

8.4.3 Procurement of Well Drilling Equipment

1) Required Equipment and Materials

The materials and equipment necessary for well drilling are as listed below. Besides the items below, workshops (repair shop and storage room) for the well drilling machine and other equipment and materials will also be necessary.

- (1) Well drilling machine (rig) and accessory equipment, such as slurry pump, air compressor, etc.
- (2) Support vehicle (water tank vehicle, crane, station wagon, etc.)
- (3) Logging equipment and pumping test equipment
- (4) Geophysical prospecting equipment
- (5) Communication equipment
- (6) Workshop vehicle
- (7) Casings and strainers
- (8) Submersible motor pump

2) Required Number of Well Drilling Machines

A truck-mounted type of well drilling machine will be suitable since it can cope with the various geological, drilling depth, and site conditions of the Study Areas. Both percussion type and rotary type machines should be used and a reverse circulation function must be provided for talus material.

A total of 9 well drilling machines, 2 units for Chuquisaca, 1 unit for the southern part of La Paz, 1 unit for Oruro, 2 units for Tarija, and 3 units for Santa Cruz, are necessary in order to achieve the targets of the project in five years.

Three models of well drilling machine are being considered depending on the major estimated drilling depths. The breakdown of the required number of well drilling machines by model are shown in Table 8-4-2. Since there are many blocks with a planned drilling depth of 300 m or more in the two Departments of Chuquisaca and Santa Cruz, type C equipment are necessary for these Departments. Type B equipment will be suitable for the three Departments of La Paz, Oruro, and Tarija. Although there are many water supply blocks in all Departments for which type A equipment will be sufficient, upper-grade models should be procured in order to accommodate for blocks with deep drilling as well.

Table 8-4-2 Required Number of Well Drilling Machines

	Chuquisaca	South of La Paz	Oruro	Tarija	Santa Cruz	Total
A (100-150m class)				1	1	2
B (200-300m class)	1	1	1	1	1	5
C (400-500m class)	1				1	2
Total	2	1	1	2	3	9

2) Procurement Method

When the supporting vehicle, logging and pumping test equipment, communication equipment, geophysical prospecting equipment, and other accessory equipment and materials are included, the well drilling equipment procurement cost will come to comprise approximately half of the total project cost. Procurement by the domestic funds of Bolivia will thus be difficult and international cooperation (direct overseas investment) is anticipated for the necessary funds. Furthermore, upon procuring the equipment, it is necessary to provide technical transfer on the operation, maintenance and repairing of the equipment to the engineers of each Prefecture for a term of half a year to a year or more.

While well casings can be procured in Bolivia, stainless steel or FRP strainers must be imported.

8.5 Organizational Arrangement Program

8.5.1 Basic Policy

1) Each Prefecture shall be the implementation organization in charge of rural groundwater development projects. Basic sanitation Unit (UNASBA) shall be responsible for the execution of the well drilling works and the management of drilling machines.

2) Construction works of water supply systems shall be implemented mainly under the control of the Prefecture. The Municipality might be organization in charge of the projects depending on the conditions at local communities. Community participation shall be promoted on the progress of the projects.

3) Daily operation and maintenance of the facilities shall be performed independently by the beneficiary communities. The Prefecture and/or the Municipality shall provide the communities with technical and financial supports required for sustainability of water supply services.

8.5.2 Implementation Organization

1) Establishment of Implementation Organization

Figure 8-5-1 shows a model of groundwater development project implementation flow. Beneficiary communities should perform the operation and maintenance of water supply systems, while the construction should be realized on the responsibility of the government.

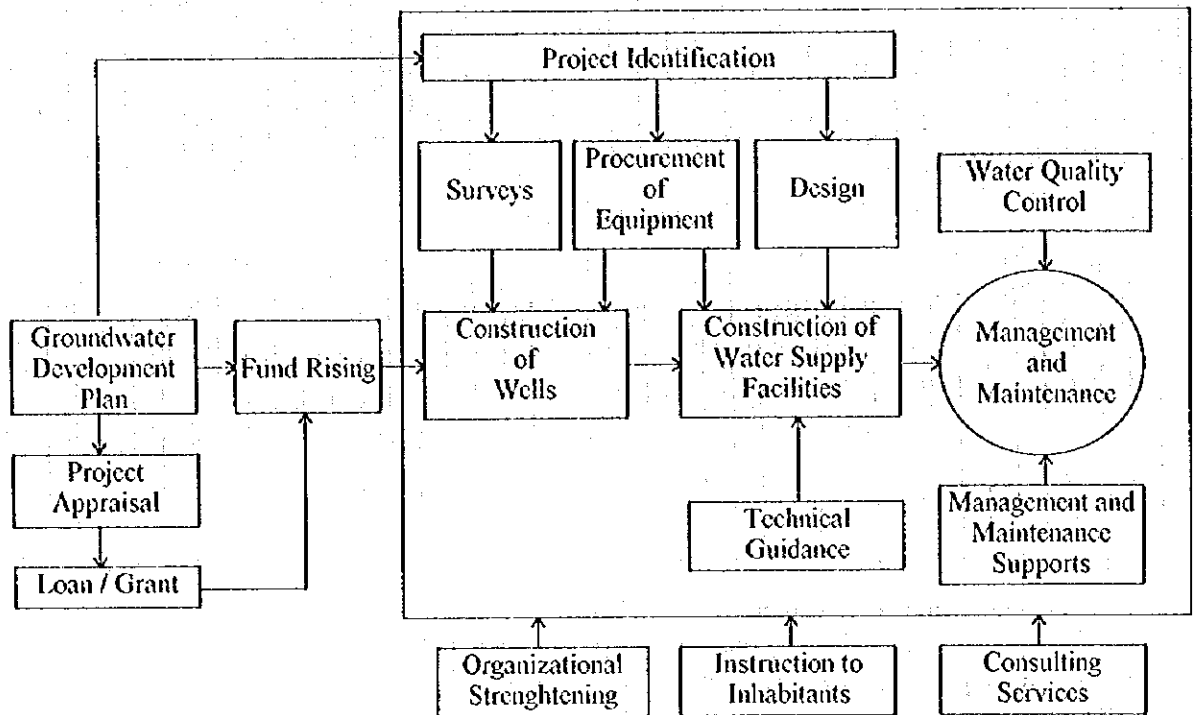


Figure 8-5-1 Groundwater Development Implementation Flow

Administration system in Bolivia consists of the central government, the Prefectures, the Municipalities and communities from the top and the decentralization is promoted currently. While ex-CORDES was most informed about the actual situation of rural water supply and accumulated technical information through the performance of water supply projects, they were integrated and reorganized to the Prefectures. However, as the ability of the Municipalities is still yet settled, the Prefectures must be worthy of the organizations for responsible for implementation of rural groundwater development projects. The Prefectures shall be responsible for well drilling works, management of well drilling equipment and enforcement of construction works of water supply system. In case of medium-scale cities, the Municipality could be the organization in charge of constructing the water supply facilities.

Table 8-5-1 shows an arrangement of organizational responsibilities among the central government, the Prefectures, the Municipalities and the private engineering services in the progress of groundwater development and water supply projects.

Table 8-5-1 Organizational Arrangement for the Projects

	Government	Prefecture	Municipal- ity	Community	Private Services
Planning	△	○	○		
Procurement of Rig	○	○			
Investigation/Design		○	○		△
Well Drilling		○			
Construction of Facilities		○	○	△	○
Operation and Maintenance				○	
Technical Support		○	○		△
Procurement of Funds	○	○	○	○	
Institutional Arrangement	○	○	○		
Education and Training	○	○			

2)Responsibility of the Prefectures

Rural groundwater development projects shall be executed under the responsibility of each Prefecture including the following works.

- a. Procurement of finance for the proposed projects
- b. Formulation of implementation program
- c. Operation and maintenance of well drilling equipment
- d. Detailed design of required facilities
- e. Planning and supervision of the construction works
- f. Land acquisition, and other required matters and procedures for the commencement of the construction works
- g. Procurement and supply of main materials and equipment
- h. Coordination with the authorities concerned
- i. Establishment of organizational arrangement
- j. Provision and training of the staff

The Prefecture shall perform the projects through the Basic Sanitation Unit (UNASBA) of the Department of Popular Participation. UNASBA shall organize the project team to establish the project implementation system.

It is proposed to establish the coordinating committee, composed of the Prefecture, the Municipalities, health center and school to secure smooth and effective implementation of the project.

8.5.3 Human Resources Development

1) Central Government

The Government shall take the leadership for smooth promotion of international cooperation, coordination among the Prefectures, financial assistance of project funds, and supervision and evaluation of the projects. For these purposes, DINASBA is required to increase the engineers and staff by three or five at least.

2) Prefectures

UNASBA of each Prefecture shall organize groundwater exploration team, drilling team, water supply planning and design team, and community strengthening team. The groundwater exploration team shall perform hydrogeological field survey and geophysical prospecting. Well drilling team shall perform drilling work and management of rigs. Required number of a team is estimated over five, consisting of hydrogeologist, mechanical engineers and technicians. As the drilling works are to continue for 24 hours a day, the back-up system shall be also established. Water supply planning and design team shall be in charge of technical support to the beneficiary communities and operation and maintenance education as well as planning and design. Community strengthening team shall be responsible for sanitary education, guidance for the establishing the Water Committee and the management, and patrol of the existing water supply systems in rural area.

Each Prefecture shall establish the project team and the inspection committee for supervision of the project. Facility design, preliminary works and supervision of construction works could be carried out through consultant engineering services.

3) Beneficiary Communities

The success of the proposed projects will be realized with the appropriate operation and maintenance practices in the constructed water supply systems, including dairy maintenance of the facilities, collection of water tariff and other miscellaneous works. Proposed personnel organization of the beneficiary communities is as follows.

- a. Urban city with a population of over 10,000 : 10 or more full-time staff shall be employed.
- b. Urban city with a population from 2,000 to 10,000 : Several number of full-time staff shall be employed.
- c. Rural community with a population from 500 to 2,000 : One or more full-time staff shall be employed for maintaining the system with part-time members of the Water Committee.
- d. Rural community with a population from 50 to 500 : Part-time members of the Water Committee shall maintain the system by turns.

The Prefecture shall make the communities of the proposed projects to organize the Water Committee for independent operation and maintenance of the water supply systems. The Water

Committee shall appoint the manager and operator responsible for operation and maintenance of the equipment.

8.5.4 Development Priority by Department

The priority for groundwater development projects by Department was evaluated in the progress of the Study. The results are summarized in Table 8-5-2. As for La Paz, the evaluation focuses to not total Department but four Provinces in the Study Area.

a. Urgency of the Project

Santa Cruz and Chuquisaca have twice as much population unserved as other three Departments. Especially, Chuquisaca has first priority of groundwater development because many communities have no alternative water sources. Many communities in Oruro also has few alternatives and the groundwater development is required.

b. Difficulty of Well Drilling Works

Chuquisaca is disadvantageous for implementation of the groundwater development project because most part is located in the arid valley area with bad traffic condition. The drilling works is expected easy in Oruro but the concentration of salts in groundwater might be so high due to dry climate that the advanced technology is required for groundwater exploration. Santa Cruz includes some area difficult to access the communities in rainy season.

c. Organizational Aspect

Among five Departments, Santa Cruz has gotten the most achievement of water supply projects in the period of ex-CORDES and retains a financial ability, followed by Tarija and Oruro. have as much performance of investment per capita as Santa Cruz. Chuquisaca has uncertain factors in the organizational aspects in the course of recent decentralization process.

d. Technical Level

Santa Cruz and Tarija employ so many high-level engineers to perform the water supply projects and accumulate considerable amount of planning technologies. Chuquisaca and Oruro, which own an old-type rig respectively, continue to perform well drilling works little by little but the technologies are outdated at present compared with the international level. La Paz has few examples of groundwater development projects.

e. Sustainability of the System

It might be more difficult to sustain the operation and maintenance of the system for small-scale communities than larger ones. Oruro and the southern part of La Paz include such communities so much. In Chuquisaca, the traffic conditions and the distances from the departmental capital will be disadvantage factors for establishing the supporting system. Santa Cruz is expected to establish the local station for supporting system because of extensive area.

f. Expectation for Future Use of Equipment

Santa Cruz and Tarija are expected to make the most use of well drilling equipment because the organizations are reliable with strong wills for promoting the groundwater

development projects. Although Chuquisaca has a iron will for the project, the organization is unsettled at present. As the Study Area in La Paz covers only four Provinces, the comprehensive plan on groundwater development is expected to establish for the total area of the Department.

Table 8-5-2 Development Priority by Department

	Chuquisaca	S.of La Paz	Oruro	Tarija	Santa Cruz
Project Urgency	A	B	B	B	A
Drilling Difficulty	C	B	C	B	B
Organization	C	C	B	B	A
Technical Level	B	C	B	A	A
Sustainability	B	B	B	A	A
Future Use of Equipment	B	B	A	A	A

The departmental priority for rural groundwater development can be arranged Santa Cruz, Chuquisaca, Oruro, Tarija and the southern part of La Paz in order named from the view point of the urgency of the projects. And the order of Santa Cruz, Tarija, Oruro, Chuquisaca and the southern part of La Paz are another line-up from the view point of the reliability.

8.6 Operation and Maintenance Program

8.6.1 Basic Policy

The function of the water supply facilities depends on operation and maintenance practices, which shall be in accordance with the following basic policies.

- 1) Daily operation and maintenance works of the facilities and groundwater pumping practices shall be performed independently by the beneficiary communities.
- 2) Each Prefecture shall guide the communities to organize the Water Committee and support them to promote the operation and maintenance by the communities.
- 3) In principle, operation and maintenance costs shall be burdened by the beneficiaries, including the expenses for exchange of spare parts and easy repairing of broken equipment.
- 4) The Prefectures shall perform the training on operation and maintenance practices and work managements for the members of beneficiary communities.
- 5) The drilling equipment shall be managed under the responsibility of the Prefectures.
- 6) The Prefectures shall establish the groundwater monitoring and well management system to promote groundwater conservation.

8.6.2 Management of Well Drilling Works

Well drilling shall be performed in accordance with the following advises.

- a. To prepare implementation program of the drilling works
- b. To conduct regular inspection of the drilling equipment at least once a year
- c. To secure the repair shop and workshop of the drilling machine and other equipment
- d. To prepare the report on the drilling works in each time and the annual report on the progress of the projects to present to the central government and authorities concerned
- e. To execute the training of groundwater development technologies and the exchange of information

8.6.3 Operation and Maintenance of Water Supply Systems

1) Well Management

Constructed well shall be managed in accordance with the following advises.

- a. To prevent over-drafting
- b. To prevent the contamination of groundwater
- c. To conduct daily inspection on voltage, pressure, fuel consumption and conveyance time of the motor pump

2) Operation and Maintenance of Equipment

Operation and maintenance of the water supply system shall be executed in accordance with the following advises.

- a. To appoint an manager and operator responsible for daily works.
- b. To prepare and store the catalogue and drawing of the facilities and equipment.
- c. To conduct the inspection and cleaning regularly
- d. To prepare the record on water volume, fuel consumption and operation costs and the account book
- e. To observe the actual capacity to improve the declining facilities
- f. To hold a general meeting of the Water Committee regularly to report the activities and accountings.
- g. To receive an inspection of engineering specialist once a year

3) Technical Supporting System

Technical support is required for the sustainable operation and maintenance by the communities in the following matters.

- a. Regular inspection for preventive maintenance
- b. Repairing works of declined equipment
- c. Operation and maintenance training and sanitary education for communities

The Prefectures shall establish the supporting system in cooperation with the municipal corporations of water supply and sewerage and/or private constructors.

8.6.4 Community Education Program

The objectives of operation and maintenance education are to train the personnel of the beneficiary communities and to promote sustainability of the water supply systems.

Major subjects consist of primary knowledge on well management and water supply systems, daily operation and maintenance practices, accounting practices and reporting manners. Each Prefectures shall systematically execute the training program in advance of the project implementation.

Sanitary education aims at improving sanitary habits of water utilization and public consciousness on water pollution, sanitation, and water tariff.

8.7 Investment Planning

1) Past Public Investment

Table 8-7-1 shows the performance of total public investment all over the country from 1991 to 1994. Average annual investment amounts to \$496 million, \$32 million (6.4%) of which is the investment for basic sanitation sector. External funds accounts for 58 percent of total investment to finance through FNDR and FIS.

Table 8-7-1 Total Public Investment (Whole Country)

(Unit: million dollars)

Year	1991	1992	1993	1994	Average (92-94)
Total Investment (T)	420.5	531.6	480.6	473.3	495.9
External Fund (E)	192.8	282.2	283.4	292.1	285.9
E/T	45.9%	53.1%	59.0%	61.7%	57.7%
Investment to Basic Sanitation (S)	12.9	31.6	34.2	29.4	31.7
External Fund (ES)	6.1	18.9	18.4	18.5	18.6
ES/S	47.3%	59.8%	53.8%	62.9%	58.7%
S/T	3.1%	5.9%	7.1%	6.2%	6.4%

Past public investment in the Study Area is shown in Table 8-7-2. Total annual investment amounted to \$240 million, \$20 million of which was for basic sanitation sector.

Table 8-7-2 Average Investment in the Study Area (1991-1994)

(Unit: thousand dollars)

Department	Chuqui- saca	South of La Paz	Oruro	Tarija	Santa Cruz	Total
Total Investment (A)	40,914	11,924	24,127	46,104	116,472	239,541
Per Capita	139	95	154	229	175	142
Investment to BS.(B)	3,352	1,345	3,472	3,415	8,720	20,304
B/A	8.2%	11.3%	14.4%	7.4%	7.5%	8.3%
Net Fund of ex-CORDES (C)	10,765	3,702	3,316	11,656	28,871	58,310
Per Capita	33	30	21	58	43	40
C/A	26.3%	31.0%	13.7%	25.3%	24.8%	25.7%
Net Fund of ex-CORDES to BS (D)	882	417	476	864	2,163	4,802

Note: The column of the south of La Paz is estimated from the performance all over Department by percentage of the population.

2) Financial Trends

The Popular Participation Law in 1994 has reorganized the flow of public investment from the central government to the communities. Regional investment funds are distributed to the municipality of each section depending on the population. Amount of money is \$20 per person per year.

Ex-CORDES had been integrated to the Prefectures by the Administrative Decentralization Law and the responsibility for planning and implementation of regional development and public investment was transferred to the Prefectures.

3) Outline of the Project

Period	5 years
Total costs	\$71.3 million (\$279 per capita)
Domestic Fund	\$31.8 million (\$124 per capita)
External Fund	\$39.5 million (\$154 per capita)
Total population of the beneficiary:	255,785 (Year 2000)
Project costs except for rig procurement	\$37.7 million (\$148 per capita)

The breakdown of the project costs by year and works is shown in Table 8-7-3.

Table 8-7-3 Investment Plan for Groundwater Development Project Up To 2000 Year

(Unit: thousand dollars)

Items	1996		1997		1998		1999		2000		Total	
	External	Domestic	External	Domestic	External	Domestic	External	Domestic	External	Domestic	External	Domestic
Chuquisaca												
Procurement of equipment	7,800	300		1,640		1,640		0		1,643	8,960	6,863
Drilling works	780	90		155		155		155		153	780	618
Construction materials	380	140		665		665		665		665	380	2,750
Construction works		70		680		680		680		680		2,865
Personnel expenses		140		140		140		140		140		630
Total	8,960	300	0	1,640	0	1,640	0	1,643	0	1,643	8,960	6,863
South of La Paz												
Procurement of equipment	4,160										4,160	300
Drilling works	270			75		75		75		75	270	140
Construction materials	140	45		315		315		315		320	140	1,310
Construction works		50		235		235		243		243		998
Personnel expenses		40		80		80		80		80		360
Total	4,570	135	0	705	0	705	0	718	0	718	4,570	2,968
Oruro												
Procurement of equipment	4,160										4,160	456
Drilling works	1,170	65		115		115		111		111	1,170	2,020
Construction materials	340	75		490		490		485		485	340	1,550
Construction works		40		365		365		380		380		360
Personnel expenses		180		80		80		80		80		4,386
Total	5,670	180	0	1,050	0	1,050	0	1,056	0	1,056	5,670	4,386
Tarja												
Procurement of equipment	7,800										7,800	603
Drilling works	930	80		150		150		153		153	930	2,410
Construction materials	280	85		585		585		575		575	280	1,756
Construction works		70		415		415		426		426		630
Personnel expenses		140		140		140		140		140		5,399
Total	9,010	235	0	1,290	0	1,290	0	1,294	0	1,294	9,010	5,399
Santa Cruz												
Procurement of equipment	9,600										9,600	1,113
Drilling works	1,260	145		280		280		273		273	1,260	4,540
Construction materials	400	270		1,100		1,100		1,095		1,095	400	5,620
Construction works		100		1,335		1,335		1,345		1,345		900
Personnel expenses		515		200		200		200		200		12,173
Total	11,260	515	0	2,915	0	2,915	0	2,913	0	2,913	11,260	33,520
Total	33,520	1,365	0	7,600	0	7,600	0	7,624	0	7,624	39,470	31,789
Drilling works	4,410	425		775		775		765		765	4,410	13,030
Construction materials	1,540	620		3,155		3,155		3,140		3,140	1,540	12,789
Construction works		320		3,030		3,030		3,079		3,079		2,880
Personnel expenses		320		640		640		640		640		31,789
Total	39,470	1,365	0	7,600	0	7,600	0	7,624	0	7,624	39,470	31,789

4) Investment Plan

Table 8-7-4 shows the amount of investment by year and the organization calculated on the assumption of the following conditions.

- a. Rig and other equipment required for well drilling will be prepared by grant aids of foreign country at the first year of the project in each Department.
- b. The drilling works in the first year will be conducted by the donor country in cooperation with each Prefecture for technical transfer of groundwater development methods.
- c. The Prefecture will take responsibility for the drilling works in each Department from the second year and burden all costs such as the expenses of investigation, purchasing costs of casing and strainer, and salary of staff.
- d. Water supply facility will be constructed using domestic funds. The Prefecture will be in charge of technical aspects such as investigation, design and supervision.
- e. The construction costs of the system except for procurement of the equipment will be charged by the Prefecture (10%), the Municipality (30%) and the central government (60%). The beneficiary community shall provide the manpower to be required for the construction works.
- f. The funds for procurement of pump and generator will be borne by the finance of the government.
- g. The constructed water supply system will be operated and maintained by the beneficiary community.

Table 8-7-4 Investment Amount by Year and Organization Concerned

(Unit: thousand dollars)

	1996	1997	1998	1999	2000	Total
Bilateral Cooperation	39,470	0	0	0	0	39,470
Central Government	656	3,921	3,921	3,921	3,940	16,359
Prefectural government						
Chuquisaca	114	585	585	585	583	2,452
La Paz	60	283	283	283	286	1,195
Oruro	69	395	395	395	395	1,645
Tarija	105	527	527	527	527	2,213
Santa Cruz	175	980	980	980	973	4,088
Sub Total	523	2,770	2,770	2,770	2,760	11,593
Municipalities	186	909	909	909	924	3,837
Grand Total	40,835	7,600	7,600	7,600	7,624	71,259

5) Financial Review

- a. Procurement of well drilling equipment together with one-year drilling works is expected to bear in grant aids which accounts for 55.4 percent of the total project costs. This aids is a key factor to realize the groundwater development project in the Study Area.
- b. Annual investment of the central government amounts to around \$3.9 million, accounting for 51.5 percent of the required domestic funds. This investment accounts for 12 percent of the past budget to the basic sector all over the country or 19 percent of the past public investment for the Study Area. If the government takes top priority on the this project and leadership on the coordination with the authorities concerned, financial conditions can be overcome to realize implementation of the project.
- c. Annual investment of the Prefectures accounts for 36.5% of the total domestic costs. Required investment for each Prefecture reaches 45 percent to 83 percent (57.7% on the average) of the past net budget for basic sanitation sector in ex-CORDES, although the rates depend on the Prefectures. However, the investments account for around five percent of their net budgets and are considered to stay within financial abilities.
- d. The funds of investment of the Municipalities prepared by the provision of the Popular Participation Law account for 12.0% of the total domestic funds. The requirement per person amounts to US\$15, which is equivalent to three fourth of an annual tax dividend from the government. While the amount of money must be a heavy burden for the Municipalities with the project community, it is possible to pay.
- e. In conclusion, all burden shares is considered well under ceiling for each organization and the project can be viable with the grant aids depending on the policy of the donor.

CHAPTER 9 PROJECT EVALUATION

9.1 Beneficiary Communities

Implementation of the proposed project will develop the safe water, extend the water supply services and benefit 57,295 inhabitants of 58 communities in Chuquisaca, 19,957 inhabitants of 46 communities in the southern part of La Paz, 31,009 inhabitants of 72 communities in Oruro, 35,128 inhabitants of 85 communities in Tarija, and 112,396 inhabitants of 155 communities in Santa Cruz. Beneficiary population is 255,785 in total or around 15.9% of the population in the Study Area by the target year 2000. The number of beneficiaries will be considerably larger if proper account is take, of people passing through the villages and of residents from nearby communities without water supply facilities.

9.2 Willingness to Pay

Four pilot study, which consists of test well drilling, construction of the pilot project facility and educational program, was successfully carried out in cooperation of inhabitants and the water committee. On their own initiative, the communities made a decision to contribute 10 ~ 20 Bolivianos per family per month on the average for the water tariff. As the operation and maintenance costs of the water supply systems are estimated about 5 ~ 20 Bolivianos according to the sites, the contribution is, if it will be well managed, enough to cover not only the recurrent costs but also a part of the replacement costs.

However, some communities will be unable to cover the operation and maintenance costs. Technical or financial support, therefore, from the local government would be necessary.

9.3 Financial Assessment

The proposed project has formulated on the assumption that well drilling equipment shall be procured by grant aids and the Bolivian side shall proceed the drilling works and construction of water supply facility of themselves. Examined the implementation program and investment plan by each Department, the projects are assessed feasible for the financial conditions of the central government, each prefectural government and beneficiary municipality based on the possibility of direct foreign aids.

9.4 Environmental Impact Assessment

The projects focus on mainly deep groundwater development to supply safe and domestic water to rural communities without water supply service. As a few groundwater is pumped up for domestic use and deep aquifer is not developed until now, the environmental impact is expected scarce.

9.5 Overall Evaluation

The proposed project is expected to have direct and indirect regional and national impacts. Expected main effects is summarized as follows:

- (1) Human health improvement
- (2) Water procurement labor and time saving
- (3) Improvement of the living conditions
- (4) Reduced expenses for purchasing water
- (5) Strengthening water supply sectors
- (6) Increase of employment opportunities during project periods

In summary, the various impacts lead to the conclusion that the proposed project is expected to have significant beneficial effects, therefore, it should be immediately implemented.

CHAPTER 10 CONCLUSIONS AND RECOMMENDATIONS

10.1 Conclusions

10.1.1 Need for Water Development

- 1) The majority of the communities (water supply blocks) in the Study Area are isolated, scattered communities with small populations. The water supply coverage in rural area is only 23.3%. Living conditions, environment and economic situation is bad, and the shortage of water posing an extremely serious problem. 71% of total number of communities in the Study Area has not any water supply system. A large proportion of inhabitants can not obtain enough safe water for daily life, and has to depend on the unhygienic water sources such as raining water puddles. There is also the scarce shortage in water supply for farming and livestock grazing. Even communities with existing water supply systems have to face with inevitable supply restrictions in the dry season.
- 2) This lag of water supply service is due to a number of factors, including mainly: 1) the natural-geographic conditions, 2) the lag in the water resources development, 3) the lack or shortage of technology, manpower and funds for the water supply and the water resources development, 4) the lack of operation and maintenance for existing facilities.
- 3) Water development and water supply project in the rural areas of Bolivia have been pursued by the former Regional Development Corporations of each Department and the Public Service Authorities such as municipalities, with the cooperation of various countries, international agencies, and non-government organizations (NGO). These projects have included shallow wells, springs, and river-bed water. However, these projects are sporadically and located at some particular areas, so that the supply quantity is deficient in absolute terms.
- 4) There are only two departments, naming Chuquisaca and Oruro, who own a kind of well drilling equipments. In either case, however, the drilling equipments are old and obsolete and have a low performance. Other departments do not own any equipment, and have to depend on private constructors, and can not push forward the groundwater development projects continuously.
- 5) The inhabitants of many communities do not have the financial capability to cover the initial investments required for the execution of the groundwater development projects. But a majority of inhabitants strongly desires to have stable domestic water and shows a considerable awareness of the self-help efforts in the operation and maintenance of water resources and water supply facilities. In general, the inhabitants in many rural communities show the considerable willingness to pay tariffs required for the operation and maintenance of the water supply systems. Therefore, the daily operation and maintenance of the water supply system may be possible with the inhabitant self-help efforts, once the system had been constructed. Provided that the administrative organizations concerned are engaged in providing suitable education and guidance to the inhabitants and that the government offers

certain financial support or subsidies, there appears to be a high probability that the water development project will succeed. In the future, however, it is reasonable to anticipate a further reinforcement of these efforts, due to the effects of the decentralization process that now is ongoing in Bolivia.

- 6) To improve the water supply condition in Bolivian rural areas, it needs to put more efforts in the development of groundwater, as a stable water supply source whose the lack is the main cause of the shortage of drinking water in Bolivia. The groundwater, especially the ones of deep aquifer, has not been developed adequately yet, due to the lack of investment, technology, equipment, etc. But, this development should be carried out as soon, in order to improve the live conditions of the inhabitants and the public hygienic conditions in these rural communities.

10.1.2 Possibility of the Development of Groundwater

- 1) A large part of the Study Area, such as Altiplano area, Chaco Plain, etc. is dry area where the precipitation is very low. The main water sources in common used in Altiplano and in the plain in northern of Santa Cruz are wells, while the ones in mountainous areas are surface water sources.
- 2) Altiplano is a high plain closed off from other water basins, and therefore it has the big quantity of underground water preservation, though the precipitation here is not so high. The development of groundwater in this plain in the past is mainly based on the shallow wells, so then the development of deep underground water sources remains in high potential. The groundwater taken from the shallow aquifer here is becoming salty, but the ones from the deep aquifer contains low salt concentration relatively. The groundwater in the areas around the Lake of Poopo, the Uyuni Salt Flats, the Coipasa Salt Lake, Tredo City is likely to become salty, and therefore it needs to examine the possibility of the development of "fissure water" or "stratum water" at these areas.
- 3) In the hill zones, the surface water from the source such as rivers, springs is used widely, and the development of groundwater is not in adequate level. It assumed that there is a big quantity of groundwater under the ground of the valleys in these areas, thus the development potential in these areas is high. However, it has not easy access to many communities in these areas, and the drilling work may be difficult in some areas due to the existing of the hard rock stratum beneath them. These difficult conditions much be taken into consideration in the drilling plan applied to these areas.
- 4) In the northern humid area of Amazon river basin, the precipitation is high, and the groundwater can be obtained easily from relatively shallow wells. The groundwater development potential of the dry area in the southern part is also high, with the large and flat water basin, though the aquifer here is in deep location.
- 5) In the gently undulating plateau of Escudo Central area, there is a hard stratum under the ground, but the precipitation here is high relatively, and the groundwater development

potential is high with the weathering rock stratum that is rich in groundwater considerably.

- 6) In Chaco region, the groundwater preservation is small, due to its low precipitation and its location that is just at the watershed between the La Plata river basin and the Amazon river basin. However, since surface water is hard to obtain and adequate water quantities cannot be obtained with shallow wells either, there is a need to carry out active development of deep groundwater.
- 7) Until now, the development of deep groundwater has not been carried out adequately. Although the development of groundwater may not be easy depending on the geological characteristics of the area concerned, it is considerable that an adequate quantity of water with good quality as required by the inhabitants in rural communities for daily life, can be obtained with the appropriate groundwater development at these communities.

10.1.3 Regional Groundwater Development Strategies

- 1) The groundwater development strategies had been formulated to establish the basic policies to improve the water supply services in the Study Area. The strategy target year had been determined to be the 2000 Year (the fifth stage plan year). And base on the results of the case study on several project implementation strategies, the target water supply coverages had been determined separately for rural area and urban area of each Department. The target water supply coverages are given as 89% for the urban area and as 38% for the rural area, making an average of 54% for the Study Area in total. Given that the current average water supply coverage of the Study Area stands at 40.5%, this target water supply coverage marks a 13.5% increase.
- 2) To formulate the development strategies, the water supply blocks in the Study Area were classified by mean of the water supply database. At the same time, for each water supply block, the estimation of future population was made, and an evaluation was conducted to assess the supply ability of the existing water supply systems, and the numbers of projects (that is, the population benefiting from the projects) required to attain the target coverages were calculated. The next step was to conduct a series of evaluations for the three project implementation strategies in accordance with the development priorities in order to determine the time required for project completion, the effective of the investment, the structure of the executing organizations and the level of technology. Finally, a list of selected water supply blocks was made, listing the communities which were considered to be most appropriate for the implementation plan.
- 3) The number of selected water supply blocks and its total planned population are: 98 blocks, 57,295 persons for Department of Chuquisaca; 46 blocks, 19,957 persons for Southern Part of La Paz; 72 blocks, 31,009 persons for Department of Oruro; 85 blocks, 35,128 persons for Department of Tarija; and 155 blocks, 112,396 persons for Department of Santa Cruz. For all five departments, the selected number of blocks is 456 blocks, and the total planned population is 255,785 persons.

- 4) Rough facility planning was established to determine the specifications and quantities of facility and equipment and to make cost estimation. To complete the projects within five years as determined by the implementation plan, the required numbers of drilling rigs are 2 rigs for Chuquisaca, and Tarija, 3 rigs for Santa Cruz and 1 rig for Oruro and the Southern Part of La Paz.
- 5) The total project cost has been calculated to amount to US\$ 71.26 million. 47% of this total project cost is for the procurement of well drilling equipments. The initial investment required for the implementation of projects may be obtained from the fiscal subsidy from central government according to the Law of Popular Participation. In this context, it has been assumed that the procurement of drilling equipments depends on the external financial aids, which accompanies with a cooperation in short-term drilling work to conduct the on-job technical transfer. The total external financial aids is assumed to be US\$ 39.47 million, of which the cooperation by mean of conducting drilling work in one year period for each department is included.

10.1.4 Establishment of Project Implementation Plan

- 1) In recognition of the current serious shortage of drinking water, it has been concluded that the groundwater development plan should be implemented as soon as possible. It has been assumed that the procurement of the necessary drilling equipments, detailed studies, detailed surveys, detailed design, and all other preparations should be completed within five years period. On this basis, the work schedule has been established, and the project costs for each stage plan year has been calculated. In this context, the use of the bilateral financial cooperation in the initial stage plan year has been taken into consideration.
- 2) The project implementation plan has been established in such a manner that the project is started from the community with high possibility of successful groundwater development and with easy access conditions, and gradually extended to the surrounding areas.
- 3) It has been assumed that the individual prefectural governments (i.e. the UNASBAs in direct charge) should be the organizations responsible for the implementation of drilling works under this plan, and that the prefectural governments or the municipal authorities are responsible for the construction of water supply facilities. Furthermore, it has been assumed that once the water supply system had been completed, its operation and maintenance should be carried out by the cooperatives formed by the beneficiaries in the individual communities, under the jurisdiction and instructions of the competent prefectural governments.
- 4) It has been assumed that the prefectural governments have the ability to carry out the implementation plan by themselves after being provided with drilling equipments. However, the reorganization of local administrative institutions is under going, and we expect that the works will be transferred smoothly from the ex-CORDES to the prefectural agencies.
- 5) The objective of the groundwater development project is to assure a steady water supply as the

livelihood basis for the inhabitants in rural communities, who are suffering from a very scarce water supply shortage. The direct and indirect benefits of the investments, such as the improvements of the general health conditions of the inhabitants, the reduction of the working hours required to collect water, the cost savings in the acquisition of water, the activation of inhabitants' lives and communities' economic activities, etc. can be anticipated. Accordingly, the effects such as the improvement of inhabitants' living standards in long-term, the stabilization of civilian lives, the development of the communities' society and economy, etc. are the promising outcomes of the plan. Also, in terms of project operation, project maintenance and project management, etc. we can conclude that the execution of the project is totally reasonable.

10.2 Recommendations

10.2.1 Basic Policy for Project Implementation

- 1) The implementation of the groundwater development project is expected not only to fill the needs of rural inhabitants but also to improve their living standard and stabilize their public welfare. In order to implement the project quickly, the central government and the prefectural governments should confer with related agencies about the responsibility-sharing, the cooperation system and the raising funds.
- 2) Main targets of the project are the scattered communities in the rural areas, and the prefectural governments should take responsibility to carry out the project. In big and medium cities, the municipal authority can be the implementor of the water supply facilities construction project.
- 3) Investment funds necessary to implement the project should be basically recovered through tariff collection. However, central government should take responsibility to procure initial investments necessary for the project implementation. Prefectural governments should bear various expenses (including personnel expenses and traffic expenses) necessary to routine or temporary checkup and adjustment, technician training, renewals of facilities and equipments and etc. The central government and the prefectural governments should establish the financial foundation, consulting with related agencies on the strengthening of relevant organizations, ensuring personnel required, etc., in order to perform adequate and efficient operation and management for the sustainability of the system.
- 4) The communities should provide manpower in the construction of the water supply facilities, take the initiative in the operation of the water supply systems, and participate in the management and maintenance of these systems.
- 5) The selection of the water supply blocks for the project implementation were based on the data obtained from the water supply database, and on the results of a partial and rough questionnaire surveys. That means, the inhabitants' intentions and their will to participate in the project implementation have not been taken into consideration, and therefore, before the

implementation of the project, and after carrying out the field detailed surveys, this selection should be reviewed, and corrected.

- 6) However in determining the implementation of project, political interventions should be excluded to the utmost, and efforts should be made in order to obtain the appropriate and rational decision making from the neutral standpoint.
- 7) In planning and designing the facilities, an adequate and rational decision should be made, taking into consideration the social conditions, the water supply conditions, the environmental conditions, the topographical and geological conditions, the investment efficiency, the operation and maintenance ability, etc. of the targeted community.

10.2.2 Developments, Management of Groundwater Resources

- 1) Groundwater is a precious natural resource that should be developed and managed by the people who are living on that land, and based on their experiences and knowledge. During the implementing process of groundwater development project, in order to perform better measures for the development of groundwater source, the prefectural government concerned should instruct the beneficiary inhabitants on the use and the management of the groundwater source, motivate them to the formation and operation of the relevant organizations
- 2) The hydrologic and geological conditions in the Study Area are complicated and different by site of the project. Therefore, detailed hydrologic and geological surveys and geophysical prospectings should be carried out, and if it is necessary, test boring should be conducted previous to the well drilling works.
- 3) In implementing the water supply project, efforts should be made to establish the comprehensive planning which takes into consideration the organic linkage between the targeted community and the neighboring communities.
- 4) A composite technology, with wide knowledge and cross-sectorial experience are required for the development of groundwater source. Therefore, the engineers of groundwater development are required to acquire adequate technologies relating to groundwater prospecting, well drilling, well logging tests, quantitative assessments, groundwater monitoring, etc. Therefore, the prefectural governments should intentionally assign appropriate personnel in the phase of detailed design, planning of the project implementation, and enhance the levels of engineers through the on-job training. DINASBA should bear more efforts to train up technicians, conduct the technical exchanges, etc. in order to enhance their technical levels.

10.2.3 Community Commitment and Women Participation

- 1) Efforts should be made to conduct appropriate explanations to the inhabitants on the meaning of the project and on their considerable responsibility, to promote their participation

in the project implementation. The inhabitants are expected to contribute important labor force to the construction of the water supply facilities .

- 2) It is assumed that the operation and management of the water supply system are carried by the water committee or water cooperatives formed by the inhabitants, and with the financial fund formed by the inhabitants' payments.
- 3) The prefectural governments should conduct the educational programs on sanitation, and on the maintenance and management of water supply system at the beneficiary communities, with the cooperation of governmental agencies or non-governmental organizations concerned.
Efforts should be made to promote women's participation, utilize the surplus time that they might be obtained by the implementation of the project.
- 4) The active participation of women should be promoted in establishing the maintenance and management organization of the water supply systems. The life pattern and needs of women, as the end-users of the water supply services, should be considered in the water supply planning process.

10.2.4 Consideration of Environments and Public Health

- 1) For the sustainability of the wells, the organizations in charge of maintenance and management of the wells should pay adequate attention to prevent the over-pumping up of groundwater, and the inflow of polluted water into the wells. The water supply facilities should be managed carefully by daily checks, routine checks, and cleaned up always.
- 3) However, the improvement of consciousness of water supply and public health in whole community is the most important thing to be considered. Therefore, it is necessary to promote widely the sanitary education to any inhabitant, including the children and the housewives. Schools, public health centers, and other relevant regional agencies should perform the cooperative working programs to instruct the inhabitants on the public health and environmental preservation.

10.2.5 Planning, Implementation and Strengthening of Management Organizations

- 1) The National Secretariat of Popular Participation and DINASBA should be strengthened as the only organization in the central government which takes general control on the development project relating to water supply, public health, and basic sanitation.
- 2) Prefectural governments should establish and reinforce the system to operate and manage the drilling equipments, and bear following efforts to ensure the successful water supply services.
 - (1) Increase the personnel required for the implementation of the development project.
 - (2) Establish the education and training system in order to improve the technical levels of the staff members.

- (3) Intensify the internal inspection system in the project implementation organization for the efficient operation and management of the project.
 - (4) Establish separated accounts, in order to obtain the efficiency in operating and managing of the development project.
 - (5) Establish the supply, custody and delivery system of water supply equipments and materials.
 - (6) Establish the survey methods and the standards for the selection of the targeted communities. Make the technical manuals.
 - (7) Conduct the educational programs on sanitation and maintenance and management of water supply system toward the inhabitants in the targeted communities.
 - (8) Follow-up the operating and managing circumstance of installed systems, and contribute technical and financial supports to ensure the appropriate operation and management of these systems.
- 3) All equipments used in this project, and all facilities completed by this project are public properties belonging to each prefecture. Therefore, the prefectures should bear responsibility for the management and maintenance of these equipments and facilities, and make efforts to perform technical support to the communities in order to ensure the adequate operation and management, the efficient use, the long life expectancy of these equipments and these facilities.

10.2.6 Information Management

- 1) The development of aquifers in deep location is the main target of this groundwater development project. But in Bolivia, the distribution and recharging mechanism of deep aquifers have not been known fully, due to the lack of data, and it is desirable that an overall study on groundwater should be conducted.
Moreover, in order to implement adequate and efficient management of the water supply facilities, and obtain necessary and effective data for the groundwater development project in the future, it is necessary to conduct groundwater monitoring, make the well inventory, collect, adjust and analyze the hydrometeorologic data, and also establish the system for the groundwater observation and maintenance and management of the groundwater using facilities.
- 2) The water supply database which was built up by this study, has the water supply blocks as the smallest unit, and is important and meaningful. In future, more efforts should be made to update the database, extend its use to the departments standing outside of the Study Area, utilize it in formulating the water supply plan, and in the management of groundwater development project in the whole nation.
- 3) In order to coordinate various water supply projects, which have individually carried out by the ex-CORDES, or by the foreign cooperation organization, or NGO etc., it is necessary to establish the information system to manage the informations on the contents, the implementing situation, etc. of these projects.

- 4) In consideration of the current water shortage in the areas outside of the Study Area, in order to be able to implement the same water supply project to remote mountain villages, and to the inhabitants who have not obtained water supply thought are living in the service area of a water supply system, the detailed surveys should be conducted immediately, in accompanying with the implementation of the development project.
- 5) More efforts should be made to conduct the follow-up surveys on the usage of the completed water supply systems, and to feed back the experienced lessons into the implementation of future project, and promote the interchange of technical knowledge between the persons in charge at the prefectural governments.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for transparency and accountability, particularly in financial reporting and auditing. The text notes that incomplete or inaccurate records can lead to significant errors and potential legal consequences.

2. The second part of the document outlines the various methods and tools used for data collection and analysis. It mentions the use of spreadsheets, databases, and specialized software to ensure that data is organized and accessible. The text also highlights the importance of regular data backups and security measures to protect sensitive information from loss or unauthorized access.

3. The third part of the document focuses on the process of data validation and quality control. It describes how to identify and correct errors, such as missing values, duplicates, and inconsistencies. The text stresses that high-quality data is crucial for making accurate and reliable decisions based on the information.

4. The fourth part of the document discusses the importance of data privacy and security. It outlines the necessary steps to ensure that data is stored and transmitted securely, in compliance with relevant regulations and standards. The text also mentions the importance of limiting access to data to only those individuals who need it for their work.

5. The fifth part of the document concludes by summarizing the key points and emphasizing the overall importance of a robust data management system. It encourages the reader to implement the best practices discussed throughout the document to ensure the integrity and security of their data.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for ensuring transparency and accountability in financial operations. This section also highlights the role of internal controls in preventing fraud and errors.

2. The second part of the document focuses on the implementation of robust risk management strategies. It outlines various risk assessment techniques and provides guidance on how to identify, measure, and mitigate potential risks. The text stresses the need for a proactive approach to risk management to protect the organization's assets and reputation.

3. The third part of the document addresses the importance of effective communication and reporting. It discusses the need for clear and concise communication channels and the role of regular reporting in keeping stakeholders informed. This section also touches upon the importance of maintaining accurate financial statements and the role of auditors in verifying the accuracy of these reports.

4. The fourth part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for ensuring transparency and accountability in financial operations. This section also highlights the role of internal controls in preventing fraud and errors.

5. The fifth part of the document focuses on the implementation of robust risk management strategies. It outlines various risk assessment techniques and provides guidance on how to identify, measure, and mitigate potential risks. The text stresses the need for a proactive approach to risk management to protect the organization's assets and reputation.

6. The sixth part of the document addresses the importance of effective communication and reporting. It discusses the need for clear and concise communication channels and the role of regular reporting in keeping stakeholders informed. This section also touches upon the importance of maintaining accurate financial statements and the role of auditors in verifying the accuracy of these reports.

7. The seventh part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for ensuring transparency and accountability in financial operations. This section also highlights the role of internal controls in preventing fraud and errors.

8. The eighth part of the document focuses on the implementation of robust risk management strategies. It outlines various risk assessment techniques and provides guidance on how to identify, measure, and mitigate potential risks. The text stresses the need for a proactive approach to risk management to protect the organization's assets and reputation.

9. The ninth part of the document addresses the importance of effective communication and reporting. It discusses the need for clear and concise communication channels and the role of regular reporting in keeping stakeholders informed. This section also touches upon the importance of maintaining accurate financial statements and the role of auditors in verifying the accuracy of these reports.

10. The tenth part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for ensuring transparency and accountability in financial operations. This section also highlights the role of internal controls in preventing fraud and errors.

[The page contains extremely faint and illegible text, likely bleed-through from the reverse side of the paper. No specific content can be transcribed.]



JICA