procurement and transport of the equipment and materials, and for dispatch of the Japanese engineers. The Consultant, based on the approval by both Governments, shall make a tendering in Japan on behalf of GWSC. After opening the tenders, the Consultant shall evaluate the bidding, recommend the successful bidder to GWSC, and witness the negotiation and the contract between GWSC and the successful bidder.

It will take about 3.5 months from the E/N to the supplier contract, while about four months for procurement of equipment and materials and at least 2.5 months for ocean and inland transport will be necessary. The procurement of equipment/materials is, however, divided into two steps; a) procurement of equipment and materials for borehole construction which required immediately, as well as the cooperation on borehole construction, and b) also procurement of equipment and materials for the District Maintenance Centers which are not so urgently required compared to the former.

According to the works schedule, the construction works for the remaining 247 facilities under the Project will require 15.5 months to complete, so the implementation period of the Project will be around 26.0 months after the E/N. The Government of Japan shall cooperate in the construction of 166 borehole facilities in the Project areas by the dispatching of Japanese engineers for 12 months.

The operation and maintenance of the borehole facilities will be continued after completion of the Project implementation.

The implementation programme of the Project mentioned above is shown in Figure 4-6-1.

4-7. Project Cost

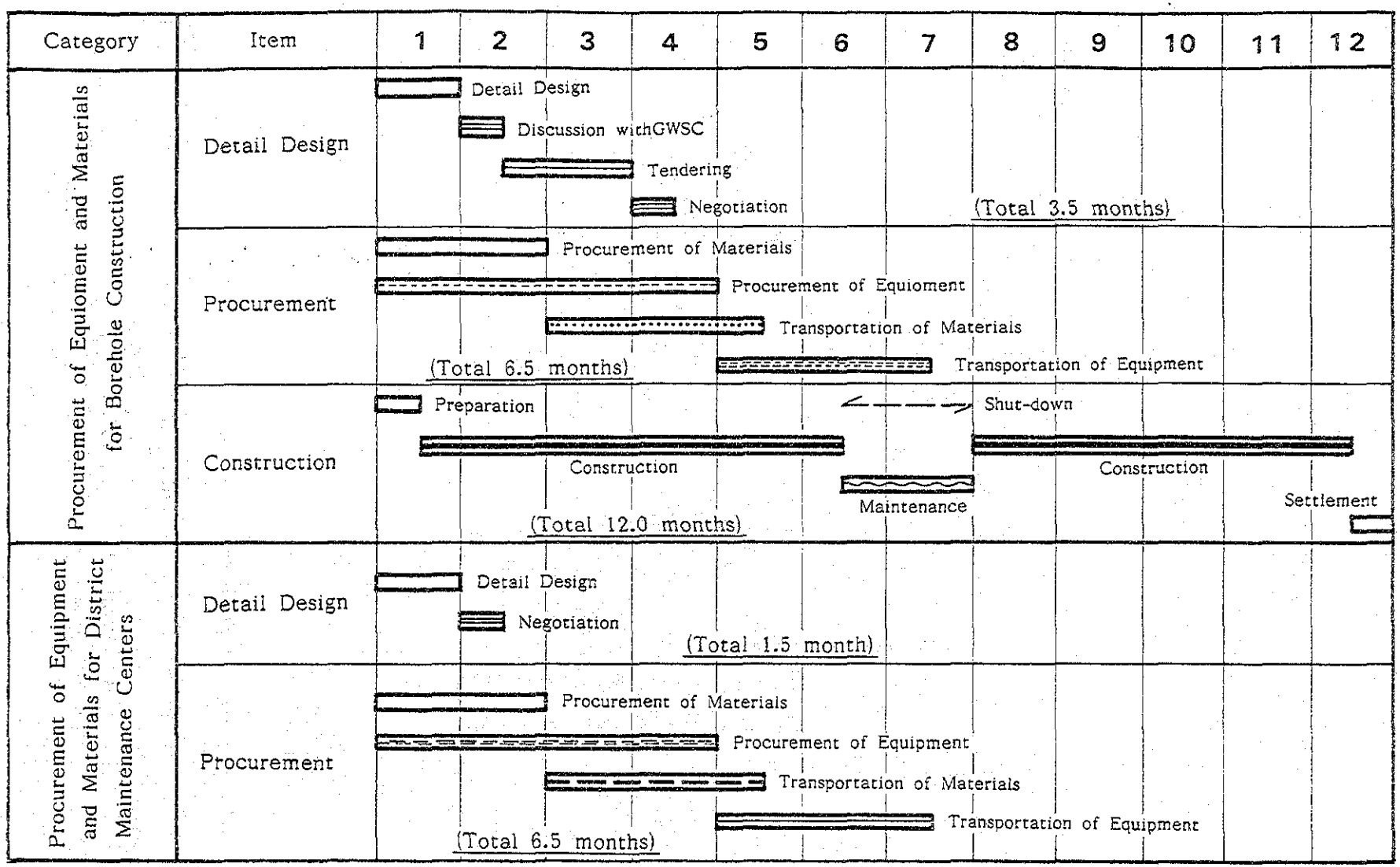
(1). The Project Implementation Cost

The Project implementation cost is roughly estimated as follows;

1) Remuneration	₡25,026,000.-	
2) Materials	₡26,426,000.-	
TOTAL	₡51,452,000.-	(¥24,681,000.-)

Figure 4-6-1.

IMPLEMENTATION SCHEDULE



The basis of the cost estimate are explained below and the detail process of the calculations are shown in Appendix-11.

(2). Bases of the Cost Estimate

The construction works shall be carried out on GWSC force account basis, and the Government of Japan shall assist GWSC in the construction of 166 out of a total of 307 borehole facilities for about one year.

The basic cost adopted for the cost estimation are released from GWSC as shown in Table-A (Remuneration and Labor Cost) and Table-B (Unit costs of Materials) both in the Appendix. The foreign exchange rate applied herein are as follows, based on the exchange index shown in Table-C.

US$ 1.00 = ₵ 302.0 = ¥ 145.0
₵ 1.0 = US$ 0.0033 = ¥ 0.48
¥ 1.0 = US$ 0.0067 = ₵ 2.08

General provision for the cost estimation are as follows;

Personnel

A total of 116 people will be engaged in the implementation of the Project as shown in the Personnel Plan. And five Japanese engineers will cooperate with them for about one year.

Construction Period

As described in the work schedule, the construction period for Ghanaian will be about 26.0 months.

Work Volume

- Construction of borehole facility	307 holes	(141)
- Drilling of borehole	411 holes	(190)
- Total drilling length	20,550 m	(9500)

() : to be done by GWSC alone.

CHAPTER 5. PROJECT EVALUATION AND CONCLUSION

5-1. Project Evaluation

First of all, it must be made clear that the expected impact and benefits depends on a combination of other factors. Safe water supply alone is not the solution. It should be complimented by the provision of latrines and more importantly a health education back-up. These complimentary activities will be taken care of in the follow-up programmes.

Improved community water supply and sanitation can have a wide-ranging health, economic, social and environmental impact on the lives of people particularly in the rural areas. Accrued benefits may include reduced morbidity and mortality, higher productivity and income, and the relief of women and children from the drudgery of carrying water over long distances. In addition to direct human benefits, there can also be positive effects at the community and national levels, especially when water and sanitation programmes form part of, or help to trigger wider development efforts. Some of these expected impacts are such that rigorous economic justification cannot be formulated. The merits proposed therefore rest on an empirical assessment of the anticipated benefits.

The Project Phase-II is just included into "6000 Drilled Wells Programme" (1987-1991) and it is taking an important principle that it will cover the most remote and undeveloped districts in the country. The direct benefits to be borne by the Project, as mentioned above, are finally summarized as follow:

(1) The stable and healthy potable water supply, together with improved sanitation environment, can mitigated the high occurrence rate of water-borne diseases, in particular the infant mortality rate, as well as alleviate the heavy burden of medical expenditure of the rural people.

(2) The effective allocation of borehole facilities can remarkably alleviate the home labor wasted in water fetching work.

(3) The stable and healthy potable water supply can stabilize and raise the living standard of the rural inhabitants.

And in addition, the following ripple effects can be expected:

(4) The surplus labor forces created from above mentioned (1) and (2) can be reallocated to productive activities like agriculture and it can contribute to the development of the local economy or the national economy finally.

(5) The communication of inhabitants and the solidarity of communities can be strengthened through and centering on the borehole facilities.

Furthermore, the durable equipment such as drilling rigs, supporting equipment and vehicles supplied under the Japanese grant aid, can contribute to the construction of more borehole facilities even after completion of the cooperation or the Project. These construction works, as well as the latest technology transferred to the Ghanaian staff through the Project, will be quite helpful and effective for the early realization of an improvement to the rural water supply condition.

5-2. Conclusion

As mentioned so far, the Project aims to provide potable water supply facilities to the rural people who are suffering from the drudgery of carrying water and the high occurrence of water-borne diseases because of a lack of adequate water supply system. The Project is very significant in this meaning that it will meet to such a basic human needs of the rural people.

Then, the Project includes not only the provision of water supply facilities (boreholes equipped with hand-pumps) but to provide equipment and materials required in the construction as well as the latest technology transferred from the Japanese engineers. Thus, the Project aims also to provide and strengthen the fundamentals of GWSC for their own water supply development, which fits to the national policy with the highest priority.

Furthermore, the benefits for the wide range, mentioned in the previous section, are expected when the Project is implemented.

Besides the aforesaid direct and indirect benefits to meet the

human needs and socio-economic requirements, it can be considered that the friendly relationship between two countries will be strengthen and firmly established, and such being the case, the Project is quite sound and feasible for implementation under the Japanese grant aid assistance.

5-3. Recommendations

The Study Team recommends the Ghanaian authorities concerned to pay attention on the following matters for successful implementation of the Project.

(1). The materials and staffs required to complete the remaining 141 borehole facilities after the Japanese cooperation should be procured/mobilized under the full responsibility of the Ghanain authorities concerned and supplied without any undue delay to the schedule with appropriate budgetary support including foreign exchange allocation.

(2). As many staffs as possible who are to be assigned to the O&M services of the borehole facilities should be engaged in the borehole construction works. And one of these civil engineers of the civil works party should be selected as the chief of the District Maintenance Center to be provided in the Project.

(3). Educating rural people on the public health and sanitary environment is very important to realize the full benefits of the Project. Although these complemental programmes are under mainly the Ministry of Health, GWSC also should take necessary and appropriate measures as early as possible for public education to the beneficiaries of the Project in close cooperation with the aforesaid authorities and agencies.

(4). The borehole facilities are essentially public properties in close relation with the health and daily life of the rural people, and be of benefit for a long time by careful and effective maintenance with reasonable expenditure. For the beneficiaries to have full understanding on the matter, it is considered that the best way is to have the beneficiaries carry out routine maintenance of the facilities themselves. In such consideration, it is recommended to complete and expand the "VLOM" Programme as early as possible.

(5). The durable equipment supplied under the Project, such as drilling rigs and vehicles etc., should be available after completion of the Project for at least two or three years. Therefore it is recommendable to formulate further rural water supply projects with own budgetary source along the national development plan for rural populations still without adequate water supply.

Appendix

1. Member List of the Study Team
2. Itinerary of the Field Survey
3. Organizations and Related Officials contacted
4. Minutes of Discussions on the Project
5. List of Equipment,Materials & Services requested
6. Contents of the Revised Request
7. List of the Target Communities
8. Location Map of the Target Communities
9. Groundwater Quality Table
10. Water Quality Designation
11. Basis of the Ghanaian Project Cost
12. Geological Map of Ghana

Appendix－1　Member list of the Study Team

Basic Design Study on the Rural Water Supply Project (Phase II)
in
The Republic of Ghana

Member List of the Survey Team

Position	Name	Firm
Team Leader	Akira KONO	First African Division, Middle Eastern/African Affairs Bureau, Ministry of Foregn Affairs.
Grounwater Development / Chief Engineer	Ryoichi KAWASAKI	SAnyu Consultants Inc., Tachnical Laboratory.
Drilling Equipment/ Hydrogeology	Makoto UOTANI	Sanyu Consultants Inc., Technical Laboratory.

Appendix－2　Itinerary of the Field Survey

Date/Day	Work Schedule	Stay
Nov. 26 (Sun)	Leave Tokyo for London (BA 008/13:40/17:35)	London
27 (Mon)	Leave London for Ghana (BA 079/11:00/19:15)	Accra
28 (Tue)	Coutesy call to EOJ, MFEP, GWSC, etc.	"
29 (Wed)	Meeting at GWSC, explanetion of Inception Report and preparation of Field Inspection.	"
30 (Thu)	Move to Kumasi, meetin at Drilling Unit.	Kumasi
Dec. 1 (Fri)	Move to Sunyani, discussion meeting at Regional Office of Brong Ahafo Region.	Sunyani
2 (Sat)	Field Inspection for Berekum/Jaman District, visiting to the Base Camp.	"
3 (Sun)	-ditto-, then return back to Kumasi.	Kumasi
4 (Mon)	Discussion meeting with Drilling Unit, return back to Accra.	Accra
5 (Tue)	Discussion meeting with GWSC Headquarters, moving to Secondi, meeting with Regional Office of Western Region.	Secondi
6 (Wed)	Move to Wiawso.	Wiawso
7 (Thu)	Field Inspection for Sefwi-Wawso District	"
8 (Fri)	-ditto-, then return to Accra through Secondi to meet with Regional Office.	Accra
9 (Sat)	Inner meeting with Team Leader.	"
10 (Sun)	Field Inspection for Western Region with Team Leader, then inner meeting.	"
11 (Mon)	Discussion meeting Rural Water Division at GWSC Headquarters.	"
12 (Tue)	-ditto-, Signing on the Minutes of Discussions, reporting to EOJ and MEFP. TeamLeader left Accra.	"
13 (Wed)	Data collection at GWSC, ISD, MSD, CSIR, etc., reporting to JICA, Ghana.	"
14 (Thu)	Data collection at GWSC, SD, GSD, etc., coutesy call to EOJ.	"
15 (Fri)	Leave Accra for London (BA 078/08:00/16:45)	London
16 (Sat)	Leave London for Japan (JL 402/19:00)	(plane)
17 (Sun)	Arrival at Tokyo (15:50).	

Appendix－3

Organizations and Related Officials Contacted

A. Embassy of Japan (EOJ)

1. H.E. Mr. S. ANDO	Ambassador
2. Mr. S. NISHIMURA	Counselor
3. Mr. H. KIKUCHI	First Secretary
4. Mr. T. OTSUKI	Special Assistant
5. Mr. K. AKIYAMA	Information Officer

B. JICA, Ghana

1. Mr. T. NAGAKURA	Director
2. Mr. S. MIURA	Deputy Director

C. Ministry of Finance and Economic Planning (MFEP)

1. Mr. Samuel K. KABO	Principal Economic Planning Officer
2. Mr. Michel BADOO	Economic Planning Officer
3. Mr. OPOKU	Asst. Economic Planning Officer

D. Ghana Water and Sewerage Corporation (GWSC)

Headquarters, Accra

1. Mr. T.B.F. Acquah	Managing Director
2. Mr. E.N.A. Archampong	Ag. Deputy Managing Dirtector Director of Operations and Maintenance
3. Mr. P.O. Sackey	Director of Rural Water Supply
4. Mr. Clement A. KWEI	Principal Hydrogeologist
5. Mr. Emmanuel NKRUMA	Hydrogeologist

Drilling Unit, Kumasi

1. Mr. A.D. Gyamfi	Drilling Engineer

Project Base Camp (Drobo, Jaman District)

1. Mr. A.D. Van-Ess	Project Manager
2. Mr. T.M.K. OSEI	Site Manager
3. Mr. Daniel AMANKWAA	Asst. Hydrogeologist
4. Mr. M.K. OBOUR	Superintendant
5. Mr. Kwame OFRI	Artisan (Mechanic)
6. Mr. Chales OWUSU	Artisan (Electric)

D. GWSC cont.

Regional Office, Sunyani

1. Mr. J.N.A. NUMOO	Regional Director
2. Mr. J.F. BAFFOE	Mechanical Engineer

Regional Office, Takoradi

1. Mr. K. AKATOR	Regional Director
2. Mr. R.S. NAMPUSUOR	Regional Engineer
3. Mr. H. ADO-POKU	Project Engineer

3000 Wells Maintenance Unit

1. Mr. E.F. BOATENG	Co-Manager, Accra
2. Mr. Evans E. AIDOO	Supervisor, Takoradi
3. Mr. KANKAM	Supervisor, Kumasi

E. District Office

1. Mr. B.K. DARKO	PNDC District Secretary, Juabeso-Bia District
2. Mr. AMOA	PNDC District Secretary, Sefwi-Wiawso District

Appendix—4 Minutes of Discussions on the Project

MINUTES OF DISCUSSIONS
ON
THE PROJECT FOR RURAL WATER SUPPLY (PHASE II)
IN
THE REPUBLIC OF GHANA

In response to a request from the Government of the Republic of Ghana, the Government of Japan decided to conduct a Basic Design Study on the Project for RURAL WATER SUPPLY (PHASE II) (hereinafter referred to as "the Project"), and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to the Republic of Ghana the study team headed by Mr. Akira Kono, First African Division, Middle Eastern and African Affairs Bureau, Ministry of Foreign Affairs, from November 26 to December 17, 1989.

The team had a series of discussion on the Project with officials concerned of the Government of the Republic of Ghana headed by Mr. P.O. Sackey, Director of Rural Water Supply, Ghana Water & Sewerage Corporation and conducted a field survey in the Project related places.

As a result of the study, both parties agreed to recommend to their respective Governments that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the Project.

Accra, December 12, 1989

Akira Kono
Leader of Mission, JICA

T.B.F. Acquah
Managing Director/G.W.S.C.

MAJOR POINTS OF UNDERSTANDING

OBJECTIVE

1. The objectives of the Project are to construct 307 boreholes equipped with manual pumps and to provide the necessary equipment/materials for borehole drilling and maintenance in the rural area in order to develop healthy potable water and to improve the standard of living of the rural inhabitant.

PROJECT SITE

2. The Project area is to be the following five districts:

Berekum and Jaman Districts	Former Berekum/Jaman District
Juabeso-Bia District)	
Bibiani-Anhwianso-Bekwai District)	Former Sefwi-Wiawso District
Sefwi-Wiawso District)	

REQUEST

3. The Project components requested by Ghanaian side are as follows:
   1) Provision of Spare parts and equipment/materials for borehole construction
   2) Provision of equipment and materials for District Maintenance Centers
   3) Provision of services for the implementation of the Project.

EXECUTING AGENCY

4. Ghana Water & Sewerage Corporation has responsibility for the administration and execution of the Project.

JAPAN'S GRANT AID SYSTEM

5. Ghana Water & Sewerage Corporation has understood Japan's Grant Aid System explained by the team which includes a principle of usage of a Japanese Consultant firm and a Japanese General Contractor for the construction and supply of materials.

UNDERTAKING OF THE GOVERNMENT OF JAPAN

6. The team will convey to the Government of Japan the desire of the Government of the Republic of Ghana that the former takes necessary measures to co-operate in construction of facilities and equipment and material supply within the scope of Japan's Grant Aid Program.

UNDERTAKING OF THE GOVERNMENT OF THE REPUBLIC OF GHANA

7. The Government of the Republic of Ghana will take necessary measures listed in ANNEX I, as proposed by the team on condition that the Japan's Grant Aid would be extended to the Project.

A N N E X I

1. To acquire the land or the right-of-way required for the Project implementation.

2. To ensure the land or right-of-way necessary for construction of the temporary access roads from existing rural roads to the proposed construction sites.

3. To allow transportation of vehicles, machinery and construction equipment on the existing national and rural roads.

4. To exempt import duties and incidental expenses which may be imposed in the Republic of Ghana and to take necessary measures for customs clearance of the products brought to for the implementation of the Project.

5. To assume commissions to the Japanese foreign exchange bank for banking services based on the banking arrangement as follows:

   5.1 Advising Commission Authorization to Pay
   5.2 Payment Commission

6. To accord Japanese nationals whose services may be required in connection with the supply of products and service under the verified contracts, such facilities as may be necessary for their entry into and stay in Ghana for the performance of their work.

7. To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in Ghana with respect to the supply of products and services under the verified contracts.

8. To bear all the expenses, other than those to be borne by the Grant Aid, necessary for the implementation of the Project.

9. To fully maintain the facilities which are constructed under the Project.

Appendix—5 List of Equipment, Materials & Services requested

Item No.	Description	Quantity
1.	Equipment and Materials	
1.1	For the Borehole Construction	
1.1.1	Casing materials 4" x 4m	3,200 units
1.1.2	Strainer 4" x 4m	1,600 units
1.1.3	Hand pumps	400 units
1.1.4	Supplemetal drilling tools	1 lot
1.1.5	Spare parts for supplied equipment for 2.5 years operation	1 lot
1.1.6	Spare parts for Geophysical and E.M equipment	1 lot
1.1.7	Bentnite	160 tons
1.1.8	CMC	1.5 tons
1.2	For the District Maintenance Center	
1.2.1	Servicing rig	3 units
1.2.2	Pick-up (4WD)	3 units
1.2.3	Work-shop equipment & tools	2 lots
1.2.4	Spare parts for the above for 2.5 years operation	1 lot
1.3	For Percussion Drilling rig	
1.3.1	Truck mounted percussion drilling rig	2 units
1.3.2	Standard accessories & tools	2 lots
1.3.3	Air-Compressor	2 units
1.3.4	Cargo truck (8tons capacity)	2 units
1.3.5	Station Wagon (4WD)	2 units
1.3.6	Pick-up (4WD)	2 units
1.3.7	Trailor mounted water lorry	2 units
1.3.8	Spare parts for the above for the 2.5 years operation	1 lot
	Truck mounted rotary drilling rig Package	
	Transportation	

Item No.	Description	Quantity
2	Services	
2.1	Consultancy Services	
2.1.1	Services for procurement	4 man/month
2.1.2	Supervising engineer	12 man/month
2.1.3	Hydrogeologist	12 man/month
2.2	Expertise Services	
2.2.1	Senior mechanical engineer	24 man/month
2.2.2	Senior driller	24 man/month
2.3	Construction Materials	
2.3.1	Equipment	1 lot
2.3.2	Camping and Transport	1 lot
2.3.3	Fuel	1 lot
2.3.4	Oil & Grease	1 lot
2.3.5	Gravel	1 lot
2.3.6	Cement	1 lot
2.3.7	Sand	1 lot
2.3.8	Other materials	1 lot

Appendix—6 Contents of the Revised Request

Item No.	Description	Quantity
1.	EQUIPMENT AND MATERIALS	
1.1	For the Borehole Construction	
1.1.1	Casing materials 4" x 4m	3,377 units
1.1.2	Strainer 4" x 4m	1,689 units
1.1.3	Hand pumps	354 units
1.1.4	Supplemetal drilling tools	1 lot
1.1.5	Spare parts for supplied equipment for 3 years operation	1 lot
1.1.6	Spare parts for Geophysical and E.M equipment	1 lot
1.1.7	Bentnite	160 tons
1.1.8	CMC	1.5 tons
1.2	For the District Maintenance Centers	
1.2.1	Servicing rig	3 units
1.2.2	Pick-up (4WD)	3 units
1.2.3	Work-shop equipment & tools	2 lots
1.2.4	Hand Pump	30 units
1.2.5	Hand Pump Cylinder	30 units
1.2.6	Submersible pump	3 units
1.2.7	Diesel Generator	3 units
1.2.8	Motor Cycles	9 units
1.2.9	Spare parts for the above for 3 years operation	1 lot
1.3	For Rotary Drilling Rigs	
1.3.1	Truck mounted rotary drilling rig	2 units
1.3.2	Standard accessories & tools	2 lots
1.3.3	Operating tools for DTH drilling	2 lots
1.3.4	Operating tools for rotary drilling	2 lots
1.3.5	Fishing,casing and other miscellaneous tools	2 lots
1.3.6	Air-Compressor	2 units
1.3.7	Cargo truck (8 tons capacity)	2 units
1.3.8	Station Wagon (4 WD)	2 units
1.3.9	Pick-Up (4WD)	2 units
1.3.10	Truck mounted water lorry	2 units
1.3.11	Spare parts for the above for 3 years operation	1 lots

Item No.	Description	Quantity
2	SERVICES	
2.1	Consultancy Services	
2.1.1	Services for procurement	4 man/month
2.1.2	Supervising engineer	12 man/month
2.1.3	Hydrogeologist	12 man/month
2.2	Expertise Services	
2.2.1	Senior mechanical engineer	24 man/month
2.2.2	Senior driller	24 man/month
2.2.3	Study tour of 3 GWSC Engineers to Japan	6 man/week
2.2.4	Air tickets	3
2.3	Construction Materials	
2.3.1	Equipment	1 lot
2.3.2	Camping and Transport	1 lot
2.3.3	Fuel	1 lot
2.3.4	Oil	1 lot
2.3.5	Grease	1 lot
2.3.6	Gravel	1 lot
2.3.7	Cement	1 lot
2.3.8	Sand,etc.	1 lot
2.3.9	Other materials	1 lot

Appendix-7 List of the Target Communities

BEREKUM DISTRICT

No.	TARGET COMMUNITY	POPULATION 1990*	EXISTING BOREHOLES	PLANED BOREHOLES
1	NKYENKYEMAN	707	0	2
2	NENESUANO	567	0	1
3	NKANRANKA	695	0	2
4	KATO	2,320	2	4
5	KORASO	3,421	2	4
6	NANTEASEM/HENEKROM	1,073	0	3
7	TWUMASIKROM	505	0	1
8	BOBOKROM	1,056	1	2
9	MPARASE	1,264	0	3
10	DORNEABRA/AMPENKRO	548	0	1
11	BODOA	489	0	1
12	ANYINASU	420	0	1
13	KUTRE II	401	0	1
14	SENASE	3,200	0	4
15	BIADAN	2,750	0	3
16	ABI	480	0	1
17	BEREKUM SUBURB	4,270	1	3
18	FETENTA	1,400	2	1
19	NSAPOR	2,050	3	1
20	KYEREYAWKROM	560	0	1
21	MANTUKWA	410	0	1
22	AKROFRO	1,300	0	1
23	AMANKOKWA	490	0	1
TOTAL	23 COMMUNITIES	30,376	11	43

* ...Estimated, Based on 1984

JAMAN DISTRICT

No.	TARGET COMMUNITY	POPULATION 1990*	EXISTING BOREHOLES	PLANED BOREHOLES
1	ABRIKASU	862	0	3
2	BUOBUNU	568	0	2
3	KOMFORKROM	824	1	1
4	KONSIA	1,387	0	2
5	DODOSUO	1,351	0	3
6	BAANO No.1	740	1	1
7	BAANO No.2	772	1	1
8	KWAMESEIKROM	1,680	0	1
9	BORDER POINT	420	0	1
10	SEBRENI	1.035	0	3
11	GONASUA	2,502	0	5
12	BABIANIHA	2,890	1	2
13	BASAKROM	415	0	1
14	KOJOKESEKROM	485	0	1
15	BATEA	430	0	1
16	KWAMEPRAKROM	444	0	1
17	DROBO	1,701	1	4
18	KOFUKO	666	0	1
19	FAAMAN	1,352	0	2
20	JENJEMIREJA	1,085	0	3
21	MERMANO	1,165	1	2
22	BUNI	1,404	0	1
23	NYAMEFIE	655	0	2
24	ABUOKROM	588	0	2
25	ASUOGYA	626	0	1
26	BAADWE	415	0	1
27	TEKESE/NKOTOTUA	558	0	1
28	APENKRO/ASRATUA	529	0	1
29	GYANKUFA	1,072	0	1
30	ASIRI	2,662	0	1
31	TAINANO NO.2	620	0	1
32	ZEZERA	2,266	0	5
33	ASUOKOR	2,151	3	2
34	ASEMPANEYA	1,121	1	2
35	GOKA	3,627	0	2

JAMAN DISTRICT

No.	TARGET COMMUNITY	POPULATION 1990*	EXISTING BOREHOLES	PLANED BOREHOLES
36	ABENKRO	433	0	1
37	NSONSOMEA	648	0	1
38	SEKETIA	1,234	1	1
39	BODAA	788	0	1
40	KOKOA	2,276	1	2
41	MORLE	969	1	1
42	KOKOSUA No.1	1,026	0	2
43	KOKOSUA No.2	563	0	1
44	BONAKERI	783	0	1
45	ADADIEM	1,046	0	2
46	KABILE/BUKO	1,480	0	3
47	JAMERA	1,716	0	1
48	ADIOKOR No.2	1,654	0	3
49	YAW TWENEKROM	411	0	1
50	ADIOKOR No.1	495	0	1
51	JININI	780	0	2
52	MPUASU	1,632	0	2
53	ATUNA	2,416	0	2
54	ABOTAREYE	477	0	1
55	KOTI	420	0	1
56	GONASUA	435	0	1
57	BAANAFUO	480	0	1
58	KWASIBUOKROM	2,001	1	2
59	KATAKYIEKROM	2,287	0	2
TOTAL	59 COMMUNITIES	67,518	14	100

JUABESO-BIA DISTRICT

No.	TARGET COMMUNITY	POPULATION 1990*	EXISTING BOREHOLES	PLANED BOREHOLES
1	AHIBENSO	1,337	0	3
2	AMOYAW	1,567	0	4
3	KWASIKROM	1,113	0	3
4	SANTAASE	871	0	2
5	PATAKRO	864	0	2
6	ANTOBIA	1,119	0	3
7	JUABESO	1,924	1	4
8	SUIANO	684	0	2
9	KWAFUKAA	887	0	2
10	SEFWI-NKWANTA	938	0	2
11	SEFWI-KOFIKROM	679	0	2
12	SEFWI-PRASO	875	0	2
13	BENKASA	1,835	0	5
14	ADJUAFRA	2,104	4	1
15	MAFIA ROMAN	993	0	2
16	KANTANKRUBO	586	0	2
17	KOJINA	754	0	2
18	ETESO	658	0	2
19	ASEMPANAYE	923	0	2
20	ELLUOKROM	836	0	2
21	NEW TECHIMAN	881	0	2
22	PAMPRAMASE	1,015	0	3
23	SIF SIKAFREMOGYO	860	0	2
24	KOJO FOSOKROM	1,124	0	3
25	NEW BREKUM	749	0	2
26	OLD DEBISO	999	0	2
27	ESSEM	2,173	3	2
28	KWAME BIKROM	1,460	0	4
29	KOJO ABA	1,003	0	3
30	KAASE	831	0	2
31	ABABOKROM	1,535	0	4
32	KWAM TAWIAKROM	1,213	0	3
33	PAPASE	947	0	2
34	KWASAREKROM	878	0	2
35	KOFIKROM	626	0	2
36	KOJOKROM	684	0	2
TOTAL	36 COMMUNITIES	38,525	8	89

SEFWI-WIAWSO DISTRICT

No.	COMMUNITY	POPULATION 1990*	EXISTING BOREHOLES	PLANED BOREHOLES
1	ADU AKURAA	1,247	0	3
2	AKWANTAMBRA	2,009	0	5
3	KWAME ABRAHAM	1,060	0	3
4	APRUTU	784	0	2
5	TIKOBO	663	0	2
6	BOKABO	784	0	2
7	SEFWI-ACHIACHEM	709	0	2
8	KWASI AKRUMAH	601	0	2
9	ASANTEKROM	631	0	2
10	NAFIADU	805	0	2
11	BOPA	808	0	2
12	SEFWI-EWIASE	919	0	2
13	ASANTEMAN	613	0	2
14	EDUMAFUA	1,172	0	3
15	AKWADUM	875	0	2
16	ASAMOAKROM	597	0	2
17	NKONYA DONKORKROM	661	0	2
18	KOKOKROM	1,173	0	3
19	PABOASE	667	0	2
20	PUNIKROM AYEBOOSO	1,559	0	4
21	BUAKO	2,226	0	6
22	SEFWI CAMP	769	0	2
23	NKWADUMU	857	0	2
24	SUI	1,074	0	3
25	ENYINABRIMU	1,603	0	4
26	BEKYIMA	965	0	2
27	AHOKWAA	910	0	2
28	ADIEMBRA	658	0	2
TOTAL	28 COMMUNITIES	27,399	0	72

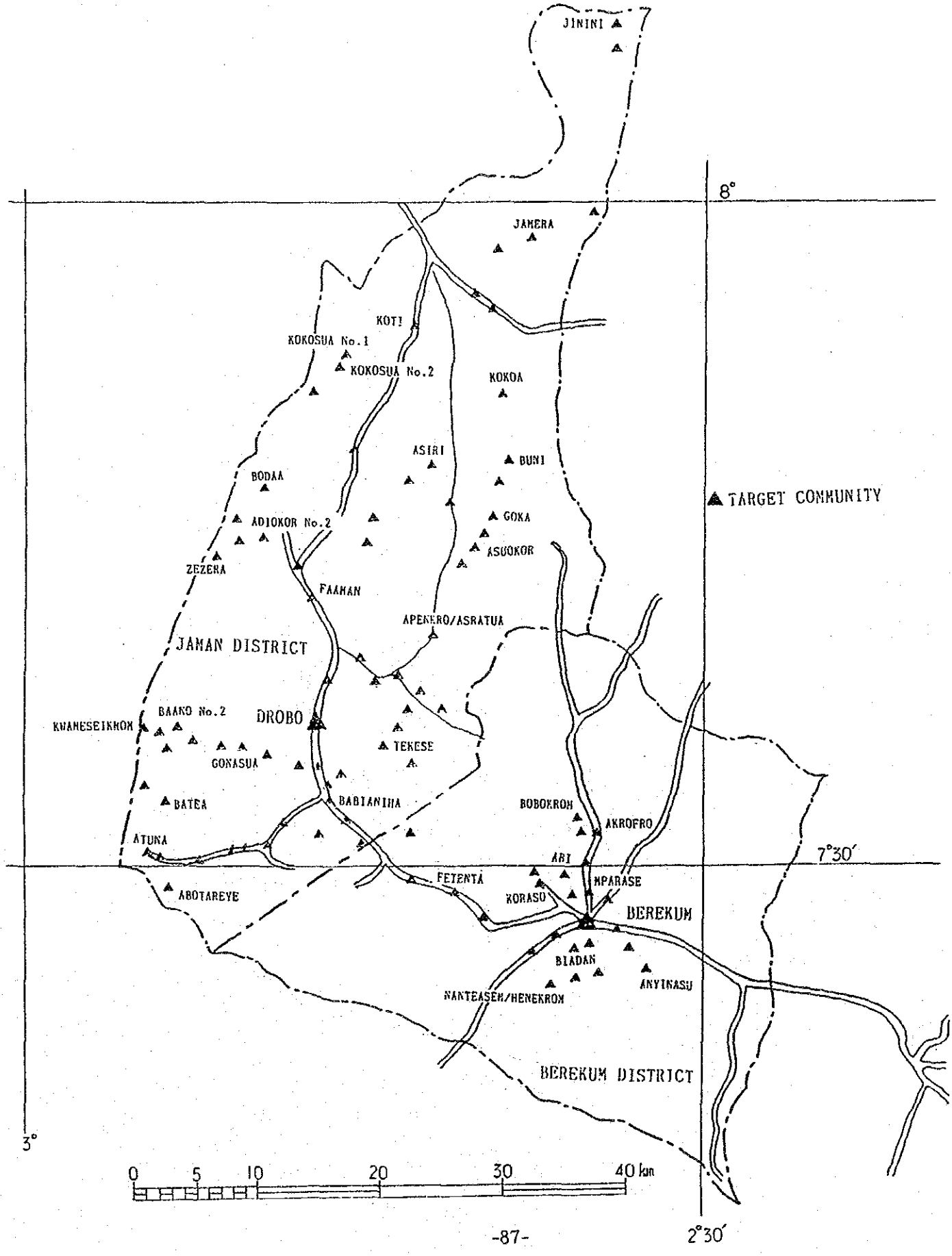
BIBIANI-ANHWIASO-BEKWAI DISTRICT

No.	TARGET COMMUNITY	POPULATION 1990*	EXISTING BOREHOLES	PLANED BOREHOLES
1	KOFI AKAAKROM	1,173	0	3
TOTAL	1 COMMUNITY	1,173	0	3

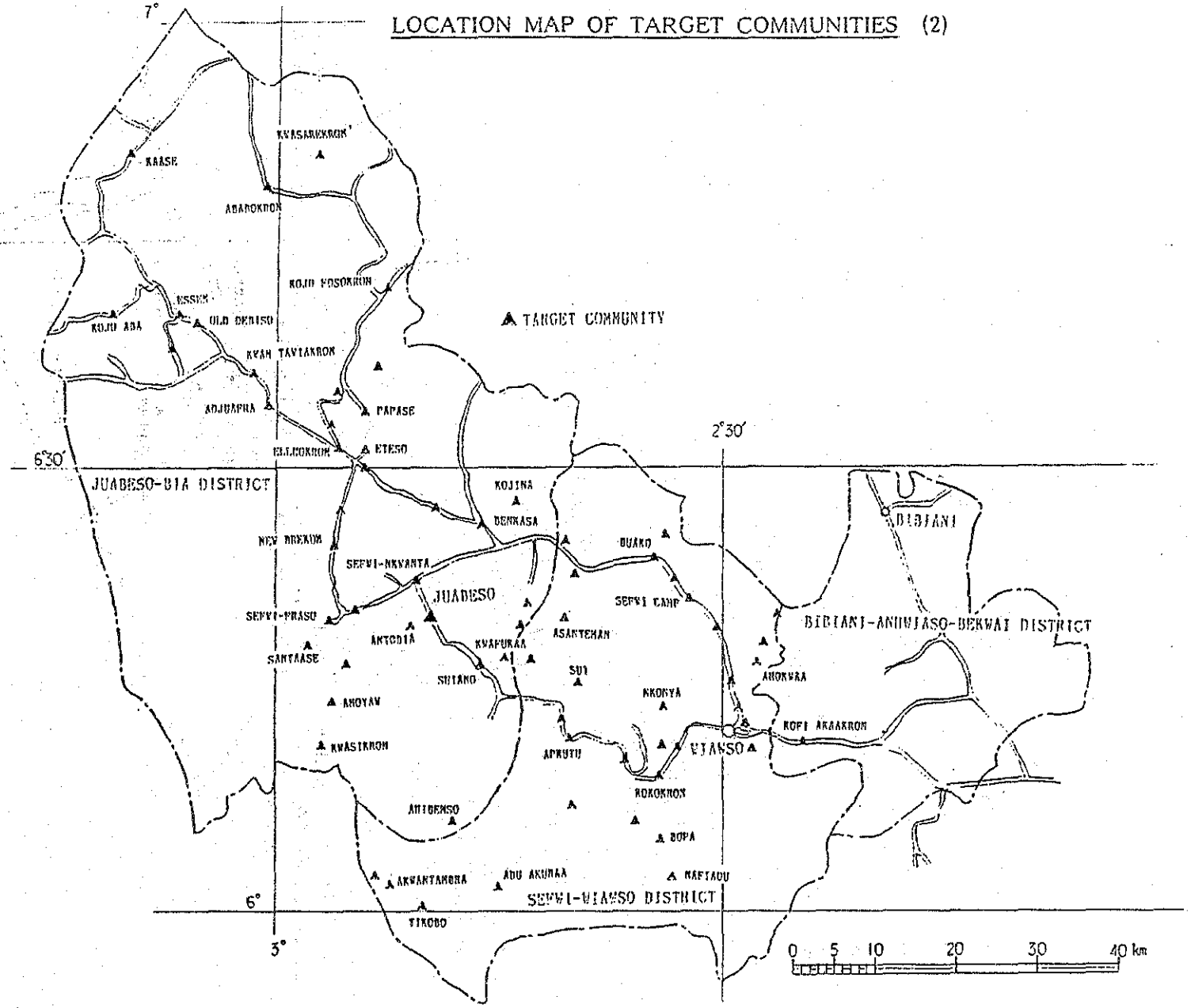
GRAND TOTAL

DISTRICT	COMMUNITY	POPULATION 1990*	EXISTING BOREHOLES	PLANED BOREHOLES
BEREKUM	23	30,376	11	43
JAMAN	59	67,518	14	100
JUABESO-BIA	36	38,525	8	89
SEFWI-WIAWSO	28	27,399	0	72
BIBIANI-ANHWIASAO-BEKWAI	1	1,173	0	3
GRAND TOTAL	147	164,991	33	307

Appendix--8 LOCATION MAP OF TARGET COMMUNITIES (1)



LOCATION MAP OF TARGET COMMUNITIES (2)



Appendix—9 Groundwater Quality Table

Region	Community	Temp. (°C)	E.C. (μS/cm)	pH	Alkalinity ($CaCO_3$) (mg/l)	Total Hardness (mg/l)	Total Fe (mg/l)	Nitrate (mg/l)	Cl (mg/l)	Mn (mg/l)	Mg (mg/l)	Ca (mg/l)	SiO_2 (mg/l)	HCO_3 (mg/l)	SO_4 (mg/l)	F (mg/l)	T.Dislved Solid (mg/l)	Data from
PROJECT SITE	Abrikasu	27.6	197	5.9														GWSC
	Buobunu	27.8	202	6.2														"
	Meremano	27.3	137	5.6														"
	Nyamefie	27.1	204	5.0														"
	Baanafuo	29.2	89	5.0														"
	Average	27.8	165.8	5.54	—	—	—	—	—	—	—	—	—	—	—	—	—	
BRONG AHAFO	Dwenen		350	6.9	228	230	0.25	nil	12.0	0			1600			nil		GWSC
	Nkrakwanta	24.8	375	6.9	154	116	0.10	0.01	6.0	0	0.97	44.8	28.8	92.4	1.64	"	262.0	"
	Kukuem,B6			7.08	277	292	*0.50	0.5	21.0	0	20.4	*83.2	8.0	166.2	1.8	"	39.0	"
	-do- ,B3	26.0	480	6.3	190	201	0.25	0.4	26.0	trace	22.3	42.0	2.8	37.9	nil	"	415.6	"
	-do- ,B1			6.3	77	53	0.1	2.0	7.0	0	1.5	10.8	40.0	46.2	1.1	"	203.0	"
	Koraso	26.7	48	6.31	30	25	0.01	1.2	7.0	0								3000 WELLS
	Berekum	26.5	83	7.06	80	13	0.02	1.0	12.0	*1.7								"
	Kato	25.0	275	6.82	60	52	0.02	1.0	76.0	0.05								"
	Drobo	25.9	79	6.71	20	32	0.02	0.4	19.0	0.15								"
	Mperasi	24.8	362	8.43	190	138	0.01	1.3	30.0	0.25								"
	Domfete	24.9	59	6.56	30	20	0.01	1.5	10.0	0.1								"
	Nsapo	24.5	140	6.95	85	50	0.01	1.1	6.0	0								"
	Anyimom	24.7	85	6.52	22.5	40	0.01	4.5	11.0	0.1								"
	Jamdere		65	6.72	35	30	0.01	3.5	8.0	0.25								"
	Adom	26.0	160	6.53	90	45	0.05	3.7	17.6	*4.00								"
	Average	25.4	182.2	6.81	104.6	89.1	0.09	1.47	17.9	*0.44	11.3	45.2	19.7	85.7	1.14	nil	229.9	
WESTERN	Aboduamu	24.8	123	6.54			*2.50	0.4	9.2	0								3000 WELLS
	Punikrom	26.5	130	5.98			0.08	1.0	11.0	0								"
	Amhfia	27.0	171	6.48			0.2	0.6	9.5	0.1								"
	Futa	26.1	453	6.84			0.25	8.6	28.0	0.2								"
	Bosomooso	26.5	242	6.28			0.16	7.1	21.0	0.1								"
	Amafia	26.3	191	6.65			0.01	1.2	9.4	0.1								"
	Wenchi	25.7	572	6.67			*1.7	0.1	75.0	0.1								"
	Datano	26.7	120	6.07			*0.7	0.6	13.0	0.3								"
	Kunkunso	25.9	350	6.51			*0.62	0.6	16.0	0.2								"
	Pataboso	27.5	169	6.06			0.08	0.4	22.5	0								"
	Average	26.3	252.1	6.41	---	---	*0.63	2.06	21.5	0.11	—	—	—	—	—	—	—	

* : Exceeding WHO designation

Appendix—10 Water Quality Designation

Items (stipulated in ST-108)	JAPAN	WHO
1) Turbidity	less than 2	—
2) Color	less than 5	—
3) Odor	unobjectionable	—
4) Taste	unobjectionable	—
5) Potassium per manganate demand	less than 10 ppm	less than 10 ppm
6) pH value	5.8 - 8.6	6.5 - 9.2
7) Nitrite- Nitrogen	undetectable with Ammonium-Nitrogen	—
8) Nitrate-Nitrogen	less than 10 ppm	less than 40 ppm
9) Ammonium-Nitrogen	undetectable with Nitrite-Nitrogen	—
10) Chrorine (Residual Chlorine)	more than 1.0 ppm*	—
11) Hexavalent chromium	less than 0.05 ppm	less than 0.05 ppm
12) Total iron	less than 0.3 ppm	less than 0.2 ppm
13) Copper	less than 1.0 ppm	less than 0.1 ppm
14) Zinc	less than 1.0 ppm	less than 5.0 ppm
15) Total hardness (as $CaCO_3$)	less than 300 ppm	100 - 500 ppm
16) Chroride (ion)	less than 200 ppm	less than 200 ppm
17) Total contents of micro-organisms	less than 100 per 1 cc	—
18) Coliform	undetectable in 50 cc	less than 10 MPN throughout a year

* : more than 0.1 ppm as extricated residual chlorine
more than 0.4 ppm as combined residual chlorine

APPENDIX-11

Basis and Detail of Cost Estimation

A. Calculation of consumables

(1) Basic running distances of vehicles

a). Rig-truck and Cargo-trucks

Each rig-truck and cargo truck will simply move from one drilling point to the other. Since most of the target communities are located along major roads, all rig and cargo-trucks will pass through all target communities. The average distance between communities and total passing distance through all communities are as follows;

- former Berekum/Jaman	av. 7.57	total 546 km
- former Sefwi-Wiawso	av. 7.71	total 501 km
Total average/distance	av. 7.12	Total 1050 km

In addition to the community to community distance, about 2.0 km of short moving or access within each community will be needed for the trucks, and it totals about 300 km (147 x 2.0 km).

Besides, the trucks must run about 800 km to make the round trip between Kumasi and the Project site. Thus the rig and cargo trucks will run a total distance of 2,150 km (1050+300+800 km), and the average basic running distance of these trucks for one borehole can be calculated as shown below;

(2150km x 4trucks)/411holes = approx. 20.9 km

Practically, the basic running distance of these trucks is estimated at 31 km/hole with 50% allowance, taking road conditions into consideration.

b). Tank-Truck

Tank-trucks of three water-tank and a fuel-tank truck

will run a distance equivalent to the total communities distance in excess of the rig-truck's running distance mentioned above because of water or fuel supply.

The basic running distance of the tank-trucks can be calculated as;

- total community distance (1050kmx4carsx2)/41holes=	20 km
- rig-truck's running distance (above mentioned)	= 31 km
Total	51 km

c). Other supporting vehicles

Supporting vehicles such as pick-up truck and wagons etc. will go between the base camp and the drilling sites every day. The average distances of such "base camp - drilling site" are picked up from the location map as shown below;

- former Berekum/Jaman District	35 km
- former Sefwi-Wiawso District	35 km
Average	35 km (for one way)

Since the drilling period for one borehole (average through successful and dry holes) is 3.83 days, the running distance of these vehicles per one borehole is;

70km x 3.83days = approx. 268 km

Then, these vehicles will also travel about 800 km from/to Kumasi, and a distance of about 2.0 km per hole can be allocated to each vehicle. As a result, the basic running distance of the supporting vehicles will be at 270 km per drilling hole (268 + 2 km).

(2) Running time of equipment

a). Bulldozer

The running time of the bulldozer is about 3 hours per hole as mentioned in the works schedule. The fuel consumption rate of GVW 10 ton class bulldozer is 15 lit./hr from its output

power of 110 PS.

b). Air-compressor

The high-pressure air-compressor will run for air-hammer drilling and for washing/developing of the drilled hole.

- air-hammer drilling	2.0 hour
- washing/developing	2.0 hour
Total	4.0 hour

c). Other equipment

- Generator (for pumping test)	5.0 hour
- Welder (for casing works)	2.5 hour
- Concrete mixer	4.0 hour

(3) Volume of consumables for one borehole

a). Fuel (Diesel)

- Rig	1	set	x	16 hr x 21 l/h	=	336 lit.
- Compressor	1	"	x	4 " x 60 "	=	240 "
- Rig-truck	1	"	x	31 km / 3.5 km/l	=	9 "
- Cargo truck	1.33	"	x	31 " / 4.0 "	=	10 "
- Tank truck	1	"	x	51 " / 4.0 "	=	13 "
- Bulldozer	1	"	x	3 hr x 15 l/h	=	45 "
- Right vehicles	5	"	x	270 km / 5 km/l	=	270 "
- Generator	1	"	x	5 hr x 4 l/h	=	20 "
- Welder	1	"	x	2.5 " x 3 "	=	8 "
- Concrete mixer	1	"	x	4 " x 4 "	=	6 "
Total						957 lit.

b). Lubricants

- Mechanical oil	diesel x 0.05	48 lit.
- Grease	(diesel x 0.01) x 0.8	8 kg

c). Gravel (for gravel packing)

- Type-I Q = 0.425 m3
- Type-II Q = 0.887 "

Average required volume with 30% allowance is,

(0.425 x 8 + 0.887 x 2)/10 x 1.3 = 0.673 m3/hole

d). Concrete materials

Volume of the concrete works for each borehole facility is;

- platform	0.7625 m3
- conduit	0.405 "
- drain pit	0.456 "
Total	1.6235 m3

The required concrete volume will be 2.11 m3 including 30% allowance (1.624 x 1.3). The materials for 1.0 m3 of concrete (in the case of W:C:S:G = 1:1.7:4.5:5.4) are 310 kg of cement and 1835 kg of sand-gravel. Then, iron bars of 16m in the platform, 16m in the conduit and 23.2m in the drain pit are required for reinforcement (16+16+23.2=55.4m).

Thus, the volume of materials to be procured for the concrete works are calculated as below;

- Cement	310 kg x 2.11 m3 = 654 kg
- Gravels	1835 " x 2.11 " = 3872 kg
- Iron bar	55.4 x 0.5 kg/m = 27.5 kg

e). Grout sealing materials

The uppermost space between casing and wall of the borehole will be sealed by cement mortar of C:S:W = 1:3:0.75 component for 6m span on an average.

The calculated sealing volume is 0.282 m3, and the required volume of grout mortar including 30% of allowance is about 0.367 m3 (0.282 x 1.3 = 0.367). The materials for 1.0 m3 of mortar are 455 kg of cement and 1364 kg of sand, so that the required volume of each materials is;

- Cement	455 kg/m3 x 0.367 = 167 kg
- Sand	1364 " x 0.367 = 500 kg

f). Oxygen and Acetylene

Both of these welding materials will be consumed at the rate of approximately 30% of a cylinder (7 m3 cylinder for oxygen and 7 kg cylinder for acetylene) for the casing work of one borehole.

B. Calculation of construction cost

(1) Remuneration

The remuneration and labor cost are calculated below. As shown in the calculation table, the remuneration of the Project Manager and Stock Managers are not summed up because they will serve concurrently with their own job, as Chief Engineer and workshop engineer as the Drilling Unit, GWSC.

Profession	persons	term	unit-cost	amount
Project Manager	(1)	(26.0)	-	-
Site Manager	1	26.0	20,749.	539,474.
Hydrogeologist (siting)	3	26.0	17,855.	1,392,690.
Asst. -do-	3	26.0	15,715.	1,225,770.
Hydrogeologist (test)	2	26.0	17,855.	928,460.
Asst. -do-	2	26.0	15,715.	817,180.
Mech. Engineer	1	26.0	17,855.	464,230.
Asst. -do-	2	26.0	15,715.	817,180.
Civil Engineer	3	26.0	15,715.	1,225,770.
Driller Chief	4	26.0	19,132.	1,989,728.
Asst. Driller	4	26.0	15,715.	1,634,360.
Stock Manager	(2)	(26.0)	-	-
Accountant	1	26.0	11,042.	287,092.
sub-total	26 (3)	-	-	11,321,934.
Foreman	4	26.0	11,042.	1,148,368.
Driver (Heavy Eq.)	8	26.0	10,852.	2,257,216.
Driver (Light Ve.)	2	26.0	9,810.	510,120.
Typist/secretary	1	26.0	9,886.	257,036.
Cook	2	26.0	8,081.	420,212.
Guard/watcher	8	26.0	6,887.	1,432,496.
Labor (skilled)	12	26.0	6,887.	2,148,744.
Labor (unskilled)	39	26.0	5,454.	5,530,356.
sub-total	76	-	-	13,704,548.
TOTAL	102	-	-	₵25,026,482.-

Table A

REMUNERATION AND LABOR COST

PROFESSION	COST/MONTH*	PROFESSION	COST/MONTH*
Project Manager	20,749.	Labor (Skilled)	6,887.
Site Manager	17,855.	Labor (Unskilled)	5,454.
Hydrogeologist	17,855.	Driver (Heavy)	10,852.
Mech. Engineer	17,855.	Driver (Light)	9,810.
Civil Engineer	15,715.	Accountant	11,042.
Driller (Chief)	19,132.	Typist	9,886.
Driller (Asst.)	15,715.	Cook	8,081.

* ... Ghanaian Cedi,Based on GWSC H.Quarter and D.Unit(1989, December)

Table B

UNIT COST OF MATERIALS

ITEM	SPECIFICATION	UNIT	UNIT COST*
1. CONSTRUCTION MATERIALS			
1-1. Cement	Portland, 50kg/bag	bag	2,500
1-2. Gravel & Sand	Aggregate	m^3	3,000
1-3. Iron rod	ϕ 9mm	ton	200,000
1-4. Nail	1-2 inch	kg	600
1-5. Board	For mold	m^2	540
1-6. Oxygen	7 m^3/bottle	bottle	4,000
1-7. Acetylene	7 kg/bottle	bottle	14,000
2. BOREHOLE MATERIALS			
2-1. Sandgravel	For gravel pack	m^3	20,000
2-2. Casing	4" PVC, 4m length	piece	15,000
2-3. Screen	4" PVC, 4m length	piece	25,000
2-4. Socket	4" PVC	piece	1,200
2-5. Paste	For PVC, 0.5kg/can	can	2,225
3. FUELS			
3-1. Gasoline		liter	61
3-2. Diesel Fuel		liter	56
3-3. Engine Oil		liter	370
3-4. Grease		kg	500
4. OTHERS			
4-1. Hand pump	India MK II	set	300,000
4-2. Drum-can	Empty	can	8,000

* ... Ghanaian Cedi,Based on GWSC H.Quarter and D.Unit(1989, December)

(2) Materials

The material cost to be borne by GWSC are calculated as;

Diesel	188holes	x	957	l/hole	x	56 ¢	= 10,075,296.-
Oil	188 "	x	48	"	x	370 "	= 3,338,880.-
Grease	188 "	x	9	kg/hole	x	500 "	= 752,000.-
Gravel	141 "	x	673	m3/hole	x	3000 "	= 284.679.-
Cement	141 "	x	821	kg/hole	x	50 "	= 5,788,050.-
Sand	141 "	x	4372	"	x	5 "	= 3,082,260.-
Iron bar	141 "	x	28	"	x	200 "	= 789,600.-
Oxygen	188 "	x	0.3	pcs	x	4000 "	= 225,600.-
Acetylene	188 "	x	0.3	"	x	14000 "	= 789,600.-
Miscellaneous			26.0	months	x	50000	= 1,300,000.-
Total							¢26,425,965.-

Table C EXCHAGE INDEX (CEDI-US$)

as of December, 1989.

Month	Day	Rate	Month	Day	Rate
June	2	1US$= 268. ¢	October	6	1US$= 283. ¢
	9	268.		13	284.
	16	268.		20	286.
	23	270.		27	287.
	30	270.		average	280.8
	average	268.8	November	3	289.
Jujy	7	271.		10	291.
	14	271.		17.	294.
	21	273		24	298.
	28	273.		average	293.0
	average	272.0	December	1	301.
August	4	275.		8	301.
	11	275.		15	303.
	18	277.		average	301.3
	25	277.			
	average	276.0			

Appendix—12 Geological Map of Ghana