No.

BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
RURAL DRINKING WATER SUPPLY IN
SHAN STATE
IN
UNION OF MYANMAR

FINAL REPORT

MARCH 2001

JAPAN INTERNATIONAL COOPERATION AGENCY
PACIFIC CONSULTANTS INTERNATIONAL

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PREFACE

In response to a request from the Government of the Union of Myanmar, the Government of Japan decided to conduct a basic design study on the Project for Rural Drinking Water Supply in Shan State and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Myanmar a study team from September 3 to October 12, 2000.

The team held discussions with the officials concerned of the Government of Myanmar, and conducted a field survey at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Manmar in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Union of Myanmar for their close cooperation extended to the teams.

March, 2001

Kunihiko Saitoh
President
Japan International Cooperation Agency

March, 2001

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Rural Drinking Water Supply in Shan State in the Union of Myanmar.

This study was conducted by the Pacific Consultants International, under a contract to JICA, during the period from August, 2000 to March, 2001. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Myanmar and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

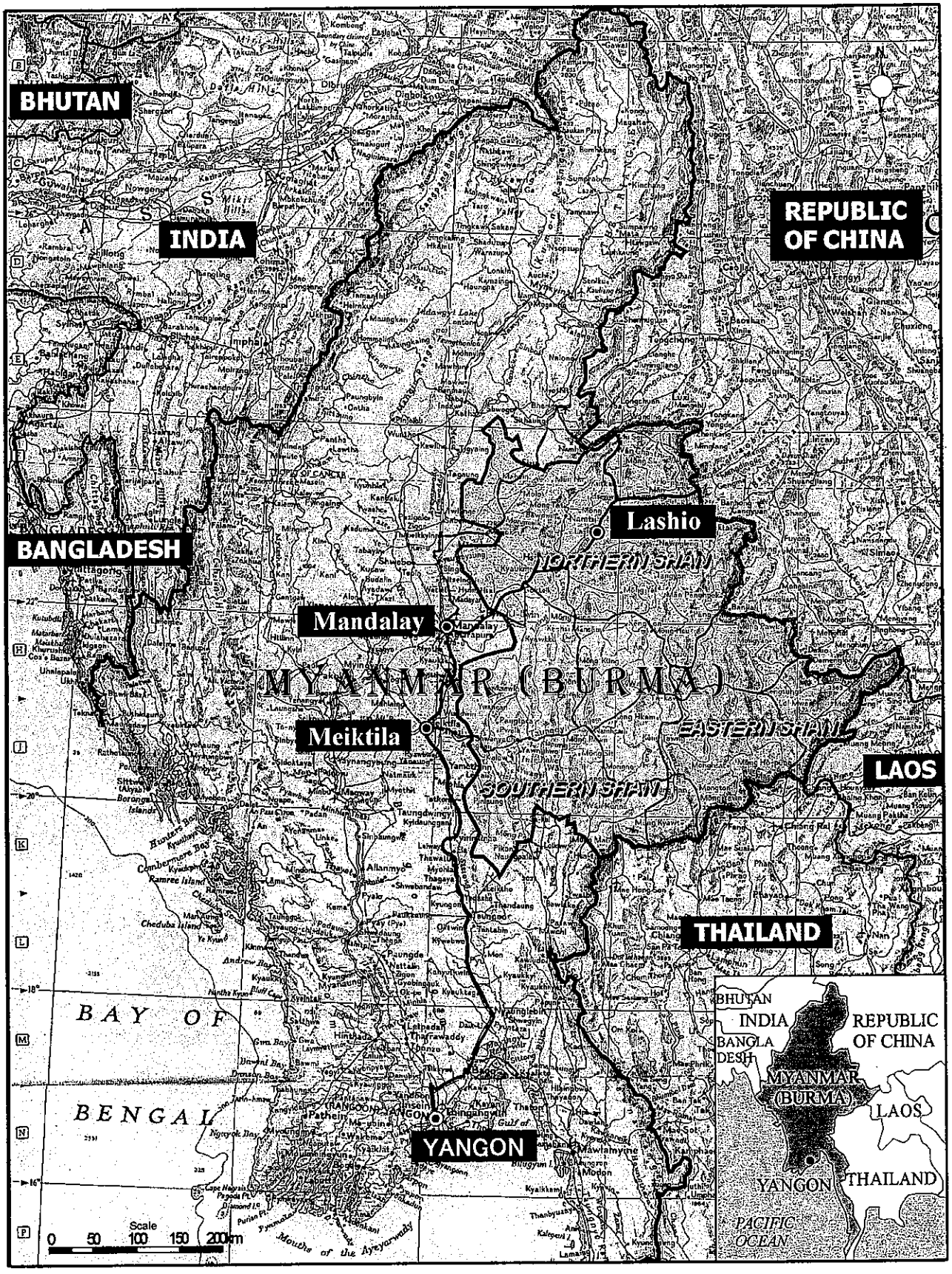
Very truly yours,

Shinichiro Matsumoto

Project Manager,

Basic design study team on the Project for
Rural Drinking Water Supply in Shan State

Pacific Consultants International



LOCATION MAP

Abbreviations

CHEB	: Central Health Education Bureau/ Ministry of Health
DAP	: Department of Agricultural Planning/ Ministry of Agriculture and Irrigation
DDA and	: Department of Development Affairs/ Ministry of Progress of Border Areas National Races and Development Affairs
DO	: Dissolved Oxygen
DTH	: Down-the-Hole Hammer Drilling
DTW	: Deep Tube Well
EC	: Electric Conductivity
E/N	: Exchange of Notes
ESD	: Environmental Sanitation Division/ Ministry of Health
FERD	: Foreign Economic Relations Department
JICA	: Japan International Cooperation Agency
M/D	: Minutes of Discussions
NPA	: National Programme of Action
O&M	: Operation and Maintenance
pH	: Potential of Hydrogen
PDM	: Project Design Matrix
STW	: Shallow Tube Well
UNDCP	: United Nations International Drug Control Programme
UNDP	: United Nations Development Programme
UNICEF	: United Nations International Children's Emergency Fund
WHO	: World Health Organization
WRUD	: Water Resources Utilization Department
cfm	: cubic feet per minute
psi	: pound per square inch

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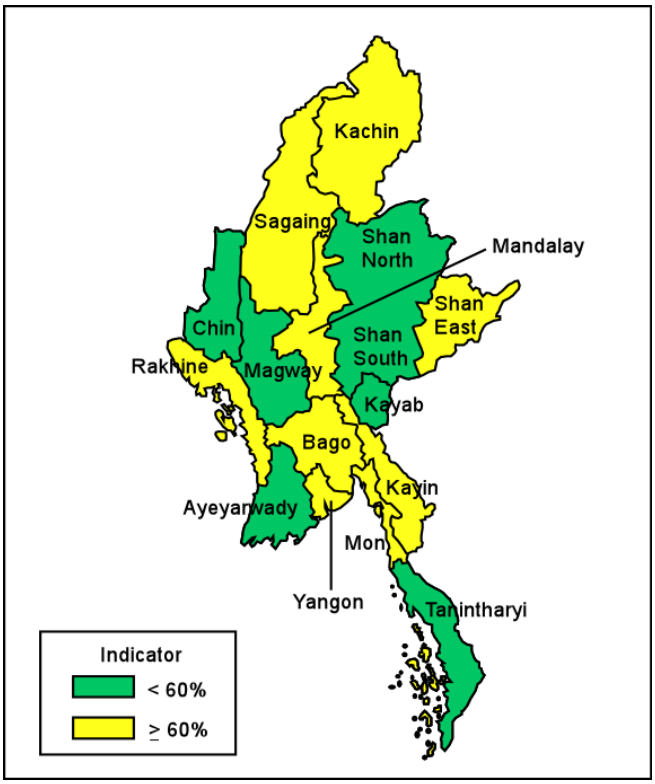
Background of the Project

CHAPTER 1 BACKGROUND OF THE PROJECT

The Union of Myanmar (hereinafter referred to as 'Myanmar') has its territory of a diamond shape with dimensions of about 2,000 km from north to south, and 700 km from east to west. It is surrounded by India and Bangladesh in the west, China, Laos and Thailand in the north and the east, and Bay of Bengal in the southwest. Myanmar covers a land area of 676,500 km^2 (approximately 1.8 times of Japan) and a population of about 49 million inhabitants in 2000. It is a multiracial nation, where 70 % of the population is the Burmese majority and the remaining 30 % are ethnic minorities such as Shan, Kayin, etc.

In this country, due to the delay in establishing water supply facilities and insufficient conditions in public healthcare, approximately 17,000 thousand children under five years old have been reportedly died of diarrhea. These conditions would be improved by the consolidation of water supply facilities and public sanitary conditions. Based on this background, the Government of Myanmar has carried out a water supply facility development program in cooperation with UNICEF with the objective of providing access to the safe drinking water to the whole population by 2000. However, the population can access to the safe drinking water is estimated to be as low as 66% in the whole country, with 60% in the rural areas and 88% in the urban areas (1997). This means that the aforementioned objective has not been attained yet. As shown in Fig 1.1.1, it is found that the water supply development in the mountainous areas of the border has been delayed. Therefore, the task of water supply development in these areas is considered as very important from now on.



Source: UNICEF

Fig 1.1.1 Rates of Population Possibly Accessing to the Safe Drinking Water

In view of public healthcare and sanitation, the domestic water supply is considered as the most important issue in the country. Water supply projects have been implemented since 1952, and the Water Resources Utilization Department (**WRUD**) has constructed about 13,200 deep tube wells and 21,300 shallow tube wells respectively with the assistance from various donor agencies such as **UNICEF** etc., supplying potable water to 7.9 million inhabitants.

The Shan state situated in the eastern border area is a hilly area with an elevation varying from 1,500m to 2,000m. The state has various difficulties in education, healthcare and sanitation as well as economic development. Since it has been left under poor public infrastructure and community services, the security conditions have not been found to be in a proper situation. It has caused a delay in the water supply development task carried out by **WRUD**, resulting in the risk of spreading water borne diseases through the unsafe drinking water. It is considered that about 3.2 million people, equivalent to three quarters of the whole population, are subjected to the danger of water borne diseases in this state. Besides, especially in the border areas and the central dry zone where the water resources are considered scarce, women and children are engaged in taking water by spending a long time in a day. This situation has also resulted in their poor health conditions.

The tube well construction was commenced just in the early 1990s. Since then 172 deep tube wells and 70 shallow tube wells have been drilled so far. However, according to **UNICEF - WRUD**, 1,600 new units of tube wells have to be further constructed in order to supply the potable water to the whole population in Shan state and this implementation is considered to be an urgent task to be carried out.

Due to its topographic as well as geological conditions, the groundwater development in the Shan state is found to be insufficient, being left behind the other areas. **WRUD** has been in charge of drilling boreholes in the rural areas. And, rotary table type drilling rigs have been used in the deep tube well construction in the Shan state. However, the tertiary rocky geology prevailing in the state requires the rock drilling type, and their rigs of rotary type have been found to be unsuitable for drilling in these rocky areas. The shortage of spare parts is also considered as a serious problem.

Therefore, in February 2000, the Government of Myanmar requested the Government of Japan to provide a grant aid of drilling rigs of Down-the-Hole Hammer Drilling (DTH) type which enable effective drilling in rocky condition, spare parts for the existing rotary type drilling rigs, and construction equipment for related construction works in order to reinforce the institution of groundwater development.

The content of the original request from the Government of Myanmar includes the provision of the equipment and spare parts as mentioned below:

(1) Truck Mounted Water Well Drilling Rig for Depth of 300 - 150 m

- 4 x 4 heavy duty truck mounted water well drilling rig	2 units
- 4 x 4 heavy duty truck mounted high pressure air compressor for air flush/DTH drilling	2 units
- Drilling tools and accessories for direct rotary drilling for 200 m depth with 10-5/8" to 6-1/2" borehole	2 sets
- Spare parts for the above equipment	2 lots

(2) Spare Parts for Existing TRD-300 Drilling Units (5 units)

- Spare parts for TRD-300 drilling units	1 lot
- Spare parts for NAS-5H pump units	1 lot
- Spare parts for mounting truck	1 lot
- Spare parts for drilling accessories	1 lot

(3) Supporting Equipment for Groundwater Development and Portable Water Supply

- Bulldozer, 130 HP	1 unit
- Wheel loader, 150 HP, 2.5 m^3 bucket	1 unit
- Motor grader, 155 HP, 3.6 m blade, scarffire	1 unit
- Hydraulic excavator, wheel type, 105 HP, 0.4 m^3 bucket	1 unit
- Vibration roller, wheel type, 6t	1 unit
- Steel bridge, TEC3, 40 t, 26 m x 4 m	5 units
- Mobile workshop for emergency services in drilling and construction	1 unit

Chapter 2
Contents of the Project

CHAPTER 2 CONTENTS OF THE PROJECT

2.1 Objectives of the Project

Myanmar's rural people access to safe water is estimated to be as low as 60 % in comparison with 88% of urban people (1997). Therefore, the rural water supply is the most important issue in view of improvement of health and sanitary conditions.

The objective of the Project is to support the Government of Myanmar through provision of drilling rigs and other related equipment for groundwater development in Shan State, in order to improve the living conditions of rural people.

2.2 Basic Concept of the Project

2.2.1 General

This Project (*The Project for Rural Drinking Water Supply in Shan State*) is within the frame work of the plan "*Safe Drinking Water Supply Programmes for the Year 2001-2005*" of Water Resources Utilization Department (**WRUD**), Ministry of Agriculture and Irrigation. The equipment procured by the Project will be used for tube wells, which are planned for Shan State in the above-mentioned **WRUD** Five (5) Year Plan.

Table 2.2.1 shows the summary of Project's activities, indicators for verifying Project's performance, means of verification, and the assumptions for obtaining the envisaged effects of the Project.

Table 2.2.1 Project Design Matrix

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal			
1. Improvement of health and sanitary conditions of rural people in Shan State 2. Decrease of infection rate of water-borne diseases and Infant mortality rate	1. Rural water supply rate 2. Infection rate of water-borne diseases 3. Infant mortality rate	・Statistical yearbook ・Monitoring report of UNICEF and Ministry of Health	・Continuation of rural water supply development policies
Project Purpose			
1. Supplement of safe water for rural people in Shan State	1. Water quality and number of beneficiaries	・Water quality test ・WRUD's report and monitoring ・Daily, monthly and annual reports for operation and maintenance	・Continual secured of rural water development budget of the WRUD ・Continuation of the political situation stability
Outputs			
1. Construction of 50 shallow tube wells and 250 deep tube wells 2. Improvement of well's success rate 3. Improvement of geophysical survey techniques for ground water	1. Number of well construction 2. Success rate 3. Number of skilled operator for geophysical survey	・WRUD's report and yearbook ・Monitoring	・Budget allocation for rural water supply in Shan state by WRUD ・Continuation of UNICEF's assistance
Activities	**INPUTS**		・Well construction in Shan state will be carried out by the equipment of Japan's Grant Aid
1. Study of appropriate procurement plan for well drilling equipment 2. Study of appropriate procurement plan for geophysical survey equipment 3. Technical transfer for geophysical survey by soft component	**Japanese Side** 1. Provision of well drilling rigs 2. Provision of supporting equipment 3. Provision of geophysical survey and water quality analysis equipment 4. Dispatch of geophysical survey expert. (1 person x 2.0 month)	**Manmar Side** 1. Establishment of WRUD/Lashio district office 2. Organization of geophysical survey team for Shan state 3. Investment of Myanmar's possessing equipment 4.Inprovement of access route (railway underpass near Thipaw)	・Understanding and cooperation of the habitant in the project area **Pre-conditions** ・Budget action to be covered by the Myanmar side. ・Authorization for the Japanese staff entry and permission of stay in Myanmar ・Execution of all custom and tax to the equipment supplied by the Project ・Acquisition of number plate for vehicles supplied by the Project

2.2.2 WRUD's Safe Drinking Water Supply Programme in Shan State

Number of drilling wells and well drilling plan confirmed by Myanmar side is summarized in **Table 2.2.2**. Number of drilling wells in the Shan state is shown in **Table 2.2.3**. These numbers are quoted from the WRUD Safe Drinking Water Supply Programme for the Year 2001-2005. Appropriate numbers of equipment required for this Project were estimated based on the number of drilling wells in the Northern Shan.

Table 2.2.3 WRUD's Safe Drinking Water Supply Programme in Shan State

Region	Programme	Shallow well	Deep well	Total
Northern Shan	UNICEF+WRUD	50	170	220
	WRUD Only	0	80	80
	Sub-total	50	250	300
Southern Shan	UNICEF+WRUD	150	0	150
	WRUD Only	0	90	90
	Sub-total	150	90	240
Total	UNICEF+WRUD	200	170	370
	WRUD Only	0	170	170
	Total	200	340	540

Source**: WRUD**

An annual well drilling programme will be presumed as shown in **Table 2.2.4** because requested equipment can be available for use from the fiscal year 2002. Using JICA groundwater development design manual, required number of drilling rigs for each year are calculated as shown below.

Table 2.2.4 Annual Well Drilling Programme in Shan State

Item		2001	2002	2003	2004	2005	Total
Northern Shan	STW	50	0	0	0	0	50
	DTW	0	60	60	65	65	250
Southern Shan	STW	0	40	40	35	35	150
	DTW	0	0	0	45	45	90
Number of annual drilling wells (AW)		50	100	100	145	145	540
Success rate (SR)		0.8	0.8	0.8	0.8	0.8	
Annual possible drilling days (AD)		270	270	270	270	270	
Required drilling days for 1 well (SD)		10	10	10	10	10	
Required number of drilling rigs (RR)		2.14	4.30	4.30	6.23	6.23	
Rig ①	Existing rig: TRD-300S	■	■	■	■	■	
Rig ②	Existing rig: TRD-300S	■	■	■	■	■	
Rig ③	Requested rig		■	■	■	■	
Rig ④	Requested rig		■	■	■	■	
Rig ⑤					▨	▨	
Rig ⑥					▨	▨	

Note 1) Required number of drilling rigs (RR)=(AW x (SD+(1-SR) x (SD-2)))/AD
Note 2) Annual possible drilling period = 9 months (270 days)
Note 3) Required drilling days for 1 well= Transportation (2 days) +Preparation (2 days) +Drilling (5 days) +Dismantling (1day)

Table 2.2.2 Well Drilling Programmes for Shan State

	Number of Wells in Request Letter		UNICEF 5 Year Plan	DAP 5 Year Plan				WRUD 5 Year Plan			
	Township	DTW	(STW+DTW)	UNICEF/WRUD		WRUD only	Total	UNICEF/WRUD		WRUD only	Total
				STW	DTW	DTW		STW	DTW	DTW	
Northern Shan	1. Lashio	25	0								
	2. Theinni	15	18								
	3. Kutkaing	25	10								
	4. Muse	10	16								
	5. Kongyan	10	0								
	6. Namkan	10	9								
	7. Kunlong	10	9								
	8. Hopang	10	3								
	9. Thipaw	20	28								
	Sub-total	**135**	**93**								
	Others	70	29								
	Sub-total	205	122					50	170	80	300
Southern Shan		not clear	117					150	0	90	240
Eastern Shan		not clear	62					0	0	0	0
Total		1600	268	200	80	80	360	200	170	170	540
Remarks	In request letter, it is mentiond that 135 deep tubewells for 9 townships and 1,600 deep tube wells for Shan State shall be required		Extracts from "Proposed Area Focused Townships for 2001 to 2005 by State/ Division"	Formal Project Name: Proposed Drinking Water Supply Programmes for Universal Coverage by the Year 2005				Formal Project Name: Proposed Safe Drinking Water Supply Programmes for the Year 2001-2005			
Sources			UNICEF	DAP				WRUD			

Note) STW: Shallow tubewell, DTW: Deep tubewell

2.2.3 Conditions of Deep Tube Wells in Northern Shan

WRUD had constructed the following twenty (20) deep wells in Northern Shan as shown in **Table 2.2.5**. Average drilling depth, average static water level and average yield are 72 m, 12 m and 210 l/min, respectively. Considering the conditions of existing wells, the type and number of well drilling equipment were studied.

Table 2.2.5 Conditions of Existing Deep Wells in Northern Shan

No.	Township	Well Location	Well No.	Drilling Depth (feet)			Water Level (feet)		Yield (gph)
				Soil Layer	Rock Layer	Total	Static	Dynamic	
1	Lashio	Lashio College	8017	72	328	400	95	187	2,000
2	"	Hot Spring Resort	8018	35	285	320	15	130	6,000
3	"	No(5) Artillery	8019	5	435	440	27	150	3,000
4	"	Monastery	8020	5	210	215	0	140	1,500
5	"	Rehabilitation Center	8021	50	145	195	60	106	2,000
6	"	AMD (56)	8022	65	130	195	-	-	-
7	Kutkhing	No.(241)Regiment	8023	45	55	100	54	59	4,000
8	"	M.I (23)	8024	40	110	150	92	138	2,000
9	"	Hospital	8025	30	85	115	50	62	2,000
10	"	M.C.C.A	8026	20	60	80	37	49	2,000
11	Theinni	No.(240)Regiment	8027	30	70	100	43	66	2,500
12	Lashio	Railway Station	8028	25	90	115	18	40	1,700
13	"	Lashio Motel	8029	45	290	335	20	112	1,500
14	"	Service Quarter	8030	26	462	488	65	180	1,500
15	"	Hotel &Tourism	8031	21	317	338	12	91	1,500
16	"	Hq. For NEC	8032	30	310	340	33	194	1,800
17	"	Military (41)	8033	25	150	175	50	142	2,000
18	"	Golf Club	8034	40	50	90	35	57	4,500
19	Naungcho	Farm	8039	128	272	400	10	200	2,000
20	"	Farm	8040	48	102	150	12	60	9,000
Average				39.3 (feet)	197.8 (feet)	237.1 (feet)	38.3 (feet)	113.8 (feet)	2,763 (g/h)
				12.0 (m)	60.3 (m)	72.2 (m)	11.7 (m)	34.7 (m)	209 (l/min)

Source: WRUD

2.2.4 Existing Equipment of Groundwater Division in WRUD

Even though many heavy construction machines are available within the Ministry of Agriculture and Irrigation, and other departments, these machines are rent internally among themselves only in a few cases. Therefore, necessity of equipment requested was studied in consideration with existing equipment of the Groundwater Division in **WRUD** as shown in **Table 2.2.6**.

Table 2.2.6 Existing Equipment of Groundwater Division in WRUD

No.	Equipment	Number			Remark
		RN	RP	Total	
1	Drilling rig	22	8	30	Overage
2	H.P. air compressor	2	0	0	Overage
3	L.P. air compressor	20	12	32	Overage
4	Cargo truck with crane	7	0	7	Lack of number
5	Water tanker	15	5	20	Overage (1979)
6	Pick-up truck	0	0	0	
7	Station wagon	10	0	10	Overage
8	Mobile workshop	0	0	0	
9	Electromagnetic survey equipment	0	0	0	
10	Resistivity survey equipment	2	2	4	
11	Borehole logging equipment	2	18	20	Overage
12	Portable water quality test equipment	0	10	10	Repairable
13	Bulldozer	2	0	2	Donated by KR2
14	Trailer truck	0	0	0	
15	Wheel loader	0	0	0	
16	Excavator	2	0	2	Donated by KR2

Source: **WRUD** Note: RN: running RP: repairable

2.2.5 Confirmed Contents of the Request

Alterations regarding the contents of the request from Myanmar side were made at three stages. First alteration was made at the Minutes of Discussion dated September 15, 2000, second one was made through **WRUD**'s letter dated October 9, 2000 at the end of the field survey and third one was made at the Minutes of Discussion on explanation of draft final report dated December 15, 2000.

(1) Minutes of Discussion

Contents of the Minutes of Discussions is attached in **Appendix IV** and main alterations of the request are as follows:

Withdrawal of the Request

In consequence of discussion with **WRUD** about rural conditions and purpose of machinery and considering that the objective of this project is construction of wells and not construction of access roads, the following equipment were withdrawn from the request as shown in the **Table 2.2.7**.

Table 2.2.7 Withdrawn Equipment

Equipment	Specification	Quantity	Using-purpose
Motor grader	155HP, 3.6 m blade	1	Road construction
Vibration roller	Wheel type, 6 ton	1	Road construction
Steel bridge	TEC3, 40 ton, 26 m x 4 m	5	Bridge construction

Alteration of Quantities of Spare Parts for Existing TRD-300S Drilling Rigs

Quantities of spare parts for existing TRD-300S drilling rigs were changed from 5 sets to 2 sets because the requested spare parts were for rigs allocated to the Shan State only.

Additional Equipment

The following equipment was additionally requested by **WRUD**. In the additionally requested equipment, Water tanker, Cargo truck with crane and borehole logging equipment shall be indispensable for well construction works and construction material transportation. Pick-up truck, electromagnetic survey equipment and resistivity survey equipment will be used for groundwater survey, and transportation of related staff and equipment to improve the success rate of well construction and the efficiency of groundwater development programme.

Table 2.2.8 Additional Equipment

No.	Item	Quantity	Purpose
1	Water tanker	2	Rotary mud drilling and well construction
2	Cargo truck with crane	1	Transportation of drilling equipment
3	Pick-up truck (Double cab)	2	Transportation of drilling crew
4	Electromagnetic survey equipment	1	Effective groundwater investigation
5	Resistivity survey equipment	1	Effective groundwater investigation
6	Borehole logging equipment	2	Borehole logging test
7	Portable water quality test equipment	2	Water quality test

Project Area, Commissioning Site and Handing Over Site

After discussion with **WRUD**, the following matters were confirmed;

- The Project sites are located in the Shan State
- Commissioning will be conducted in **WRUD**'s Meiktila Workshop
- All equipments will be handed over at **WRUD**'s Meiktila Workshop

(2) WRUD's Letter

The Consultant received a letter from **WRUD**, attached in **Appendix V**, regarding the alteration of contents. The following items were requested in addition to those recorded in the Minutes of Discussions.

Table 2.2.9 Additional Request in WRUD's Letter

No.	Equipment	Number in M/D	Number in Letter		Total	Reasons
			Additional	New		
1	Water tanker	2	**2**		4	For existing rigs
2	Cargo truck with crane	1	**3**		4	Lack of equipment
3	Pick-up truck (Double cab)	2	**1**		3	Lack of equipment
4	Electromagnetic survey equipment	1	**1**		2	For effective survey
5	Resistivity survey equipment	1	**1**		2	For effective survey
6	Borehole logging equipment	2	**2**		4	Lack of equipment
7	Low pressure air compressor			**4**	4	For well development
8	Station wagon			**1**	1	Authority inspection
9	Trailer truck			**1**	1	Transportation of bulldozer
10	Drilling bits for TRD-300S			**2**	2	Lack of bits

(3) Minutes of Discussions on Explanation of Draft Final Report

Contents of the Minutes of Discussions on explanation of draft final report is attached in **Appendix VI**. Main alterations of the request are summarized in **Table 2.2.10**.

Table 2.2.10 Alteration of Quantities and Specifications

Equipment	Before Alteration		After Alteration		
	Q'ty	Specification	Q'ty	Specification	Remarks
High pressure air compressor	2	750 cfm	1	750 cfm	
			1	600 cfm	for saving of fuel consumption
Water tanker	4		2		WRUD's offer
Cargo truck with crane	4	4x4 driven, length of bed: 4.5m over	2	6x6 driven, length of bed: 6.0 m over	for transportation of long heavy materials
			2	4x2 driven, length of bed: 6.0 m over	for transportation of long materials from Yangon to Lashio
Portable water quality test equipment	2	20 analysis items	2	10 analysis items	for coordination with WRUD/UNICEF standard

(4) Sequence of alteration of Contents of Request

Sequence of alteration made in the contents of request and **WRUD**'s priority is summarized in **Table 2.2.11.**

Table 2.2.11 Sequence of Alteration made in the Contents of WRUD's Request

Item No.	Equipment	Quantity of Request: Request Letter 2000/2/1	Quantity of Request: Field Survey M/D 2000/9/15	Quantity of Request: Field Survey WRUD's Letter 2000/10/9	WRUD's Priority 2000/10/9	Quantity on Draft Final Report	Alteration of Request on Explanation of Draft Final Report 2000/12/15	Final Confirmed Contents of WRUD's Request: Item No.	Equipment	Quantity	Capacity/Specification
A.1	Drilling rig	2	2	2	A	2	none	A.1	Drilling rig	2	1) 4x4 truck mounted, left handle steering 2) Drilling capacity: 200m with 4-3/4" drill pipe 3) Top drive type, DTH direct air/ mud circulation type
A.2	High pressure air compressor	2	2	2	A	2	Capacity of discharge of 1unit (less than 600cfm)	A.2.1	High pressure air compressor: Type-A	1	1) 4x4 truck mounted, left handle steering 2) Pressure: less than 21.1kg/cm^2 (300psi) 3) Discharge: less than 21.2m^3/min (750cfm)
								A.2.2	High pressure air compressor: Type-B	1	1) 4x4 truck mounted, left handle steering 2) Pressure: less than 14.1kg/cm^2 (200psi) 3) Discharge: less than 14.2m^3/min (500cfm) 4) Engine power: less than 200PS
A.3	Drilling tools	2	2	2	A	2	none	A.3	Drilling tools	2	1) Standard accessories for DTH, drilling bits and tools 2) Well development tools
A.4	Low pressure air compressor			4	new (2): A exi. (2): C4	2	none	A.4	Low pressure air compressor	2	1) Skid type、 2) Pressure: less than 7.0kg/cm^2 (100psi) 3) Discharge: less than 8.5m^3/min (300cfm)
A.5	Mobile workshop	1	1	1	A	1	none	A.5	Mobile workshop	1	1) 3ton crane, 4x4 truck mounted, left handle steering 2) Electric welder, gas welding/cutting equipment and compressor
A.6	Water tanker		2	4	new (2): A exi. (2): C5	4	Cut on quantity (from 4units to 2units)	A.6	Water tanker	2	1) 4x4 truck mounted, left handle steering 2) Water capacity: not less than 6,000 liters
A.7	Cargo truck with crane		1	4	new (2): A exi. (2): C7	4	Wheel drive and length of bed	A.7.1	Cargo truck with crane: Type-A	2	1) 5 ton crane, 6x6 truck mounted, left handle steering, 2) Length of bed: not less than 6.0m, 3) Load capacity: not less than 10ton
								A.7.2	Cargo truck with crane: Type-B	2	1) 3 ton crane, 4x2 truck mounted, left handle steering, 2) Length of bed: not less than 6.0m, 3) Load capacity: not less than 10ton
A.8	Pick-up truck		2	3	A	3	none	A.8	Pick-up truck	3	1) 4x4 driven, left handle steering, double cab, 2) Load capacity: not less than 0.5ton
A.9	Electromagnetic survey equipment		1	2	A	2	none	A.9	Electromagnetic survey equipment	2	1) Survey depth: 300m
A.10	Resistivity survey equipment		1	2	A	2	none	A.10	Resistivity survey equipment	2	1) Survey depth: 300m
A.11	Borehole logging equipment		1	4	new (2): A exi. (2): B	2	none	A.11	Borehole logging equipment	2	1) Survey depth: 200m, 2) Relative resistance, natural electric potential, gamma layer evaluation
A.12	Portable water quality test equipment		2	2	A	2	Addition of arsenic	A.12	Portable water quality test equipment	2	1) Handy type 2) Analysis item: 10 items including coliform and arsenic
A.13	Bulldozer	1	1	1	C2	0		Withdrawal of Request			
A.14	Wheel loader	1	1	1	C3	0					
A.15	Excavator	1	1	1	C6	0					
A.16	Trailer truck			1	C1	0					
A.17	Station wagon			1	A	0					
A.18	Motor grader	1									
A.19	Vibration roller	1									
A.20	Steel bridge	1									
B.1	Spare parts for TRD-300S	5	2	2	B	2	none	B.1	Spare parts and drilling bits for existing rig	1	1) Spare parts and drilling bits for 2 units of TRD-300S
	Drilling bits for TRD-300S			2	B	2					

Note) Rank of priority : A>B>C7>C6>C5>C4>C3>C2>C1

2.2.6 Selection of Equipment to be Supplied by the Government of Japan

Based on the above-mentioned basic concept and results of discussion with **WRUD**, equipment to be supplied by the Government of Japan for the Project were studied by the Consultant as shown in **Tables 2.2.12** and **2.2.13**, The following equipment and the respective quantity were selected as the final equipment to be supplied by the Government of Japan for the Project. Its distribution plan is shown in **Fig.2.2.1**.

Item No.	Equipment	Quantity
A.1	Drilling Rig	: 2 units
A.2.1	High Pressure Air Compressor Type-A	: 1 unit
A.2.2	High Pressure Air Compressor Type-B	: 1 unit
A.3	Drilling Tools	: 2 units
A.4	Low Pressure Air Compressor	: 2 units
A.5	Mobile Workshop	: 1 unit
A.6	Water Tanker	: 2 units
A.7.1	Cargo Truck with Crane Type-A	: 2 units
A.7.2	Cargo Truck with Crane Type-B	: 2 units
A.8	Pick-up Truck	: 3 units
A.9	Electromagnetic Survey Equipment	: 2 units
A.10	Resistivity Survey Equipment	: 2 units
A.11	Borehole Logging Equipment	: 2 units
A.12	Portable Water Quality Test Equipment	: 2 units
B.1	Spare Parts and Drilling Bits for 2 Units of TRD-300S	: 1 set

Table 2.2.12 Priority by Japanese Side for the Equipment

Item No.	Item	Requested Number		Priority on the view of Necessity for the Project	Priority on the view of Equipment Holding in WRUD	Priority on the view of Technical Capacity of WRUD's Staff	Priority of WRUD Side	Remarks	Priority by Japanese Side
		Request Letter	WRUD's Letter						
A.1	Drilling rig	2	2	A	A	B	A	Since main drilling target is hard limestone layer, drilling rig facilitating DTH shall be required	A
A.2	High pressure air compressor	2	2	It is necessary for drilling of hard rock layer in Northern Shan	WRUD has not a drilling rig with top head drive rotary type and DTH type	Staff of WRUD have no experience in DTH drilling but have excellent drilling technics			
A.3	Drilling tools	2	2						
A.4	Low pressure air compressor		4	A It is necessary for well development after drilling	B No holdings for new drilling rigs	A Staff of WRUD have experience in using compressor	A: 2 units for new rigs C4: 2 units for existing rigs	Existing rigs can use its mounted compressor for well development	A: 2units for new rigs D: 2units for existing rigs
A.5	Mobile workshop	1	1	A There are many various accidents of drilling rigs and related equipment in deep well construction	A No holdings	A Staff of WRUD have experience in workshop	A	Since there is no local repair shop in Northern Shan, mobile workshop shall be required	A
A.6	Water tanker		4	A It is necessary for rotary mud drilling	A No holdings for new drilling rigs	A Staff of WRUD have experience in operation	A: 2 units for new rigs C5: 2 units for existing rigs	Since new rigs will be used in hilly area having few surface water, water tanker for new rigs shall be more required than existing rigs which are used in lowlands	A: 2units for new rigs B2: 2units for existing rigs
A.7	Cargo truck with crane		4	A It is necessary for transportation of heavy drilling tools and materials	A No holdings for new drilling rigs	A Staff of WRUD have experience in operation	A: 2 units for new rigs C7: 2 units for existing rigs	For transportation of heavy drilling tools and materials, cargo truck with crane shall be required	A: 2units for new rigs B3: 2units for existing rigs
A.8	Pick-up truck		3	A It is necessary for transportation of crew and equipment	A No holdings	A Staff of WRUD have experience in operation	A	Since WRUD has no pick-up truck, it shall be required	A: 2units B6: 1unit
A.9	Electromagnetic survey equipment		2	A It is necessary for groundwater exploration in hard rock layer	A No holdings	B Staff of WRUD have no experience but their endowments are high	A	Since WRUD's geophysical survey team is not yet established, priority of second one has evaluated as of B5 rank	A: 1unit B5: 1unit
A.10	Resistivity survey equipment		2	A It is necessary for groundwater exploration in alluvium	B Holding of 2units of old type (made in Sweden)	A Staff of WRUD have experience in operation	A	Since priority of resistivity survey is less than electromagnetic survey equipment in the Project area, priority of second one has evaluated as of B4 rank	A: 1unit B4: 1unit
A.11	Borehole logging equipment		4	A It is necessary for designing a casing programme	A Holding of 2units of old type (1980)	A Staff of WRUD have experience in operation	A: 2 units for new rigs B: 2 units for existing rigs	Well development works for 4 units of drilling rigs including existing rigs can be corresponded by 2 units of borehole logging equipment	A: 2units for new rigs B1: 2units for existing rigs
A.12	Potable water quality test equipment		2	A It is necessary for safe drinking water supply	A No holdings	A Staff of WRUD have experience in operation	A	Since WRUD has no portable water quality test equipment, it shall be required	A
A.13	Bulldozer	1	1	C On the view of the mobility, it is not so necessary for the Project	C Holding of 2units (made in Japan:1998 by	A Staff of WRUD have experience in operation	C2	Since low frequency of use and 2 units holdings in WRUD, priority of bulldozer has evaluated as low rank as C2	C2
A.14	Wheel Loader	1	1	C As low frequency in use, it is no so necessary for the Project	A No holdings	A Staff of WRUD have experience in operation	C3	Since almost of proposed drilling sites are located along/near main roads, its frequency of use is very low	C3
A.15	Excavator	1	1	B It is more necessary than wheel loader for the Project	C Holding of 2units (made in Japan:1998 by	A Staff of WRUD have experience in operation	C6	Its frequency of use for construction of approach road is low but excavator can use other civil works such as excavation of mud pit and canal	C4
A.16	Trailer truck		1	C As low frequency in use, it is no so necessary for the Project	A No holdings	A Staff of WRUD have experience in operation	C1	Since trailer truck use only transportation of bulldozer, its priority is the lowest rank (C1) of all equipment	C1
A.17	Station wagon		1	D On the view of Japanese Grant Aid, it is not so necessary for the Project	C Holding of 10 vehicles	A Staff of WRUD have experience in operation	A	Since its utilization is limited only to the inspection by high level authority, station wagon shall be excluded from the Project	D
B.1	Spare parts for existing rig	5	2	B Existing rigs are limited to use in rotary mud drilling	A No holdings	A WRUD's capacity of operation and maintenance for drilling rigs is excellent	B	Since hard limestone layer are widely distributed in Northern Shan, rotary mud drilling points are less than central dry zone. Therefore, priority of spare parts and drilling bits for TRD-300S has evaluated as of B7 rank	B7
	Drilling bits for existing rig		2	B Existing rigs are limited to use in rotary mud drilling	A No holdings	A WRUD's capacity of operation and maintenance for drilling rigs is excellent	B		B7

Note: Rank of Priority by Japanese Side: A > B 7 > B 6 > B 5 > B 4 > B 3 > B 2 > B 1 > C 4 > C 3 > C 2 > C 1

Table 2.2.13 Results of Selection of Equipment

Item No.	Item	Purpose	Capacity/Specification	Final Number for the Project	Requested Number from WRUD	Priority by Japanese Side	Reasons
A.1	Drilling rig	Well drilling in hard rock layer	1) 4x4 truck mounted, left handle steering 2) Drilling capacity: 200m with 4-3/4"drill pipe 3) Top drive type, DTH direct air/mud circulation type	2	2	A	According to the WRUD, 250 deep wells are planned in Northern Shan region. Considering drilling capacity of WRUD's past record (24 wells/rig/year), it will be necessary more than 10 years to complete of the project. Therefore, two (2) drilling rigs shall be required for the Project.
A.2.1	High pressure air compressor Type-A	DTH hammer drilling	1) 4x4 truck mounted, left handle steering 2) Pressure: 21.1kg/cm^2 (300psi) 3) Discharge: 21.2m^3/min (750cfm)	1	2	A	New drilling rigs should be required a high pressure compressor for DTH drilling. Capacity of compressor were selected 2 types. Considering the introduction of power pumps, a high pressure compressor type-A shall be required 750cfm of discharge for drilling of 8-5/8" hole diameter.
A.2.2	High pressure air compressor Type-B	DTH hammer drilling for less than 6-1/4" hole diameter	1) 4x4 truck mounted, left handle steering 2) Pressure: 14.1kg/cm^2 (200psi) 3) Discharge: 14.2m^3/min (500cfm) 4) Engine power: less than 200PS	1			Considering the saving of fuel expenses, a high pressure compressor type-B shall be required 500cfm of discharge and shall be limited to drill less than 6-1/4" hole diameter.
A.3	Drilling tools	"	1) Drilling bits and tools, well development tools and others	2	2	A	For each new drilling rig
A.4	Low pressure air compressor	Well development	1) Trailer mounted 2) Pressure: 7.0kg/cm^2 (100psi) 3) Discharge: 8.5m^3/min (300cfm)	2	4	A: 2units (N) D: 2units (E)	Low pressure air compressor is necessary for well development. Two (2) low pressure air compressors shall be procured for new drilling rigs.
A.5	Mobile workshop	Repair of equipment	1) 4x4 driven , with 3ton crane, left handle steering 2) Electric welder, gas welding/cutting equipment and air compressor	1	1	A	For corresponding to various accidents of drilling rigs and related equipment, one (1) mobile workshop shall be required for the Project.
A.6	Water tanker	Rotary mud drilling	1) 4x4 driven, left handle steering 2) Water capacity: not less than 6,000 liter	4	4	A: 2units (N) B2: 2units (E)	Water tanker is necessary for rotary mud drilling and washing of equipment. Two (2) water tankers shall be procured for new drilling rigs.
A.7.1	Cargo truck with crane Type-A	Transportation of heavy drilling equipment	1) 6x6 driven, left handle steering, 3ton crane 2) Load capacity: not less than 10 tons 3) Length of bed: not less than 6.0m	2	4	A : 2units (N)	For transportation of heavy drilling tools, 6x6 cargo truck with 5 tons crane shall be required. two (2) units as same as request from WRUD.
A.7.2	Cargo truck with crane Type-B	Transportation of UNICEF's PVC casing and other	1) 4x2 driven, left handle steering, 3ton crane 2) Load capacity: not less than 6 tons 3) Length of bed: not less than 6.0m	2		B3: 2units (E)	For transportation of UNICEF's PVC casing and others from Yangon to Lashio, 4x2 cargo truck with 3 tons crane shall be required. two (2) units as same as request from WRUD.
A.8	Pick-up truck	Transportation of crew and equipment	1) 4x4driven, left handle steering, double cab. 2) Charge capacity: 0.5ton over	3	3	A: 2units B6: 1unit	For transportation of crew and equipment, pick-up truck shall be required. Three (3) pick-up trucks shall be procured for the Project as same as request from WRUD
A.9	Electromagnetic survey equipment	Groundwater survey (for fissure)	1) Survey depth: 300m 2) Frequencies: 10 steps (110Hz to 56,320Hz)	2	2	A: 1unit B5: 1unit	Electromagnetic survey equipment shall be required for groundwater exploration in hard rock layer. Considering the area of Northern Shan and receiving capacity of WRUD, two (2) units shall be procured for the Project as same as request from WRUD.
A.10	Resistivity survey equipment	Groundwater survey (for alluvium)	1) Survey depth: 300m 2) Measuring range: -10V to +10V	2	2	A: 1unit B4: 1unit	Resistivity survey equipment shall be required for groundwater exploration in alluvium. Considering the area of Northern Shan and receiving capacity of WRUD, two (2) units shall be procured for the Project as same as request from WRUD.
A.11	Borehole logging equipment	Borehole logging test	1) Survey depth: 200m 2) Relative resistance, natural electric potential, gamma layer evaluation	2	4	A: 2units (N) B1: 2units (E)	For confirming the precise section of aquifers for designing a casing programme after completion of drilling, borehole logging equipment shall be required. Two (2) units shall be procured for the Project.
A.12	Portable water quality test equipment	Water quality test in field	1) Handy type 2) Analysis items: 10 items including coliform and arsenic	2	2	A	For safe drinking water supply project, water quality test equipment shall be required. Considering the area of Northern Shan and receiving capacity of WRUD, two (2) units shall be procured for the Project as same as request from WRUD.
A.13	Bulldozer	Approach road	1) 80HP	0	1	C2	Considering low necessity of equipment, bulldozer shall be excluded from the Project.
A.14	Wheel loader	Approach road	1) 85HP 2) Bucket capacity: 1.3m^3	0	1	C3	Considering low necessity of equipment, wheel loader shall be excluded from the Project.
A.15	Excavator	Approach road and well construction	1) Wheel type, 80HP 2) Bucket capacity: 0.4m^3	0	1	C4	Considering low necessity of equipment, excavator shall be excluded from the Project.
A.16	Trailer truck	Transportation of bulldozer	1) 20 ton	0	1	C1	Considering low necessity of equipment, trailer truck shall be excluded from the Project.
A.17	Station wagon	High level authority inspection	1) 4x4 driven, left handle steering	0	1	D	Considering low necessity of equipment, station wagon shall be excluded from the Project.
B.1	Spare parts for existing rig	Rotary mud drilling	1) for TRD-300S	2	2	B7	Pay providing the spare parts and drilling bits, it will be possible to use the existing drilling rig (TRD-300S) for more than 5 years. Spare parts and drilling bits for 2 units of existing drilling rigs, which will be used in Northern Shan, shall be procured for the Project.
	Drilling bits for existing rig	Rotary mud drilling	1) for TRD-300S	2	2	B7	

Note: Priority: A>B7>B6>B5>B4>B3>B2>B1>C4>C3>C2>C1 N: New drilling rig, E: Existing drilling rig

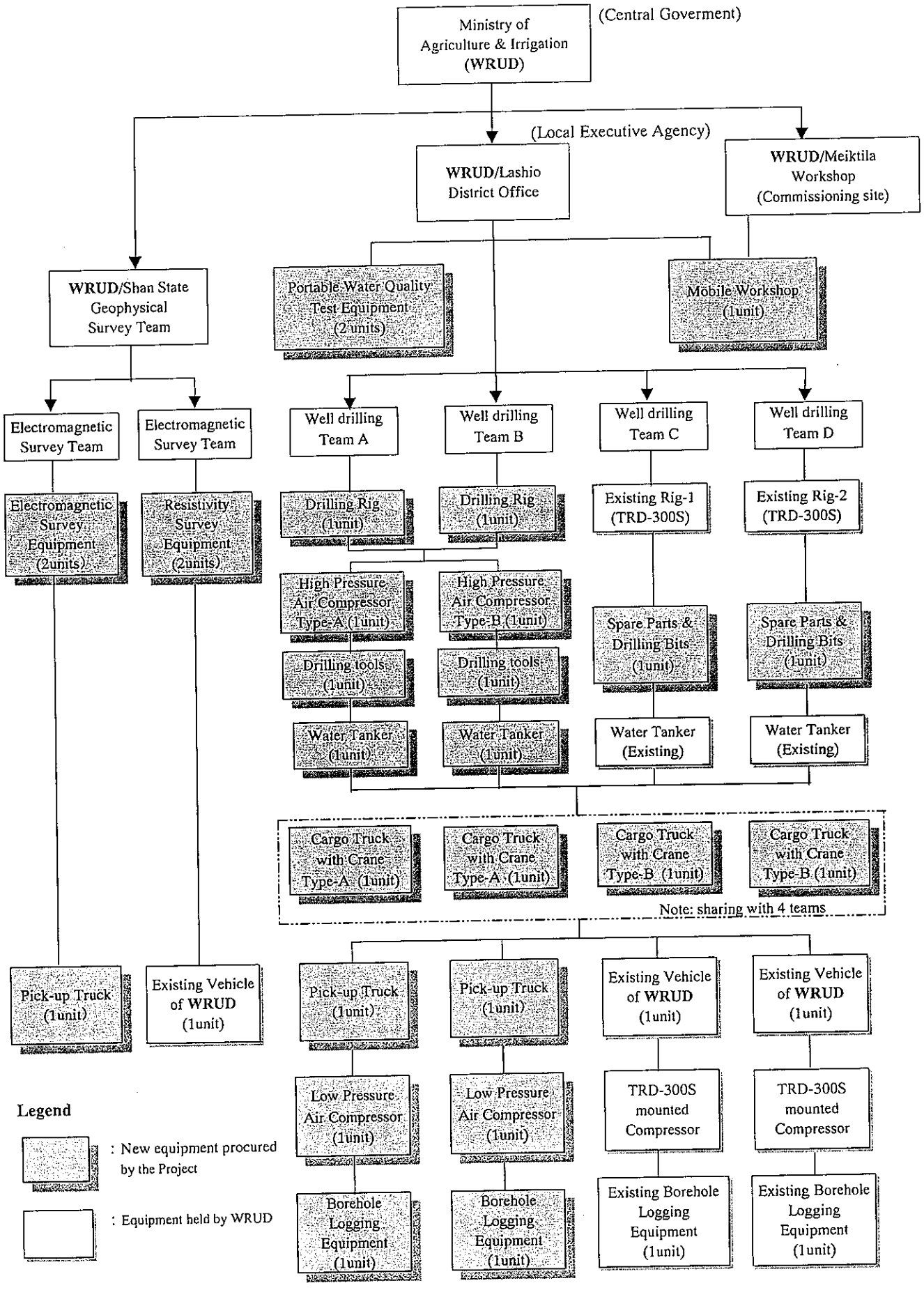


Fig. 2.2.1 Distribution Plan for the Equipment

2.3 Basic Design

2.3.1 Design Concept

(1) Natural Conditions

Climate

The climate in the Shan state is categorized as tropical climate, which is characterized with rainy season (May to October) and dry season (November to April). The average annual rainfall is about 1,300 mm and 87 % of annual rainfall is concentrated in the rainy season.

Table 2.3.1 Climate Conditions in Lashio

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean temperature (℃)	23	26	30	32	31	29	28	28	29	28	25	23
Mean monthly rainfall (mm)	2	8	14	57	131	199	210	249	205	142	73	9
Dry/rainy season	Dry season (163mm)				Wet season (1,136mm)						Dry	

Source**: WRUD**

Geology

Since hard limestone/granite layer are widely distributed in Northern Shan region as shown in **Fig. 2.3.1**, the drilling rig shall be of the top head drive rotary type, capable of facilitating DTH hammer drilling. In case of the development of groundwater in fissure, average and maximum depth of wells will be presumed as 70-100m and 200m, respectively. Therefore, the rig shall be capable of 200m depth with 4-3/4" drill pipe. Since groundwater explorations have scarcely been conducted in Shan State, essential geophysical survey shall be required. On the other hand, existing mud rotary drilling rig (TRD-300S) can be used to develop groundwater in alluvium along the main rivers.

(2) Social Conditions

Water User Association and Water Charge

As rural water supply system by deep tube wells in Shan State is underdeveloped in comparison with central dry zone, water user associations and water charge systems also are less functional in Shan State. However, conditions of existing water supply system (dug wells and public hydrants using spring water) are well maintained by volunteers due to their own efforts. Considering well-organized rural communities and townships, tube wells with handpump promoted by WRUD will be operated and maintained by rural communities.

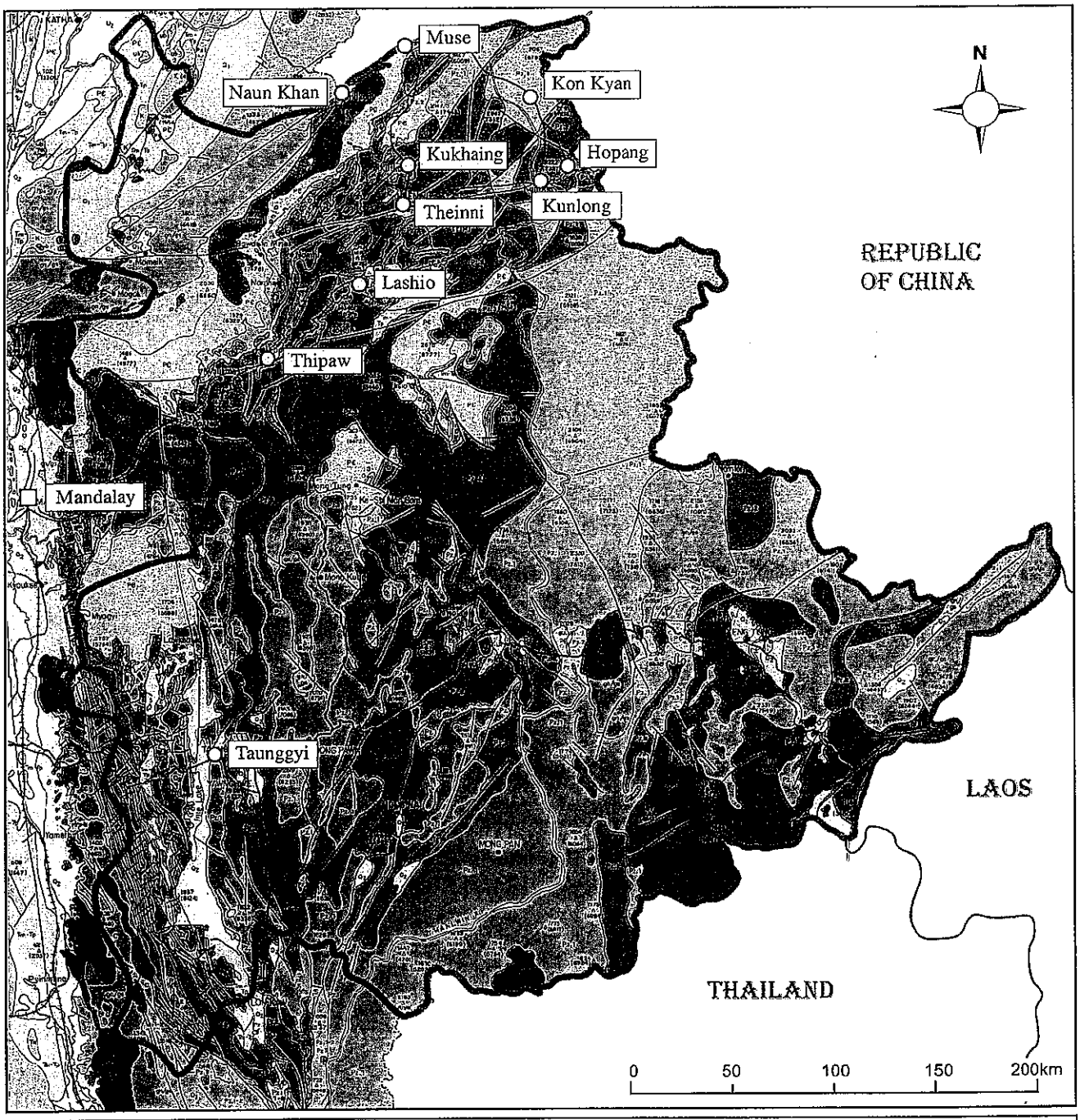
Main Road

The road network in Northern Shan is shown in **Fig. 2.3.2**. Main road of this area is the national road route 3 (Mandalay-Lashio-Muse) which is called as "Burmese Road". This road is maintained by a private enterprise (Asia World Company Ltd.) which had established four (4) toll gates at Lashio, Theinni, Kutkaing and Maing Yu. The toll rate at each gate is shown in **Table 2.3.2**.

Table 2.3.2 Toll Rates at Each Station along National Route 3

No.	Category	Rates (Kyat)
1	Small Cars (under 1MT)	100
2	Medium Cars (between 1 MT and 2-3/4 MT)	300
3	Passenger Cars (large)	500
4	Truck (up to 10 MT)	1,000
5	Large Truck (up to 20 MT)	2,000

Source: Asia World Company Ltd.



LEGEND

- Q_2 Alluvium
- Tm-Tp Irrawaddy Group (Miocen-Pliocene)
- JK Kalow Red Formation (Jurassic-Cretaceous)
- J Namyau Group (Jurassic)
- R Bawgyo Group (Triassic)
- PZ2 Shan Dolomite Group (Upper Palaeozoic)
- PZ1 Undifferentiated Sedimentary Rocks (Palaeozoic)
- S Marl, Silstone (Silurian)
- O Limestone, Sandstone (Ordovician)
- pЄ Phyllite, Gneiss (Precambrian)
- pt/Ps Metamorphic Rocks
- Granite (Mesozoic, Cenozoic)
- Granite & Intrusives (Age unknown)
- Gabbro & Intrusives (Age unknown)
- Volcanic Rocks (Cenozoic)
- Geological Boundary
- Fault, Lineament
- Thrust
- Mudvolcano
- City/Town
- Road
- Railway
- Shan District

Fig. 2.3.1 Geological Map of Shan State

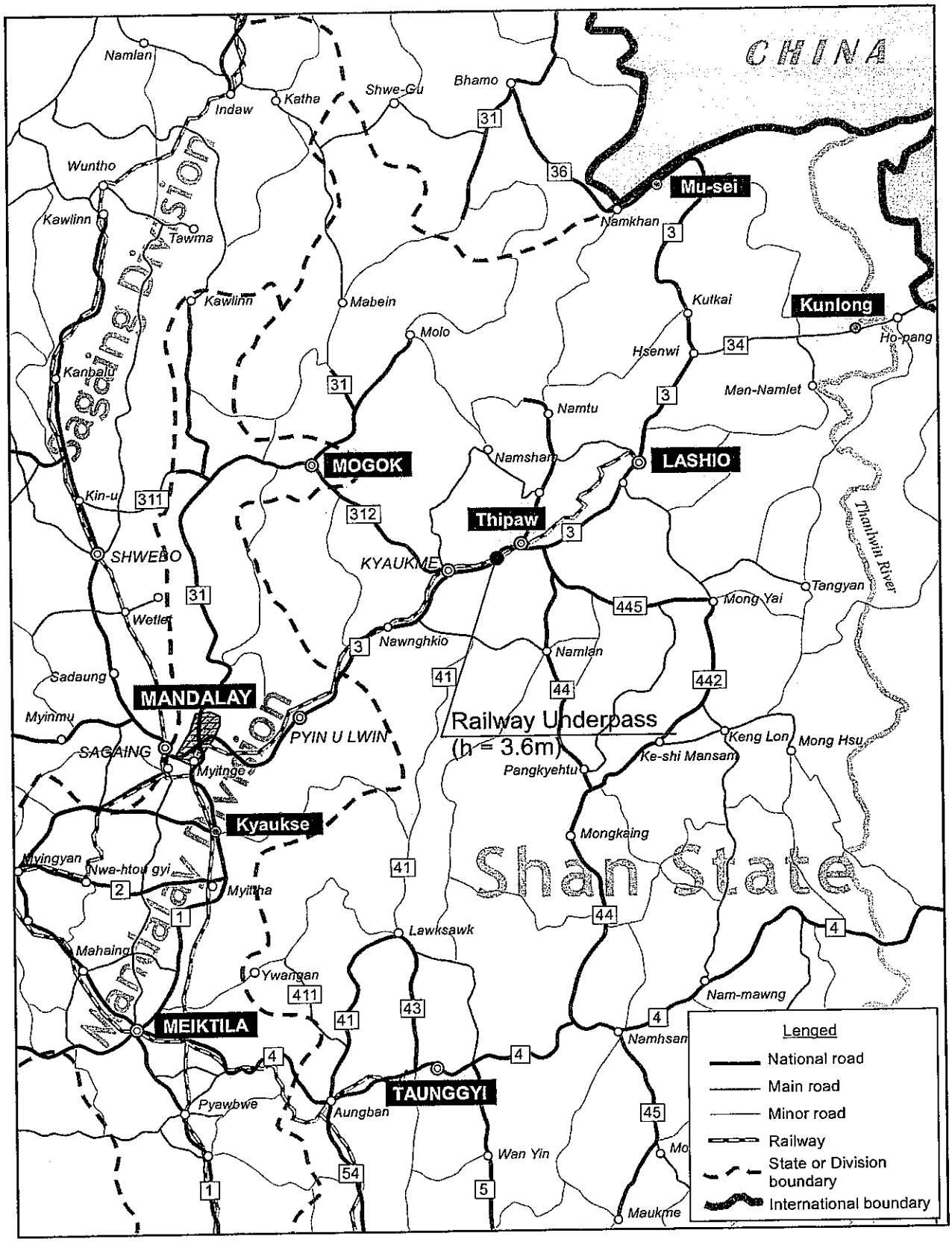


Fig. 2.3.2 Road Network in Northern Shan

Since the route 3 has relatively good pavement, it is possible to transport the Project Equipment in rainy seasons. But there are many narrow sections, curves and overage bridges. Especially, the clearance of the railway underpass between Kyaukme and Thipaw is less than 3.6m as shown in **Photo 2.3.1** and truck mounted drilling rigs, truck mounted high pressure air compressors and cargo trucks with crane cannot pass through the railway underpass. It is undesirable to dismantle mast from drilling rig and crane from truck when passing through the railway underpass, mechanically. Therefore, it seems to be better to improve underpass or take/make a detour.

Photo 2.3.1 Railway Underpass

Photo 2.3.2 Landslips at Route 34

Route 34 branched from Theinni of the Route 3 to Kunlong is also maintained by Asia World Company. However, transportation in rainy season shall be dangerous because of many narrow sections and landslips in mountainous areas as shown in **Photo 2.3.2.**

Rural Road

Density of rural road network in Northern Shan is very low as shown in **Fig. 2.3.2**. Almost all of the rural roads are unpaved and made up of uncovered lateritic soil. Therefore, 4x4 driven vehicle cannot be used for transport in rainy season. This Project should be promoted in line with improvement of rural roads.

(3) Construction Conditions and Utilization of Local Contractors

For protection of foreign currency reserves, there are many restrictions on imported goods in Myanmar. Import quantities of vehicles and construction heavy machines also have been limited since 1997. Though, tariff rate is lower than before, license for the import merchant is severely controlled by government. Therefore, there is no local agent for drilling rig maker. For the present, after sales services for equipment procured by the Project shall be depended on their suppliers.

Unloading port in Myanmar shall be Yangon port which is a river port, and capacity of quay is less than 12,000 ton class. Shipping from Yokohama to Yangon shall require three (3) weeks and custom clearance may take 2 or 3 days. Therefore, transportation from Yokohama to Meiktila shall take at least 1 month.

Other problem for the Project is bad quality of fuel available in Northern Shan. Countermeasures for using bad fuel shall be required for the Project.

(4) Operation and Maintenance Capacity of the Implementing Agency

WRUD's staff is capable to operate and to maintain the drilling rigs and other related equipment, and drilling rigs donated in 1970's are still functioning. Since **WRUD** has many skillful geologists, drillers and mechanics, there are few limitations on receiving capacity for equipment and implementation of the Project.

However, organization of **WRUD**'s Groundwater Division in the Shan State is undeveloped now. Therefore, the essential **WRUD** Lashio district office shall be established by April, 2002, at the commencement of the Project.

In Myanmar, there is no proper coordination among Ministries/Departments/Divisions and each Ministry/Department/Division is independently promoting their projects. As of now, close cooperation between **WRUD** and **DDA** cannot be expected as coordination among Departments/Divisions in the Ministry of Agriculture and Irrigation is not so good. Therefore, it is difficult to rent the equipment from other organizations for the implementation of the **WRUD** rural water supply projects.

(5) Concept for Scope and Grade of Facilities and Materials

Development Level

Development level of existing rural water supply system in Northern Shan are dug wells, public hydrants and rainfall collecting systems. Using of power pumps are only limited to hospitals, hotels and facilities of local governments. Besides piping system is also not so popular. **WRUD** shall aim to introduce handpumps and withhold to introduce power pumps. Therefore, equipment should be selected based on the assumption of using handpump.

Procurement of Equipment

<Well Drilling Equipment>

For the appropriate selection of well drilling equipment, standard well structure is considered as shown in **Fig. 2.3.3**. Considering the **UNICEF**'s assistance, diameter of standard casing of well is adopted as 4 inches.

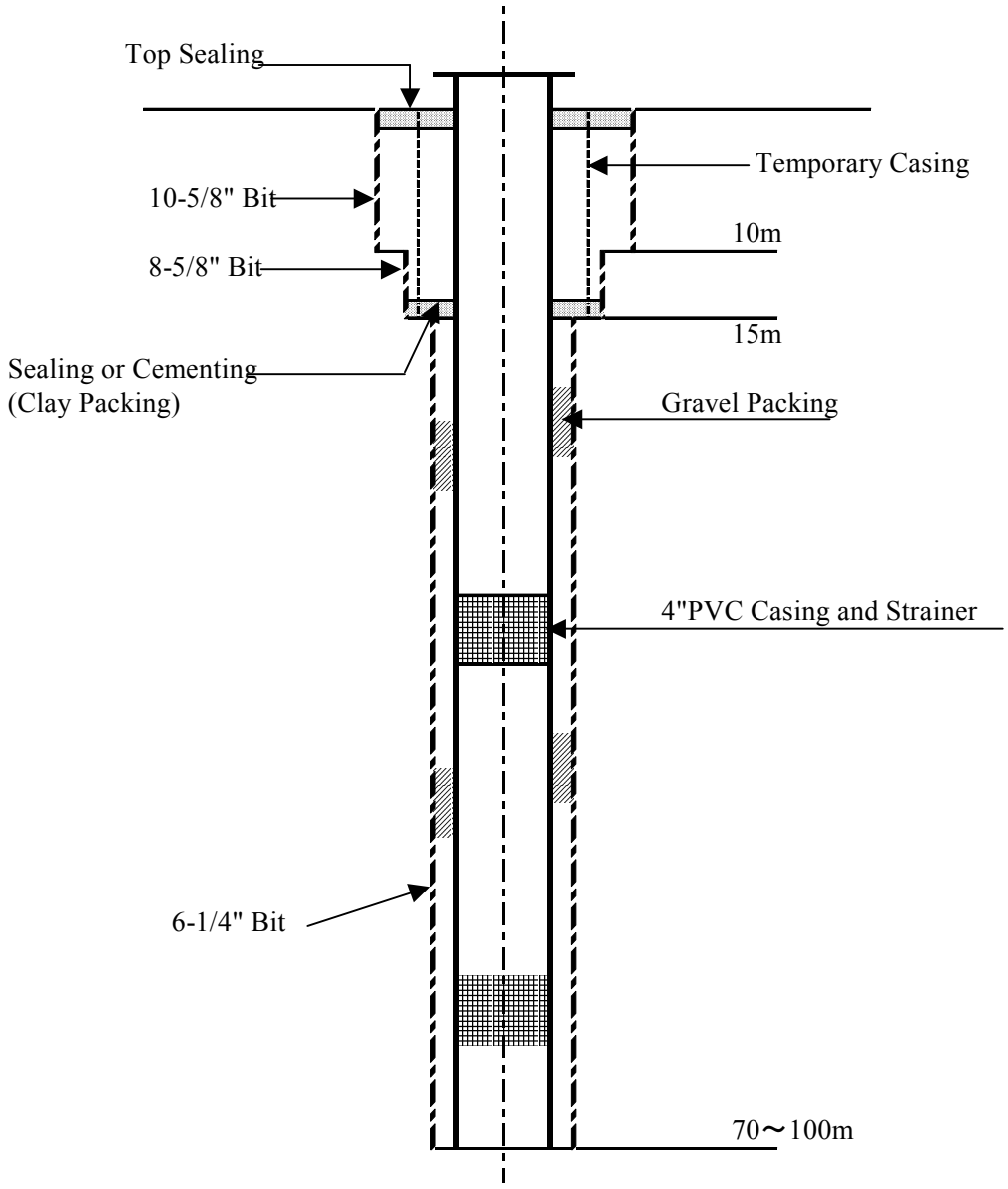


Fig. 2.3.3 Standard Well Structure (Deep tube well)

<Geophysical Survey Equipment>

Since the type of aquifer expected as water resources for tube wells in the Northern Shan are fissure type of limestone/granite and sedimentary types of alluvium, both electromagnetic and resistivity survey equipment shall be required for geophysical survey.

(6) Technical Cooperation

As mentioned in the Minutes of Discussions on the basic design study, WRUD had requested for the following technical cooperation.

- Counterpart Training in Japan
  - One (1) person for mechanical engineer of drilling rigs (first priority)
  - One (1) person for geophysical survey engineer (second priority)
- Short-term Expert
  - One (1) person for geophysical survey

Since hard limestone layer is widely distributed in the Northern Shan, electromagnetic survey shall be required for fissure type groundwater exploration. As staff of **WRUD** do not have experience in electromagnetic survey, technical transfer in soft component shall be required. Detailed content of soft component is mentioned in **Section 3.1.3**. The expected technical transfers for the project are summarized in **Table 2.3.3**.

Table 2.3.3 Expected Technical Cooperation for the Project

Item	Technical Transfer in the Project		Others	
	Commissioning	Soft Component	Counterpart Training in Japan	Short-term Expert
Well drilling	- With request - 1 month - Technical transfer for DTH drilling		- With request - Operation and maintenance of drilling rig - 1 person	
Geophysical survey	- With request - 1 month - Technical transfer for operation of geophysical survey	- With request - 2.5 months - Technical transfer for the appropriate operation and analysis of geophysical survey	- With request - Geophysical survey - 1 person	- With request - Geophysical survey - 1 person

(7) Concept for Construction Period

Considering the regulation of the Japan's Grant Aid Program, the grant aid project has to be implemented within one fiscal year. Therefore, the Project should be finished by March, 2002. The required time for production is 5 months for drilling equipment, taking 40 days for ocean freight and customs process. The geophysical survey equipment should be procured by October, 2001 because training for geophysical survey will also be implemented in the Project. Period of this training in Myanmar will be 2.0 months after handing-over the geophysical survey equipment.

2.3.2 Basic Design

(1) Outline of the Project

Equipment to be procured by the Project will be distributed to **WRUD** Lashio district office finally. Since **WRUD** Lashio district office is a temporary office now, it has problems in operation and maintenance, if all equipments are distributed to Lashio district office. Hence, **WRUD** is requesting for land to build a new Lashio district office with related organizations.

Therefore, all equipment will be distributed in **WRUD** Meiktila workshop of Mandalay division and Meiktila workshop will function as a temporary base. Thereafter, equipment will be relocated to the new Lashio district office.

Considering the appropriate schedule and righteous tendering for the Project, the equipment list consists of the following two (2) lots and thirteen (13) items as shown in **Table 2.3.4**.

Table 2.3.4 List of Equipment

Lot	Item No.	Item		Quantity	Remarks
A	A.1	Drilling rig		2	
	A.2	High pressure air compressor			
		A.2.1	High pressure air compressor: Type-A	1	
		A.2.2	High pressure air compressor: Type-B	1	
	A.3	Drilling tools		2	
	A.4	Low pressure air compressor		2	
	A.5	Mobile workshop		1	
	A.6	Water tanker		2	
	A.7	Cargo truck with crane			
		A.7.1	Cargo truck with crane: Type-A	2	
		A.7.2	Cargo truck with crane: Type-B	2	
	A.8	Pick-up truck		3	
	A.9	Electromagnetic survey equipment		2	
	A.10	Resistivity survey equipment		2	
	A.11	Borehole logging equipment		2	
	A.12	Portable water quality test equipment		2	
B	B.1	Spare parts and drilling bits for 2 units of TRD-300S		1	designation of merchandise

(2) Final Equipment Plan

The equipment to be supplied by the Government of Japan for the Project is summarized in **Table 2.3.5**.

Table 2.3.5 Specification and Purpose of Final Equipment

Item No.	Items	Quantity	Specifications	Purpose
A.1	Drilling rig	2	- Wheel drive: 4x4, left handle steering - Drilling capacity: 200m with 4-3/4" drill pipe - Top drive type/correspond to DTH and rotary mud drilling	Well drilling
A.2.1	High pressure air compressor: Type-A	1	- Wheel drive: 4x4, left handle steering - Discharge: 21.2m^3/min (750cfm) - Pressure: 21.1kg/cm^2 (300psi)	Well drilling
A.2.2	High pressure air compressor: Type-B	1	- Wheel drive: 4x4, left handle steering - Discharge: 14.2m^3/min (500cfm) - Pressure: 14.1kg/cm^2 (200psi)	Well drilling
A.3	Drilling tools	2	- Standard accessories for DTH - Drilling bits and tools - Well development tools	Well drilling
A.4	Low pressure air compressor	2	- Skid type - Discharge: 8.5m^3/min (300cfm) - Pressure: 7.0kg/cm^2 (100psi)	Well development
A.5	Mobile workshop	1	- Wheel drive: 4x4, left handle steering - Crane capacity: 3 ton	Repair of equipment
A.6	Water tanker	2	- Wheel drive: 4x4, left handle steering - Tank capacity: 6,000 liters over - With supply pump	Transportation of water for drilling
A.7.1	Cargo truck with crane: Type-A	1	- Wheel drive: 6x6, left handle steering with 5 ton crane - Load capacity: 10 ton over - Length of bed: 6.0 m over	Transportation of heavy equipment and materials
A.7.2	Cargo truck with crane: Type-B	1	- Wheel drive: 4x2, left handle steering with 3 ton crane - Load capacity: 6 ton over - Length of bed: 6.0 m over	Transportation of UNICEF's equipment
A.8	Pick-up truck	3	- Wheel drive: 4x4, left handle steering - Seating capacity: 5 persons - Load capacity: 0.5 ton over	Transportation of crew and equipment
A.9	Electromagnetic survey equipment	2	- Survey depth: 300m - Natural radio activity: 150-55,000Hz	Groundwater survey (fissure)
A.10	Resistivity survey equipment	2	-Survey depth: 300m -Output : 600V	Groundwater survey (aquifer in alluvium)
A.11	Borehole logging equipment	2	- Logging depth: 200m - Relative resistance, natural electric potential and gamma layer evaluation	Decision of aquifer depth and its range
A.12	Portable water quality test equipment	2	- Handy type - Analysis items: 10 items including coliform, arsenic, temperature, turbidity, pH, Cl, Fe etc.	Water quality tests in field
B.1	Spare parts and drilling bits for TRD-300S	1	- Spare parts and drilling bits for 2 units of TRD-300S	Rotary mud drilling

A.1 Drilling Rig

Since drilling target is hard limestone layer or Quaternary sediment, drilling rig shall be capable of facilitating both down-the-hole (DTH) air hammer drilling for hard rock and mud rotary drilling for unconsolidated formations. Taking into account the advantages on drilling efficiency and fuel expenses as shown in **Table 2.3.6**, top drive rotary is selected. Considering the maximum depth of tube well in the project area, the rig shall capable of 200m depth with 4-3/4" drill pipe. Moreover the drilling rig should be truck-mounted type to mitigate the damage caused by jolting during transit and 4 x 4 all wheel drive truck shall be required in rainy season because almost all of rural roads in the project area are unpaved and of lateritic top soil.

Table 2.3.6 Comparison between Top Drive and Rotary Table Type Drilling Rig

Item	Top Drive Type Drill Rig	Rotary Table Type Drill Rig
1. Power line mechanism	Because of hydraulic system, power transmission line is more simple than rotary table type. Total cost of top drive type is cheaper than that of rotary table type. Also due to less quantity of gears or shafts, maintenance cost can be saved.	Compared with top drive type, mechanical power transmission line is provided with transmission assembly for bit speed change and gearing for power distribution to rotary table, main drum and sand drum. Because of these additional components, cost of rotary table type is rather expensive than that of top drive type.
2. Drill pipe connecting time	Connecting time of drill pipe for top drive is much faster (approx. 50% of rotary table type) and can result to save running cost. Also drilling efficiency will be more effective.	Drill pipe connection is rather troublesome than top drive type.
3. Weight of drill unit	Due to adoption of hydraulic components for power line, total weight of drill unit can be minimized. This may save the fuel consumption during transportation and durability of drill unit can be lasted.	Due to adoption of more quantity of mechanical components for power line, total weight of drill unit is apt to be heavier than that of top drive type.
4. Protection of component	As hydraulic system has a relief system to protect the gears or shafts from the damage caused by overload, repair cost is cheaper than that of rotary table.	As mechanical power line system can not absorb the overload, gears or shafts may be sometimes broken or damaged and repair cost is more expensive.

A.2 High Pressure Air Compressor

The compressor carrier truck shall be 4 x 4 all wheel drive type for reasons same as drilling rig. High pressure air compressor shall be applicable to use for air flush and DTH drilling in hard rock and extreme hard formations. When extracting slime smoothly from the borehole, the velocity at ring sections recommended to be from 16.7 to 25.0 m/sec. The relationship between compressor capacity and velocity at ring sections are shown in **Table 2.3.7**.

Table 2.3.7 Velocity at Ring Sections

Capacity of compressor		Hole diameter (inch)	Rod diameter (inch)	Area of ring section (m^2)	Velocity at ring section (m/s)	Fuel expenses (l/hour)
(cfm)	(m^3/min)					
900	25.5	6-1/4	4-3/4	0.00834	51.0	62.0
		8-5/8	4-3/4	0.02623	17.6	(400PS)
750	21.2	6-1/4	4-3/4	0.00834	42.4	48.8
		8-5/8	4-3/4	0.02623	13.5	(315PS)
600	17.0	6-1/4	4-3/4	0.00834	34.0	32.6
		8-5/8	4-3/4	0.02623	10.8	(210PS)
500	14.2	6-1/4	4-3/4	0.00834	28.4	29.5
		8-5/8	4-3/4	0.02623	9.0	(190PS)

In case of under 600 cfm and 8-5/8" hole diameter, velocity at ring is too slow. Considering the frequency of hole diameter and saving of fuel expenses, two different capacity types of compressor were selected such as Type-A (750 cfm) and Type-B (500 cfm). Type A can correspond to drilling of 8-5/8" hole diameter and type-B can only be used in drilling less than 6-1/4" hole diameter.

A.3 Drilling Tools

Drilling tools consist of the following tools and accessories:

- Standard accessories for drilling rig
- Drill strings
- Drilling bits and tools
- Casing and casing handling tools
- Miscellaneous drilling tools
- Well development tools
- Equipment and tools for drilling works

A.4 Low Pressure Air Compressor

Low pressure air compressor for well development shall be of a screw type and skid mounted. Considering the average well depth (70 to 100m), the following specifications shall be required for well development:

- Rated pressure: not less than 100 psi (7.0 kg/cm^2)
- Free air delivery: not less than 300 cfm (8.5 m^3/min)

A.5 Mobile Workshop

For corresponding to various accidents of drilling rigs and related equipment, the following equipment shall be mounted for mobile workshop. The carrier truck shall be 4 x 4 all wheel drive type for reasons same as drilling rig.

- Hydraulic 3ton crane
- Diesel engine driven DC welder
- Oxygen-acetylene gas welding/cutting equipment
- Motor driven air compressor

A.6 Water Tanker

As every drilling well period is estimated to be a week, 6,000 liters seems to be suitable for the water tank capacity. The carrier truck shall be 4 x 4 all wheel drive type for reasons same as drilling rig.

A.7.1 Cargo Truck with Crane Type-A

For transportation of heavy drilling tools, the following specifications shall be required.

- Wheel drive: 6x6 all wheel drive
- Lifting capacity of crane: Not less than 3.0 tons at 2.5 m
- Load capacity: Not less than 10 tons
- Length of bed: Not less than 6.0 m

A.7.2 Cargo Truck with Crane Type-B

For transportation of UNICEF's PVC casings and other materials from Yangon to Lashio, the following specifications shall be required.

- Wheel drive: 4x2 rear wheel drive
- Lifting capacity of crane: Not less than 3.0 tons at 2.5 m
- Load capacity: Not less than 6 tons
- Length of bed: Not less than 6.0 m

A.8 Pick-up Truck

Pick-up truck shall be used for transportation of crew and equipment. Considering the utilization, the following specifications shall be required:

- Type: Diesel engine driven, pick-up type 4x4, left steering
- Seating capacity: Not less than 5 persons
- Load capacity: Not less than 0.5 ton

A.9 Electromagnetic Survey Equipment

Electromagnetic survey equipment is the ideal geophysical tool for locating conductive targets such as fractured zone for groundwater exploration and mineralized veins for mineral exploration. Resistivity can be measured by non-ground-contact method. The electric resistivity is calculated by the secondary magnetic field. Considering the geological conditions in the project area, the following specifications shall be required.

- Survey depth: 300m
- Frequencies: 10 steps (150Hz to 55,000Hz)
- Measurement items: In-phase and quadrature components of the secondary magnetic field (in % of primary field)
- Transmitter console: Remote-controlled by receiver through reference cable

A.10 Resistivity Survey Equipment

Resistivity survey equipment shall be used for groundwater exploration in alluvium. The unit shall be of alternative direct current and digital-data stacking type. Considering the geological conditions in the project area, the following specifications shall be required.

- Survey depth: 300m
- Measuring range: -10V to +10V
- Resolution: 1 micro V
- Output voltage: 600 V (1,200Vp-p) max.
- Current range: 300mA, 700mA, 1.8A, 2.5A
- Input impedance: 10 mega ohm
- Stacking: Any stacking numbers are possible by keyboard control
- Power supply: DC 12V internal rechargeable battery or external rechargeable battery

A.11 Borehole Logging Equipment

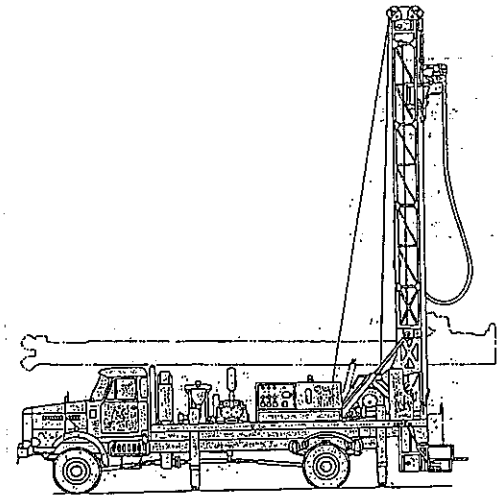
Borehole logging equipment is necessary to confirm the precise section of aquifers for designing a casing programme after completion of drilling. The equipment shall basically consist of normal resistivity, natural electric potential and natural gamma. Logging depth required shall be not less than 200m.

A.12 Portable Water Quality Test Equipment

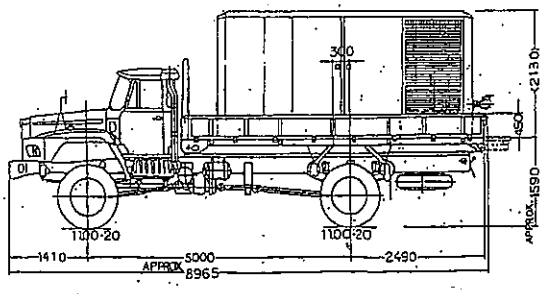
For quick water quality test in the field, portable water quality test equipment shall be provided. After the discussion with **WRUD**, the following ten (10) analytical items were required at least.

- Turbidity
- pH
- Hardness
- Iron
- Electrical conductivity
- Arsenic
- Fecal coliform (detection paper)
- Chloride
- Nitrate
- Fluoride

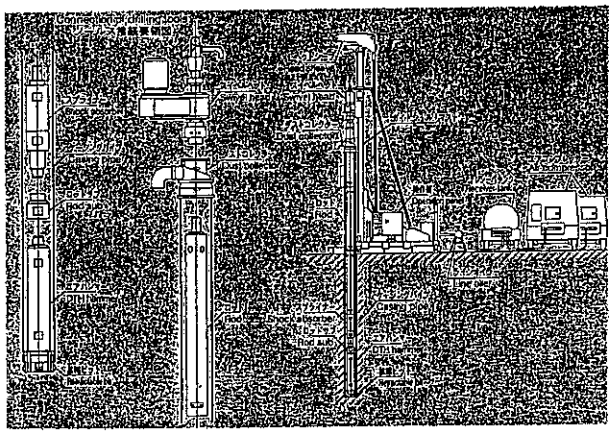
A.1: Drilling Rig



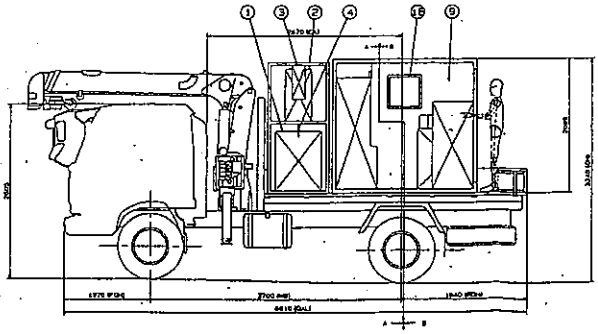
A.2: High Pressure Air Compressor



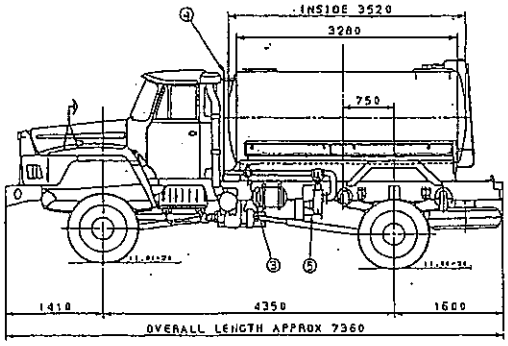
A.3: Drilling Tools



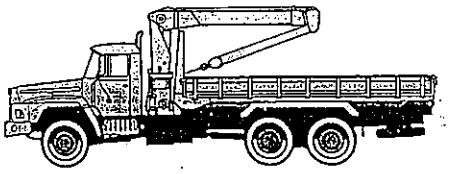
A.5: Mobile Workshop



A.6: Water Tanker



A.7: Cargo Truck With Crane
(Type-A)



(Type-B)

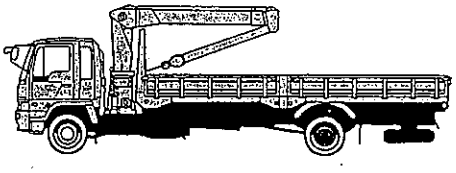


Fig. 2.3.4 Outline Drawing of Main Equipment

Chapter 3
Implementation Plan

CHAPTER 3 IMPLEMENTATION PLAN

3.1 Implementation Plan

3.1.1 Implementation Concept

The purpose of the Project is to supply necessary equipment for **WRUD**, in order to develop safe drinking water in Shan state, and **WRUD** is responsible for the construction of tube wells. Therefore, the construction of well drilling, water supply facilities and installation of equipment will not be included in the Project. However, soft component (dispatch of consultant's engineer) for technical transfer regarding the geophysical survey equipment will be planned for the Project.

As all equipment will be handed over at **WRUD** Meiktila Workshop, inland transportation from Yangon to Meiktila will be included in the Project. The commissioning, which requires technical transfer regarding operation and maintenance of drilling rigs and other related equipment by supplier's engineer, will be conducted just before handing over the equipment. To conduct the commissioning as scheduled, it is important to procure the custom clearance of equipment and assigning of vehicle's number plates by Myanmar side as quickly as possible.

3.1.2 Procurement Plan

The existing drilling rigs and related equipment have been donated by Japan and Australia, as they are not manufactured in Myanmar. Myanmar side requested that the equipment made in Japan should be procured for the Project due to superior quality and applicability of after sales services by Japanese manufacturers. Moreover, **WRUD**'s staffs have experience in Japanese equipment because **WRUD** have five (5) Japanese drilling rigs and other related Japanese equipment. Spare parts for truck's engine can be easily procured in local market because there are some Japanese manufacturers' local agents in Myanmar. Considering the **WRUD**'s request, the experience of **WRUD**'s mechanics and equipment's market service conditions, the Japanese equipment were selected for the Project.

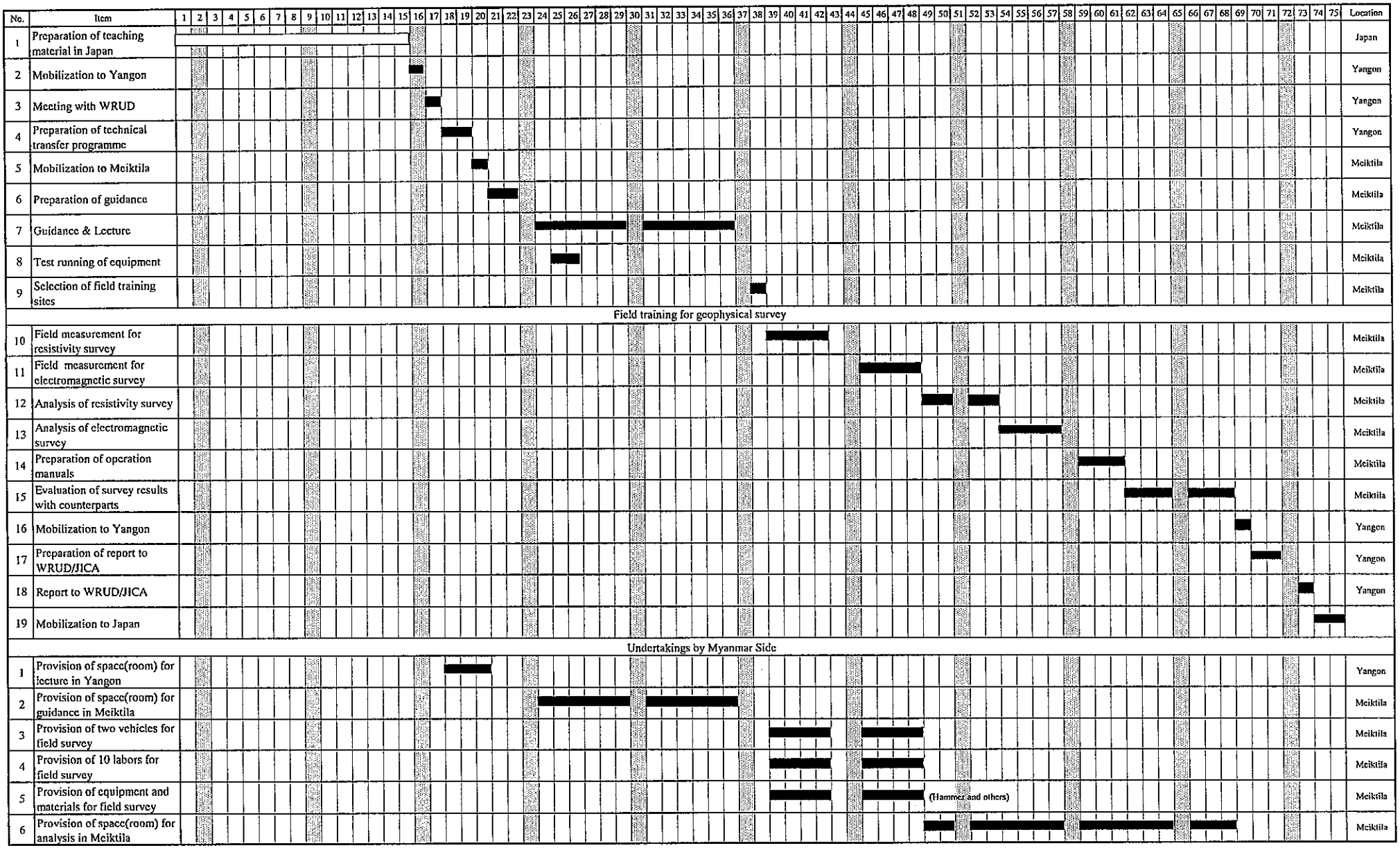
3.1.3 Soft Component

Staffs of **WRUD** have enough experience in the operation and maintenance of well drilling but do not have enough confidence in the operation and analysis for geophysical survey. Especially, as they are inexperienced in electromagnetic survey, **WRUD** expects technical transfer in these aspects to be conducted by Japanese engineers as much as possible.

Geophysical survey is indispensable to improve the well success rate and to promote groundwater development project quickly and effectively. For quick and effective establishment of groundwater survey system, soft component - having technical transfer regarding operation of geophysical survey equipment and interpretation of the survey results by the consultant's engineer, shall be proposed for inclusion in the Project.

The period required for the soft component shall be 0.5 month for preparation of teaching materials in Japan, 2.0 months for training in Myanmar, totally at least 2.5 months. The commencement of soft component shall be scheduled on time before which the geophysical survey equipment shall be transported to Myanmar. Proposed schedule and contents of the soft components are shown in **Fig. 3.1.1**.

Fig.3.1.1 Implementation Schedule for Soft Component



3.1.4 Implementation Schedule

On the limitation of the **E/N** period, all inspection/delivery, technical guidance and handing over of equipment has to be finished within one year. The Project implementation period shall be 11.5 months in total, Detail Design period (after E/N, consultant's contract, tender until supplier's contract) shall be 4 months, the required production time of drilling rigs and various vehicles will be 5 months, taking 1.5 months for ocean freight, custom clearance and inland transportation and 1 month for commissioning of procured equipment.

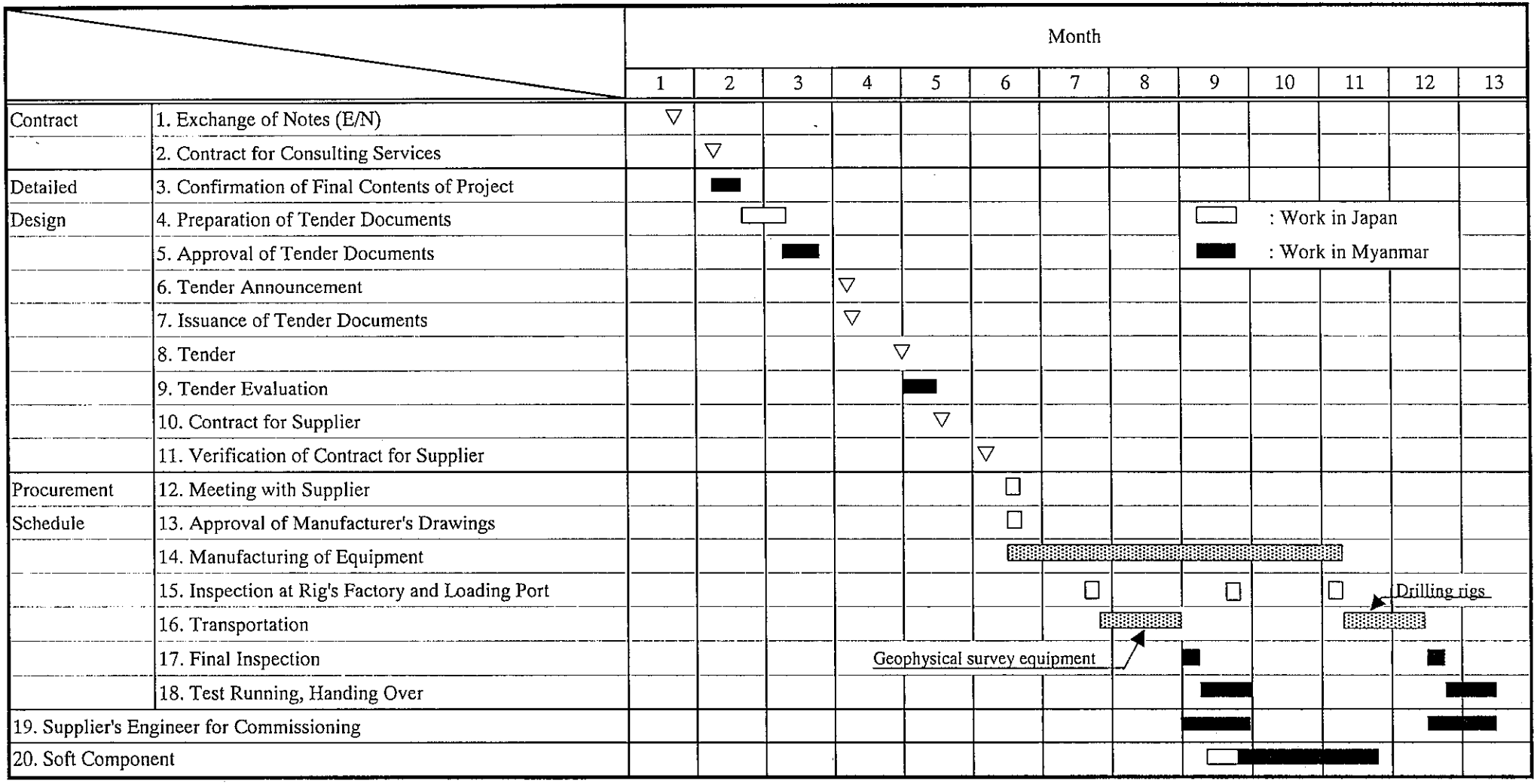
The whole schedule is presented in Fig. 3.1.2.

3.1.5 Obligations of the Recipient Country

The obligations required for the Government of Myanmar for the project implementation are as follows:

1) To bear the commissions to the Japanese foreign exchange bank for the banking services based upon the banking arrangement (B/A)
2) Execution of all custom formalities and tax payment concerned to the equipment supplied by the Project
3) Acquisition of number plates for vehicles supplied by the Project
4) Authorization for the Japanese staff entry and permission of stay in Myanmar
5) To organize a new Lashio district office and to assign the staff for the implementation of the Project
6) To secure sufficient budgets for local executive agency during the project execution
7) To improve the railway underpass near Thipaw or to make a detour for smooth transportation of drilling rigs
8) To bear all the expenses, other than those to be borne by the Grant, necessary for soft component and commissioning.

Fig. 3.1.2 Implementation Schedule



3.2 Project Cost Estimation

3.2.1 Project Cost Shouldered by Myanmar Side

The Myanmar side will be responsible for cost estimated at Kyat 13,282,000 and US$ 6,250 with breakdown as stated below:

1)	Vehicles and labor cost for Soft Component:	Kyat	62,000
2)	Materials and labor cost for Commissioning:	Kyat	220,000
3)	Cost for establishment of new Lashio District Office:	Kyat	13,000,000
	sub-total	Kyat	13,282,000
4)	Commissions to the Japanese foreign exchange bank for the banking services based upon the B/A:	US$	6,250

3.2.2 Operation and Maintenance Cost Shouldered by Myanmar Side

Equipment procured by the Project is divided into well drilling equipment and geophysical survey equipment. The former shall be maintained by the **WRUD** Lashio district office and the latter shall be maintained by the Shan State Groundwater Survey Team under the Groundwater Division of **WRUD** headquarters.

(1) **WRUD** Lashio District Office

The following staff will be assigned for the groundwater division in **WRUD** Lashio district office by April, 2002.

Table 3.2.1 Required Staff for WRUD Lashio District Office

	Head	Geolo-gist	Chief driller	Driller			Driver	Mech-anics	Clerk	Labor	Total
				G-3	G-4	G-5					
Office and workshop	1							5	3	6	15
Drilling team①: new rig		1	1	2	1	1	2				8
Drilling team②: new rig		1	1	2	1	1	2				8
Drilling team③: TRD-300S		1	1	2	1	1	2				8
Drilling team④: TRD-300S		1	1	2	1	1	2				8
Total	1	4	4	8	4	4	8	5	3	6	47

(2) Shan State Geophysical Survey Team

The following staff will be assigned for the Shan State Geophysical Survey Team by April, 2002.

Table 3.2.2 Required Staff for Shan State Geophysical Survey Team

No.	Position	Assignment	Number of Staff
1	Team Leader	Overall duty	1
2	Chief Geologist	In-charge, Interpretation of results	2
3	Geologist A	Data interpretation	4
4	Geologist B	Data collection (Field survey)	8
5	Helper	Field survey assistant	12
6	Driver		2
	Total		29

(3) Annual Operation and Maintenance Cost

The annual operation and maintenance cost for the Project shall be estimated at Kyat 6,600,000 as shown in **Table 3.2.3**.

Table 3.2.3 Annual Operation and Maintenance Cost

Item	WRUD Lashio District Office				WRUD Geophysical Survey Team			
Personnel expenses	Position	Unit price (Kyat)	Q'ty	Cost (Kyat)	Position	Unit price (Kyat)	Q'ty	Cost (Kyat)
	Head	116,400	1	116,400	Team leader	102,000	1	102,000
	Geologist	90,000	4	360,000	Chief geologist	78,000	2	156,000
	Chief of driller	70,800	4	283,200	Geologist A	70,800	4	283,200
	Driller (G-3)	63,600	8	508,800	Geologist B	70,800	8	566,400
	Driller (G-4)	56,400	4	225,600	Helper	63,600	12	763,200
	Driller (G-5)	49,200	4	196,800	Driver	56,400	2	112,800
	Driver	56,400	8	451,200				
	Mechanics	63,600	5	318,000				
	Clark	63,600	3	190,800				
	Labor	36,000	6	216,000				
	Sub-total			2,866,800	Sub-total			1,983,600
Others	Fuel/expendable			1,133,200	Fuel/expendable			616,400
Sub-total				4,000,000	Sub-total			2,600,000
Total								**6,600,000**

Chapter 4

Project Evaluation and Recommendation

CHAPTER 4 PROJECT EVALUATION AND RECOMMENDATION

4.1 Project Effects

(1) Direct Effects

The following direct effects are expected from the Project, and will contribute to improve the living conditions of rural people.

- 50 shallow tube wells and 250 deep tube wells will be constructed in Northern Shan area by 2005. (It is estimated that about 81,000 people can approach the safe and convenient drinking water.)

Shallow tube well (hand pump):	50 sites x 150 persons/site =	7,500 persons
Deep tube well (hand pump):	170 sites x 150 persons/site =	25,500 persons
Deep tube well (power pump):	80 sites x 600 persons/site =	48,000 persons
Total:		81,000 persons

- New drilling rigs will be in use for at least 15 years after 2005, and considering that 2wells can be drilled per unit and month, 720 tube wells (2 units x 24 sites/year x 15 years) will be constructed. More 270,000 people, and totally about 350,000 peoples can have access to the safe and convenient drinking water.

Tube well using hand pump:	360 sites x 150 persons/site =	54,000 persons
Tube well using power pump:	360 sites x 600 persons/site =	216,000 persons
Total:		270,000 persons

- Safe drinking water supply will contribute to decrease in infant mortality rate, parasitic diseases and diarrhoeal deaths.

- Implementation of geophysical survey will contribute to save the project cost due to improving of well success rate.

(2) Indirect Effects

- The Project will not only contribute to improve the living condition in the frontier area but to revitalize the communities due to implementation of group works in operation and maintenance of the tube wells.

- Accumulation of geophysical survey will contribute to improve the data-base and hydro-geological maps for groundwater development in the Shan state, and to improve the technology for analysis of geophysical survey in Myanmar.

- The latest technologies for drilling in hard rock layers and geophysical survey will be widespread in the whole country by **WRUD**'s staff.

4.2 Recommendations

Even though a significant impact is expected from the Project, the following items are required for its smooth implementation.

(1) Systematization of Groundwater Survey in Shan State

Geophysical survey should be implemented earlier than well drilling works. Using the electromagnetic and resistivity survey equipment procured through the project, effective geophysical survey should be conducted.

(2) Strengthening the Inhabitants Participation in O&M

The inhabitants participation is essential for success of the Project. The participation of beneficiaries, water user's association and township in planning, execution and O&M will stimulate their conscience on importance of management and O&M of the rural water supply system. It is not necessarily clear the demarcation of cost sharing for O&M. Considering the ability to pay by community residents, it is desired to share the cost of O/M as follows;

No.	Item	WRUD	Community	Remarks
1	Daily maintenance		○	
2	Replacement of hand pumps and valves		○	
3	Replacement of distribution pipes and standpipes		○	
4	Replacement of power pump	○	○	
5	Rehabilitation of deep well	○		
6	Water quality monitoring	○		2 times/year

(3) Strengthening of Sanitation & Hygiene Education

In spite of the campaigning for sanitation and hygiene education, the people in Shan state continue to drink water without any treatment such as boiling the coliform contaminated water. Hence, effective and strong campaign for sanitation awareness and hygiene education should be conducted in the frontier area.

APPENDICES

Appendix I

Member List of the Study Team

Appendix I Member List of the Study Team

1. The List of Study Team (Field Survey of Basic Design Study)

	Name	Assignment	Position	Period of Dispatch
1	Mr. Shigetada KAYUMI	Leader	Institute for International Cooperation, JICA	2000/9/3-9/17
2	Ms Emiko IBARAKI	Planning Management	First Project Management Div., Grant Aid Management Dept., JICA	2000/9/3-9/15
3	Mr. Shinichiro MATSUMOTO	Chief Consultant/ Groundwater Development Planning	Pacific Consultants International	2000/9/3-10/12
4	Mr. Yasumasa YAMASAKI	Hydrogeological Survey	Pacific Consultants International	2000/9/11-9/30
5	Mr. Shinichi YOSHIKAWA	Equipment Planning	Pacific Consultants International	2000/9/3-10/12
6	Mr. Hironori HONMA	Procurement Planning/ Cost Estimation	Pacific Consultants International	2000/9/13-10/2

2. The List of Study Team (Explanation on Draft Final Report)

	Name	Assignment	Position	Period of Dispatch
1	Mr. Shigetada KAYUMI	Leader	Institute for International Cooperation, JICA	2000/12/9-12/17
2	Mr. Hidetake AOKI	Planning Management	First Project Management Div., Grant Aid Management Dept., JICA	2000/12/9-12/17
3	Mr. Shinichiro MATSUMOTO	Chief Consultant/ Groundwater Development Planning	Pacific Consultants International	2000/12/9-12/20
4	Mr. Shinichi YOSHIKAWA	Equipment Planning	Pacific Consultants International	2000/12/9-12/20

Appendix II

Study Schedule

Survey Schedule on Field Survey of Besic Design Study

Date				JICA		Consultant				Stay
				Ibaraki	Kayumi	Matsumoto	Yoshikawa	Yamasaki	Honma	
1	9	3	Sun.	Mobilization (Narita11:00-15:30Bangkok18:00-Yangon18:5						Yangon
2		4	Mon.	Courtesy call and meeting wirh JICA(9:00), Embassy of Japan(10:00)、DAP(15:00) and FERD(16:50)						Yangon
3		5	Tue.	Courtesy call and meeting with WRUD(9:45) and WRUD(15:00)						Yangon
4		6	Wed.	Mobilization: Yangon:700-Mandalay:9:00 (HK005), Courte to WRUD/Mandalay div. and inspection of existing rig						Mandalay
5		7	Thu.	Mobilization: Mandalay-Meiktila-Mandalay Inspection of Meiktila WRUD Workshop						Mandalay
6		8	Fri.	Mobilization: Mandalay:7:15-Lasho:16:00 Courtesy call and meeting wirh Pyin-Oo-Lyin/WRUD Office						Lasho
7		9	Sat.	Field survey (Lashio-Thenni-Muse-Numkan-Muse)						Muse
8		10	Sun.	Field survey (Muse-Kutkhaing-Thenni-Lashio)						Lasho
9		11	Mon.	Field survey (Lasho-Thipaw-Mandalay) and team meeting				Arr. In Yangon		Mandalay
10		12	Teu.	Mobilization: Mandalay:9:25-Yangon:11:15(HK006) and team meeting						Yangon
11		13	Wed.	Meeting with WRUD (am: draft M/D, pm: schedule of second field survey					Arr. In Yangon	Yangon
12		14	Thu.	Meeting with WRUD (Roport of results of field survey, draft M/D, second field survey)						Yangon
13		15	Fri.	Signing of M/D、Consultant team meeting						Yangon
				Move to BKK						
14		16	Sat.	Arr. In TYO	Move to BKK	Yangon:700-Mandalay:9:00 (HK005)、WRUD/Mandalay				Mandalay
15		17	Sun.		Arr. In TYO	Inspection of Meiktila WRUD Workshop and existing wells				Mandalay
16		18	Mon.			Field survey (Mandalay-Thipaw-Lashio)				Lashio
17		19	Teu.			Field survey (Lashio-Thenne-Muse)				Muse
18		20	Wed.			Field survey (Muse-Namkan-Muse)				Muse
19		21	Thu.			Field survey (Muse-Kyukok-Kutkhaing-Thenni-Lashio)				Lashio
20		22	Fri.			Field survey (Lashio-Thenni-Kunlon-Thenni-Lashio)				Lashio
21		23	Sat.			Field survey (Lashio-Existing Deep Tubewells-Thipaw)				Thipaw
22		24	Sun.			Field survey (Thipaw-Pyin Oo Lyin/WRUD-Mandalay)				Mandalay
23		25	Mon.			Field survey (Mandalay-Monywa/WRUD-Mandalay)				Mandalay
24		26	Teu.			Mandalay:9:45-Yangon:11:35 (GT402), Team meeting				Yangon
25		27	Wed.			Meeting with WRUD and JICA、JICA				Yangon
26		28	Thu.			Arrangement of results of field survey, Meeting with WRUD				Yangon
27		29	Fri.			Meeting with WRUD		Move to BKK	Initial cost estimation	Yangon
28		30	Sat.			Arrangement of collecting dat		Arr. In TYO		Yangon
29	10	1	Sun.			Arrangement of collecting dat			Move to BKK	Yangon
30		2	Mon.			Preparation of draft T/N			Arr. In TYO	Yangon
31		3	Teu.			Preparation of draft T/N				Yangon
32		4	Wed.			Preparation of report fot GOJ				Yangon
33		5	Thu.			Preparation of report fot GOJ				Yangon
34		6	Fri.			Meeting with WRUD (draft T				Yangon
35		7	Sat.			Preparation of report fot GOJ				Yangon
36		8	Sun.			Preparation of report fot GOJ				Yangon
37		9	Mon.			Meeting with WRUD				Yangon
38		10	Teu.			Report to JICA and Embassy				Yangon
39		11	Wed.			Yangon - BKK				aircraft
40		12	Thu.			Narita				

Note) DAP: Department of Agricultural Planning/ Ministry of Agriculture and Irrigation
WRUD: Water Resources Utilization Department/ Ministry of Agriculture and Irrigation
FERD: Foreign Economic Relations Department

Survey Schedule on Explanation on Draft Final Report

Date				JICA		Consultant		Stay
				Kayumi	Aoki	Matsumoto	Yoshikawa	
1	12	9	Sat.	Mobilization (Narita10:30-Bangkok15:30/TG641)		Mobilization (Narita11:00-Bangkok15:55/JL717)		Yangon
				Mobilization (Bangkok17:45-Yangon18:30/TG305)				
2		10	Sun.	Arrangement of explaining documents	Mobilization (Yangon07:00-Mandalay08:30/HK011)		Arrangement of explaining documents	Yangon Mandalay
					Meeting with WRUD Meiktila Workshop			
3		11	Mon.		Mobilization (Mandalay09:15-Yangon11:15/HK006)			Yangon
				Courtesy call and meeting JICA, Embassy of Japan and WRUD				
4		12	Teu.	Meeting with WRUD				Yangon
5		13	Wed.	Meeting with WRUD				Yangon
6		14	Thu.	Meeting with WRUD				Yangon
7		15	Fri.	Signing of M/D Reprt to Embassy of Japan and JICA				Yangon
8		16	Sat.	Mobilization (Yangon10:25-Bangkok12:05/TG3 Bangkok23:20-		Meeting with WRUD		Yangon
9		17	Sun.	Narita06:50/NH916)		Arrangement of collecting data/ team meeting		Yangon
10		18	Mon.			Meeting with WRUD		Yangon
11		19	Teu.			Arrangement of collecting data		Aircraft
						Mobilization (Yangon19:30-Bangkok21:10/TG3		
12		20	Wed.			Bangkok22:50-Narita06:20/JL718)		

Note) WRUD: Water Resources Utilization Department/ Ministry of Agriculture and Irrigation

Appendix III

List of Party Concerned in the Recipient Country

Appendix III List of Party Concerned in the Recipient Country

(At Field Survey of Basic Design Study)

Ministry of National Planning and Economic Development/ Foreign Economic Relations Department (FERD)

1)	U SOE LIN	Director General
2)	DAW MYO NEW	Director

Ministry of Agriculture and Irrigation/ Department of Agricultural Planning (DAP)

1)	Dr. THEIN HTAY	Acting Director General
2)	U KYI WIN	Deputy Director

Ministry of Agriculture and Irrigation/ Water Resources Utilization Department (WRUD)

1)	U WIN SHWE	Director General
2)	U HLA MYINT MAUNG	Deputy Director General
3)	U KYAW WIN	Director, Groundwater Div.
4)	U TUN AYE CHO	Director, Administration Div.
5)	U SAW KYAW TUN	Deputy Director, Planning Div.
6)	U MYINT THWIN	Deputy Director, Groundwater Div.
7)	U KHIN AUNG THEIN	Assistant Director, Groundwater Div.

Embassy of Japan

1)	Mr. Naoki ITO	Counsellor
2)	Mr. Kazuhiro FURUKAWA	Second Secretary
3)	Mr. Yasuyuki NISHIO	Second Secretary
4)	Mr. Shigeo KATO	Special Assistant

JICA Myanmar Office

1)	Mr. Toshimichi AOKI	Resident Representative
2)	Mr. Takahisa FURUICHI	Assistant Resident Representative
3)	Mr. Kenji YOKOMORI	Project Formulation Advisor
4)	Ms Migusa SHIMAOKA	Project Formulation Advisor
5)	U TIN WIN	Program Officer

UNICEF Myanmar Office

1)	RAMESHWAR PRASAD	Project Officer
2)	TERENCE KADOE	Assistant Project Officer
3)	DEEPAK BAJRACHARYA	Chief /Water & Environmental Sanitation

(At Explanation on Draft Final Report)

Ministry of Agriculture and Irrigation/ Water Resources Utilization Department (WRUD)

1)	U HLA MYINT MAUNG	Deputy Director General
2)	U KYAW WIN	Director, Groundwater Div.
3)	U TUN AYE CHO	Director, Administration Div.
4)	U KHIN MG HTWE	Director, Planning Div.
5)	U CHAN THEIN	Director, Procurement Div.
6)	U SWE	Director, Civil Work Div.
7)	U SAW KYAW TUN	Deputy Director, Planning Div.
8)	U MYINT THWIN	Deputy Director, Groundwater Div.
9)	U THAN TUN	Deputy Director, Administration Div. (Finance)
10)	U KRISTOPHA NGIN	Deputy Director, Administration Div.
11)	U KYAW MIN OO	Deputy Director, Pump Div.
12)	U KHIN AUNG THEIN	Assistant Director, Groundwater Div.
13)	U DAW NYONYO WIN	Assistant Director, Civil Work Div.
14)	U THAN HLAING	Deputy Director, Mandalay Div.
15)	U TIN TUN	Assistant Director, Mandalay Div.
16)	U THANT CHO	Staff Officer, Mandalay Div.
17)	U TUN AUNG KYAW	Assistant Director, Sagaing Div.

Embassy of Japan

1)	Mr. Mr. Kazuhiro FURUKAWA	Second Secretary

JICA Myanmar Office

1)	Mr. Toshimichi AOKI	Resident Representative
2)	Mr. Takahisa FURUICHI	Assistant Resident Representative
3)	Mr. Eiji KOZUKA	Technical Cooperation Section
4)	Ms Kimiko KAITANI	Project Formulation Advisor
5)	U TIN WIN	Program Officer

UNICEF Myanmar Office

1)	RAMESHWAR PRASAD	Project Officer
2)	TERENCE KADOE	Assistant Project Officer
3)	DEEPAK BAJRACHARYA	Chief /Water & Environmental Sanitation

Appendix IV

Minutes of Discussions

(Field Survey)

MINUTES OF DISCUSSIONS
ON
THE BASIC DESIGN STUDY ON
THE PROJECT FOR RURAL DRINKING WATER SUPPLY IN SHAN STATE
IN THE UNION OF MYANMAR

In response to a request from the Government of the Union of Myanmar (hereinafter referred to as Myanmar), the Government of Japan decided to conduct a Basic Design Study on the Project for Rural Drinking Water Supply in Shan State (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent the Basic Design Study Team (hereinafter referred to as " the Team") to Myanmar, which is headed by Mr. Shigetada KAYUMI, Development Specialist, JICA, and is scheduled to stay in the country from September 3 to October 11, 2000.

The Team held discussions with the officials concerned of the Government of Myanmar and conducted a field survey in the study area.

As a result of discussions and field survey, both parties have confirmed the main items described on the attached sheets. The Team will proceed to further works and prepare the Basic Design Study Report.

Yangon, September 15, 2000

Mr. Shigetada Kayumi
Leader
Basic Design Study Team
Japan International Cooperation Agency

U Hla Myint Maung
Deputy Director General
For U Win Shwe, Director General
Water Resource Utilization Department
Ministry of Agriculture and Irrigation

Witnesses:

Daw Myo Nwe, Director
for U Soe Lin, Director General
Foreign Economic Relations Department
Ministry of National Planning and
Economic Development

Dr. Thein Htay
Acting Director General
Department of Agricultural Planning
Ministry of Agriculture and Irrigation

ATTACHMENT

1. Objective of the Project

The objective of the Project is to support the Safe Drinking Water Supply Programmes of the Government of Myanmar through provision of drilling rigs and other related equipment for groundwater development for Shan State, in order to improve living conditions of rural people.

2. Project Sites

The project sites are located in Shan State. A map indicating the area is shown as Annex–1.

3. Responsible and Implementing Agencies

Responsible and Implementing Agency is the Water Resource Utilization Department (WRUD), Ministry of Agriculture and Irrigation. The organization chart of WRUD is shown as Annex–2.

4. Main Items Requested by the Government of Myanmar

After discussions with the Team, Myanmar side finally requested the items described in Annex-3. JICA will assess the appropriateness of the request and will recommend to the Government of Japan for approval.

5. Japan's Grant Aid Scheme

5-1. Myanmar side understood the Japan's Grant Aid Scheme explained by the Team, as described in Annex- 4.

5-2. Myanmar side will take the necessary measures, as described in Annex–5, for smooth implementation of the Project, as a condition for the Japan's Grant Aid to be implemented.

6. Schedule of the Study

6-1. The consultants will proceed to further studies in Myanmar until October 11.

6-2. Based on the study results, JICA will prepare the draft report in English and dispatch a mission in order to explain its contents in December 2000.

6-3. In case that the contents of the report is accepted in principle by the Government of Myanmar, JICA will complete the final report and send it to the Government of Myanmar by February 2001.

7. Other Relevant Issues

7-1. Safe Drinking Water Supply Programmes

Construction of shallow and deep tube wells will be implemented by WRUD and by WRUD-UNICEF cooperation, based on the Safe Drinking Water Supply Programmes for The Year 2001 – 2005 as shown in Annex-6. In the programme for Shan State, Northern Shan Region is given the first priority in implementation.

7-2. Place of Deployment of the Equipment

All the equipment procured under the Project will be used in Shan State. Two (2) units of the existing drilling rigs (TRD-300) which require spare parts and are currently deployed in Mandalay will be also used in Shan State.

7-3. Delivery and handing over of the Equipment

The proposed place of delivery, assembly, and test operation is the WRUD workshop in Meiktila. After the test operation is completed, the equipment is handed over to WRUD.

Assembly and test operation are done by the engineers of the manufacturing companies of the main equipment such as drilling rigs and geophysical survey equipment in order to provide instructions for proper operation and maintenance.

7-4. Operation and Maintenance of the Equipment

WRUD will allocate sufficient budget and personnel with appropriate technical skills to ensure proper and effective operation and maintenance of the equipment procured under the Project.

7-5. Technical Cooperation

Myanmar side requested the following technical cooperation. The Team will convey the request to the Government of Japan.

(1) Counterpart Training in Japan

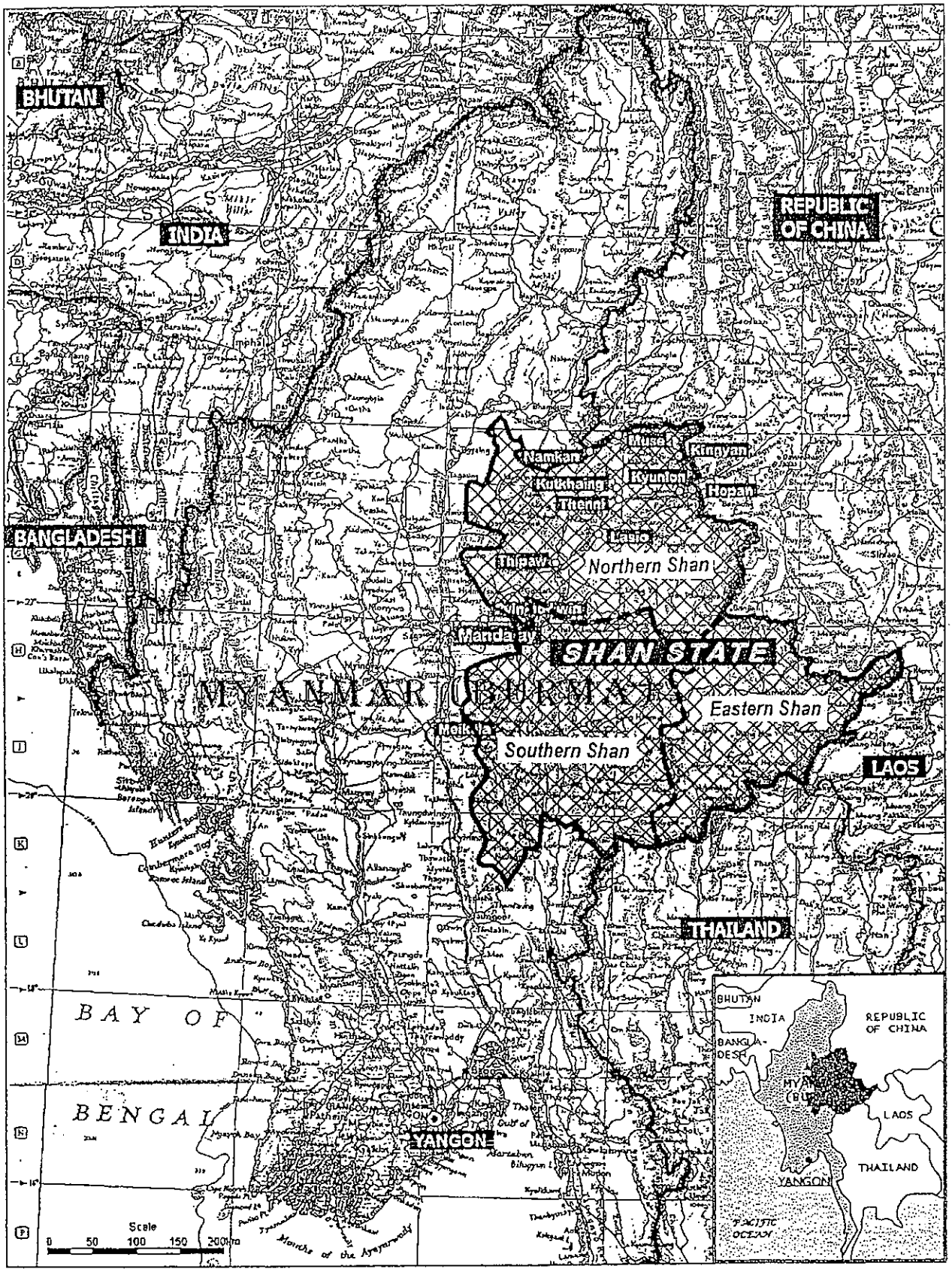
One (1) person for mechanical engineer of drilling rigs (first priority)
One (1) person for geophysical survey engineer (second priority)

(2) Short-term Expert

One (1) person for geophysical survey

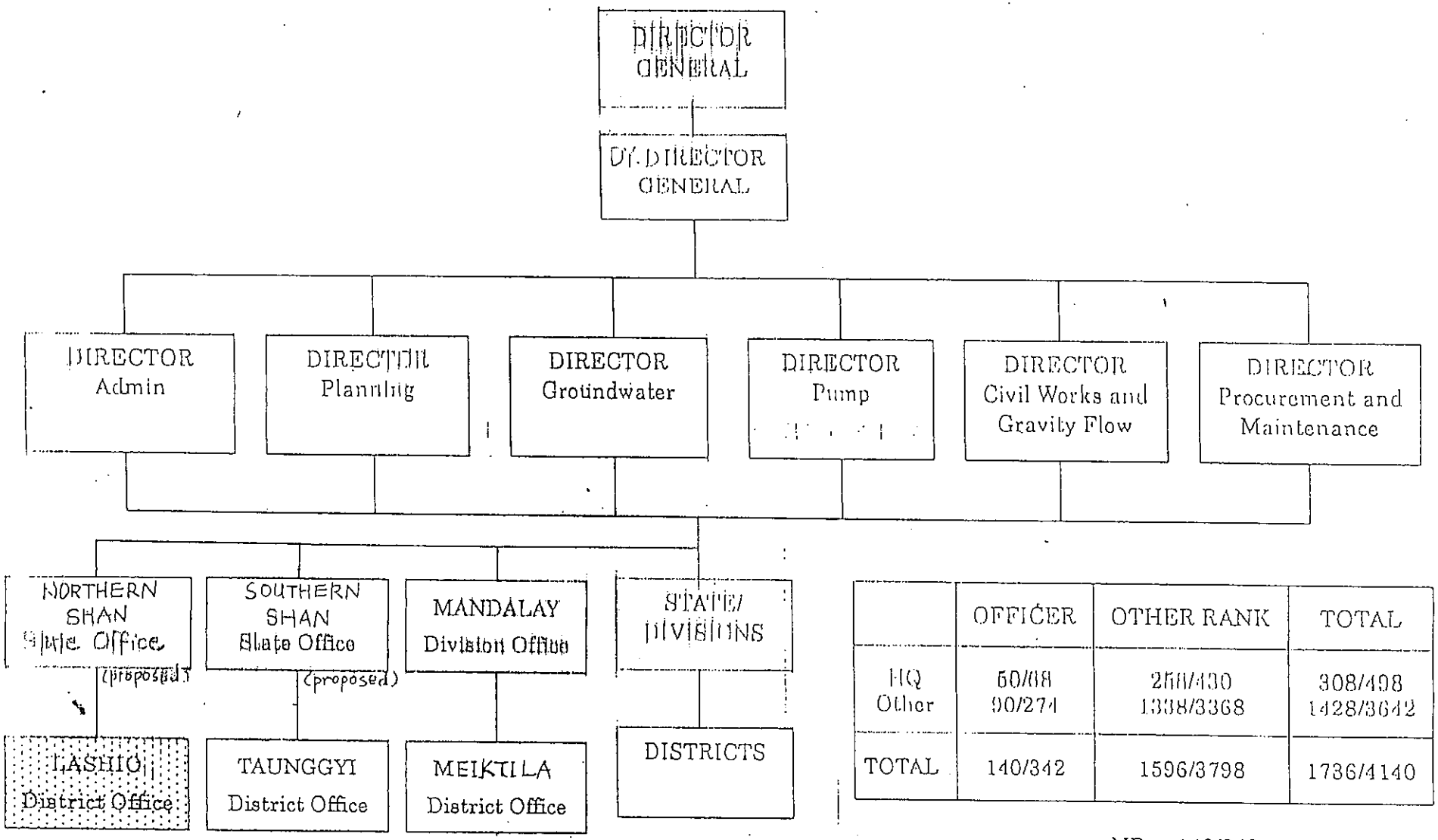
Annexes:

1. Location Map
2. Organization Chart of WRUD
3. List of Items Requested by the Government of Myanmar
4. Japan's Grant Aid Scheme
5. Necessary Measures to be Taken by the Government of Myanmar
6. Safe Drinking Water Supply Programmes for 2001-2005



Location Map of the Study Area

ORGANIZATION CHART OF WATER RESOURCES UTILIZATION DEPARTMENT



	OFFICER	OTHER RANK	TOTAL
HQ Other	50/68 90/274	258/430 1338/3368	308/498 1428/3642
TOTAL	140/342	1596/3798	1736/4140

NB: 140/342
140 = Recuted
142 = Allotted

IV-5

Annex-2

Annex-3

List of Items Requested by the Government of Myanmar

The equipment and materials requested by the Government of Myanmar are as follows:

(1) Truck Mounted Water Well Drilling Rig for 300 - 150 m

- 4x 4 heavy duty truck mounted water well drilling rig	2 units
- 4 x 4 heavy duty truck mounted high pressure air compressor for air flush/DTH drilling	2 units
- Drilling tools and accessories for direct rotary drilling for 200 m depth with 10-5/8" to 6-1/2" borehole	2 sets
- Spare parts for above equipment	2 lots

(2) Supporting Equipment for Groundwater Development and Drinking Water Supply

- Bulldozer, 130 HP	1 unit
- Wheel loader, 150 HP, 2.5 m^3 bucket	1 unit
- Hydraulic excavator, wheel type, 105 HP, 0.4 m^3 bucket	1 unit
- Mobile workshop for emergency services in drilling and construction	1 unit
- Water tanker	2 units
- Cargo truck with crane	1 unit
- Pick-up truck (Double cab)	2 units

(3) Geophysical Survey Equipment and Water Quality Test Equipment

- Electromagnetic survey equipment	1 unit
- Resistivity survey equipment	1 unit
- Bore hole logging equipment	2 units
- Portable water quality test equipment	2 units

(4) Spare Parts for two (2) units of Existing TRD-300S Drilling Rigs

- Spare parts for TRD-300S drilling units	1 lot
- Spare parts for mud pump units	1 lot
- Spare parts for mounting truck	1 lot
- Spare parts for drilling accessories	1 lot

JAPAN'S GRANT AID

1. Japan's Grant Aid System

(1) Grant Aid Procedures

1) Japan's Grant Aid Program is executed through the following procedures:

• Application	(Request made by a recipient county)
• Study	(Basic Design Study conducted by JICA)
• Appraisal & Approval	(Appraisal by the Government of Japan and Approval by the Cabinet of Japan)
• Determination of Implementation	(The Notes exchanged between the Governments of Japan and the recipient country)
• Implementation	(Implementation of the Project)

2) Firstly, the application or a request for a Grant Aid project submitted by a recipient country is examined by the Government of Japan (the Ministry of Foreign Affairs) to determine whether or not it eligible for Japan's Grand Aid. If the request is deemed appropriate, the Government of Japan assigns JICA (Japan International Cooperation Agency) to conduct a study on the request.

Secondly, JICA conducts the study (Basic Design Study), using (a) Japanese consulting firm(s).

Thirdly, the Government of Japan appraises the project to see whether or not it is suitable for Japan's Grant Aid Program, based on the Basic Design Study report prepared by JICA , and the results are then submitted to the Cabinet for approval.

Fourthly, the project, once approved by the Cabinet, becomes official with the Exchange of Notes signed by the Governments of Japan and the recipient country.

Finally, for the implementation of the project, JICA assists the recipient country in such matters as preparing tenders, contracts and so on.

(2) Basic Design Study

1) Contents of the Study

The aim of the Basic Design Study (hereafter referred to as "the Study") conducted by JICA on a requested project (hereafter referred to as "the Project") is to provide a basic document necessary for the appraisal of the Project by the Japanese Government. The contents of the Study are as follows:

i) Confirmation of the background, objectives, and benefits of the requested Project and also institutional capacity of agencies concerned of the recipient country necessary for the Project's implementation,

ii) Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, social and economical point of view,

iii) Confirmation of items agreed on by both parties concerning the basic concept of the Project,

iv) Preparation of a basic design of the Project,
v) Estimation of costs of the Project.

The contents of the original request are not necessarily approved in their initial form as the contents of the Grant Aid project. The Basic Design of the Project is confirmed considering the guidelines of Japan's Grant Aid Scheme.

The Government of Japan requests the Government of the recipient country to take whatever measures are necessary to ensure its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization in the recipient country actually implementing the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country through the Minutes of Discussions.

2) Selection of Consultants

For smooth implementation of the Study, JICA uses (a) registered consultant firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms. The firm(s) selected carry(ies) out a Basic Design Study and write(s) a report, based upon terms of reference set by JICA.

The consulting firm(s) used for the Study is (are) recommended by JICA to the recipient country to also work in the Project's implementation after the Exchange of Notes, in order to maintain technical consistency and also to avoid any undue delay in implementation should the selection process be repeated.

(3) Japan's Grant Aid Scheme

1) What is Grant Aid?

The Grant Aid Program provides a recipient country with non-reimbursable funds to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

2) Exchange of Notes (E/N)

Japan's Grant Aid is extended in accordance with the Notes exchanged by two Governments concerned, in which the objectives of the Project, period of execution, conditions and amount of the Grant Aid, etc., are confirmed.

3) "The period of the Grant Aid" means the one Japanese fiscal year which the Cabinet approves the Project for. Within the fiscal year, all procedures such as exchanging of the Notes, concluding contracts with (a) consultant firm(s) and (a) contractor(s) and final payment to them must be completed. However in case of delays in delivery, installation or construction due to unforeseen factors such as weather, the period of the Grant Aid can be further extended for a maximum of one fiscal year at most by mutual agreement between the two Governments.

4) Under the Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased.

When the two Governments deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country.

However the prime contractors, namely, consulting, constructing, and procurement firms, are limited to "Japanese nationals". (The term "Japanese nationals" means persons of Japanese nationality or Japanese corporations controlled by persons of Japanese nationality.)

5) Necessity of the "Verification"
The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by the Government of Japan. This "Verification" is deemed necessary to secure accountability to Japanese taxpayers.

6) Undertakings required of the Government of the Recipient Country
In the implementation of the Grant Aid project, the recipient country is required to undertake such necessary measures as the followings:

i) To secure land necessary for the sites of the Project and to clear, level and reclaim the land prior to commencement of the construction.

ii) To provide facilities for the distribution of electricity, water supply and drainage and other incidental facilities in and around the sites.

iii) To secure buildings prior to the procurement in case the installation of the equipment.

iv) To ensure all the expenses and prompt execution for unloading, customs clearance at the port of disembarkation and internal transportation of the products purchased under the Grant Aid.

v) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of the products and services under the Verified Contracts.

vi) To accord Japanese nationals whose services may be required in connection with the supply of the products and services under the Verified Contracts, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work.

vii) "Proper Use"
The recipient country is required to maintain and use the facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign staff necessary for this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.

viii)"Re-export"

The products purchased under the Grant Aid should not be re-exported from the recipient country.

ix) Banking Arrangement (B/A)

a) The Government of the recipient country or its designated authority should open an account in the name of the Government of the recipient country in an authorized foreign exchange bank in Japan (hereinafter referred to as "the Bank"). The Government of Japan will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to the Government of Japan under an authorization to pay issued by the Government of the recipient country or its designated authority.

2. Grant Aid Procedure

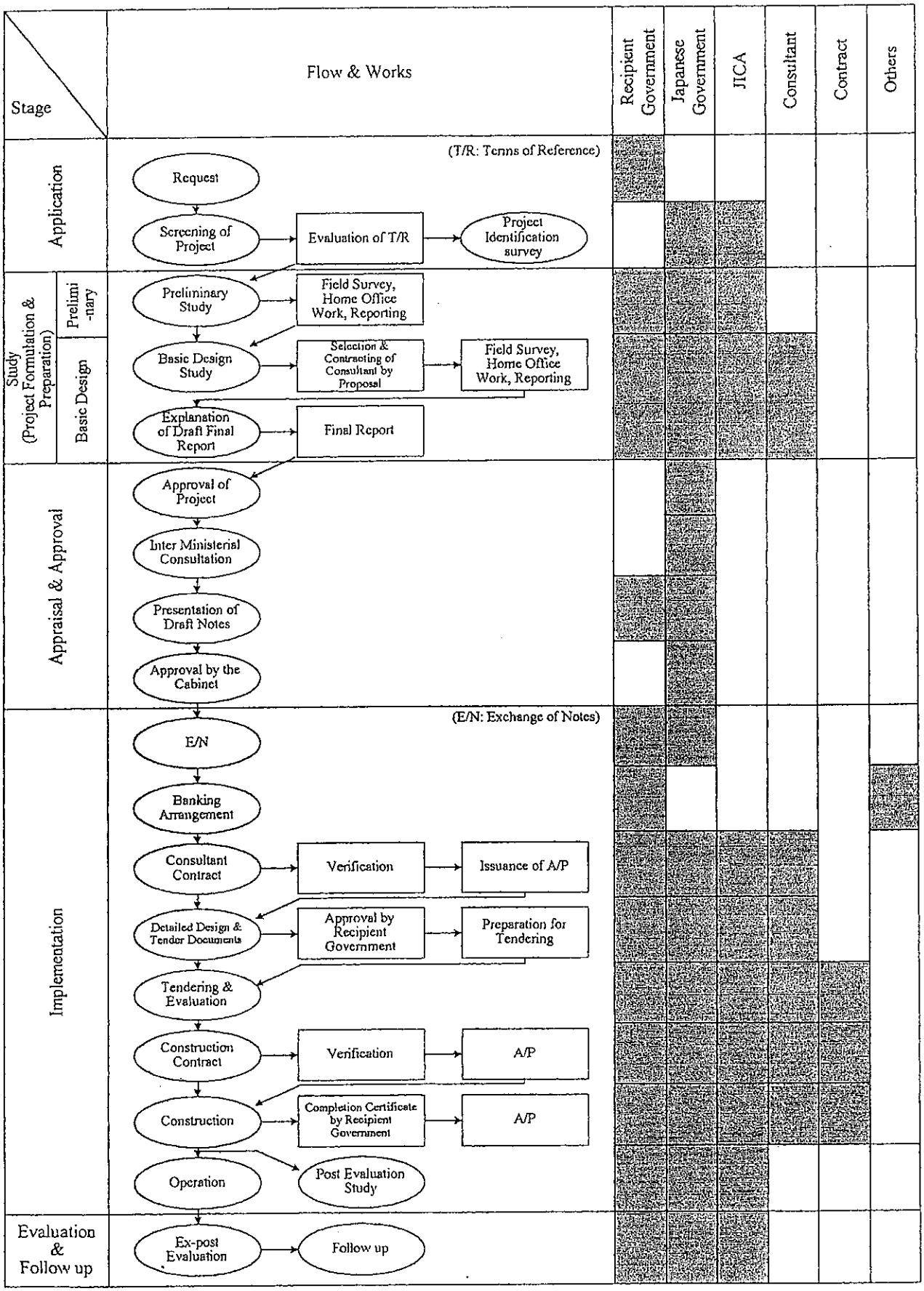
(1) Flowchart of Japan's Grant Aid Procedures

Refer to Attachment 1.

(2) Major Undertaking to be taken by Each Government

Refer to Attachment 2.

Flowchart of Japan's Grant Aid Procedure



Attachment 2

Major Undertakings to be Taken by Each Government

No.	Items	To be Covered by Grant Aid	To be Covered by Recipient Side
1	To bear the following commissions to the Japanese foreign exchange bank for the backing services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
2	To ensure unloading and customs clearance at port of disembarkation in the recipient country		
	1) Marine (Air) transportation of the products from Japan to the recipient country	●	
	2) Tax exemption and custom clearance of the products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	(●)	(●)
3	To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contact such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
4	To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contracts		●
5	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant		●
6	To bear all the expenses, other than those to be borne by the Grant, necessary for construction of the facilities as well as for the transportation and installation of the equipment		●

B/A : Banking Arrangement
A/P : Authorization to Pay

Annex-5

Necessary Measures to be Taken by Government of Union of Myanmar on Condition that Japan's Grant Aid is Extended

1. To support prompt execution for customs clearance of the equipment imported to the country under the Grant Aid.

2. To accord Japanese nationals whose services may be required in connection with the supply of products and services under the verified contracts such facilities as may be necessary for their entry into the country and stay therein for the execution of their work.

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

4. To maintain and use the facilities constructed under the Grant Aid properly and effectively and to assign the staff necessary for operation and maintenance for the facilities.

5. To bear all the expenses other than those to be borne by the Grant Aid necessary for the execution of the Project.

6. To bear advising commissions for Authorization to Pay and payment commission to a Japanese bank for the banking services based upon the banking arrangement.

PROPOSED SAFE DRINKING WATER SUPPLY PROGRAMMES FOR THE YEAR 2001-2005

Sr	State/ Division	Programme	Number of Systems									
			STW ($1\ 1/_2$ x 150)	DTW (4 x 200 WJ)	DTW (4 x 300 DTH	DTW (4 x 400 DR)	DTW (4 x 700 DR)	Rehab. Of Old DTW	Gravity Flow System	Tapping Dam	Improved Pond	Improved Dug Well
1	Sagaing	UNICEF + WRUD	650	90		75	30	40	5			
		WRUD only		100		75		40	2			
2	Mandalay	UNICEF + WRUD	600	120		75	65	70		5		
		WRUD only		140		75		70		5		
3	Magway	UNICEF + WRUD	750	120		75	65	75		5		
		WRUD only		140		75		75		5		
4	Bago	UNICEF + WRUD	600	40		15		10			100	100
		WRUD only		50		15		10				
5	Yangon	UNICEF + WRUD	600	30				5			100	
		WRUD only		40				5				
6	Ayeyawaddy	UNICEF + WRUD	700	80							550	100
		WRUD only		100								
7	Kachin	UNICEF + WRUD	500	20		10			3			
		WRUD only		30		10						
8	Kayah	UNICEF + WRUD	200		60				10		100	
		WRUD only			60				2			
9	Kayin	UNICEF + WRUD			40				20			
		WRUD only			40				2			
10	Shan	UNICEF + WRUD	200		170							
		WRUD only			170							
11	Mon	UNICEF + WRUD			50							
		WRUD only			50							
12	Rakhine	UNICEF + WRUD	200								150	
		WRUD only										
13	Chin	UNICEF + WRUD							12			
		WRUD only							4			
	Sub Total	UNICEF + WRUD	5000	500	320	250	160	200	50	10	1000	200
		WRUD only		600	320	250		200	10	10		
	Total		5000	1100	640	500	160	400	60	20	1000	200

Appendix V

WRUD's Letter for Additional Request

THE GOVERNMENT OF UNION OF MYANMAR
MINISTRY OF AGRICULTURE AND IRRIGATIONE
WATER RESOURCES UTILIZATION DEPARTMENT

Ref. Ma A Ya / 1-419(၉၃၆ / 2000)
Date 9th October, 2000

Mr. Shinichiro MASTUMOTO
Chief Consultant
Basic Design Study Team
Japan International Cooperation Agency

Subject: Additional Request For Shan State Water Supply Project

Mr. S. MASUMOTO,

We are very much thank to Government of Japan for sending Basic Design Study Team to our country to provide safe drinking water supply programmes in Shan State.

For drinking water supply programmes we have discussed thoroughly with Mr. Shigetada KAYUMI and also signed Minutes of Discussions on September 15, 2000. After signing of Minutes of Discussions, we, WRUD, held several meetings on "Annex-3: List of Items Requested by the Government of Myanmar", as mentioned in Minutes of Discussion, we found some essential items are not included in previous request .

In this context, if available, we, WRUD, would like to submit an additional request items to Government of Japan, as shown in ATTACHMENT-1, for successful implementation of water supply programmes in Shan State.

We highly appreciate the Basic Design Study Team for their efforts and we do hope the water supply project will be started before 2002. Please convey this additional request letter to JICA.

Thanking you for your cooperation.

Yours sincerely,

For Director General
(Hla Myint Maung)
Deputy Director General
Water Resources Utilization Department

ADDITIONAL REQUEST ITEMS

The following items are newly requested in addition to Items requested in Minutes of Discussions dated on 15th of September 2000 for the successful implementation of rural water supply programmes in Shan State.

(1) Four (4) low pressure compressors and related tools are newly requested for well development.

(2) Additional (3) cargo trucks with crane are requested for transportation of drilling equipment and well component.

(3) Additional (2) water tankers are requested for rotary mud drilling because of shortage of WRUD's water tankers.

(4) One (1) trailer truck is newly requested for transportation of bulldozer.

(5) Additional (1) pickup truck is requested for geophysical survey and water quality test.

(6) One (1) station wagon is newly requested for high level authority inspection.

(7) Additional (1) Electromagnetic survey equipment is requested for effective investigation.

(8) Additional (1) Resistivity survey equipment is requested for effective investigation.

(9) Additional (2) borehole logging equipment are requested for effective investigation.

(10) Two (2) lots of drilling bit for TRD-300S are newly requested for severe shortage.

(11) The drill bits, drill pipes and spare parts for newly provided drilling rigs are highly requested as much as possible because of scarcity of these items and not available locally.

(12) The equipment made in Japan should be procured for the Project due to the quality, applicability of after sales services by manufacturers, etc.

The priority of equipments by WRUD for this Project is shown in **Annex-1**.

Annex-1 LIST OF EQUIPMENT AND PRIORITY FOR JAPAN'S GRANT AID

Stage on Request Letter				Stage on Minutes of Discussions					Stage on WRUD's Letter					Priority
No	Item	Specification	Q'ty	No	Item	Specification	Q'ty	Reason for Change	No	Item	Specification	Q'ty	Reason for Change	
1	**Truck Mounted Water Well Drilling Rig**			1	**Truck Mounted Water Well Drilling Rig**				1	**Truck Mounted Water Well Drilling Rig**				
1.1	4x4 Heavy Duty Truck Mounted Water Well Drilling Rig	Top-300 Drive type	2	1.1	4x4 Heavy Duty Truck Mounted Water Well Drilling Rig		2		1.1	4x4 Heavy Duty Truck Mounted Water Well Drilling Rig	Rotary with DTH	2		A
1.2	4x4 Heavy Duty Truck Mounted High Pressure Air Compressor	For Air Flush/DTH	2	1.2	4x4 Heavy Duty Truck Mounted High Pressure Air Compressor	For Air Flush/DTH	2		1.2	4x4 Heavy Duty Truck Mounted High Pressure Air Compressor	For Air Flush/DTH	2		A
1.3	Drilling Tools and Accessories for Direct Rotary Drilling	For 200m depth with 10-5/8 to 6-1/2 borehole	2	1.3	Drilling Tools and Accessories for Direct Rotary Drilling	For 200m depth with 10-5/8 to 6-1/2 borehole	2		1.3	Drilling Tools and Accessories for Direct Rotary Drilling		2		A
1.4	Spare parts for Above Equipment		2	1.4	Spare parts for Above Equipment		2		1.4	Spare parts for Above Equipment		2		A
2	**Supporting Equipment**			2	**Supporting Equipment**				2	**Supporting Equipment**				
2.1	Bulidozer	130HP, st.till	1	2.1	Bulldozer	Bulldozer	1		2.1	Bulldozer	Bulldozer	1		C-2
2.2	Wheel Loader	150HP, 2.5m3 bucket	1	2.2	Wheel Loader	Wheel Loader	1		2.2	Wheel Loader	Wheel Loader	1		C-3
2.3	Motor Grader	155HP, 3.6m3 blade	1					Withdrawing						
2.4	Hydraulic Excavator Wheel Type	105HP, 0.4m3 bucket	1	2.3	Hydraulic Excavator Wheel Tyne	105HP, 0.4m3 bucket	1		2.3	Hydraulic Excavator Wheel Type	105HP, 0.4m3 bucket	1		C-6
2.5	Vibration Roller Wheel Type	6ton	1					Withdrawing						
2.6	Steel Bridge	TEC3, 40t. 26mx4m	5					Withdrawing						
2.7	Mobile Workshop		1	2.4	Mobile Workshop		1		2.4	Mobile Workshop		1		A
				2.5	Water Tanker		2	Newly addition, Lack of equipment	2.5	Water Tanker		4	Addition of Number, Lack of Numbers	2units: A 2units: C-5
				2.6	Cargo Truck With Crane		1	Newly addition, Lack of equipment	2.6	Cargo Truck With Crane		4	Addition of Number, Lack of Numbers	2units: A 2units: C-7
				2.7	Pickup Truck	Double Cab	2	Newly addition, Lack of equipment	2.7	Pickup Truck	Double Cab	3	Addition of Number, Lack of Numbers	A
									2.8	Station Wagon		1	Newly addition, Lack of equipment	A
									2.9	Trailer Truck		1	Transportation for Bulldozer	C-1
									2.10	Low Pressure Compressor		4	Newly addition, Lack of equipment	2units: B 2units: C-4
				3	**Geophysical Survey Equipment and Water Quality Test Equipment**				3	**Geophysical Survey Equipment and Water Quality Test Equipment**				
				3.1	Electromagnetic Survey Equipment		1	Newly addition, Fissure water	3.1	Electromagnetic Survey Equipment		2	Addition of Number, Lack of Numbers	A
				3.2	Resistivity Survey Equipment		1	Newly addition, Fissure water	3.2	Resistivity Survey Equipment		2	Addition of Number, Lack of Numbers	A
				3.3	Borehole Logging Equipment		2	Newly addition, Lack of equipment	3.3	Borehole Logging Equipment		4	Newly addition, Lack of equipment	2units: A 2units: B
				3.4	Portable Water Quality Test Equipment		2	Newly addition, Lack of equipment	3.4	Portable Water Quality Test Equipment		2		A
3	**Spare Parts for Existing Drilling Rigs**			4	**Spare Parts for Existing Drilling Rigs**				4	**Spare Parts for Existing Drilling Rigs**				
3.1	Spare Parts for TRD-300S Drilling Rig		5	4.1	Spare Parts for TRD-300S Drilling Rig		2		4.1	Spare Parts for TRD-300S Drilling Rig		2		B
3.2	Spare Parts for NAS-5H Pump Units		5	4.2	Spare Parts for NAS-5H Pump Units		2		4.2	Spare Parts for NAS-5H Pump Units		2		B
3.3	Spare Parts for Mounting Truck		5	4.3	Spare Parts for Mounting Truck		2		4.3	Spare Parts for Mounting Truck		2		B
3.4	Spare Parts for Drilling Accessories		5	4.4	Spare Parts for Drilling Accessories		2		4.4	Spare Parts for Drilling Accessories		2		B
									4.5	Bits for TRD-300S Drilling Rig		2	Newly addition, Lack of equipment	B

Note: Rank of Priority : A > B > C-7 > C-6 > C-5 > C-4 > C-3 > C-2 > C-1

Appendix VI

Minutes of Discussions

(Explanation on Draft Final Report)

MINUTES OF DISCUSSIONS
ON
THE BASIC DESIGN STUDY ON
THE PROJECT FOR THE RURAL DRINKING WATER SUPPLY
IN SHAN STATE
IN THE UNION OF MYANMAR
(EXPLANATION ON DRAFT FINAL REPORT)

In September 2000, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched a Basic Design Study Team on the project for the rural drinking water supply in Shan State (hereinafter referred to as "the Project") to the Union of Myanmar (hereinafter referred to as "Myanmar"), and through discussion, field survey, and technical examination of the results in Japan, JICA prepared a draft report of the study.

In order to explain and to consult the Myanmar on the components of the draft report, JICA sent to Myanmar the Draft Final Report Explanation Team (hereinafter referred to as "the Team"), which is headed by Shigetada KAYUMI, Senior Advisor, JICA, from December 9 to December 20.

As a result of discussions, both parties confirmed the main items described on the attached sheets.

Yangon, December 15, 2000

Shigetada Kayumi
Leader
Basic Design Study Team
Japan International Cooperation Agency

Kyaw Win
Director (Groundwater Division)
for Win Shwe, Director General
Water Resource Utilization Department
Ministry of Agriculture and Irrigation

ATTACHMENT

1. Components of the Draft Final Report

The Myanmar side agreed and accepted in principle the components of the draft of final report explained by the Team. After discussions with the Team, the Myanmar side finally confirmed the items described in Annex-I.

2. Japan's Grant Aid scheme

The Myanmar side understands the Japan's Grant Aid Scheme and the necessary measures to be taken by the Government of Myanmar as explained by the Team and described in Annex-IV and Annex-V of the Minutes of Discussions signed by both parties on September 15, 2000.

3. Schedule of the Study

JICA will complete the final report in accordance with the confirmed items and send it to Myanmar by March 2001.

4. Other relevant issues

(1) The Myanmar side will be responsible for cooperation to proceed each step of the implementation schedule properly so that the Project can be completed by the middle of March 2002.

(2) The Myanmar side agreed not to take off the mounted parts of the equipment from the trucks, when the equipment is to be transported from/to Shan State.

(3) The Myanmar side requested the consultant services for 60 days in Myanmar as soft component program for operation and maintenance on electromagnetic and resistivity survey equipment as one of the components of the Grant Aid, and assured to subsidize the expense to provide lecture rooms and Water Resource Utilization Department (WRUD) personnel for this component.

(4) For the sake of the technology transfer on sustainable operation and maintenance, the Myanmar side requested dispatch of Japanese experts as well as sending the Myanmar staff for technical training in Japan.

(5) The Myanmar side promised that all the equipment covered by the project will be utilized properly and effectively under the safe drinking water supply programs.

(6) The Myanmar side agreed to employ the existing equipment to organize the appropriate number of drilling teams.

(7) Both sides agreed all the equipment procured under the Project will be used in Shan State. The two (2) units of the existing drilling rigs (TRD-300S), which require spare parts, are currently deployed in Mandalay will be also used in Shan State.

(8) Construction of shallow and deep tube wells will be implemented by WRUD and by WRUD-

UNICEF cooperation, based on the Safe Drinking Water Supply Programs for The Year 2001 – 2005 as shown in Annex-VI of the Minutes of Discussions signed by both parties on September 15, 2000. In the program for Shan State, Northern Shan Region is given the first priority in implementation.

(9) The place of delivery, assembly, and test operation is the WRUD workshop in Meiktila. After the test operation is completed, the equipment is to be handed over to WRUD. Assembly and test operation are to be done by the engineers of the manufacturing companies of the main equipment such as drilling rigs and geophysical survey equipment in order to provide instructions for proper operation and maintenance.

(10) The Myanmar side promised to establish WRUD office and workshop in Lashio, which are planned to be completed by the end of 2001.

(11) The Myanmar side strongly requested the following alteration in specification and spare parts for some items. The Japanese side explained that it will be examined in Japan later, and the Myanmar side agreed to accept the decision by the Japanese government.

a) A.1 More spare parts for top head drive rotary unit and its hydraulic pump unit

b) A.7 Two Cargo trucks with crane (6x2, over 6m long)

c) A.12 Analytical items of the water quality test equipment are to be modified

(12) The Team handed one copy of the draft detailed specification of the equipment to the Myanmar side. Both sides agreed that this draft specification is confidential and should not be duplicated or released to any outside parties except for WRUD.

Annex-I

List of Equipment to be Provided under the Japan's Grant Aid Project

Item No.	Equipment with spare parts		Quantity
A.1	Drilling rigs (Top head drive with DTH type)		2 units
A.2-1	High pressure air compressor	(750 cfm, 300psi)	1 unit
A.2-2	High pressure air compressor	(600 cfm, 300psi)	1 unit
A.3	Drilling tools		2 units
A.4	Low pressure air compressor		2 units
A.5	Mobile workshop		1 unit
A.6	Water tanker		2 units
A.7	Cargo truck with crane	(6x6, over 6m long)	2 units
A.8	Pick up truck		3 units
A.9	Electromagnetic survey equipment		2 units
A.10	Resistivity survey equipment		2 units
A.11	Borehole logging equipment		2 units
A.12	Portable water quality test equipment		2 units
B.1	Spare parts and drilling rigs for 2 units of TRD-300S		1 set

THE GOVERNMENT OF THE UNION OF MYANMAR
MINISTRY OF AGRICULTURE AND IRRIGATION
WATER RESOURCES UTILIZATION DEPARTMENT

Date. 14th December , 2000
Ref. Ma A Ya / 3-454
(1196 / 2000)

Dear Kayumi,

Subject: Provision of Drilling Rigs.

Regarding the provision of two units of Top Head Drive drill rig as mentioned in your final draft report, we, WRUD, would like to place some comments on that subject for your consideration and necessary action.

As you are aware, we have technical proficiency and capability in operation and maintenance of Rotary Table type drilling rigs through our decades long experience in groundwater exploration.

However, we are happy to inform you that provision of Top Head Drive Drilling rigs , as an alternative option is acceptable , provided one top head drive assembly together with one hydraulic pump assembly are included in each drill units , in addition to JICA's normal routine spare parts supplied .

It would be highly appreciated if the aforesaid parts were to be supply, as there have no such Top Head Drive type rigs are being utilized both by the government and other agencies and thus availability of those parts is inevitable.

Thanking you for your usual cooperation and kind assistance.

Yours Sincerely

Kyaw Win 14/12
(Director- Groundwater)
For Director General

Mr.Shigetada Kayumi
Team Leader
Basic Design Study Team
JICA

Copy to
-Director (Admin) WRUD
-Office copy
-Float

Appendix VII

Cost Estimation Borne by the Recipient Country

Appendix VII Cost Estimation Borne by the Recipient Country

No.			Item	Unit Price	Quantity	Amount
1			Vehicles and labor cost for soft component			
	1.1		2 vehicles including drivers and fuel (8days) (HSD)	160	2 x 100	32,000
	1.2		10 labors (line men) x 8 days (DRIVER)	4,700	2 x 1	9,400
	1.3		others (LABOUR)	100	10 x 10	10,000
	1.4		(OTHER)			10,000
			sub-total			61,400
2			Materials and labor cost for commissioning			
	2.1		materials and labor for test boring (5days)	108,100	2	216,200
	2.2		others			
	2.3		sub-total			216,200
3			Cost for establishment of new Lashio District Office			
	3.1		obtaining of land			
	3.2		construction of main office (26 x 8 m2)	2,500,000	1	2,500,000
	3.3		construction of warehouse (15 x 8 m2)	2,000,000	2	4,000,000
	3.4		construction of workshop (15 x 8 m2)	1,500,000	3	4,500,000
	3.5		cost of electric and water supply facilities etc.	1,200,000	1	1,200,000
	3.6		cost of office supplies (desks, chairs etc.)	500,000	1	500,000
	3.7		others			300,000
	3.8		sub-total			13,000,000
4			Annual personnel cost of WRUD new Lashio district office			
	4.1		head (AD+AE) (1+4)	9700/ 7500	1\4	524,400
	4.2		chief driller (4)	5,900	4	283,200
	4.3		driller (G-3) (8)	5,300	8	588,800
	4.4		driller (G-4) (4)	4,700	4	225,600
	4.5		driller (G-5) (4)	4,100	4	196,800
	4.6		driver (8)	4,700	8	451,200
	4.7			5,300	5	318,000
	4.8		clerk (UD) (3)	5,300	3	190,800
	4.9		labor, watchmen (5+1)	3,000	6	216,000
5			Annual personnel cost of WRUD geophysical survey team			
	5.1		team leader (AE)	8,500	1	102,000
	5.2		chief geologist (Senior SAE)	6,500	2	156,000
	5.3		geologist A (data interpretation)	5,900	4	283,200
	5.4		geologist B (data collection)	5,900	8	566,400
	5.5		Helper (line man)	5,300	12	763,200
	5.6		driver	4,700	2	112,800
6			Annual Operation and Maintenance Cost			
	6.1		Expendables in Table 2.2.3			
7			Fuel Mireage (gal/hour)	gal/hour		
	7.1		drilling rig : Borne (300 PS) HP	4		
	7.2		drilling rig : TRD-300S (240 PS)HP	3		
	7.3		high pressure air compressor (420 cfm,250 psi)	6		
8			Water charge of WRUD water supply			
9			Maximum depth (m) of well using 4" UNICEF PVC Casing			

Source: **WRUD** (answer to consultant's questionnaire)

Appendix VIII

Other Relevant Data

Data-1 General Information of Township

No.	District	Township		Number of Village	Population			Education			Health			
					Urban	Rural	Total	BEPS	BEMS	BEHS	TH	SH	RHC	SRHC
I	Lashio	1	Lashio	503	95,904	143,857	239,761	120	10	6	3	0	5	0
		2	Theinni	300	26,135	39,203	65,338	47	3	1	1	0	2	8
		3	Tantyan	605	67,959	101,939	169,898	86	5	1	1	0	2	0
		4	Maingye	233	25,186	37,778	62,964	43	2	1	1	0	1	0
II	Kaukme	5	Kyaukme	400	40,059	138,216	178,275	156	8	3	6	0	4	0
		6	Thipaw	546	32,639	113,784	146,423	140	5	3	2	0	4	0
		7	Naungcho	251	14,784	101,692	116,476	156	8	1	2	0	6	0
		8	Moemeik	105	11,825	51,724	63,549	84	7	1	2	0	2	0
		9	Mabein	49	3,821	26,568	30,389	49	3	1	1	0	2	0
		10	Namsan	126	29,826	65,996	95,822	119	6	1	1	0	5	0
		11	Manton	165	1,521	31,171	32,692	37	0	1	1	0	1	0
		12	Namatu	136	6,006	71,102	77,108	53	5	2	2	0	2	0
III	Muse	13	Muse	140	53,393	80,088	133,481	57	5	2	2	0	2	0
		14	Namkham	188	24,365	84,418	108,783	86	6	2	1	1	2	7
		15	Kukhaing	472	68,186	102,278	170,464	123	6	2	3	2	6	31
IV	Kunlon	16	Kunlon	170	25,730	38,597	64,327	52	1	2	2	0	2	0
		17	Hopan	107	31,590	47,384	78,974	53	3	1	2	0	2	0
V	Laukaing	18	Laukaing	155	7,135	54,944	62,079	15	1	1	1	0	0	0
		19	Kongyan	179	1,243	39,779	41,022	12	0	0	1	0	0	0
Total				4,830	567,307	1,370,518	1,937,825	1,488	84	32	35	3	50	46
Average					117.5	283.8	401.2	0.308						

Note: BEPS: Basic Education Primary School
BEMS: Basic Education Middle School
BEHS: Basic Education High School
TH: Tpwnship Hospital
SH: Station Hospital
RHC: Rural Health Center
SRHC: Sub Rural Health Center

Data-2: Climate in Lashio

MONTHLY RAINFALL (mm) OF LASHIO STATION

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
1981	1	7	2	58	294	247	117	91	226	109	168	36
1982	0	4	0	102	49	273	155	391	202	41	86	0
1983	0	12	59	73	112	280	159	225	249	195	124	38
1984	4	1	0	49	143	338	208	299	193	253	0	8
1985	0	1	4	41	228	141	281	261	250	75	79	0
1986	0	0	3	68	70	210	314	199	82	367	26	1
1987	14	30	22	95	38	280	108	327	323	53	95	7
1988	0	0	0	87	154	196	209	238	79	63	74	0
1989	0	0	6	70	98	193	342	348	119	175	30	18
1990	0	13	24	41	256	130	144	199	159	102	26	10
1991	2	0	1	76	222	233	104	361	217	212	106	11
1992	12	24	0	15	37	97	221	118	214	279	36	7
1993	2	38	1	21	185	213	184	217	207	178	4	0
1994	0	8	58	44	68	211	228	236	198	37	49	9
1995	0	2	0	13	116	224	220	283	289	131	225	0
1996	0	4	50	84	56	133	300	231	225	70	75	8
1997	0	0	13	44	72	114	234	295	301	93	17	16
1998	5	0	29	62	155	163	198	189	170	87	21	0
1999	1	0	1	37	138	109	262	217	187	184	141	1
2000	1	28	30	93	139	203	350					

Mean MAXIMUM TEMPERATURE (°C) OF LASHIO STATION

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
1981	25.1	28.2	30.5	31.5	30.2	29.3	29.9	29.9	29.8	29.1	25	23.4
1982	24.5	26.6	31.7	30	33.2	30.1	29.9	29	30	28.3	25	23
1983	23.5	28	28.6	31.6	30.1	30.4	30.3	29.1	29.2	29.9	24.7	23.3
1984	24.5	28.5	32	33.3	30.5	29.3	28.2	29.5	29.5	28.1	27.5	25.5
1985	25.7	27.1	32	33.2	32.1	30.1	28.6	29.7	28.9	28.8	25.8	25.2
1986	25	28.5	30.9	34	32.4	31	28.3	30.5	30.2	28	26.9	26.3
1987	25.5	27	29.9	32.1	33.9	30.3	30	29.7	29.1	29	27.6	24.5
1988	25	28.8	31.9	32.3	32.1	30.6	29.8	29.3	30.7	29.8	26	25.6
1989	25.7	26.5	31.7	33.9	33.1	30.9	29.4	29.8	30.5	29.1	26.7	23.3
1990	25.7	25.9	27.4	31.9	30.4	30	28.7	30	29.9	28.8	28.1	24.4
1991	25.8	29	32.7	33.1	30.9	29.8	29.8	28.9	30.3	28	26.2	24.3
1992	23.5	23.8	31.7	33.7	32.2	31.6	28.7	30	29.8	25.9	25.9	23.1
1993	24.1	26.1	30.6	32.8	30.8	29.9	30.1	28.6	30	28.3	28	27
1994	27.7	28.5	31	32.7	33.4	30.2	30	29.2	30.4	29.3	26.9	25.4
1995	26.9	28.4	33.1	35.2	32.7	30.6	29.9	29.5	28.7	30.2	26	24.6
1996	25.4	27.4	30.5	32	31.9	29.6	28.7	28.9	30.1	29.7	26.7	25
1997	24	26.4	30.7	29.7	31.7	30.8	29.4	29.7	28.8	29.2	27	25.3
1998	25.9	27.9	30.9	32.2	31	31.1	27.7	29.3	30.7	30.8	29	26.7
1999	26.1	31.3	31.7	34.7	30.5	30.7	29.7	28.4	29.7	28.9	26.7	24.2
2000	26.2	26.8	29.2	32	29.1	30.2	29.3					

Mean MINIMUM TEMPERATURE (°C) OF LASHIO STATION

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
1981	6.4	5.8	10.4	14.9	19.6	22	22.2	22.1	20.9	19.7	15.9	10.5
1982	5.5	7.1	8.7	15	18.6	21.8	22.2	21.6	20.9	18.6	13	7
1983	4.4	8	11.2	14.1	18	21.8	22.5	21.8	20.6	19.4	13.6	5.9
1984	5.7	6.7	7.4	16.1	19.9	21.4	21.4	21.4	19.4	18	11	8.1
1985	3.8	3.6	9.4	15.7	19	22.1	21.2	21.6	20.4	13.5	12.4	6.4
1986	5.2	5.5	7.8	16	18.9	21.6	21.7	21.6	20.2	18.7	11.5	9
1987	6.6	6.5	9.7	14.5	18.1	22.2	22	21.6	21.2	16.6	14.9	8.1
1988	5.8	5.9	9.6	15	20.2	21.2	21.9	21.9	21.2	18.9	13.2	7.8
1989	2.4	5	9.4	13.4	19.3	21.3	21.5	21.3	21.1	19.1	11.3	6.3
1990	4.1	6.4	10.2	13.8	18.7	21.8	21.5	21.4	20.3	17.3	14.9	6.9
1991	5.1	4.4	9.4	14.7	18.5	21.8	21.9	21.5	21.1	19.4	14.2	6.3
1992	5.3	6.4	9.3	13.6	17.9	21.1	21.4	21.5	20.5	17.9	12.6	6.8
1993	4.7	6	8	12.8	18.3	21	22.1	21.8	20.7	19.5	12.2	5.9
1994	3.4	4.7	9.1	14.4	19.7	21.9	21.6	21.6	21.3	16.6	12.2	6.6
1995	4.1	5	7.1	14.3	20.3	22.4	22	21.8	20.8	18.9	15.9	7.3
1996	4.7	6.8	11	14.3	19.5	21.1	22	21.6	20.9	18.6	13.4	10.3
1997	3.2	3.6	10	14.1	18.1	21.3	22.1	22	20.3	17.5	14.1	9.9
1998	5.7	7.5	10.5	13.4	19.4	21.9	22.5	22.3	20.8	18.8	13.9	7.7
1999	4.4	6.2	7.9	15.7	20	21.8	21.7	22	21.2	19.2	13.1	7.8
2000	3.8	6.2	10.9	15.2	19.4	21.8	21.6					

Mean RELATIVE HUMIDITY (%) at 09:30 hrs M.S.T (Lashio Station)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
1981	86	72	56	61	74	81	76	78	82	85	89	87
1982	89	74	56	69	65	80	78	84	82	85	85	84
1983	87	89	65	60	67	75	79	85	84	82	88	85
1984	87	75	61	56	74	78	81	82	83	85	86	89
1985	82	68	55	55	67	77	77	86	85	88	87	83
1986	89	75	58	56	66	76	84	82	80	83	84	81
1987	87	80	64	64	59	78	76	82	84	80	87	87
1988	85	73	54	59	75	76	77	83	80	84	87	88
1989	78	67	58	42	60	74	82	83	82	81	84	83
1990	81	74	69	56	72	80	84	82	83	82	82	89
1991	84	64	56	59	76	80	79	86	85	86	90	89
1992	90	81	56	48	64	76	82	83	85	87	83	90
1993	85	78	58	54	73	81	81	87	83	87	83	82
1994	80	68	61	64	67	80	84	85	84	82	83	88
1995	78	64	52	42	67	76	80	86	86	84	87	86
1996	84	73	58	61	69	79	82	82	85	82	86	89
1997	85	75	63	70	69	76	86	82	86	85	89	92
1998	87	74	68	67	75	81	84	86	87	84	82	83
1999	93	65	59	58	76	77	83	87	92	87	90	86
2000	82	75	69	74	81	78	88					

MEAN RELATIVE HUMIDITY (%) at 18:30 hrs M.S.T (Lashio Station)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
1981	64	51	43	51	71	78	75	79	83	81	84	79
1982	66	56	37	62	59	81	75	81	75	77	82	73
1983	66	54	50	47	61	71	75	84	81	79	83	71
1984	71	48	36	49	68	76	78	81	80	81	70	73
1985	57	40	36	42	59	73	73	81	81	76	80	74
1986	66	49	35	44	63	77	84	82	78	74	76	70
1987	66	56	45	48	54	79	77	83	81	79	77	73
1988	62	51	39	51	75	76	75	84	78	79	78	79
1989	64	48	37	33	59	70	81	81	83	83	81	78
1990	65	61	56	53	72	78	79	81	82	80	80	78
1991	64	42	37	48	75	77	76	83	82	90	80	77
1992	72	64	43	39	62	68	82	83	84	86	83	81
1993	74	64	46	44	74	80	77	84	83	85	76	71
1994	60	49	43	53	61	77	78	84	82	76	80	77
1995	62	51	34	32	69	77	78	83	84	82	84	74
1996	62	51	45	48	64	74	81	83	81	78	81	79
1997	66	52	46	57	63	77	78	82	84	75	80	75
1998	60	48	52	51	63	78	81	82	82	79	75	71
1999	61	44	33	47	68	77	78	83	81	83	80	72
2000	57	51	47	56	74	72	81					

MONTHLY MEAN OF EVAPORATION (Lashio)

		JAN	FEB	MAR	APL	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1981	Mean	3.1	4.4	5.3	5.5	4.7	3.5	3.8	4.4	3.3	3.3	2.6	2.6
	Sum	94.9	124.1	164.5	163.6	144.5	103.8	117.9	135.7	99.7	103.1	78	79.4
1982	Mean	3	4	6	4	6		4	4	5	3	3	
	Sum	90.6	125.9	175	130.9	172.4		133	119.7	150.3	104.4	83.1	
1983	Mean	2.9	3.6	4.8	5.5	4.2	3.7	3.4	2.8	3.1	3.2	2.1	2.6
	Sum	90	100.9	148.5	166.3	130.1	110.5	106.7	86.3	94.1	99	64.3	81.1
1984	Mean	3.1	4.6	5.6	5.8	4.4	3.1	2.9	2.7	3.7	3.1	3	2.8
	Sum	95.9	133.6	174.9	172.9	135.5	92.8	90.3	85.1	112.5	95.6	91.3	87.7
1985	Mean	3.2	4.7	6.1	6	5.1	3.9	2.8	3	2.6	3.1	2.6	2.6
	Sum	98.1	131.6	188.5	178.6	159.1	118.3	87.7	93.9	79	96.1	78	81
1986	Mean	2.7	4.1	5.1	6.3	5.7	4	2.2	3.9	4.3	2	3.2	2.8
	Sum	84.7	116.2	158.5	188.4	176.1	119.1	67.5	119.4	128.1	63	95.7	86.8
1987	Mean	3	4		5	7	3	4	3	3	4	3	3
	Sum	90.8	119.1		154.3	206.2	97.9	125.4	93.1	81.6	118	86.2	80.9
1988	Mean	3.2	4.5	5.6	4.8	4.1	3.5	3.7	2.9	3.6	3.4	2.1	2.4
	Sum	100.6	131.3	172.3	143.5	126.9	105.7	114.9	88.7	108.8	105.5	61.7	75.6
1989	Mean	3.7	5.1	6	7	6.8	4	3.3	3.3	3.4	2.7	3.2	2.7
	Sum	115.3	141.5	185.8	211.3	209.4	118.9	101.4	101	102.1	85	95.7	84.2
1990	Mean	3.9	3.7	4.3	5.7	4.4	3.8	2.6	3.9	3.1	3.2	3.1	2.6
	Sum	121.1	104.6	131.9	171	135.6	114.9	82.1	121.6	93.5	98.4	92.2	81.8
1991	Mean	3.4	5	5.8	6	4.5	3.6	3.8	2.6	3.1	2.3	2.6	2.6
	Sum	104.4	140.3	178.5	180.1	138.8	109.1	116.5	79.2	93.9	71.1	77.7	81.8
1992	Mean	2.7	3.3	6.1	6.6	5.9	4.8	2.8	3.4	3.1	2.5	2.5	2.2
	Sum	83.4	95.8	189.4	197.4	184.4	142.5	88	104	91.6	76.1	74.8	67.7
1993	Mean	3	4	5			3	3	2		2		
	Sum	94	106	157.7			93.1	99.1	74.9		74.4		
1994	Mean	4	5	5	6		3	3	2	3	3		3
	Sum	115.2	129.2	159	166.4		92.7	89.3	54	86.8	91.2		80.5
1995	Mean	3	4	6				3	3	2	4	2	
	Sum	106	122.8	180.1				97.1	82.1	65.4	111.4	63.2	
1996	Mean	3.4	4.2	5.5	4.9	4.2	3.5	2.6	3	3.1	2.9	2.5	2.2
	Sum	104.9	122.1	169.4	146.9	130.3	106.4	79.4	94.2	93.1	89.3	75	67.2
1997	Mean	3		5	4	5	4	4					
	Sum	92.4		140.2	124	145.2	123.1	108.9					
1998	Mean	4	5	5	6	4	5	3	3	4		4	4
	Sum	108.9	133.9	164.3	178	137	141.9	89.1	102.6	124.3		115	111.8
1999	Mean	3.6	5.3	5.4	6.1	4.1	4.6	3.8	2.5	3	3.1	2.5	2.6
	Sum	112.7	147.7	168.3	183.2	128.5	138.8	117.2	77.8	89.3	95.9	73.8	80.2

Data-3: Existing Well Data in Northern Shan

No.	District	Township	Village/Place	Latitude	Longitude	Elevation (mASL)	Aquifer	WL (m)	TOC (m)	SWL (mBGL)	Depth (mBGL)	T (℃)	pH	EC (mS/cm)	DO (mg/L)	Coliform	Note
1	Mekhtila	Wandwin	Kanthit	2110.467	9601.188	151	Alluvial	76.20	-	76.2		33.5	7.56	1.364	-	0	
2	Mekhtila	Wandwin	Kaing	2120.712	9606.028	97	Alluvial	4.27	-	4.3		30.4	7.85	2.04	-	0	
3	Mekhtila	Kukhaing	Man Pyein BEPS	2320.342	9757.281	1070	Laterite	2.07	0.57	1.5	3.02	22.1	7.16	0.536	1.9	100<	
4	Mekhtila	Kukhaing	Man Naung BEPS	2323.763	9756.472	1360	Laterite	spring				19.3	6.98	0.418	6.1	100<	
5	Muse	Naung Khan	Naung Khan BEPS	2352.672	9744.542	770	Alluvial	3.90	0.65	3.25	5.1	23.1	5.95	0.234	-	2	No.1
6	Muse	Naung Khan	Man Khan BEPS	2351.947	9743.677	755	Alluvial	3.25	0.80	2.45	5.5	23.4	5.73	0.141	-		No.2
7	Muse	Naung Khan	Kon Sar BEPS	2351.375	9742.939	740	Alluvial	tap from spring				22.9	6.39	0.621	-		
8	Muse	Naung Khan	Kun Long	2349.589	9739.024	760	Alluvial	3.05	0.75	2.30	5.15	24.7	6.07	0.369	-		
9	Muse	Naung Khan	Shwe Li Bridge	2343.748	9737.878	785	Alluvial?	public water				(25.0)	(5.95)	(0.079	-		
10	Muse	Naung Khan	Ngwn In	2349.272	9740.027	780	Alluvial	flowing			1.90	23.1	5.12	0.0808	-		
11	Muse	Muse	Nam Tee	2348.767	9739.490	780	Alluvial			0.00		23.5	5.24	0.0734	-		
12	Muse	Muse	Tein Lon	2357.680	9751.758	765	Alluvial	2.90	0.85	2.05		23.3	6.00	0.271	-		
13	Muse		Pan Kham	2358.095	9752.136	745	Alluvial	1.63	0.7	0.93					-		
14	Muse	Kyukok	Kyukok (Pan Sai)	2404.498	9803.927	850	Alluvial	public tap				21.6	6.53	0.647	6.4	23	
15	Muse		Nam Gaung	2400.770	9802.718	985	Alluvial	public tap				22.1	7.06	2.638	5.4	100<	
16	Muse	Kukhaing	Kukhaing TS Hospital	2327.595	9755.750	1335	Alluvial				115.00	21.1	7.29	0.881	7.8	12	DTW(No. 8025)
17	Muse	Kukhaing	ditto (from tap)							0.00						100<	
18	Lashio	Theinni	Kungkok BEPS	2319.455	9805.863	630	Alluvial	0.90	0.65	0.25		25.3	6.63	0.464	1.5	49	drinking
19	Lashio	Theinni	Nam Salad (Well 1)	2321.096	9812.923	910	Alluvial	0.90	0.60	0.30	4.45	26.8	6.93	1.139	5.9	84	drinking
20	Lashio	Theinni	ditto (Well 2)				Alluvial	1.05	0.70	0.35		26.5	6.62	0.876	2.8	100<	others
21	Lashio	Theinni	Se Oo (Well 1)	2318.516	9802.489	665	Alluvial	1.20	0.45	0.75	3.10	27.3	5.28	0.081	6.0	8	
23	Lashio	Theinni	Nante	2322.325	9821.191	620	Alluvial	0.35	0.00	0.35	1.40	24.0	7.02	0.702	5.2	100<	
24	Lashio	Theinni	Pesa	2314.304	9754.831		Alluvial	0.50	0.50	0.00	3.20	24.3	6.27	9.75	5.6	1	spring
25	Lashio	Lashio	Lashio Hot Spring	2259.407	9746.603	740	Limestone	38.10		38.10	?	22.2	7.28	0.487	8.5	100<	
26	Lashio	Lashio	Lashio Railway station	2258.248	9743.913	-	Limestone			0.00		21.3	7.53	0.632	5.9	100<	
27	Lashio	Lashio	Lashio Degree College	2257.272	9744.323	835	Limestone	2.40		2.40	101.60	23.5	7.63	0.581	8.2	100<	Q=9.1 m3/h
28	Kyaukme	Thipaw	Nau Aung (Route 44)	2235.537	9724.694	550	Alluvial	0.00	0.00	0.00		25.8	6.38	0.399	5.0	100<	
29	Kyaukme	Thipaw	San Phaik	2236.929	9716.957	490	Alluvial			0.00		22.8	6.11	0.147	1.9	100<	
30	Kyaukme	Thipaw	Bowgyo	2235.089	9714.480	460	Alluvial	4.8	0.75	4.05	7.20	25.4	6.65	1.028	4.8	100<	
31	Pyin U Lyin	Pyin U Lyin	Aoung Chan Thar	2156.439	9623.427	980	Limestone			0.00		23.3	7.60	3.300	4.0	1	Indian Mark II

Note
Latitude/Longitude: first and second digits show degree. Ex: 2110.467 21 degree 10.467 minutes.
TS: Township
BEPS: Basic Education Primary School

Data-4: Number of Tube Wells constructed by WRUD

No.	Division/ State	Well type	Year											Total	Beneficiaries	
			1952-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99		Persons	Ps./well
1	Sagaing	DTW	2,368	12	21	16	18	24	10	16	34	89	47	2,655		
		STW	0	0	0	94	0	120	300	480	61	100	200	1,355		
		Total	2,368	12	21	110	18	144	310	496	95	189	247	4,010	1,796,250	448
2	Bago	DTW	2,058	38	47	19	21	38	23	20	20	14	56	2,354		
		STW	460	914	351	1,324	1,324	1,028	1,026	1,343	193	121	135	8,219		
		Total	2,518	952	398	1,343	1,345	1,066	1,049	1,363	213	135	191	10,573	2,645,250	250
3	Magwe	DTW	2,143	7	21	29	11	45	23	23	28	52	64	2,446		
		STW	0	0	0	0	0	0	480	340	257	200	250	1,527		
		Total	2,143	7	21	29	11	45	503	363	285	252	314	3,973	1,696,650	427
4	Mandalay	DTW	2,438	22	43	34	34	77	41	45	44	36	64	2,878		
		STW	62	0	0	0	0	0	180	208	106	1	293	850		
		Total	2,500	22	43	34	34	77	221	253	150	37	357	3,728	1,854,300	497
5	Yangon	DTW	317	281	294	541	138	50	50	82	46	46	44	1,889		
		STW	506	12	75	568	466	638	416	491	302	250	0	3,724		
		Total	823	293	369	1,109	604	688	466	573	348	296	44	5,613	1,692,000	301
6	Ayeyarwaddy	DTW	507	0	17	21	11	8	9	12	36	63	15	699		
		STW	223	109	128	233	604	710	466	426	292	975	50	4,216		
		Total	730	109	145	254	615	718	475	438	328	1,038	65	4,915	1,051,800	214
7	Kachin	DTW	0	0	0	0	0	0	0	1	0	0	2	3		
		STW	0	0	0	0	0	0	217	120	240	0	0	577		
		Total	0	0	0	0	0	0	217	121	240	0	2	580	88,350	152
8	Kayah	DTW	0	0	0	0	9	0	0	2	0	0	5	16		
		STW	0	0	0	0	0	0	0	0	0	0	100	100		
		Total	0	0	0	0	9	0	0	2	0	0	105	116	24,600	212
9	Kayin	DTW	0	5	0	0	0	0	0	0	0	1	10	16		
		STW	0	0	0	0	0	0	10	10	0	0	0	20		
		Total	0	5	0	0	0	0	10	10	0	1	10	36	12,600	350
10	Mon	DTW	1	6	15	12	0	8	7	0	0	4	15	68		
		STW	0	0	0	0	0	0	0	0	0	15	30	45		
		Total	1	6	15	12	0	8	7	0	0	19	45	113	47,550	421
11	Rachine	DTW	9	0	0	0	0	0	0	0	0	0	0	9		
		STW	0	0	0	0	0	0	163	0	0	150	300	613		
		Total	9	0	0	0	0	0	163	0	0	150	300	622	97,350	157
12	Shan	DTW	0	7	13	0	31	27	23	15	19	7	30	172		
		STW	0	0	0	0	0	0	0	0	0	60	10	70		
		Total	0	7	13	0	31	27	23	15	19	67	40	242	113,700	470
Total		DTW	9,841	378	471	672	273	277	186	216	227	312	352	13,205		
		STW	1,251	1,035	554	2,219	2,394	2,496	3,258	3,418	1,451	1,872	1,368	21,316		
		Total	11,092	1,413	1,025	2,891	2,667	2,773	3,444	3,634	1,678	2,184	1,720	34,521	11,120,400	322

Source: WRUD

Data-5: Existing Drilling Rigs and Relevant Equipment in WRUD

No.	Equipment				Type/Specification			Q'ty/Conditions			
	Classification	Maker	Country	Year	Model	Capacity	HP	RN	RP	US	Total
1	Drilling rig	Porta	USA	1964	Loadstar	1000	131	3	2	0	5
		G.E.Failing	USA	1979	CF15	1500	250	8	4	0	12
		Bourne	Ausrlalia	1986	1500R	1500	195	2	0	0	2
		"	"	1986	1500RLD	1500	195	5	0	0	5
		Tone	Japan	1986	TRD-300S	1000		3	2	0	5
		G.E.Failing	USA	1987	WW-1	750	76	1	0	0	1
		Total						22	8	0	30
2	High pressure compressor	LEROI	USA	1985	256,S.2	250.P.S.I	420cfm	2	0	0	2
3	Low pressure compressor	LEROI	USA	1979	100,S.2	125.P.S.I	350cfm	8	4	0	12
		TANABE	Japan	1985	VLH-2114YI	10.5kg/cm^2	7.5m^3/m	5	0	0	5
		INGERSONRAND		1983	P250WD	125.P.S.I	250cfm	7	8	0	15
4	Cargo truck with crane	NISSAN	Japan	1985	TZA52	12ton	300	7	0	0	7
5	Cargo truck	I.H.	USA	1979	DS190	6ton	190	6	6	0	12
6	Water tanker	I.H.	Ausrlalia	1979	WB,ACCO1830	800gal	125	15	5	0	20
7	Pickup truck/ Jeep	Landcruser	Japan	1986	H.J.75LP-KR		75	10	0	0	10
		Landrover	England	1979			67				
9	Mobile workshop							0	0	0	0
10	Electromagnetic survey equipment							0	0	0	0
11	Resistivity survey equipment	TERRA METER	Sweden		SAS300	300m		2	2	0	4
12	Borehole logging equipment	SIE	Ausrlalia	1980	T450E	500m		2	15	0	17
		GEOLOGGER	Japan	1985				0	3	0	3
13	Portable water quality test equ.	HACH	USA	1980				0	10	0	10
14	Bulldozer	KOMATSU	Japan	1998	D85E			2	0	0	2
15	Trailer							0	0	0	0
16	Wheel Loader							0	0	0	0
17	Excavator	KOMATSU	Japan	1998	P.6220			2	0	0	2

Source: WRUD

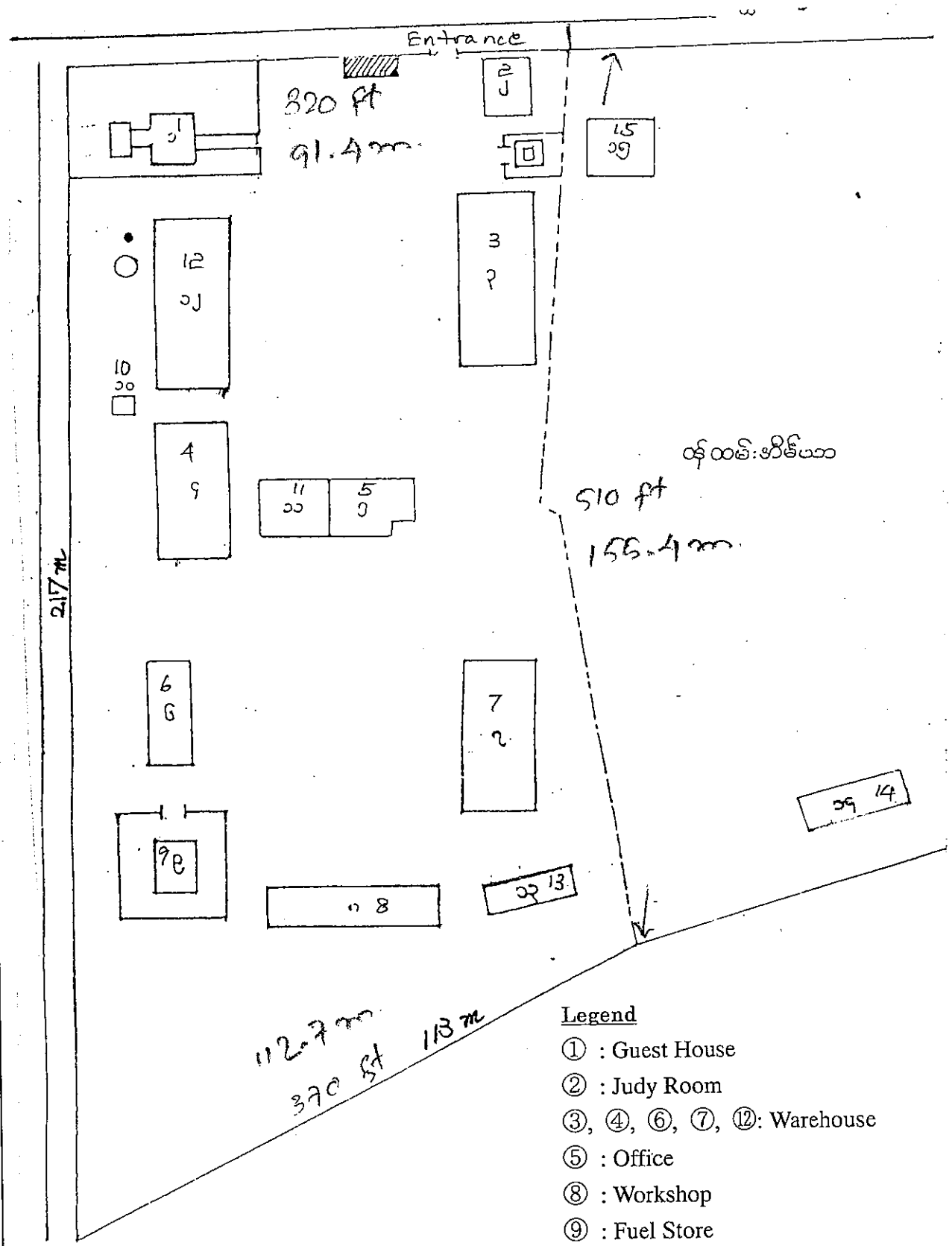
Data-6:

List of Proposed Deep Tubewell Drilling Programme in Northern Shan State

Sr.	Township	2002	2003	2004	2005	Total
1	Lashio	15	10	10	5	40
2	Theinni		5	10	15	30
3	Kutkhaing			15	15	30
4	Thipaw			15	15	30
5	Kyaukme			15	15	30
6	Naungcho	15	15			30
7	Muse	15	15			30
8	Namkham	15	15			30
	Total	60	60	65	65	250

Note: WRUD Program

Data-7: Outline of WRUD Miektila Workshop



Legend

① : Guest House
② : Judy Room
③, ④, ⑥, ⑦, ⑫: Warehouse
⑤ : Office
⑧ : Workshop
⑨ : Fuel Store
⑪ : Office
⑬: Temporary Warehouse
⑭ : House for Labor
⑮ : A. D. House

Appendix IX

References

Appendix IX: References

1. Statistical Yearbook, 1998: Central Statistical Organization
2. Drinking Water Supply, Environmental Sanitation & Hygiene Programme: UNICEF
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4. National Survey of Rural Water Supply and Sanitation: Ministry of Health/UNICEF
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8. Amendment for Proposed Myanmar-UNICEF Country Programme for year (2001-2005)