10. CONCLUSION AND RECOMMENDATIONS

10.1 Conclusion

10.1.1 Groundwater Potential of Sokoto State

(1) Aquifers

Groundwater in Sokoto State exists in both the basement rock area and the sedimentary rock area. In the basement rock area, mainly weathering zones of metamorphic rock located along faults and fractured zones forms good aquifer. In the sedimentary rock area, sedimentary rock composed of sandstone, limestone and clay of Cretaceous to Tertiary ages forms a multi-layered groundwater basin. The alluvium deposit in fadama also contains unconfined groundwater.

(2) Groundwater development in the basement rock area

Considering the properties of the aquifer as a standard for the specific capacity, the range is 5 - 40 m^3/day/m in the basement rock area and 50 - 150 m^3/day/m in the sedimentary rock area. This might not actually be called excellent aquifer, however it has adequate potential for the potable water supply objective set up for groundwater development.

In addition, although groundwater development is considered difficult in the basement rock area, if drilling is carried out with respect to the distribution thickness of the weathering zone based on hydrogeological study, success is guaranteed. According to the results of test drillings, the pumping rate of 70-40 ℓ/min is possible at a well with 90-100m depth and 100mm in diameter.

The weathering zone of the basement rock area is of irregular distribution, and the scale of the groundwater basin is small. Perennial yield from the groundwater basin, estimating from the groundwater recharge, is 140 m^3/day/km^2. As regards the preparation of groundwater development plans, it is necessary to consider this value as the upper limit standard.

(3) Groundwater development in the sedimentary rock area

In the sedimentary rock area, with the exception of one zone where the groundwater level is low, groundwater development is possible in the entire area. According to the results of test drillings, the pumping rate of 300 ℓ/m in is possible at a well with 100~150m depth and 150mm in diameter. The

groundwater basin yield must be evaluated in regards to the mining yield, however, as the groundwater basin is still under virgin condition, it is possible to withdraw groundwater without producing any undesirable results by proper allotment of the wells based on the assessment of the decline in the water level due to pumping.

10.1.2 Water Supply Project for Middle to Large Scale Villages

(1) Water supply for preferential 20 villages

Classifying the groundwater potential, shortage of water, water related diseases and accessibility, a water supply project by means of groundwater development was planned for 21 villages. The project costs for 20 villages excluding Horo Birni where the model water supply system constructed is estimated 10.7 billion Japanese Yen (7.65million U$) and the duration of construction is 30 months.

(2) Project evaluation

This project intends to supply water to the inhabitants of the middle to large scale villages in Sokoto State. The improvemnt of health environment, time savings and the activation of the community are major effects of the project and greatly contributes to the socio-economy of the rural area. In addition, the project has a validity in terms of operation and maintenance.

(3) Water supply program for other 26 villages

A tentative schedule and project costs for 26 villages excluded from detailed survey were prepared based on the results of the preliminary site survey (Appendix). This program should be executed when circumstances such as village accessibility, improved.

10.2 Recommendations

10.2.1 Groundwater Development and Management

(1) Preservation of Data

Basic data for the evaluation of groundwater resources are meteorological data, hydrogeological data, groundwater level records and borehole data (geological maps, logging records, pumping test records, hydrological data). These data should be collected continuously in the future and be input into the data base system established at the FDWR Sokoto Branch Office. The

cooperation and effort from the governmental and other agencies concerned are desired. In addition, in the future, legal and regulatory investigation is desired for groundwater management on a national level.

(2) Continuation of Discharge and Water Level Observation

It is necessary to continue the observation of stream discharge and groundwater level carried out in this study. The facilities for discharge observation are not functioning well at many stations. In order to continue observation, it is necessary to basically examine and assess the facilities for the entire Sokoto-Rima river basin.

(3) Groundwater Exploration

The success of well drilling depends on the results of the groundwater exploration. In particular, in the basement rock area, the drilling sites must be chosen based on the results of detailed hydrogeological survey and geophysical prospecting. This procedure offers positive results in drilling and is effective by its low cost. It is desirable for the concerned agencies to put to use the guidelines proposed in this study and to accumulate knowledge and experience in groundwater investigation.

(4) On-the-Job-Training

Groundwater development has its own comprehensive technology and the component technology are alone far-reaching, thus vast knowledge and experience are essential. Consequently, a necessary condition for the groundwater engineer is that he/she possess the technology which corresponds to the specialized fields of groundwater exploration, well drilling, pumping test, quantitative analysis, development and monitoring. In the future, it is expected that the concerned agencies choose the proper personnel for the detailed design stage and the construction stage of the project in order to bring up the level of the engineering staff through on-the-job-training.

10.2.2 Implementation of the Water Supply Project

(1) Project implementation

It is judged that the proposed project is feasible in a technical and socio-economical sense. It is also judged that the project has a high priority considering the retarded socio-economy in Sokoto State. Therefore, early

implementation of the project is recommended. Besides, the successive implementation of other 26 villages desirable.

(2) Operation and maintenance

It is recommended that the daily operation and maintenance be carried out by the water association composed of the village inhabitants. It is also desirable that the SSWB strengthen its financial and technical base in terms of the operation and maintenance of the water supply in the middle to large scale villages.

(3) Autonomous management of groundwater resources

Groundwater is a precious natural resource for the area in which it exists. It is a resource which might be developed and managed by experienced and knowledgeable surrounding inhabitants. It is desirable that the utilization and management of the groundwater resources be discussed and that research is done throughout the project implementation.

[Appended Table]

Water Supply Project Implementation Planning for the 26 Candidate Villages

upper : 10^8 yen
lower : U$

	Project cost \ Project year	Design	Construction			Total
		1st	2nd	3rd	4th	
Basement Rock Area (8 Villages)	1. Intake facilities	—	488	112	—	600
	(A:1,B:2,C:5 villages)	—	3,485,714	800,000	—	4,285,714
	2. Elavated tank (36 units)	—	120	32	—	152
		—	857,143	228,571	—	1,085,714
	3. Water distribution	—	41	16	—	57
	facilities (7 points)		292,857	114,286	—	407,143
	4. Rehabilitation (1 village)	—	—	—	—	—
		—	—	—	—	—
	Total (1～4)	—	649	160	—	809
		—	4,635,714	1,142,857	—	5,778,571
	5. Design & Supervision cost	50	10	—	—	60
		357,143	71,429	—	—	428,571
	Construction cost	50	659	160*	—	869
		357,143	4,707,143	1,142,587	—	6,207,143
Sedimentary Rock Area (18 Villages)	1. Intake facilities	—	—	103	194	297
	(A:2,B:4,C:6 villages)	—	—	735,714	1,385,714	2,121,429
	2. Elevated tank (18 units)	—	—	53	92	145
		—	—	378,571	657,143	1,035,714
	3. Water distribution	—	—	18	28	46
	facilities (10 points)	—	—	128,571	200,000	328,571
	4. Rehabilitation (6 villages)	—	—	20	20	40
		—	—	142,857	142,857	285,714
	Total (1～4)	—	—	194	334	528
		—	—	1,385,714	2,385,714	3,771,429
	5. Design & Supervision cost	—	40	20	20	80
			285,714	142,857	142,857	571,429
	Construction cost	—	40	214	354	608
		—	285,714	1,528,571	2,528,571	4,342,857
Ground project cost		50	699	374	354	1,477
		357,143	4,992,857	2,671,429	2,528,571	10,550,000

1. Estimated period : January 1990
2. Foreign currency exchange rate : 1 U$=140 Yen=7.4 Naira
3. Escalation is not considered.
4. * : Construction will be carried out in Birnin Yauri village.


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