is expected to be developed in large scale in the near future. Moreover, groundwater resource should be conserved in the central and the western parts of Bogotá Plain, where large volume of groundwater is currently used.

#### **c) Method of Groundwater Conservation**

Groundwater conservation should be implemented by i) artificial recharge of groundwater and ii) research and development of technology for efficient groundwater use. Artificial recharge is to be implemented using surplus river water of flood in rainy seasons. Moreover, research and development of technology of groundwater use is to be implemented to reduce loads on groundwater resources.

### **3-2 Project for Groundwater Development and Conservation**

#### **(1) Groundwater Development and Conservation Project in Eastern Hills of Bogotá Plain (Eastern Project)**

Purpose of the project in Eastern Hills is i) water supply to Bogotá City and neighboring cities and ii) improvement of water environment of Bogotá Plain. By this project, groundwater will be newly developed, amounting to  $2\text{m}^3/\text{s}$  for ordinary water supply and  $4\text{m}^3/\text{s}$  for emergency water supply. On the other hand, total volume of  $0.45\text{m}^3/\text{s}$  should be artificially recharged into

the aquifers for groundwater conservation of Eastern Hills.

**Table -1 Outline of Eastern Project**

Project Area	Number of well	Maximum Capacity (m <sup>3</sup> /s)
Cerros Norte, Santana/Chico, Suba area. New wells will be drilled next to existing tank for water supply	12	0.42
Soacha area. New wells will be drilled next to existing tank for water supply.	8	0.28
Vitelma and San Diego area.	Production wells : 13 Recharge wells : 13	0.45
Hills of Yerba Buena area, north of Bogotá City.	30	1.04
Total	Production wells : 63 Recharge wells : 13	<Production> Ordinary cases : 2.19 Emergency cases : 4.00 <Recharge> Ordinary cases : 0.45

**(2) Groundwater Conservation Plan of Area of High Groundwater Use in Bogotá Plain (Western Project)**

Groundwater resource is to be conserved in areas of high groundwater use for floriculture, irrigation and industry. This project will enable the current water use to be continued sustainably. The outline of the project is summarized in Table-2.

**Table -2 Outline of Western Project**

Well Plan of Western Project			
Area	Aquifer	Number of recharge well	Maximum recharge capacity (m <sup>3</sup> /s)
Subachoque Basin	Quaternary	8 wells in 4 sites	0.14
Chicu Basin		10 wells in 5 sites	0.18
Up-stream of Frio Basin		10 wells in 5 sites	0.18
Total		28 wells in 14 sites	0.50

  

Research and development of technology of groundwater use	
Item	<ul style="list-style-type: none"> <li>• Reuse of drained water of irrigation,</li> <li>• Use of water of Bogotá River for irrigation,</li> <li>• Improvement of irrigation efficiency</li> <li>• Use of rainwater for irrigation</li> <li>• Change of sites for new flower production</li> </ul>

**3-3 Project Evaluation**

**(1) Social Evaluation**

The following social benefits are expected from the Projects recommended in the Master Plan.

**a) Eastern Project**

- To secure municipal water for ordinary supply and emergency cases
- To improve the water supply conditions of the poor-people residential area
- To secure water for forests fire fighting

**b) Western Project**

- To prevent from lowering of groundwater level
- To enlarge the availability of groundwater use
- To secure irrigation water against emergency such as severe droughts

**c) Integrated Effects**

- To increase employment opportunity and to activate regional economy

**(2) Economic Evaluation**

EIRR (Economic Internal Rate of Return) of Eastern Project and Western Project results respectively in 22% and 21% that exceed 13% of opportunity cost of capital; consequently, the two Projects are judged to be feasible from economic point of view.

**(3) Financial Evaluation**

FIRR (Financial Internal Rate of Return) of Eastern Project results in 23% that exceeds 14% of opportunity cost of capital; consequently, the project is judged to be feasible from financial point of view. Besides, Western Project is a groundwater conservation project and does not aim to recover its projects cost; accordingly, joint investment between Government and groundwater users is recommended.

**(4) Initial Environmental Examination**

The initial environmental examination was undertaken, through a screening process and a scoping process, to determine the environmental impacts that might be caused by the implementation of both Eastern Project and Western Project. The examination concluded that the Projects would affect 4 fields such as the groundwater level, groundwater quality relating to proposed artificial recharging, wetlands interferences and land subsidence. In order to assess the impacts respectively, the further examination should be implemented.

**3-4 Recommendations**

- Using the Master Plan as guidelines
- Continuous improvement, management and application of groundwater information and analytical tools
- Immediate start of preparation for the implementation of proposed Groundwater Development and Conservation Projects
- Institutional strengthening for groundwater management