4. Well Construction Data

4.1. INTRODUCTION

1.1 General

This final report on Drilling Work for the Study on Rural Water Supply and Sanitation Improvement in North-West Region in Lao People 's Democratic Republic presents the results of the studies on the construction of deep boreholes and hand dug wells as an evaluation of the groundwater potential and planning of its development for water supply facilities. The study, which was organized by the Japan International Cooperation Agency (JICA) and under supervized by Japan Techno Co., Ltd. , has conducted by Siam Tone Co., Ltd. The study was carried out in accordance with the scope of work agreed upon by the JICA and the Ministry of Health. The study commenced geophysical survey in December,1999 and the construction of deep boreholes and hand dug wells during January - February ,2000.

1.2 Purpose

The purpose of the drilling work is to construct hand dug wells and deep boreholes as water supply facilities. Specially, the work aims to formulate a suitable water supply in the target villages.

1.3 Scope

The scope for the drilling work is described below :

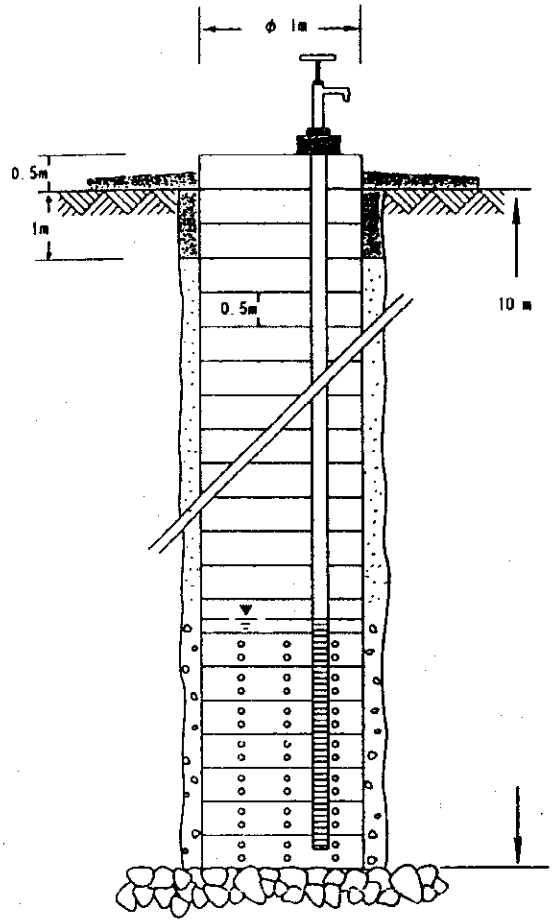
Location	Site No.	H-9	H-37	H-3
	Village Name	May Phatthana	Leang	Nam Ngao
	District	Houayxai District		
	Province	Bokeo Province		
Well Specifications	Type	Borehole	Borehole	Dug well
	Number	1	1	2
	Drilling Diam.	ϕ 10" ~ 8-1/2"	ϕ 10" ~ 8-1/2"	ϕ 1m (+)
	Depth (m)	50	50	10
	Casing Diam. & Length	ϕ 6" 32 m	ϕ 6" 32 m	ϕ 1m
	Casing Material	PVC	PVC	Concrete
	Screen Diam. & Length	ϕ 6" 18 m	ϕ 6" 18 m	ϕ 1m 3~4 m
	Screen Material	PVC	PVC	Concrete

Geophysical Survey	Geoelectric Prospecting	5 points/well	5 points/well	3 points/well
	Prospecting Method	Wenner	Wenner	Wenner
	Prospecting Depth (m)	100	100	20
Well Logging		1 time	1 time	-
Pumping Test	Step drawdown Test	5 Steps	5 Steps	None
	Continuous Test	24 Hours	24 Hours	
	Recovery Test	12 Hours	12 Hours	
Measurements to be made during Water Level Measurements		pH, temp., condutivity		
Water Quality Analysis	Standard	Drinking Water Standard according to WHO		
	Items as per attached list	25	25	25

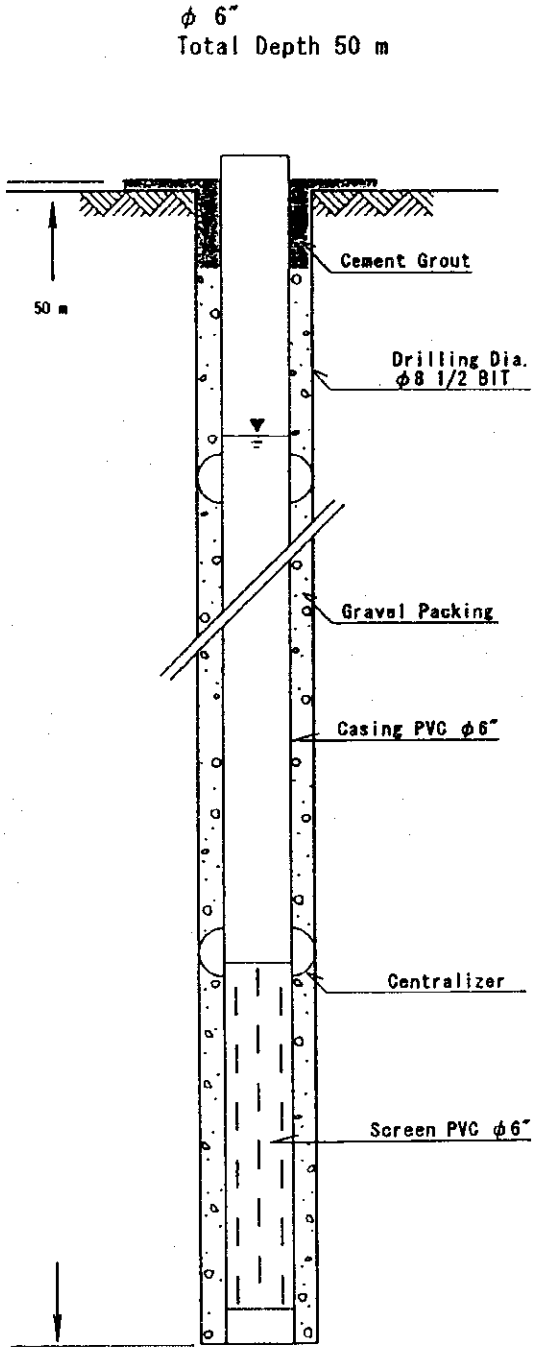
Service Items	Contract Items	
Color	1. TDS	14. Pb
Odor	2. Total Hardness	15. Hg
Taste	3. Cu	16. Ca
pH	4. Fe	17. B
Turbidity	5. Mn	18. CN
Electric Conductivity	6. Cl-	19. Se
Temperature	7. SO_4^{2-}	20. Al
	8. Zn	21. NH_4-N
	9. As	22. NO_2-N
	10. Ba	23. NO_3-N
	11. Cd	24. Coliform Group
	12. Cr^{6+}	25. Alkalinity
	13. F-	

1.4 Study Area

The study area is located in the north-west region of Lao People 's Democratic Republic. The Location of work is at Ban May Patthana, Ban Leang and Ban Nam ngao in Houayxai District , Bokeo Province as attached map.

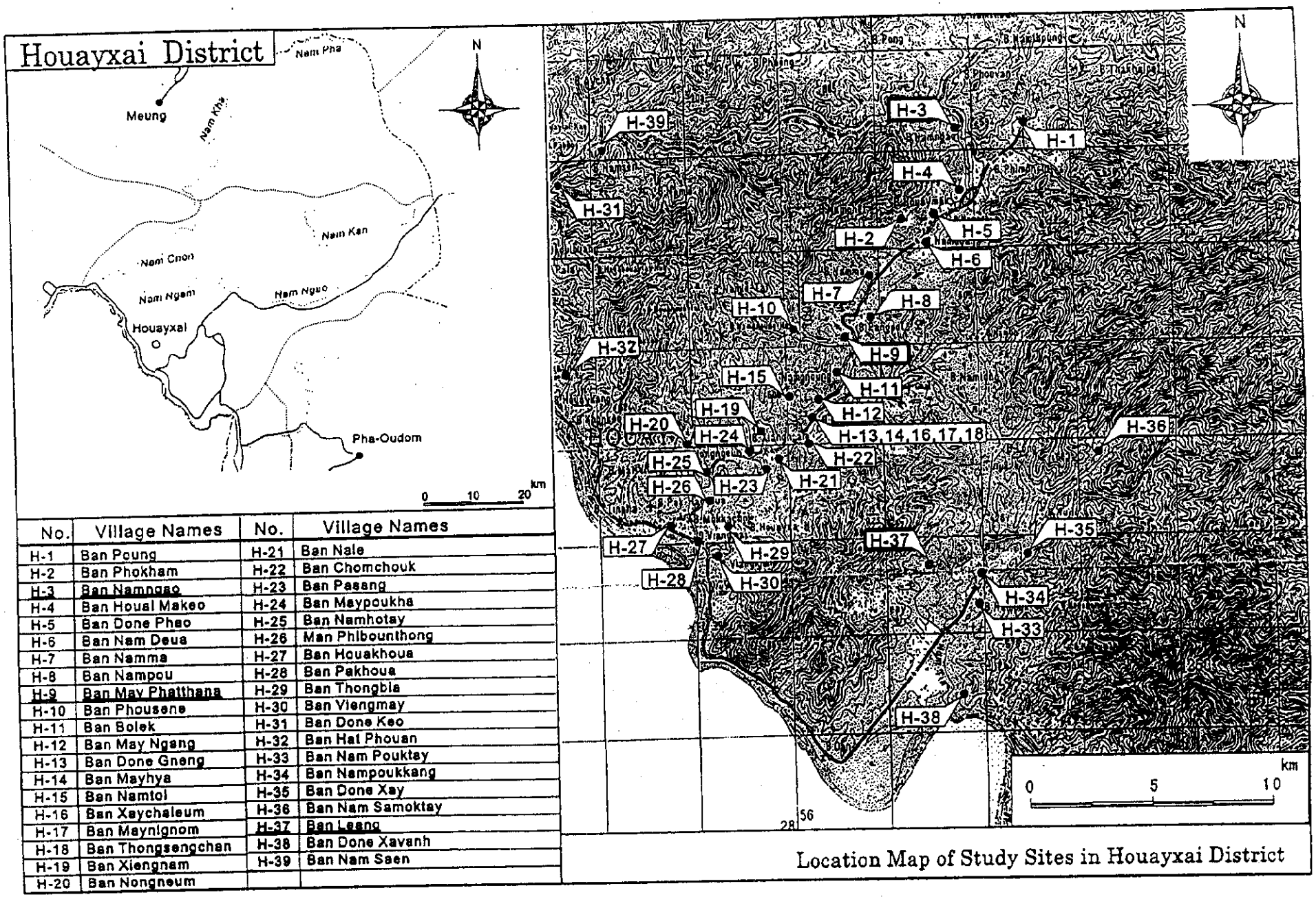


① Dugwell



② Borehole

Standard Design of Dugwell and Borehole



No.	Village Names	No.	Village Names
H-1	Ban Poung	H-21	Ban Nale
H-2	Ban Phokham	H-22	Ban Chomchouk
H-3	Ban Namngao	H-23	Ban Pasang
H-4	Ban Houai Makeo	H-24	Ban Maypoukha
H-5	Ban Done Pheo	H-25	Ban Namhotay
H-6	Ban Nam Deua	H-26	Man Phibounthong
H-7	Ban Namma	H-27	Ban Houakhoua
H-8	Ban Nampou	H-28	Ban Pakhoua
H-9	Ban May Phatthana	H-29	Ban Thongbia
H-10	Ban Phousene	H-30	Ban Viengmay
H-11	Ban Bolek	H-31	Ban Done Keo
H-12	Ban May Ngang	H-32	Ban Hat Phouan
H-13	Ban Done Gneng	H-33	Ban Nam Pouktay
H-14	Ban Mayhya	H-34	Ban Nampoukkang
H-15	Ban Namtoi	H-35	Ban Done Xay
H-16	Ban Xaychaleum	H-36	Ban Nam Samoktay
H-17	Ban Maynignom	H-37	Ban Leang
H-18	Ban Thongsengchan	H-38	Ban Done Xavanh
H-19	Ban Xiengnam	H-39	Ban Nam Saen
H-20	Ban Nongneum		

Location Map of Study Sites in Houayxai District

4.2. GEOPHYSICAL SURVEY

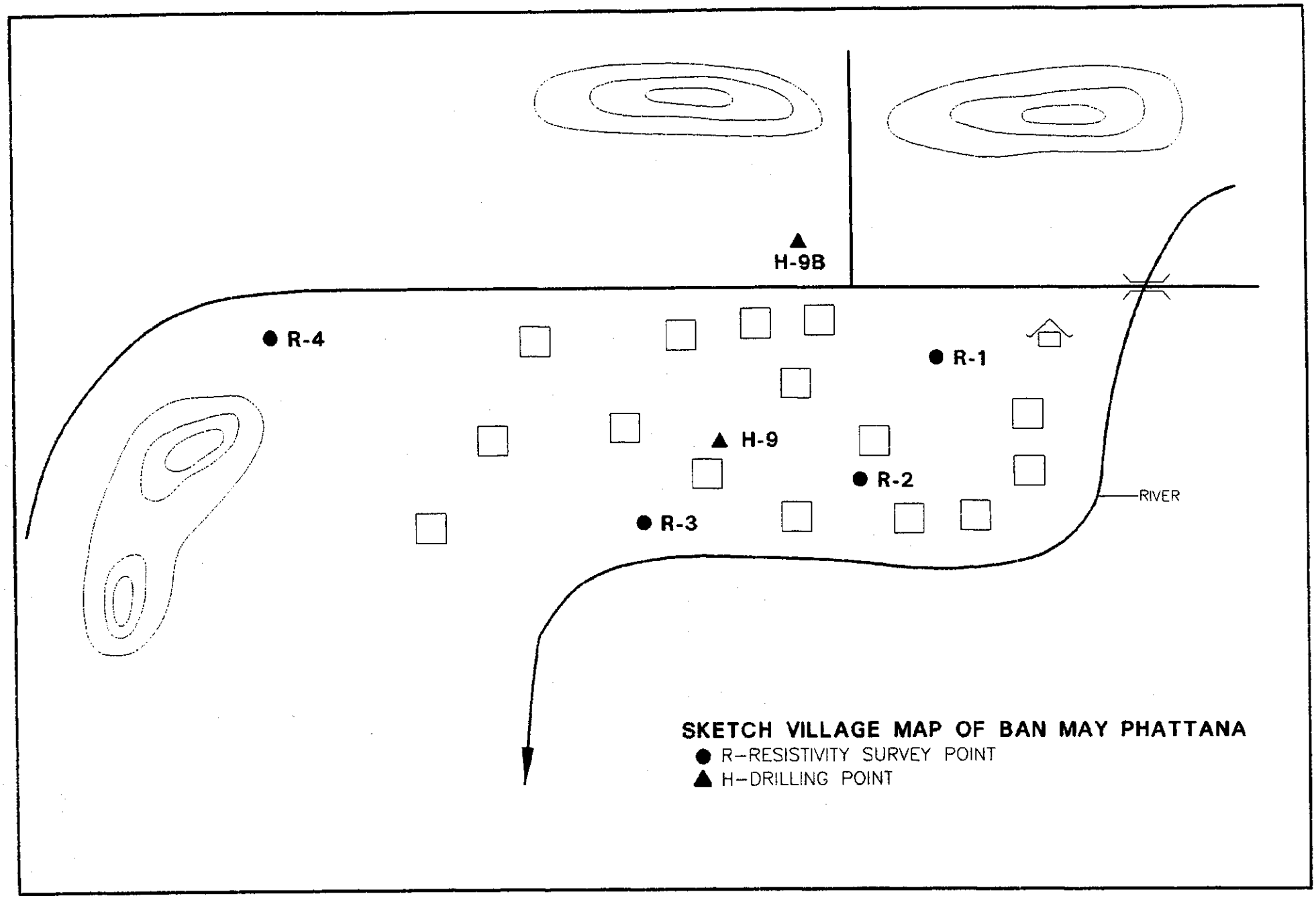
The Vertical Electrical Sounding (Resistivity Method) of geophysical exploration was conducted at target villages before construction of deep boreholes and hand dug wells to make clear basic information on drilling pionts and depths. The two villages, which targets for deep boreholes drilling comprise of H-9 Ban May Phatthana and H-37 Ban Leang were conducted resistivity survey with prospecting depth 100 m of 4 points at H-9 and 5 points at H-37. The H-3 Ban Namngao, which targets for hand dug wells construction was conducted resistivity survey with prospecting depth 20 m of 5 points. Specially, at Ban Houayxay Noy which is not the target village but also was conducted resistivity survey with prospecting depth 100 m of 1 point. The location of survey points were shown as attached map.

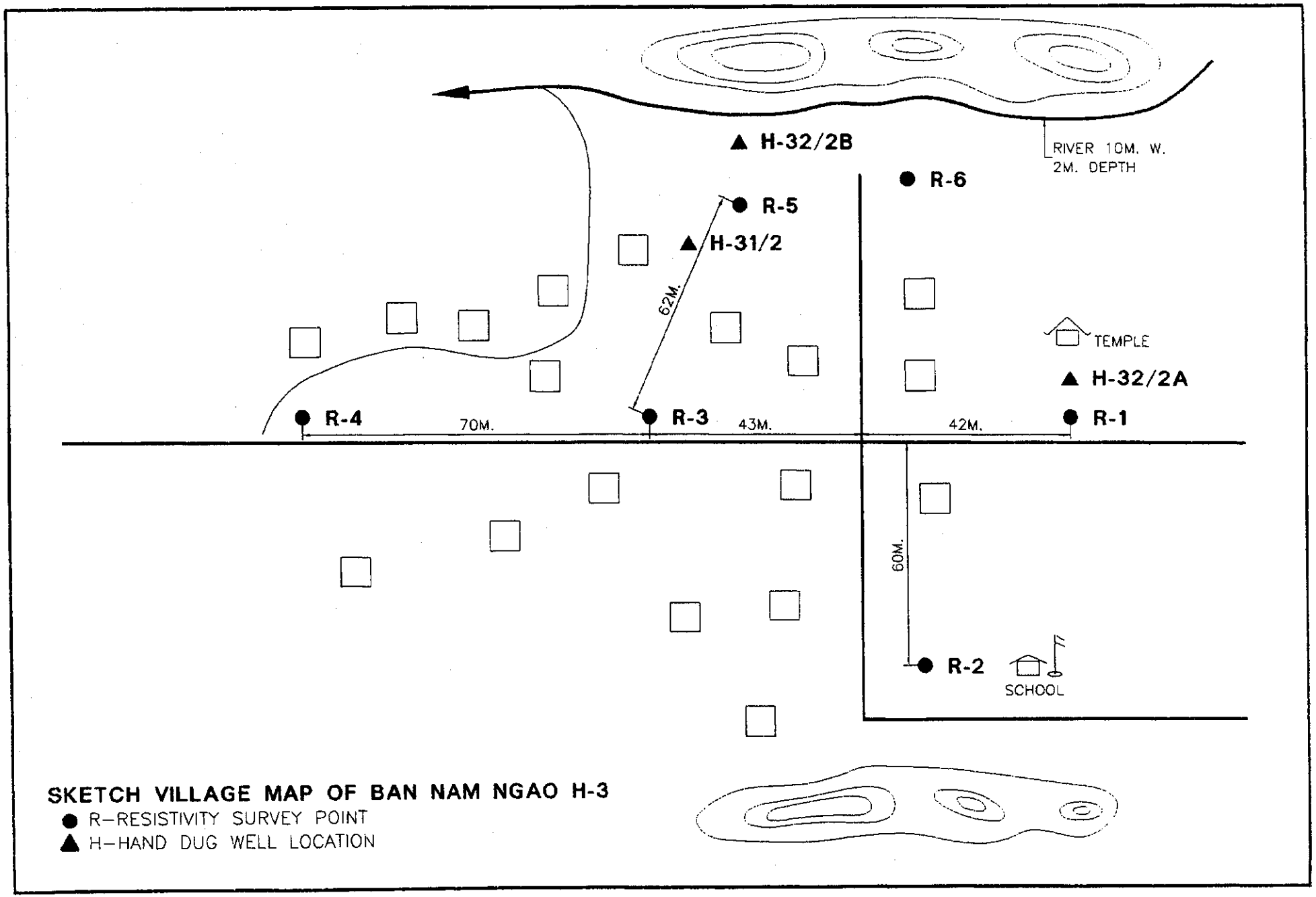
2.1 Resistivity Survey

Wenner arrangement was adopted for this work. It is considered to be the most commonly used arrangement for groundwater prospecting. It is effective to detect a flat layered geological structure. The OYO McOHM meter was used. This instrument is an electric survey unit of stacking type. The resistivity survey curves were analyzed by the graphical method using standard curves and computer aided program.

2.2 Results of Resistivity Survey

The analysis was first carried out graphically using the standard curves and the estimated resistivities were inputted as initial values for the computer program. Resistivities and depths of layers were estimated.

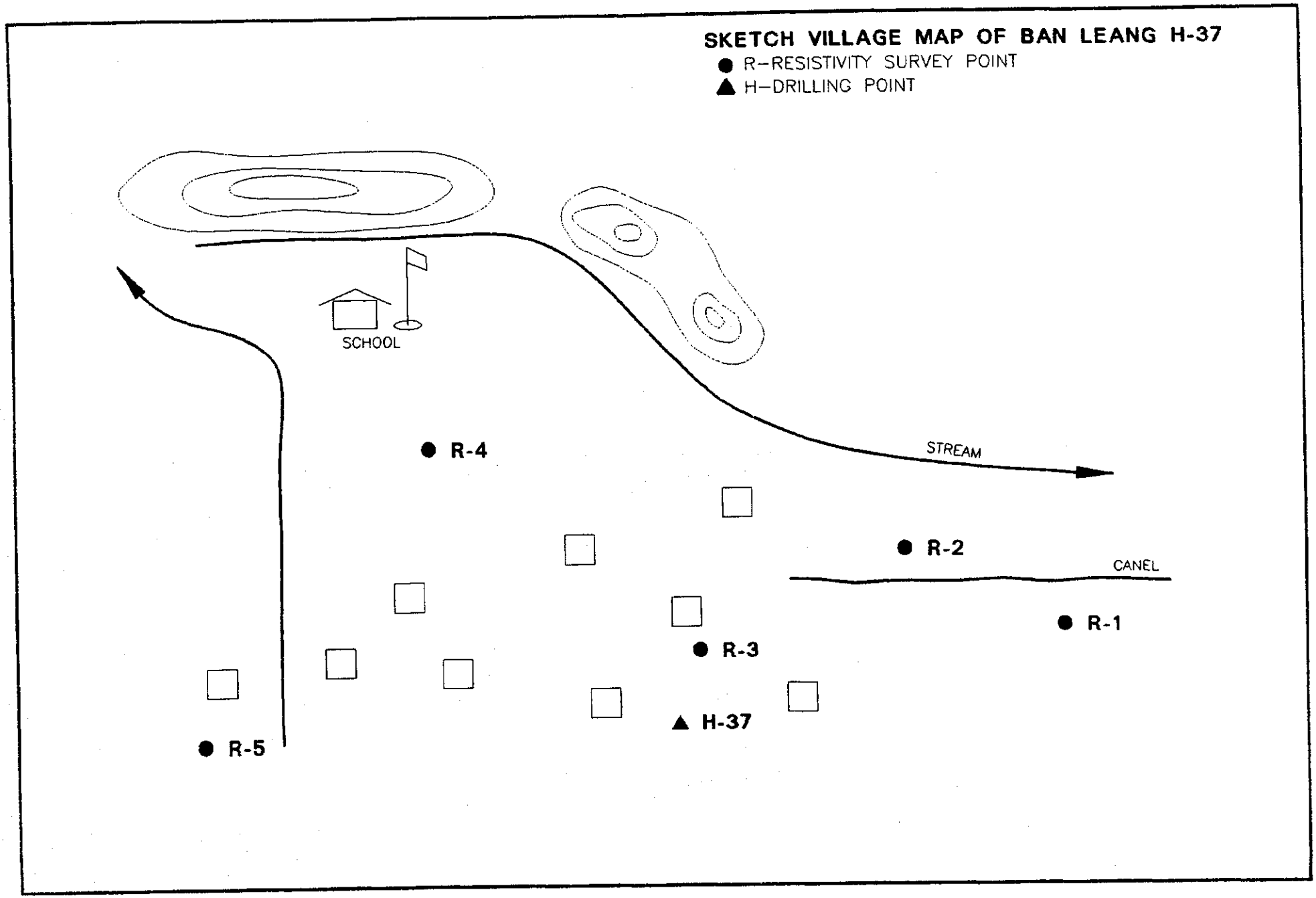

H-9B
R-4
R-1
H-9
R-2
R-3
RIVER
SKETCH VILLAGE MAP OF BAN MAY PHATTANA
R–RESISTIVITY SURVEY POINT
H–DRILLING POINT



SKETCH VILLAGE MAP OF BAN NAM NGAO H-3

● R–RESISTIVITY SURVEY POINT

▲ H–HAND DUG WELL LOCATION


SKETCH VILLAGE MAP OF BAN LEANG H-37
R-RESISTIVITY SURVEY POINT
H-DRILLING POINT
SCHOOL
STREAM
CANEL
R-1
R-2
R-3
R-4
R-5
H-37

4.3. HAND DUG WELLS CONSTRUCTION

Hand dug wells construction were conducted 2 wells at H-3 Ban Nam Ngao. The digging locations were determinded by and between JICA study team, Nam Saat Division of Bokeo Province and the villager. Well No. H-3 1/2 was located on nereby resistivity survey point 5 and dug to the depth of 8 m. Well No. H-3 2/2 were dug at 2 locations. The first location, H-3 2/2A was located on nereby between resistivity survey point 1 and temple. The well was dug to the depth of 4 m until reach rock surface but dry. The successfull well is second location, H-3 2/2B was located on nereby river. The depth of well is 9 m. The total amount of digging depth is 21 m and total casing length is 17 m. The 1 m diameter of concrete casing was used. The aquifer was gravel pack in order to stabilize aquifer and minimized sand pumping. A grain size of the gravel was 2 - 5 cm. In the completion of the gravel packed, the annular space out side the casing was backfilled by digging cutting. In addition, 0.5 m from the surface of the ground, cement grout was placed to avoid entering of water from surface. Well development was carried out by continuous pumping used submersible pump until the water turned clean and without sand. The details of the wells are Presented in attached table.

Summary of the Details of Hand Dug wells

Well No.	Location	Dig Depth (m)	Well Depth (m)	S.W.L (GL-m)	Casing		Aquifer	Gravel Pack (m)	Back Filled (m)	Cement Seal (m)	Remark
					Diameter (m)	Type					
H-3 1/2	B. Nam Ngao	8.00	8.00	6.65	1.00	Concrete	Sand	6.00-8.00	0.50-6.00	0.00-0.50	-
H-3 2/2A	B. Nam Ngao	4.00	-	-	-	-	-	-	-	-	Dry
H-3 2/2B	B. Nam Ngao	9.00	9.00	6.41	1.00	Concrete	Sand	6.00-9.00	0.50-6.00	0.00-0.50	-
	TOTAL :	21.00	17.00								

4. 4. BOREHOLES DRILLING

Boreholes drilling were conducted 2 wells at H-9 Ban May Phatthana and H-37 Ban Leang. The drilling locations were determined by and between JICA study team, Nam Saat Division of Bokeo Province and the villager. well No. H-9 were drilled at 2 locations. The first location, H-9A was located on nereby risistivity survey point 3 and drilled to the depth of 67.50 m but dry. The second location, H-9B was located on nereby resistivity point 1 and 2 which was successfull well. The depth of drilling is 47 m. Well No. H-37 was located on nereby resistivity survey point 3 and drilled to the depth of 60 m.

The total amount of drilling depth is 174.50 m. Down-the-hole drilling method was trial used but it was not successfull because of the formation is weak and possibility to collapse. The rotary drilling method with mud flushing of polymer was adopted. The diameter of drilling is 216 mm. The drilling cutting were collected and observed at every 1.5 m. The drilling speed was also recorded. The resistivity and spontaneous potential loggings were conducted at the boreholes.

The total amount of casing length were installed is 100.40 m. The 150 mm diameter of PVC pipes were used. The screen used for the well was a spiral slot type PVC screen, with and openning ratio 5% and a slot size 1 mm. The screen length and the position were determined by judging the aquifer unit based on the lithological and geophysical logging data. The screen length of 16 and 20 m were set on well No.H-9B and H-37 respectively. The total amount of screen length were used is 36 m. The annular space of the screen was filled with gravel in oder to stabilze aquifer, minimized sand pumping and increase well yields. A grain size of the gravel was 2 - 5 mm. From the top of the gravel, the annular space was filled with bentonite and the drilling cutting in order to avoid seepage from the surface. Upper most 3 m were grouted by cement. The wells were developed by a combination of water jetting, air surging and air lifting until the water turned clean and without sand. The details of the wells are presented in attached table.

Summary of the Details of Borehole Wells

Well No.	Location	Drilling			Well Depth (m)	Casing		Screen		Depth of (m)			S.W.L (GL-m)	Lithology	Remark
		Method	Dia. (mm)	Depth (m)		Dia. (mm)	Type	Depth (m)	Total (m)	Gravel Pack	Back Filled	Cement Seal			
H-9A	B. May Phattana	DTH	216	30.00	—	—	—	—	—	—	—	—	—	Sandstone	Dry
		DTH	165	67.50										Mudstone	
H-9B	B. May Phattana	Rotary	216	47.00	45.40	150	PVC	16-24	16	45.40	9.75	3.00	1.50	Sandstone	—
								28-32		—	—	—		Mudstone	
								36-40		10.75	3.00	0.00			
H-37	B. Leang	Rotary	216	60.00	55.00	150	PVC	23-31	20	55.00	16.40	3.00	7.50	Mudstone	—
								35-43		—	—	—			
								47-51		17.40	3.00	0.00			
			TOTAL :	174.50	100.40				36						

SUMMARY OF TYPE AND INSTALL DEPTH OF HAND PUMP

Well No.	Location	Type of Well	Well depth (m)	Type of Hand pump	Pump Depth (m)
H-3 1/2	B. Nam Ngao	Hand Dug Well	8.00	Lao-99	7.70
H-3 2/2 B	B. Nam Ngao	Hand Dug Well	9.00	Tara	8.80
H-9B	B. May Phattana	Borehole	45.40	Tara	26.00
H-37	B. Leang	Borehole	55.00	Afridev	35.00

4.5.PUMPING TEST

Pumping tests were performed in order to obtain aquifer constants. The step draw-down test, continuous pumping test and recovery test were conducted on borehole wells at H-9B Ban May Phattana and Ban Leang. Hand dug wells at H-3 Ban Nam ngao were conducted only continuous pumping test and recovery test. Pumping tests were conducted by using submersible pump.

The step draw-down test was conducted at 5 steps in 2 hours interval. The step number and discharge rate were determined by using a maximum pumping rate by air lifting during well development. The continuous pumping test was conducted at a constant discharge rate until reach stable condition after the step draw-down test. After the continuous pumping test, pumping was stopped and the recovery of groundwater level was measured until water level recover to static level. The quantities of pumping test are presented in attached table.

The aquifer constants, Transmissivity (T) and Hydraulic Gradient (K), were analyzed by using Jacob 's method calculated from the result of continuous pumping test and recovery test datas. Specific capacity (Sc) was calculated by using the draw-down and the pumping rate at stable conditions during the pumping test. An optimum discharge rate of the test well was evaluated by using the step draw-down test data. Taking the critical water level found on the linear relation between the pumping rate (Q) and the draw-down (s) . The aquifer constants, specific capacity and optimum discharge of the test well are summarized in attached table.

Summary of Quantities of Pumping Test

Well No.	Location	Type of Well	Well depth (m)	S.W.L (GL-m)	Pumping Test			Remark
					Step	Continuous	Recovery	
H-3 1/2	B. Nam Ngao	Hand Dug Well	8.00	6.65	-	3 H	4 H	-
H-3 2/2 B	B. Nam Ngao	Hand Dug Well	9.00	6.41	-	7 H	12 H	-
H-9B	B. May Phattana	Borehole	45.40	1.50	5	6 H	1 H	-
H-37	B. Leang	Borehole	55.00	7.50	3	2:30 H	12 H	-

SUMMARY OF THE AQUIFER CONSTANTS, SPECIFIC CAPACITY AND OPTIMUM DISCHARGE OF THE TEST WELLS

Well No.	Location	Type of Well	S.W.L. (GL-m.)	Transmissivity (T) T = (m2/day)			Hydraulic Gradient (K) K (m/day)			Specific Capacity (Sc) (m3/day/cm.)	Optimum Discharge (m3/day)
				Continuous Pumping Test	Recovery Test	Means	Continuous Pumping Test	Recovery Test	Means		
H-3 1/2	B. Nam Ngao	Hand Dug Well	6.650	52.704	40.464	46.584	26.352	20.270	23.311	-	-
H-3 2/2 B	B. Nam Ngao	Hand Dug Well	6.410	9.246	18.173	13.709	3.082	6.057	4.569	-	-
H-9B	B. May Phattana	Bore Hole	1.500	2.325	0.964	1.644	0.147	0.061	0.104	2.787	14.400
H-37	B. Leang	Bore Hole	7.500	0.135	0.141	0.138	0.007	0.007	0.007	0.613	0.010

4.6. WATER QUALITY ANALYSIS

Groundwater dissolves parts of the soil and rock as it infiltrates and percolates through them. The cations occuring in groundwater are commonly calcium, magnesium, sodium, iron, manganese and potassium. The anions are mostly carbonate, bicarbonate, sulfate, chloride and nitrate.

In this study, water samplings from the test wells were conducted analysis according to japanese standard of drinking water. The analysis was entrusted to a private laboratory. The following tables show the result of analysis.

บริษัท ดีเทอร์มิเนชั่น กรุ๊ป จำกัด

Determination Group Co., Ltd.

81/96 ถ.วิภาวดีรังสิต ซ.25 แขวงทุ่งสองห้อง เขตดอนเมือง กทม.10210

โทร. 591-1732 โทรสาร (662) 591-1732

81/96 Viphavadee-Rungsit Rd., Thungsonghong, Donmuang,

Bangkok.10210, THAILAND. Tel.591-1732 Fax. (662) 591-1732

Water Quality Analysis Report

Project Name: Laboratoty No. 43060

The Study on Rural water supply and Sanitation improvement in North-West Region in Lao P.D.R.

Sample Type Dug well

Well No. H - 3 1/2 B.Nam Gnao

Sampling date March1,2000

Reference No. 060/2543

Date March2,2000

Sample from SIAM TONE Co.,Ltd. (Mr. Supoch)

Chemical Characteristic	Result* (mg/L)	Guideline Value
Calcium (Ca)	16	300(hardness)
Magnesium (Mg)	5.9	300(hardness)
Sodium (Na)	9.1	-
Potassium (K)	1.6	-
Total-Iron (Fe)	0.00	0.3
Manganese (Mn)	0.00	0.3
Copper (Cu)	0.00	1.0
Zinc (Zn)	0.2	1.0
Ammonia (NH_4)	0.98	0
Silica (SiO_2)	19	-
p_Alkalinity "Carbonate (CO_3)"	0	-
m_Alkalinity "Bicarbonate (HCO_3)"	69	-
Carbondioxide gas (CO_2)	87	-
Chloride (Cl)	1.6	200
Sulfate (SO_4)	2.4	-
Nitrite (NO_2)	0.000	0
Nitrate (NO_3)	10	10
Fluoride (F)	0.0	0.8
Boron (B)	0.08	-
Total Hardness as $CaCO_3$	64	300
Permanent Hardness as $CaCO_3$	6	-
Total Dissolved Solids (TDS)	100	500

Physical Characteristic	Result	Guideline Value
pH	6.10	5.8-8.6
Electric Conductivity**	170	-
Color (Platinum Cobalt Scale)	0	5
Odor	Odourless	Odourless
Taste	Tasteless	Tasteless
Turbidily (NTU.)	0.3	2

Bacteriological Characteristic	Result	Guideline Value
Coliform Group	7	0/100 cc.
Number of General Bacteria	-	<100/1cc.

Toxic Substances	Result*	Guideline Value
Arsenic (As)	<0.001	0.05
Barium (Ba)	0.00	-
Chromium (Cr^{6+})	0.01	0.05
Cadmium (Cd)	<0.001	0.01
Lead (Pb)	0.00	0.1
Selenium (Se)	<0.002	-
Mercury (Hg)	<0.0005	0.000
Aluminium (Al)	0.01	-
Cyanide (CN)	<0.002	0.000

Appearance of water Small amount of insoluble matters.

Date March 3-12,2000

Analysed and approved by

(Mr. Chakan Prayoonchart)

Chemical and Research Division

* *Unit milligram/cubic decimetre (milligram/Litre)*

** *Unit microsiemen/cm. at 25 Degree celcius.*

*** *N.D: Non Detectable*

The above results are valids exclusively for tested/analysed sample as mentioned in this report.

Japanese Standard.

บริษัท ดีเทอร์มิเนชั่น กรุ๊ป จำกัด

Determination Group Co., Ltd.

81/96 ถ.วิภาวดีรังสิต ซ.25 แขวงทุ่งสองห้อง เขตดอนเมือง กทม.10210

โทร. 591-1732 โทรสาร (662) 591-1732

81/96 Viphavadee-Rungsit Rd., Thungsonghong, Donmuang,

Bangkok.10210, THAILAND. Tel.591-1732 Fax. (662) 591-1732

รายงานผลการตรวจวิเคราะห์คุณภาพน้ำ

DGC

Water Quality Analysis Report

Project Name: The Study on Rural water supply and Sanitation improvement in North-West Region in Lao P.D.R.

Laboratoty No. 43061

Sample Type: Dug well

Well No.: H - 3 2/2 B.Nam Gnao

Sampling date: March1,2000

Reference No. 061/2543

Date March2,2000

Sample from SIAM TONE Co.,Ltd. (Mr. Supoch)

Chemical Characteristic	Result* (mg/L)	Guideline Value
Calcium (Ca)	27	300(hardness)
Magnesium (Mg)	4.9	300(hardness)
Sodium (Na)	11	-
Potassium (K)	6.7	-
Total-Iron (Fe)	0.70	0.3
Manganese (Mn)	0.00	0.3
Copper (Cu)	0.02	1.0
Zinc (Zn)	0.3	1.0
Ammonia (NH_4)	1.1	0
Silica (SiO_2)	19	-
p_Alkalinity "Carbonate (CO_3)"	0	-
m_Alkalinity "Bicarbonate (HCO_3)"	82	-
Carbondioxide gas (CO_2)	64	-
Chloride (Cl)	14	200
Sulfate (SO_4)	12	-
Nitrite (NO_2)	0.076	0
Nitrate (NO_3)	26	10
Fluoride (F)	0.1	0.8
Boron (B)	0.05	-
Total Hardness as $CaCO_3$	88	300
Permanent Hardness as $CaCO_3$	21	-
Total Dissolved Solids (TDS)	162	500

Physical Characteristic	Result	Guideline Value
pH	6.31	5.8-8.6
Electric Conductivity**	248	-
Color (Platinum Cobalt Scale)	35	5
Odor	Odor	Odorless
Taste	Slightly Taste	Tasteless
Turbidity (NTU.)	50	2

Bacteriological Characteristic	Result	Guideline Value
Coliform Group	6	0/100 cc.
Number of General Bacteria	-	<100/1cc.

Toxic Substances	Result*	Guideline Value
Arsenic (As)	<0.001	0.05
Barium (Ba)	0.00	-
Chromium (Cr^{6+})	0.00	0.05
Cadmium (Cd)	<0.001	0.01
Lead (Pb)	0.00	0.1
Selenium (Se)	<0.002	-
Mercury (Hg)	<0.0005	0.000
Aluminium (Al)	0.00	-
Cyanide (CN)	<0.002	0.000

Appearance of water: Precipitated iron and insoluble matters.

Date: March 3-12,2000

Analysed and approved by

(Mr. Chakan Playoonchart)

Chemical and Research Division

บริษัท ดีเทอร์มิเนชั่น กรุ๊ป จำกัด Determination Group Co.,Ltd.

** Unit milligram/cubic decimetre (milligram/Litre)*

*** Unit microsiemen/cm. at 25 Degree celcius.*

**** N.D: Non Deteciable*

The above results are valids exclusively for tested/analysed sample as mentioned in this report.

Japanese Standard.

บริษัท ดีเทอร์มิเนชั่น กรุ๊ป จำกัด

Determination Group Co., Ltd.

81/96 ถ.วิภาวดีรังสิต ซ.25 แขวงทุ่งสองห้อง เขตดอนเมือง กทม.10210

โทร. 591-1732 โทรสาร (662) 591-1732

81/96 Viphavadee-Rungsit Rd., Thungsonghong, Donmuang,

Bangkok.10210, THAILAND. Tel.591-1732 Fax. (662) 591-1732

Project Name: The Study on Rural water supply and Sanitation Improvement in North West Region in Lao P.D.R.

Laboratoty No. 43062

Sample Type Groundwater

Well No. H - 9 B B.MayPhattana

Sampling date March1,2000

Reference No. 062/2543

Date March2,2000

Sample from SIAM TONE Co.,Ltd. (Mr. Supoch)

Chemical Characteristic	Result* (mg/L)	Guideline Value
Calcium (Ca)	106	300(hardness)
Magnesium (Mg)	14	300(hardness)
Sodium (Na)	20	-
Potassium (K)	2.4	-
Total-Iron (Fe)	0.09	0.3
Manganese (Mn)	0.00	0.3
Copper (Cu)	0.02	1.0
Zinc (Zn)	0.1	1.0
Ammonia (NH_4)	1.0	0
Silica (SiO_2)	53	-
p_Alkalinity "Carbonate (CO_3)"	0	-
m_Alkalinity "Bicarbonate (HCO_3)"	290	-
Carbondioxide gas (CO_2)	41	-
Chloride (Cl)	1.2	200
Sulfate (SO_4)	145	-
Nitrite (NO_2)	0.000	0
Nitrate (NO_3)	0.4	10
Fluoride (F)	0.2	0.8
Boron (B)	0.0	-
Total Hardness as $CaCO_3$	325	300
Permanent Hardness as $CaCO_3$	88	-
Total Dissolved Solids (TDS)	486	500

Physical Characteristic	Result	Guideline Value
pH	7.05	5.8-8.6
Electric Conductivity**	657	-
Color (Platinum Cobalt Scale)	35	5
Odor	Odor	Odorless
Taste	Slightly Tasle	Tasteless
Turbidity (NTU.)	10	2

Bacteriological Characteristic	Result	Guideline Value
Coliform Group	16	0/100 cc.
Number of General Bacteria	-	<100/1cc.

Toxic Substances	Result*	Guideline Value
Arsenic (As)	<0.001	0.05
Barium (Ba)	0.00	-
Chromium (Cr^{6+})	0.00	0.05
Cadmium (Cd)	<0.001	0.01
Lead (Pb)	0.01	0.1
Selenium (Se)	<0.002	-
Mercury (Hg)	<0.0005	0.000
Aluminium (Al)	0.02	-
Cyanide (CN)	<0.002	0.000

Appearance of water Color and small amount of insoluble matters.

Date March 3-12,2000

Analysed and approved by

(Mr. Chakan Pravobchart)

Chemical and Research Division

* *Unit milligram/cubic decimetre (milligram/Litre)*

** *Unit microsiemen/cm. at 25 Degree celcius.*

*** *N.D: Non Detectable*

The above results are valids exclusively for tested/analysed sample as mentionee in this report.

Japanese Standard.

บริษัท ดีเทอร์มิเนชั่น กรุ๊ป จำกัด

Determination Group Co., Ltd.

81/96 ถ.วิภาวดีรังสิต ซ.25 แขวงทุ่งสองห้อง เขตดอนเมือง กทม.10210

โทร. 591-1732 โทรสาร (662) 591-1732

81/96 Viphavadee-Rungsit Rd., Thungsonghong, Donmuang,

Bangkok.10210, THAILAND. Tel.591-1732 Fax. (662) 591-1732

Water Quality Analysis Report

Project Name:	Laboratoty No. 43063
The Study on Rural water supply and Sanitation improvement in North-West Region in Lao P.D.R.	
Sample Type	Groundwater
Well No.	H - 37 B.Leang
Sampling date	March1,2000

Reference No. 063/2543

Date March2,2000

Sample from SIAM TONE Co.,Ltd.
(Mr. Supoch)

Chemical Characteristic	Result* (mg/L)	Guideline Value
Calcium (Ca)	35	300(hardness)
Magnesium (Mg)	41	300(hardness)
Sodium (Na)	16	-
Potassium (K)	7.1	-
Total-Iron (Fe)	1.1	0.3
Manganese (Mn)	0.00	0.3
Copper (Cu)	0.02	1.0
Zinc (Zn)	0.1	1.0
Ammonia (NH_4)	1.3	0
Silica (SiO_2)	13	-
p_Alkalinity "Carbonate (CO_3)"	0	-
m_Alkalinity "Bicarbonate (HCO_3)"	135	-
Carbondioxide gas (CO_2)	18	-
Chloride (Cl)	6.0	200
Sulfate (SO_4)	186	-
Nitrite (NO_2)	0.007	0
Nitrate (NO_3)	0.4	10
Fluoride (F)	0.2	0.8
Boron (B)	0.0	-
Total Hardness as $CaCO_3$	258	300
Permanent Hardness as $CaCO_3$	148	-
Total Dissolved Solids (TDS)	373	500

Physical Characteristic	Result	Guideline Value
pH	7.08	5.8-8.6
Electric Conductivity**	560	-
Color (Platinum Cobalt Scale)	50	5
Odor	Odor	Odorless
Taste	Slightly Taste	Tasteless
Turbidity (NTU.)	15	2

Bacteriological Characteristic	Result	Guideline Value
Coliform Group	16	0/100 cc.
Number of General Bacteria	-	<100/1cc.

Toxic Substances	Result*	Guideline Value
Arsenic (As)	<0.001	0.05
Barium (Ba)	0.00	-
Chromium (Cr^{6+})	0.00	0.05
Cadmium (Cd)	<0.001	0.01
Lead (Pb)	0.00	0.1
Selenium (Se)	<0.002	-
Mercury (Hg)	<0.0005	0.000
Aluminium (Al)	0.00	-
Cyanide (CN)	<0.002	0.000

Appearance of water Precipitated iron and insoluble matters.

Date March 3-12,2000

Analysed and approved by

(Mr. Chakan Prayoonchart)
Chemical and Research Division

* *Unit milligram/cubic decimetre (milligram/Litre)*

** *Unit microsiemen/cm. at 25 Degree celcius.*

*** *N.D: Non Detectable*

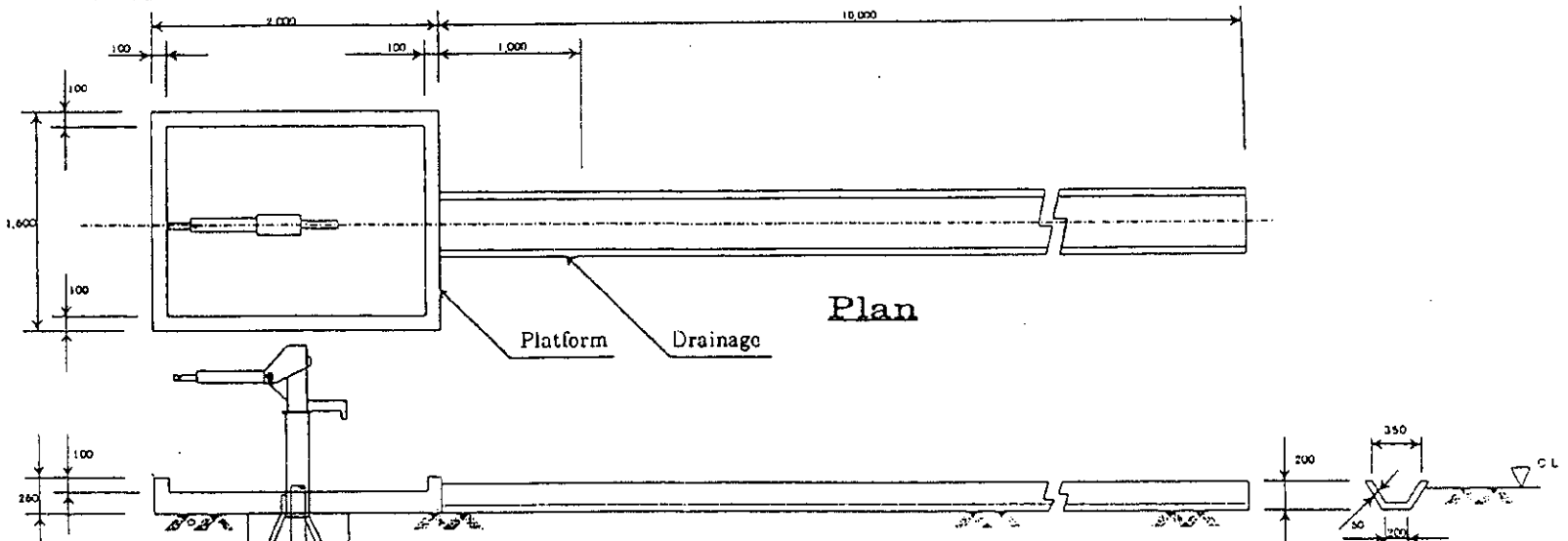
The above results are valids exclusively for tested/analysed sample as mentioned in this report.

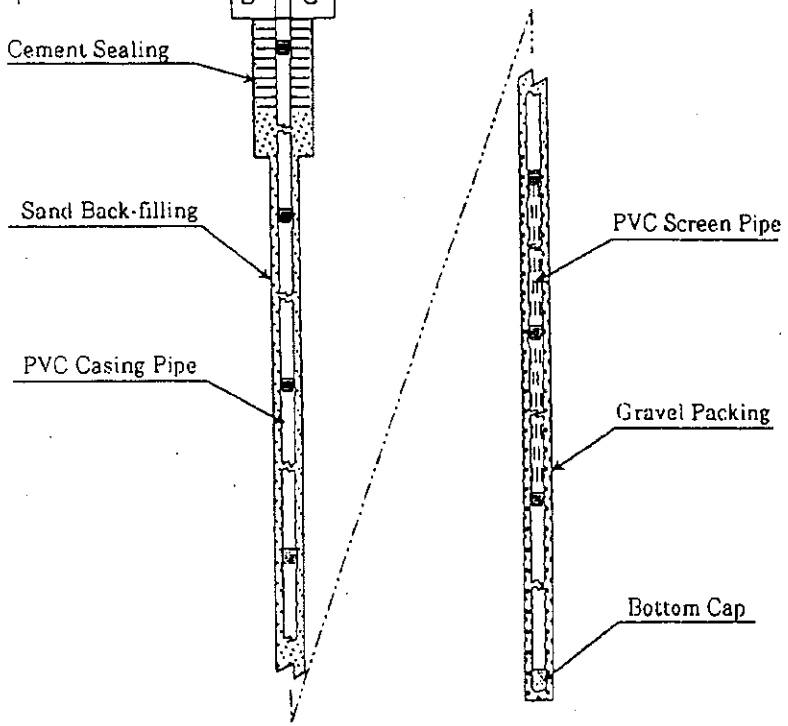
Japanese Standard.

4.7. WATER SUPPLY SYSTEM

In order to obtain design standard of the water supply systems, the test wells were completed and the pumps were installed. For H-37 Ban Leang, the afridev hand pump was installed. The cylinder was setted to the depth of 35 m. The Tara hand pumps were installed at H-9B Ban May Phattana and H-3 2/2B Ban Nam Ngao, The cylinders were setted to the depth of 26 m and 8.80 m at H-9B and H-3 2/2B respectively. For H-3 1/2 Ban Nam Ngao, the hand pum Lao-99 was installed. The cylinder was setted to the depth of 7.70 m. The following table shows the type and depth of hand pump for test wells.

The reinforced concrete platform with drain were constructed around the well for sanitary protection at each wells. The types of concrete platform are show in figure attached.





※Average Well Depth;	50m
※Average Drainage Length;	10m
※PVC Casing/Screen Dia.;	150 mm
※PVC Casing/Screen Length;	4m
※Final Drilling Dia.;	215 mm
※Grain Size of Gravel Packing;	2-5mm
※Hand Pump Riser Pipe;	PVC
※Hand Pump Connecting Rod;	Stainless Steel

PLATFORM FOR AFRIDEV HAND PUMP AT H37 BAN LEANG

Drawing title
Deep Well
"Hand Pump Type"

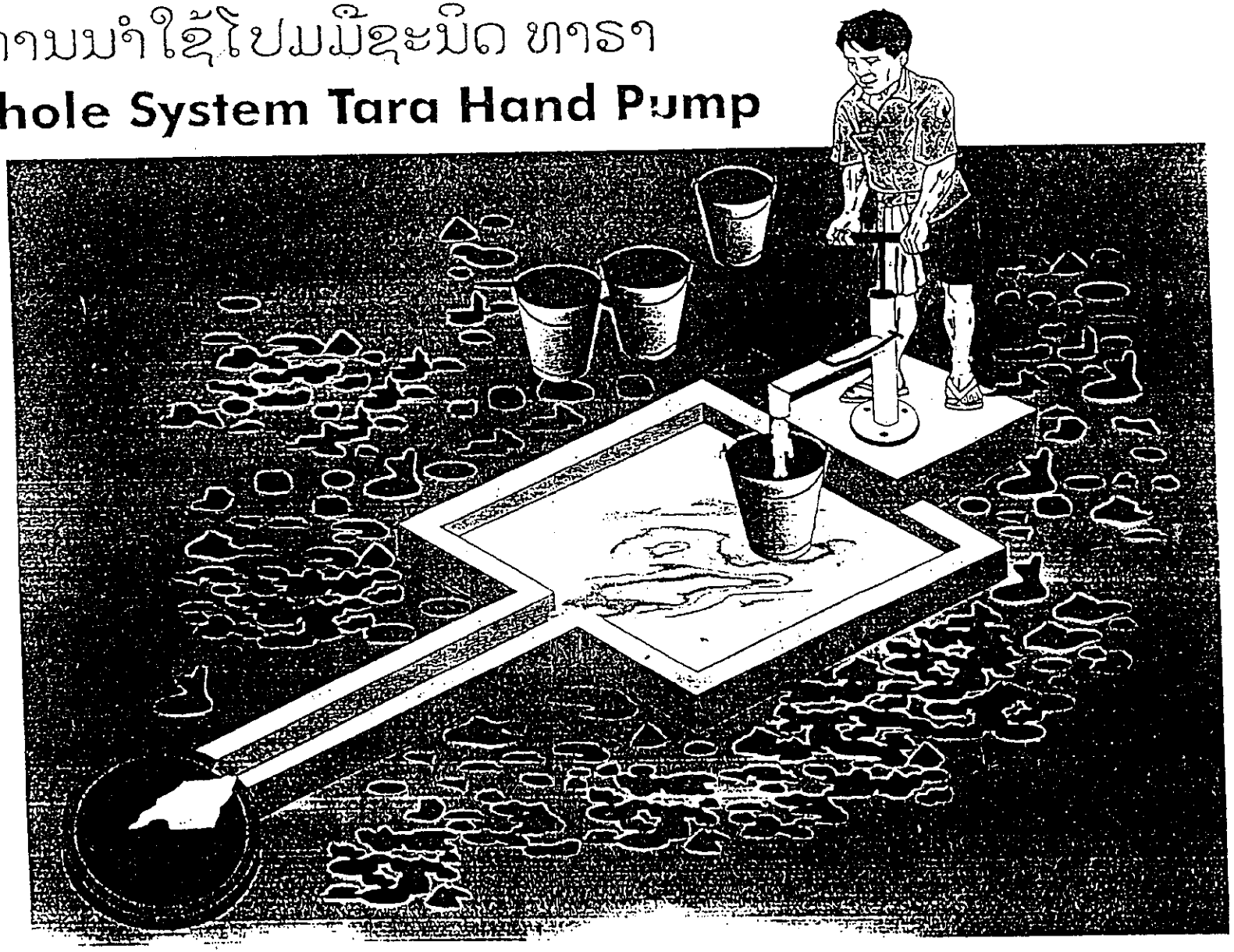
Scale
-:-

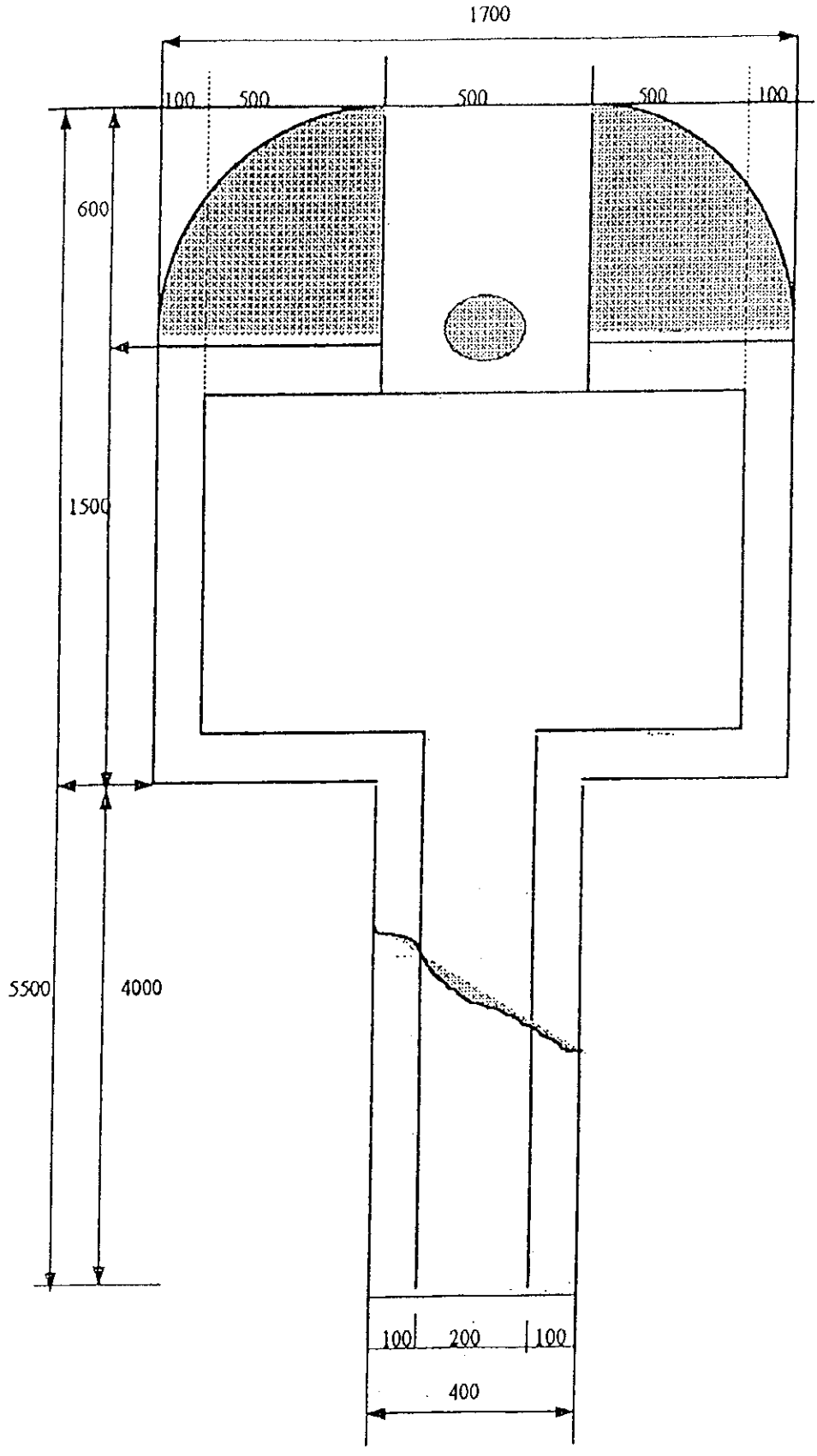
Sheet No.

NEW, Ministry of Public Health

ການນຳໃຊ້ໂຢມມືຂະນົດ ທາຣາ

Borehole System Tara Hand Pump



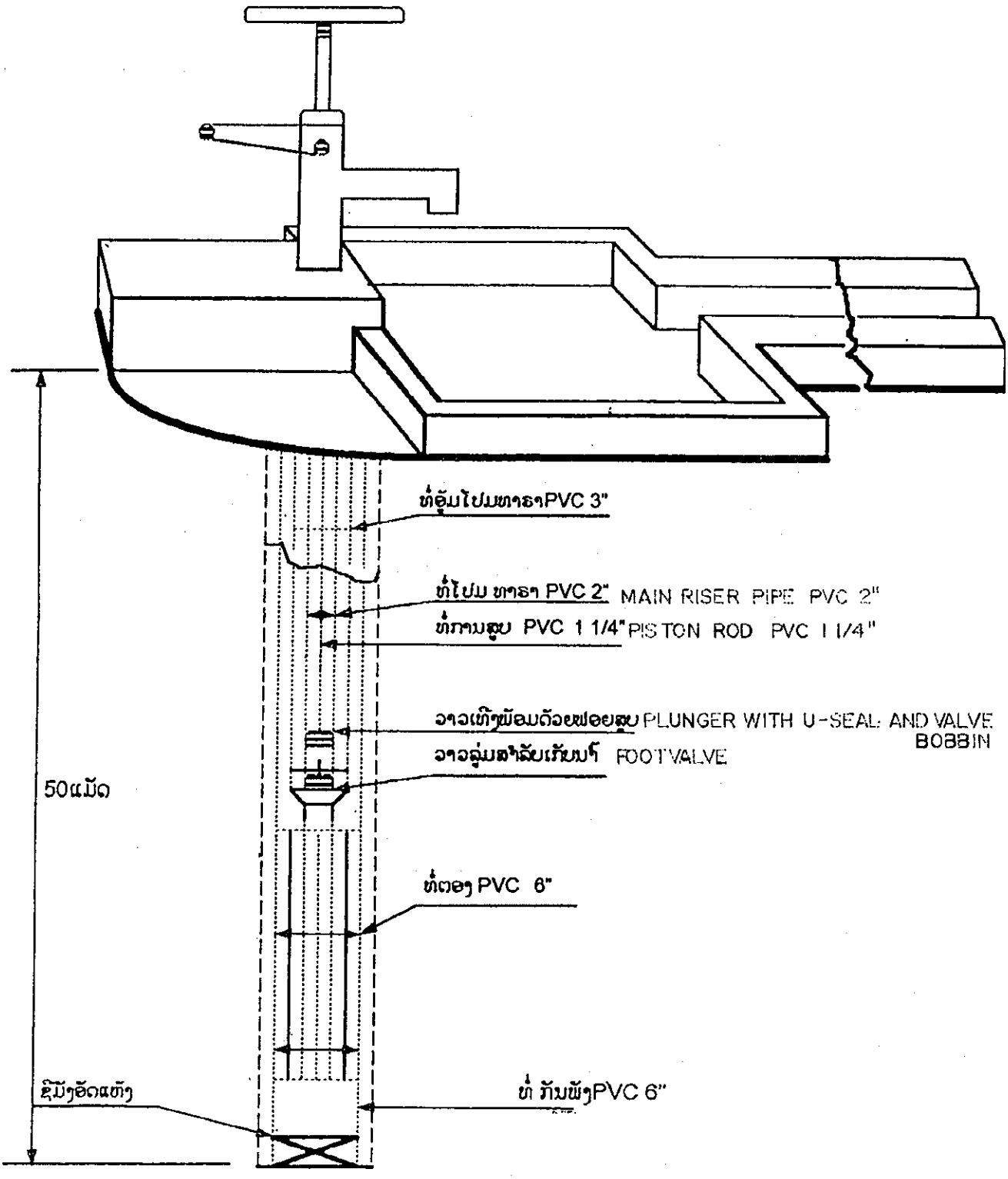


ຮູບແທ່ນກັນເປື້ອນສຳລັບໂຢມມີໂຍກທຸກຊະນິດ

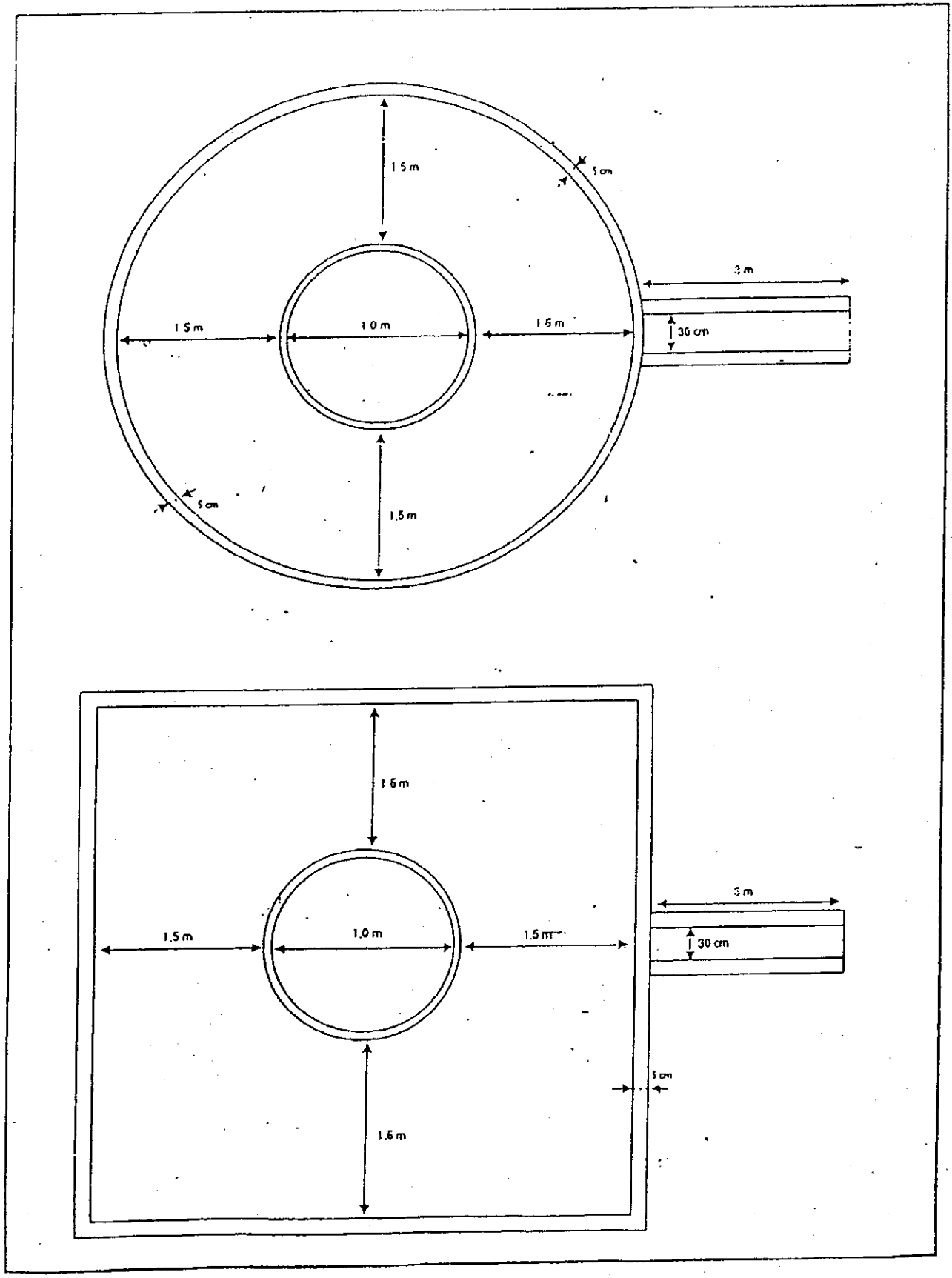
PLATFORM FOR TARA HAND PUMP

TARA HAND PUMP INSTALLATION AND PLATFORM

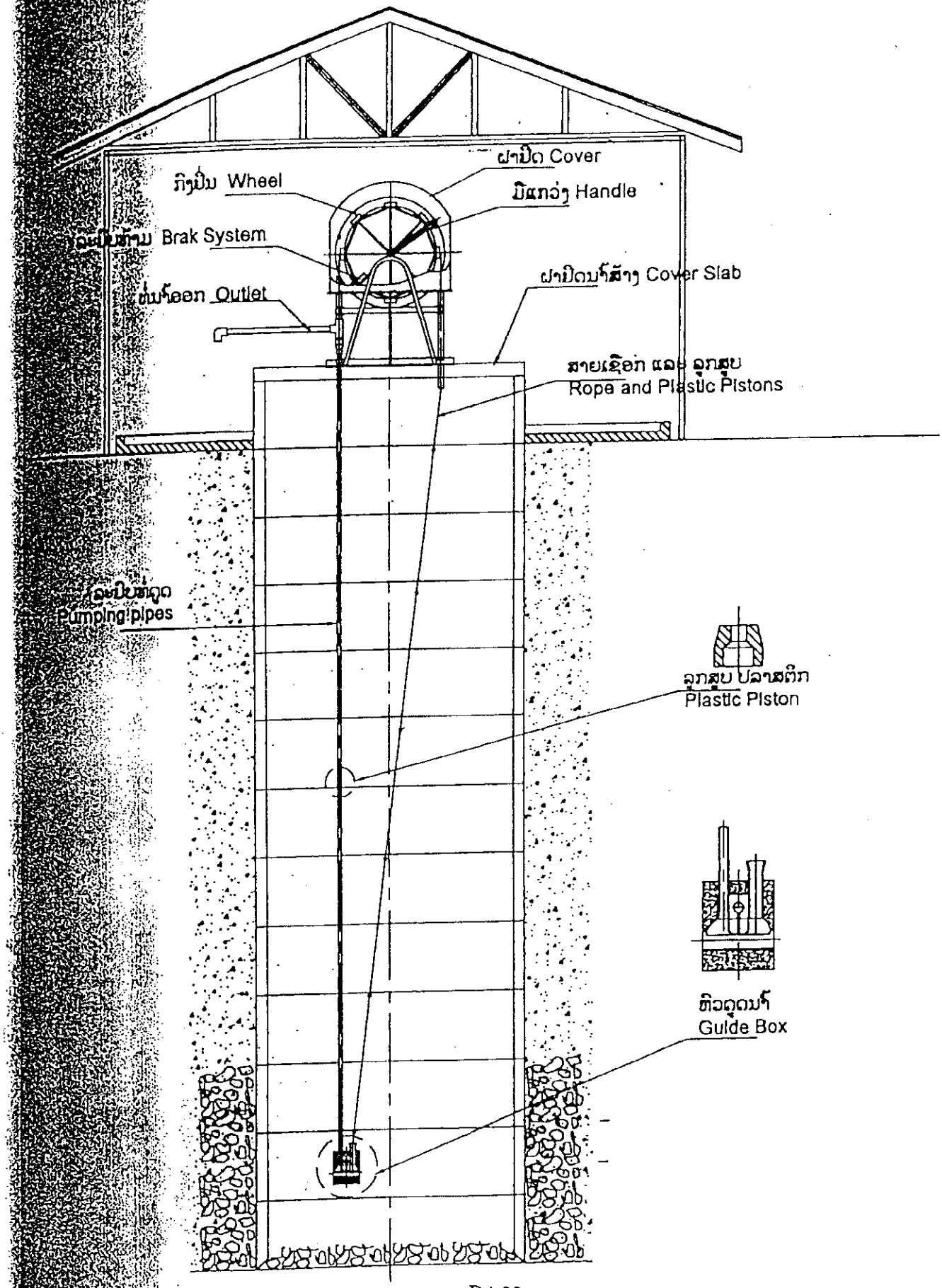
ການຕິດຕັ້ງໂປມມືໂຍກຊະນິດ ທາລາພ້ອມດ້ວຍເທແທ່ນ
ກັນເປື້ອນແລະເທຮ່ອງກັນລະບາຍນ້ຳເສ



PLATFORM FOR HAND DUG WELL WHICH INSTALLED H.PUMP LAO-99



ລະບົບການຕິດຕັ້ງ ປ໊ຳມື ລາວ-99A
System assembly of Hand Pump LAO-99A For Dug Well



4.8. CONCLUSIONS

The work was conducted for this study included well constructions, pumping test, water quality analysis and water supply system were summarized and show in figure attached.

HAND DUG WELL CONSTRUCTION

DRILLING WORK FOR THE STUDY ON RURAL WATER SUPPLY AND SANITATION IMPROVEMENT IN NORTH-WEST REGION , LAO P.D.R.

CLIENT : MINISTRY OF HEALTH , LAO P.D.R

CONSULTANT : JAPAN TECHNO CO., LTD.

CONTRACTOR : SIAM TONE CO., LTD.

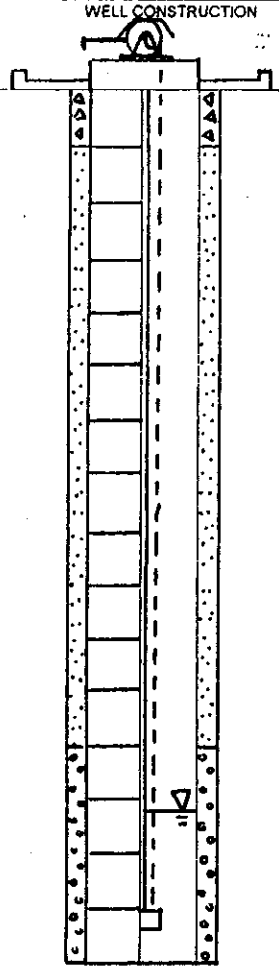
WELL NO. H-3 1/2

LOCATION BAN. Nam Ngao

PROVINCE: Bokeo

DEPTH (m)	LITHOLOGY COLUMN	DESCRIPTION
1		Silt,pale brown
2		Silty Clay,orangish brown,yellowish brown mottled
3		
4		
5		
6		
7		Sandy Clay,light orangish brown,fine to medium grain
8		Sand,light orangish brown,fine grain
9		
10		

WELL CONSTRUCTION



WATER QUALITY

pH	6.10	
EC	170	
Colour	0	
Odour	Odourless	
Taste	Tasteless	
Turbidity	0.3	NTU
Ca	16	mg/l
Mg	5.9	mg/l
Na	9.05	mg/l
K	1.57	mg/l
Fe	0	mg/l
Mn	0	mg/l
Cu	0	mg/l
Zn	0.2	mg/l
NH_4	0.98	mg/l
SiO_2	19	mg/l
CO_3	0	mg/l
HCO_3	69	mg/l
CO_2	87	mg/l
Cl	1.6	mg/l
SO_4	2	mg/l
NO_2	0	mg/l
NO_3	10	mg/l
F	0	mg/l
B	0.08	mg/l
$CaCO_3$ (Total)	64	mg/l
$CaCO_3$ (Per.)	6	mg/l
TDS	100	mg/l
Coliform	7	
As	< 0.001	mg/l
Ba	0	mg/l
Cr^{6+}	0.01	mg/l
Cd	< 0.001	mg/l
Pb	0	mg/l
Se	< 0.002	mg/l
Hg	< 0.0005	mg/l
Al	0.01	mg/l
CN	< 0.002	mg/l

DIGGING

DATE OF STARTED : 28 / 12 / 1999

DATE OF COMPLETED : 20/1/2000

DIG DIAMETER (m) 1.20

DIG DEPTH (m) 8.00

WELL DEVELOPMENT

DATE : 7/2/2000

METHOD : Continue Pumping

PERIOD : 5 Hr.

CASING INSTALLATION

DATE : 25/1/2000

CASING TYPE : Concrete Casing dia. 1m

WELL DEPTH (m) : 8.00 m

GRAVEL PACK : FROM 8.00 m TO 6.00 m,VOLUME 692 l

BACK FILLING : FROM 6.00 m TO 0.50 m,VOLUME 2,249 l

CEMENT SEALING : FROM 0.50 m TO 0.00 m,VOLUME 344 l

PLATFORM CONSTRUCTION

DATE : 21-22/2/2000

TYPE : 4.00 x 4.00 with Drain 3 m

PUMPING TEST

DATE : 8/2/2000

S.W.L (m) : 6.65

TRANSMISSIVITY (T) : 46.564 m^2/day

HYDRAULIC GRADIENT (K): 23.31 m/day

SPECIFIC CAPACTY (Sc):

HANDPUMP INSTALLATION

DATE : 25/2/2000

TYPE : LAO-99

DEPTH : 7.70 m

file: hdwcN-W

HAND DUG WELL CONSTRUCTION

DRILLING WORK FOR THE STUDY ON RURAL WATER SUPPLY AND SANITATION IMPROVEMENT IN NORTH-WEST REGION , LAO P.D.R.

CLIENT : MINISTRY OF HEALTH , LAO P.D.R

CONSULTANT : JAPAN TECHNO CO., LTD.

CONTRACTOR : SIAM TONE CO., LTD.

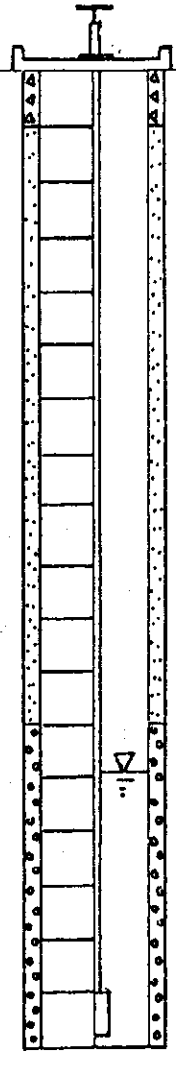
WELL NO. H-3 2/2B

LOCATION BAN. Nam Ngao

PROVINCE: Bokeo

DEPTH (m)	LITHOLOGY COLUMN	DESCRIPTION
1		Silty Clay,brown,with organic matter
2		Clay,orangish brown
3		
4		
5		
6		Silty Sand,light orangish brown,fine grain
7		Silt,light grayish brown
8		Weathered Mudstone,grayish brown,weak
9		Weathered Mudstone,light grayish brown and yellowish brown mottled,weak
10		

WELL CONSTRUCTION



WATER QUALITY

pH	6.31	
EC	248 Us/cm	
Colour	35	
Odour	Odor	
Taste	Siltly Taste	
Turbidity	50 NTU	
Ca	27	mg/l
Mg	4.9	mg/l
Na	11	mg/l
K	6.7	mg/l
Fe	0.7	mg/l
Mn	0	mg/l
Cu	0.02	mg/l
Zn	0.3	mg/l
NH4	1.1	mg/l
SiO_2	19	mg/l
CO_3	0	mg/l
HCO_3	82	mg/l
CO_2	84	mg/l
Cl	14	mg/l
SO_4	12	mg/l
NO_2	0.076	mg/l
NO_3	26	mg/l
F	0.1	mg/l
B	0.05	mg/l
$CaCo_3$ (Total)	88	mg/l
$CaCo_3$ (Per.)	21	mg/l
TDS	162	mg/l
Coliform	6	
As	< 0.001	mg/l
Ba	0	mg/l
Cr^{6+}	0	mg/l
Cd	< 0.001	mg/l
Pb	0	mg/l
Se	< 0.002	mg/l
Hg	< 0.0005	mg/l
Al	0	mg/l
CN	< 0.002	mg/l

DIGGING

DATE OF STARTED : 21/1/2000

DATE OF COMPLETED : 13/2/2000

DIG DIAMETER (m) 1.20

DIG DEPTH (m) 9.00

WELL DEVELOPMENT

DATE : 7/2/2000

METHOD : Continue Pumping

PERIOD : 5 Hr.

CASING INSTALLATION

DATE : 15-19/2/2000

CASING TYPE : Concrete Casing dia. 1m

WELL DEPTH (m) : 9.00

GRAVEL PACK : FROM 9.00 m TO 6.00 m,VOLUME 1,038 l

BACK FILLING : FROM 6.00 m TO 0.50 m,VOLUME 1,903 l

CEMENT SEALING : FROM 0.50 m TO 0.00 m,VOLUME 344 l

PLATFORM CONSTRUCTION

DATE : 24-26/2/2000

TYPE : 1.70 x 1.50 with Drain 4 m

PUMPING TEST

DATE : 9/2/2000

S.W.L (m) : 6.41

TRANSMISSIVITY (T) : 13.709 m^2/day

HYDRAULIC GRADIENT (K) : 4.569 m/day

SPECIFIC CAPACTY (Sc):

HANDPUMP INSTALLATION

DATE : 27/2/2000

TYPE : Tara Hand Pump

DEPTH : 6.80 m

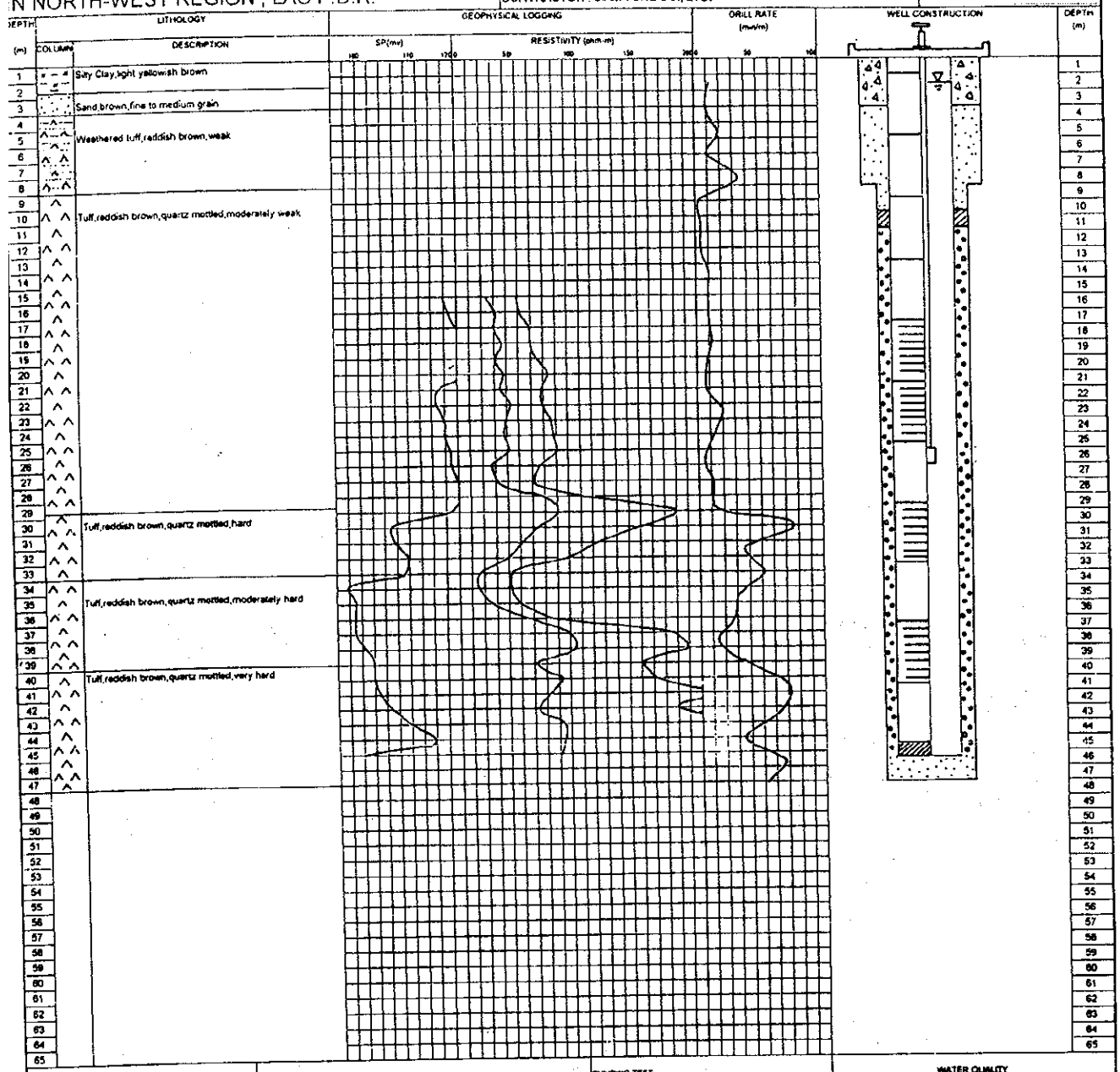
file: hdwcN-W

WELL CONSTRUCTION

DRILLING WORK FOR THE STUDY ON RURAL WATER SUPPLY AND SANITATION IMPROVEMENT IN NORTH-WEST REGION , LAO P.D.R.

CLIENT : MINISTRY OF HEALTH , LAO P.D.R.
CONSULTANT : JAPAN TECHNO CO., LTD.
CONTRACTOR : SIAM TONE CO., LTD.

WELL NO. H-98
LOCATION BAN. May Phattana
PROVINCE Bokeo



DRILLING

DATE OF STARTED: 19/2/2000
DATE OF COMPLETED: 24/2/2000
RIG TYPE: Top-500
SURFACE CASING DIA. 250 mm DEPTH 8.00 m
DRILL METHOD Rotary
DRILL DIAMETER (mm) 216
DRILL DEPTH (m) 47.00

WELL DEVELOPMENT

DATE: 26-27/2/2000
METHOD: Water Jetting and Air Lifting
PERIOD: 8 Hr.
REMARK:

CASING INSTALLATION

DATE: 26/2/2000
CASING TYPE: PVC Pipe dia. 150 mm Glade 13.5 bars
CASING 8 pcs x 3.95 = 31.60 m
SCREEN 4 pcs x 3.95 = 15.80 m
TOTAL LENGTH 47.40 m
BALANCE 2.00 m
WELL DEPTH 45.40 m
GRAVEL PACK : FROM 45.40 m TO 10.75 m VOLUME 510 l
BENTONITE SEAL : FROM 10.75 m TO 9.75 m VOLUME 15 l
BACK FILLING : FROM 9.75 m TO 3.00 m VOLUME 140 l
CEMENT SEALING : FROM 3.00 m TO 0.00 m VOLUME 344 l
SCREEN POSITION (m) : 16.75-24.65
28.80-32.55
36.50-40.45

PUMPING TEST

DATE : 27-28/2/2000
S.W.L (m) : 1.50
TRANSMISSIVITY (T) : 1.644 m²/day
HYDRAULIC GRADIENT (i) : 0.104 m /day
SPECIFIC CAPACITY (Sc) : 2.787 m²/day/m
OPTIMUM DISCHARGE : 14.40 m³/day

PLATFORM CONSTRUCTION

DATE : 29/2/2000
TYPE : 1.70 x 1.50 with Drian 4.00 m

HANDPUMP INSTALLATION

DATE : 1/3/2000
TYPE : Tara Hand Pump
DEPTH : 26.00 m

WATER QUALITY

pH	7.05	SiO_2	53 mg/l
EC	657 Us/cm	CO_3	0 mg/l
Colour	35	HCO_3	280 mg/l
Odour	Oder	CO_2	41 mg/l
Taste	Slightly Taste	Cl	1.2 mg/l
Turbidity	10 NTU	SO_4	145 mg/l
Ca	106 mg/l	NO_2	0 mg/l
Mg	14 mg/l	NO_3	0.4 mg/l
Na	20 mg/l	F	0.2 mg/l
K	2.4 mg/l	B	0 mg/l
Fe	0.09 mg/l	$CaCo_3$ (Total)	325 mg/l
Mn	0.00 mg/l	$CaCo_3$ (Per.)	86 mg/l
Cu	0.02 mg/l	TDS	486 mg/l
Zn	0.1 mg/l	Coliform	16
NH4	1.0 mg/l		

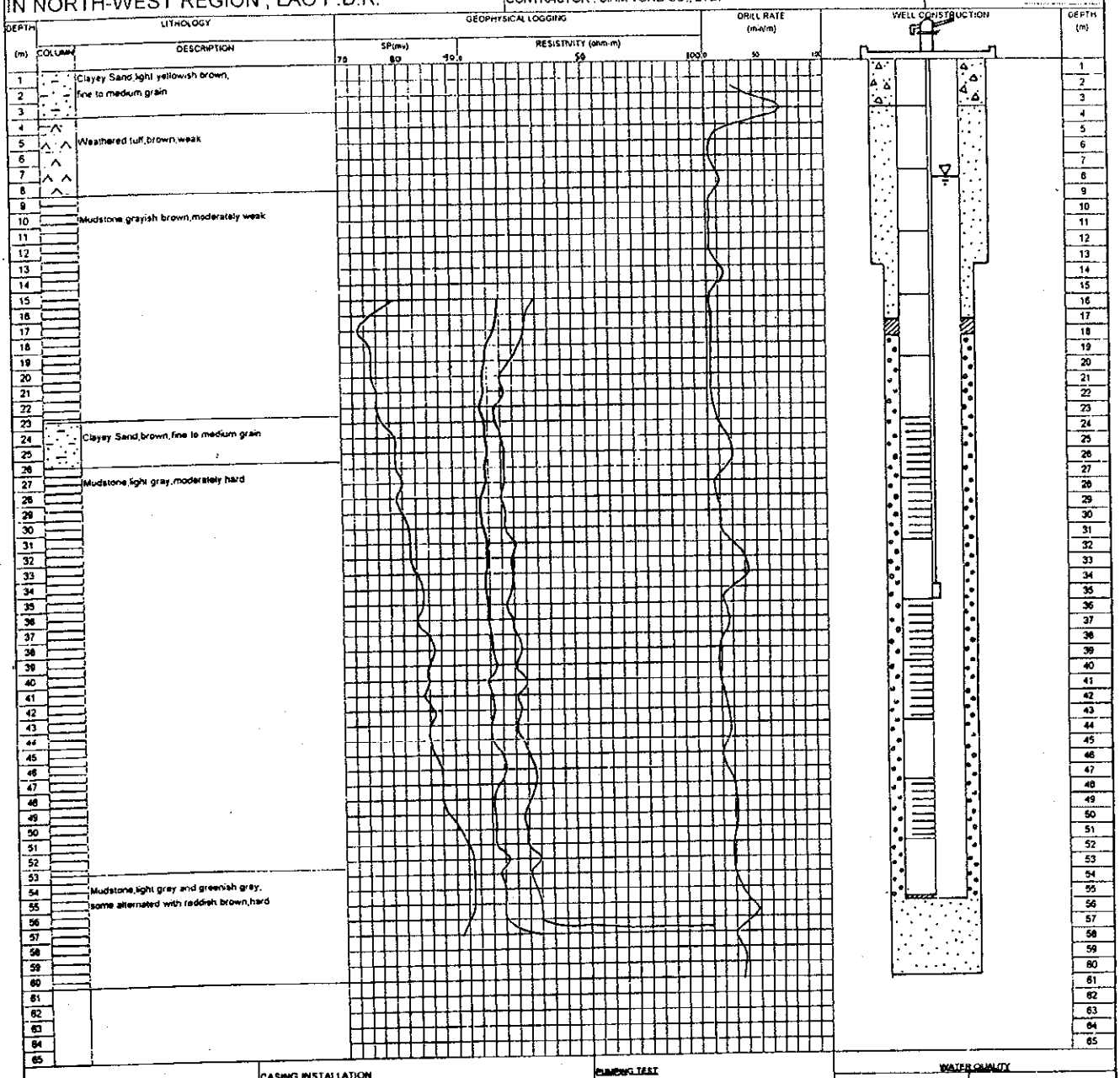
No:WellconNW

WELL CONSTRUCTION

DRILLING WORK FOR THE STUDY ON RURAL WATER SUPPLY AND SANITATION IMPROVEMENT IN NORTH-WEST REGION , LAO P.D.R.

CLIENT : MINISTRY OF HEALTH , LAO P.D.R.
CONSULTANT : JAPAN TECHNO CO., LTD.
CONTRACTOR : SIAM TONE CO., LTD.

WELL NO. H-37
LOCATION BAN. Leang
PROVINCE Bokeo



DRILLING

DATE OF STARTED: 18/1/2000
DATE OF COMPLETED: 25/1/2000
RIG TYPE : Top-500
SURFACE CASING DIA. 250 mm DEPTH 11.00 m
DRILL METHOD Rotary
DRILL DIAMETER (mm) 216
DRILL DEPTH (m) 60.00

WELL DEVELOPMENT

DATE : 27-28/1/2000
METHOD : Water Jetting and Air Lifting
PERIOD : 14.35 Hr.
REMARK :

CASING INSTALLATION

DATE : 26/1/2000
CASING TYPE : PVC Pipe dia. 150 mm Glade 13.5 bars

CASING	9	pcs x 3.95 =	35.55	m	
SCREEN	5	pcs x 3.95 =	19.75	m	
TOTAL LENGTH			55.30	m	
BALANCE			0.30	m	
WELL DEPTH			55.00	m	

GRAVEL PACK	: FROM 55.00	m TO 17.40	m,VOLUME 760	l		
BENTONITE SEAL	: FROM 17.40	m TO 16.40	m,VOLUME 15	l		
BACK FILLING	: FROM 16.40	m TO 3.00	m,VOLUME 378	l		
CEMENT SEALING	: FROM 3.00	m TO 0.00	m,VOLUME 344	l		

SCREEN POSITION (m) : 23.40-31.30
35.25-43.15
47.10-51.05

PUMPING TEST

DATE : 4-5/2/2000
S.W.L (m) : 7.50
TRANSMISSIVITY (T) : 0.130 m²/day
HYDRAULIC GRADIENT (K) : 0.0069 m/day
SPECIFIC CAPACITY (Sc) : 0.613 m³/day/m.
OPTIMUM DISCHARGE : 0.01 m³/sec.

PLATFORM CONSTRUCTION

DATE : 1/3/2000
TYPE : 1.50 x 2.00 with Drian 10 m

HANDPUMP INSTALLATION

DATE : 2/3/2000
TYPE : Afridev Hand Pump
DEPTH : 35.00 m

WATER QUALITY

pH	7.06		SiO_2	13	mg/l
EC	560 Us/cm		CO_3	0	mg/l
Colour	50		HCO_3	135	mg/l
Odour	Odor		CO_2	18	mg/l
Taste	Slightly Taste		Cl	6.0	mg/l
Turbidity	15 NTU		SO_4	186	mg/l
Ca	35 mg/l		NO_2	0.007	mg/l
Mg	41 mg/l		NO_3	0.4	mg/l
Na	16 mg/l		F	0.2	mg/l
K	7.1 mg/l		B	0	mg/l
Fe	1.1 mg/l		$CaCO_3$ (Total)	258	mg/l
Mn	0 mg/l		$CaCO_3$ (Per)	148	mg/l
Cu	0.02 mg/l		TDS	373	mg/l
Zn	0.1 mg/l		Coliform	15	
NH	1.3 mg/l				

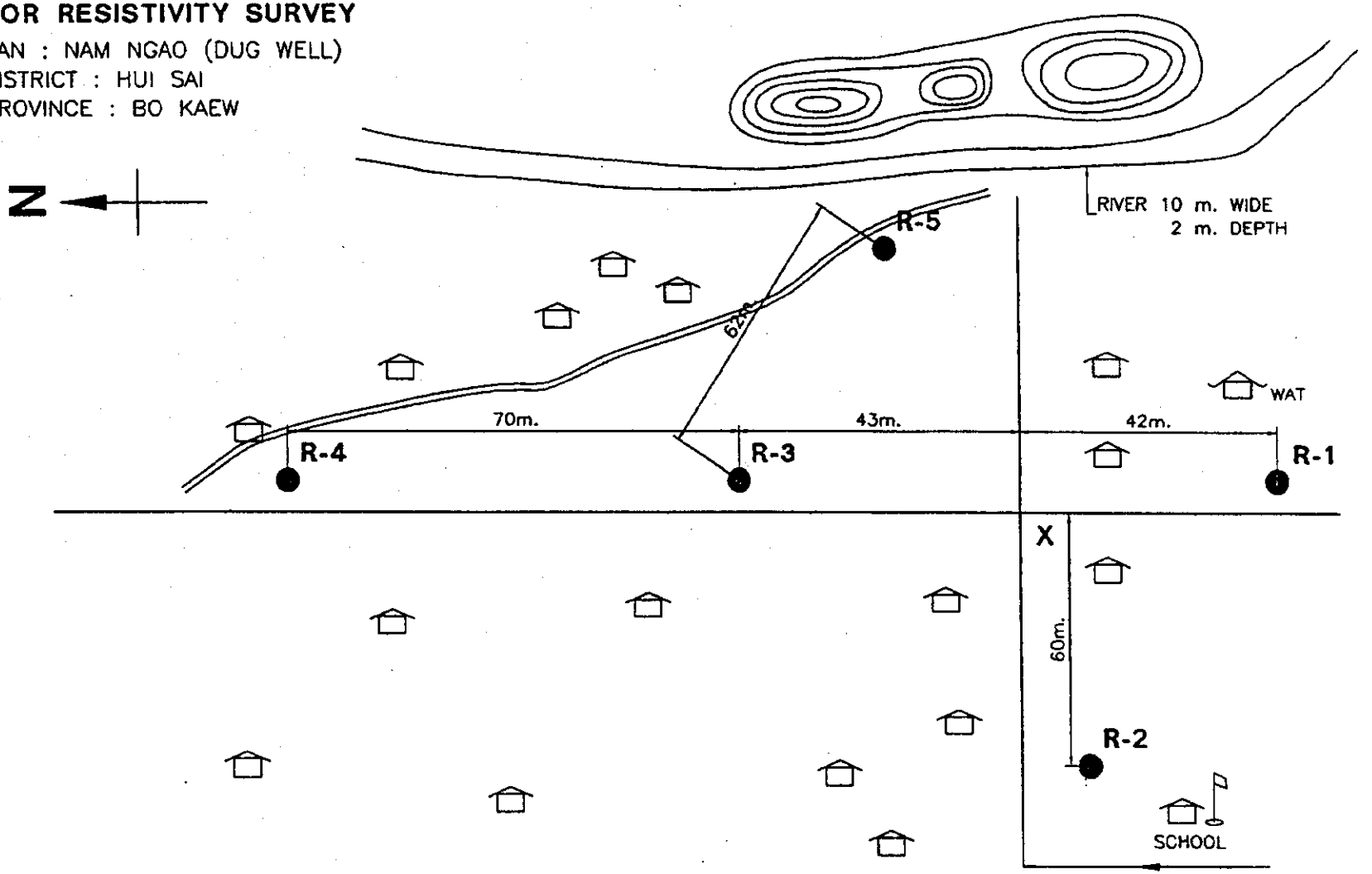
file:WellconNW

APPENDIX A

RESISTIVITY SURVEY DATA AND ANALYSIS

SKETCH VILLAGE MAP FOR RESISTIVITY SURVEY

BAN : NAM NGAO (DUG WELL)
DISTRICT : HUI SAI
PROVINCE : BO KAEW



JICA (Japan International Corperation Agency)
Nam Sa-At (National Center for Environmental Healh and Water Supply)
Rural Water Supply and Sanitation Improvement

PROJECT:
Phase II: Model Study-Groundwater Development

RESISTIVITY DATA

MISSION NO.	:	NSA-R1
LOCATION	:	BAN NAM GNAO, HEOUXAY DISTRICT,
		BORKEAW PROVINCE, LAO P.D.R.
DATE OF SURVEY	:	23/11/1999
DATE OF REPORT	:	30/11/1999

HEAD OFFICE
5/15 MOO 6 (KM. 15)
BANGNA-TRAD ROAD
BANGPLEE, BANGCHALONG
SAMUTPRAKARN 10540
TEL. 3125281-300 FAX. (66-2) 3125304

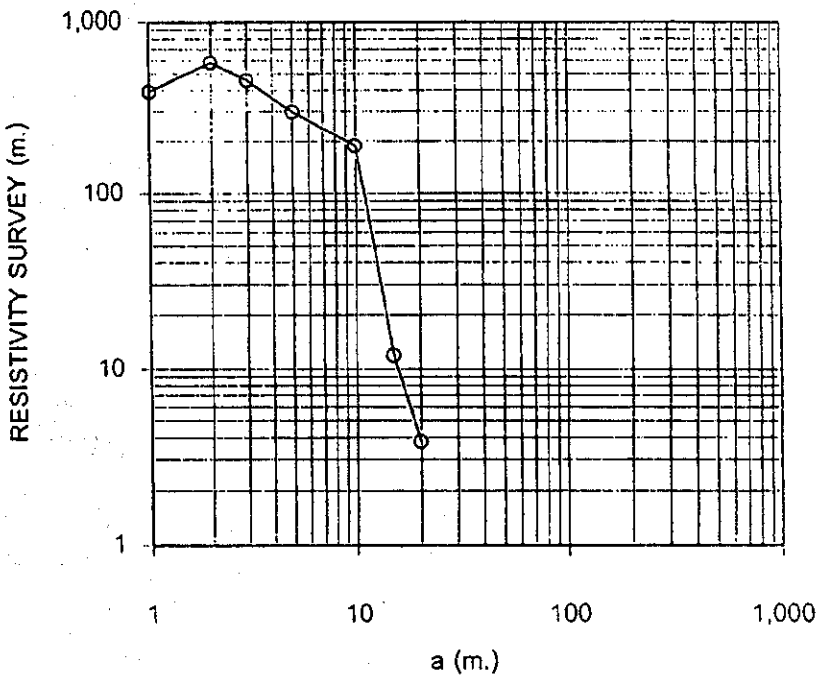
SIAM TONE CO.,LTD.
STC
OYO-INSTRUMENTS
MODEL-2115

BANGPAKONG FACTORY
700/47 BANGPAKONG
INDUSTRIAL, PARK 2
CHONBURI 20000
TEL. (038) 213-073-7
FAX. (038) 213-078

WENNER CONFIGURATION

NO.	a(m.)	F (m.)	C (m.)	2πa (u)	mV	mA	RESISTANCE (ohm.)	RESISTIVITY (ohm.m.)
1	1	0.5	1.50	6.283	3,116.00	49.90	62.445	392.341
2	2	1.0	3.00	12.570	2,317.00	49.90	46.433	583.661
3	3	1.5	4.50	18.850	1,210.00	49.90	24.248	457.084
4	5	2.5	7.50	31.420	474.00	49.90	9.499	298.459
5	10	5.0	15.00	62.850	150.00	49.90	3.006	188.928
6	15	7.5	22.50	94.280	6.36	49.90	0.127	12.016
7	20	10.0	30.00	125.710	1.51	49.90	0.030	3.804
8	25	12.5	37.50	157.140				
9	30	15.0	45.00	188.570				
10	40	20.0	60.00	251.420				
11	50	25.0	75.00	314.280				
12	60	30.0	90.00	376.990				
13	70	35.0	105.00	439.990				
14	80	40.0	120.00	502.850				
15	90	45.0	135.00	565.710				
16	100	50.0	150.00	628.570				
17								
18								
19								
20								

GEOPHYSICAL SURVEY



RESISTIVITY DATA

MISSION NO.	:	NSA-R2
LOCATION	:	BAN NAM GNAO, HEOUXAY DISTRICT,
		BORKEAW PROVINCE, LAO P.D.R.
DATE OF SURVEY	:	23/11/1999
DATE OF REPORT	:	30/11/1999

HEAD OFFICE
5/15 MOO 6 (KM. 15)
BANGNA-TRAD ROAD
BANGPLEE, BANGCHALONG
SAMUTPRAKARN 10540
TEL. 3125281-300 FAX. (66-2) 3125304

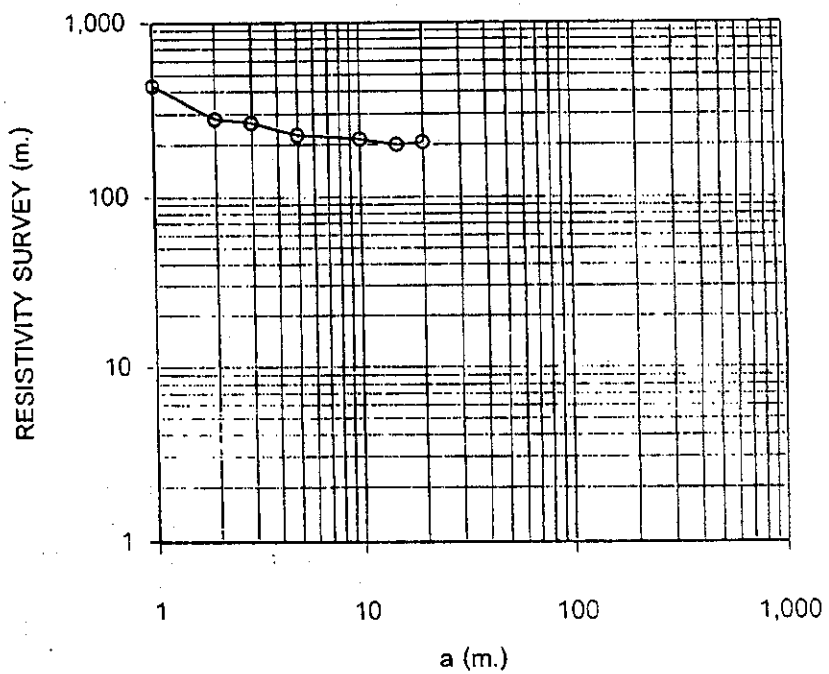
SIAM TONE CO.,LTD.
STC
OYO-INSTRUMENTS
MODEL-2115

BANGPAKONG FACTORY
700/47 BANGPAKONG
INDUSTRIAL, PARK 2
CHONBURI 20000
TEL. (038) 213-073-7
FAX. (038) 213-078

WENNER CONFIGURATION

NO.	a(m.)	F (m.)	C (m.)	2πa (u)	mV	mA	RESISTANCE (ohm.)	RESISTIVITY (ohm.m.)
1	1	0.5	1.50	6.283	3,428.00	49.90	68.697	431.626
2	2	1.0	3.00	12.570	1,121.00	49.90	22.465	282.384
3	3	1.5	4.50	18.850	708.00	49.90	14.188	267.451
4	5	2.5	7.50	31.420	362.00	49.90	7.255	227.937
5	10	5.0	15.00	62.850	171.00	49.90	3.427	215.378
6	15	7.5	22.50	94.280	106.00	49.90	2.124	200.274
7	20	10.0	30.00	125.710	82.20	49.90	1.647	207.081
8	25	12.5	37.50	157.140				
9	30	15.0	45.00	188.570				
10	40	20.0	60.00	251.420				
11	50	25.0	75.00	314.280				
12	60	30.0	90.00	376.990				
13	70	35.0	105.00	439.990				
14	80	40.0	120.00	502.850				
15	90	45.0	135.00	565.710				
16	100	50.0	150.00	628.570				
17								
18								
19								
20								

GEOPHYSICAL SURVEY



RESISTIVITY DATA

MISSION NO.	:	NSA-R3
LOCATION	:	BAN NAM GNAO, HEOUXAY DISTRICT,
		BORKEAW PROVINCE, LAO P.D.R.
DATE OF SURVEY	:	23/11/1999
DATE OF REPORT	:	30/11/1999

HEAD OFFICE
5/15 MOO 6 (KM. 15)
BANGNA-TRAD ROAD
BANGPLEE, BANGCHALONG
SAMUTPRAKARN 10540
TEL. 3125281-300 FAX. (66-2) 3125304

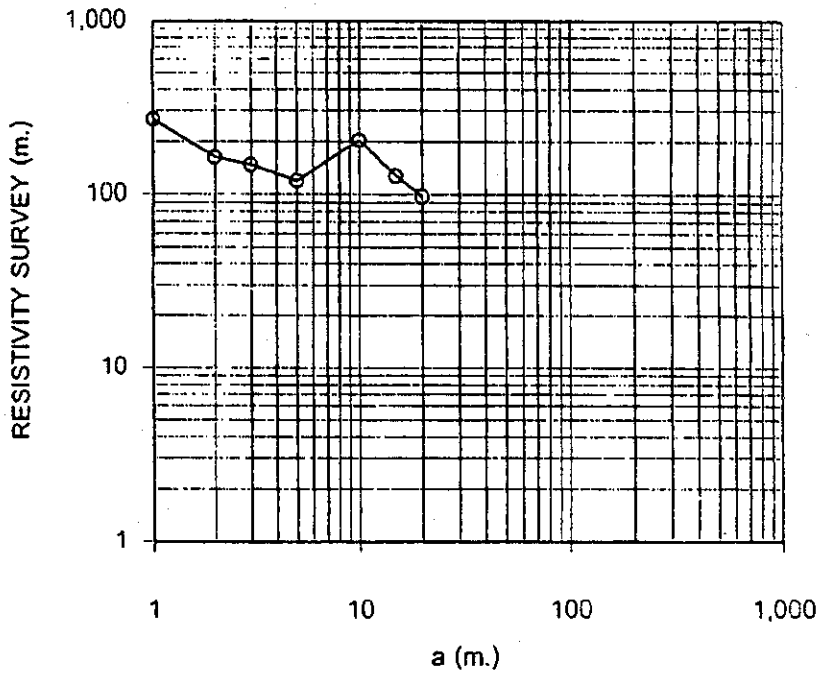
SIAM TONE CO.,LTD.
OYO-INSTRUMENTS
MODEL-2115

BANGPAKONG FACTORY
700/47 BANGPAKONG
INDUSTRIAL, PARK 2
CHONBURI 20000
TEL. (038) 213-073-7
FAX. (038) 213-078

WENNER CONFIGURATION

NO.	a(m.)	F (m.)	C (m.)	2πa (u)	mV	mA	RESISTANCE (ohm.)	RESISTIVITY (ohm.m.)
1	1	0.5	1.50	6.283	2,137.00	49.90	42.826	269.074
2	2	1.0	3.00	12.570	647.00	49.90	12.966	162.982
3	3	1.5	4.50	18.850	391.00	49.90	7.836	147.702
4	5	2.5	7.50	31.420	190.00	49.90	3.808	119.635
5	10	5.0	15.00	62.850	162.00	49.90	3.246	204.042
6	15	7.5	22.50	94.280	67.50	49.90	1.353	127.533
7	20	10.0	30.00	125.710	38.80	49.90	0.778	97.746
8	25	12.5	37.50	157.140				
9	30	15.0	45.00	188.570				
10	40	20.0	60.00	251.420				
11	50	25.0	75.00	314.280				
12	60	30.0	90.00	376.990				
13	70	35.0	105.00	439.990				
14	80	40.0	120.00	502.850				
15	90	45.0	135.00	565.710				
16	100	50.0	150.00	628.570				
17								
18								
19								
20								

GEOPHYSICAL SURVEY



RESISTIVITY DATA

MISSION NO.	:	NSA-R4
LOCATION	:	BAN NAM GNAO, HEOUXAY DISTRICT,
		BORKEAW PROVINCE, LAO P.D.R.
DATE OF SURVEY	:	23/11/1999
DATE OF REPORT	:	30/11/1999

HEAD OFFICE
5/15 MOO 6 (KM. 15)
BANGNA-TRAD ROAD
BANGPLEE, BANGCHALONG
SAMUTPRAKARN 10540
TEL. 3125281-300 FAX. (66-2) 3125304

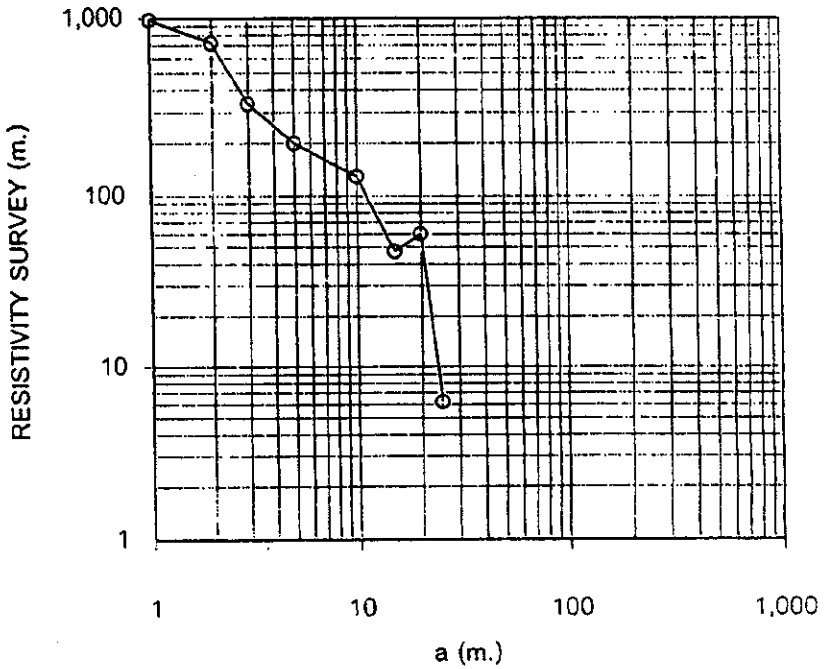
SIAM TONE CO.,LTD.
STC
OYO-INSTRUMENTS
MODEL-2115

BANGPAKONG FACTORY
700/47 BANGPAKONG
INDUSTRIAL, PARK 2
CHONBURI 20000
TEL. (038) 213-073-7
FAX. (038) 213-078

WENNER CONFIGURATION

NO.	a(m.)	F (m.)	C (m.)	2πa (u)	mV	mA	RESISTANCE (ohm.)	RESISTIVITY (ohm.m.)
1	1	0.5	1.50	6.283	778.00	4.99	155.912	979.594
2	2	1.0	3.00	12.570	287.00	4.99	57.515	722.964
3	3	1.5	4.50	18.850	89.20	4.99	17.876	336.958
4	5	2.5	7.50	31.420	32.00	4.99	6.413	201.491
5	10	5.0	15.00	62.850	10.30	4.99	2.064	129.730
6	15	7.5	22.50	94.280	2.50	4.99	0.501	47.234
7	20	10.0	30.00	125.710	24.00	49.90	0.481	60.462
8	25	12.5	37.50	157.140	1.97	49.90	0.039	6.204
9	30	15.0	45.00	188.570				
10	40	20.0	60.00	251.420				
11	50	25.0	75.00	314.280				
12	60	30.0	90.00	376.990				
13	70	35.0	105.00	439.990				
14	80	40.0	120.00	502.850				
15	90	45.0	135.00	565.710				
16	100	50.0	150.00	628.570				
17								
18								
19								
20								

GEOPHYSICAL SURVEY



RESISTIVITY DATA

MISSION NO.	:	NSA-R5
LOCATION	:	BAN NAM GNAO, HEOUXAY DISTRICT,
		BORKEAW PROVINCE, LAO P.D.R.
DATE OF SURVEY	:	23/11/1999
DATE OF REPORT	:	30/11/1999

HEAD OFFICE
5/15 MOO 6 (KM. 15)
BANGNA-TRAD ROAD
BANGPLEE, BANGCHALONG
SAMUTPRAKARN 10540
TEL. 3125281-300 FAX. (66-2) 3125304

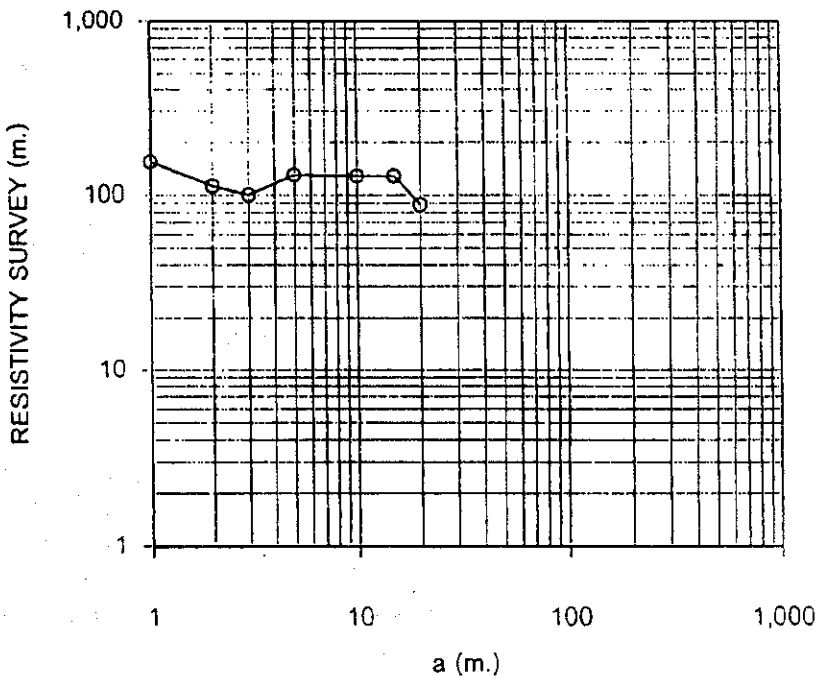
SIAM TONE CO.,LTD.
OYO-INSTRUMENTS
MODEL-2115

BANGPAKONG FACTORY
700/47 BANGPAKONG
INDUSTRIAL, PARK 2
CHONBURI 20000
TEL. (038) 213-073-7
FAX. (038) 213-078

WENNER CONFIGURATION

NO.	a(m.)	F (m.)	C (m.)	2πa (u)	mV	mA	RESISTANCE (ohm.)	RESISTIVITY (ohm.m.)
1	1	0.5	1.50	6.283	1,237.00	49.90	24.790	155.753
2	2	1.0	3.00	12.570	448.00	49.90	8.978	112.853
3	3	1.5	4.50	18.850	266.00	49.90	5.331	100.483
4	5	2.5	7.50	31.420	207.00	49.90	4.148	130.339
5	10	5.0	15.00	62.850	102.00	49.90	2.044	128.471
6	15	7.5	22.50	94.280	68.00	49.90	1.363	128.478
7	20	10.0	30.00	125.710	35.20	49.90	0.705	88.677
8	25	12.5	37.50	157.140				
9	30	15.0	45.00	188.570				
10	40	20.0	60.00	251.420				
11	50	25.0	75.00	314.280				
12	60	30.0	90.00	376.990				
13	70	35.0	105.00	439.990				
14	80	40.0	120.00	502.850				
15	90	45.0	135.00	565.710				
16	100	50.0	150.00	628.570				
17								
18								
19								
20								

GEOPHYSICAL SURVEY



RESISTIVITY DATA

MISSION NO. : NSA-R6
LOCATION : BAN NAM GNAO, HEOUXAY DISTRICT,
BORKEAW PROVINCE, LAO P.D.R.
DATE OF SURVEY : 23/11/1999
DATE OF REPORT : 30/11/1999

HEAD OFFICE
5/15 MOO 6 (KM. 15)
BANGNA-TRAD ROAD
BANGPLEE, BANGCHALONG
SAMUTPRAKARN 10540
TEL. 3125281-300 FAX. (66-2) 3125304

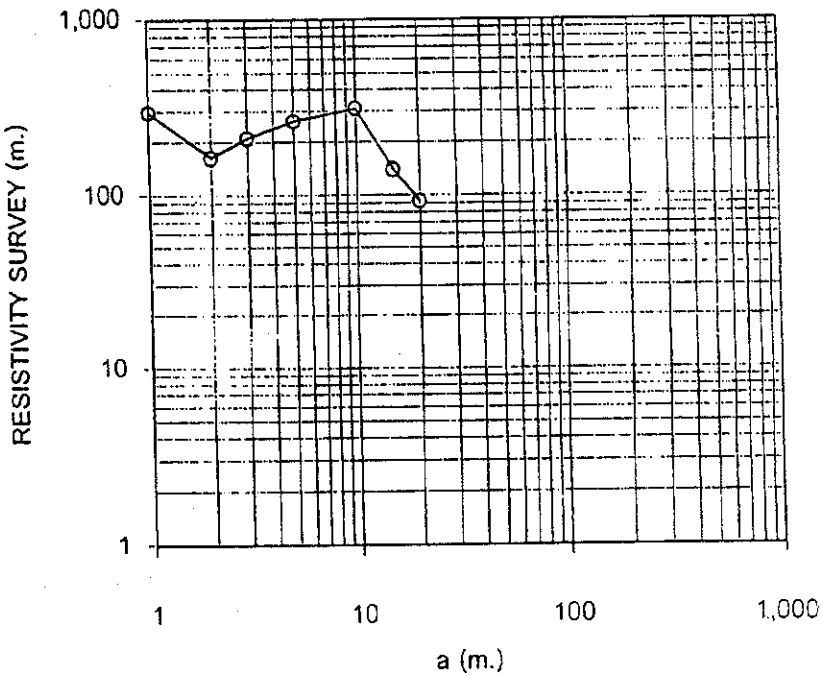
SIAM TONE CO.,LTD.
OYO-INSTRUMENTS
MODEL-2115

BANGPAKONG FACTORY
700/47 BANGPAKONG
INDUSTRIAL, PARK 2
CHONBURI 20000
TEL. (038) 213-073-7
FAX. (038) 213-078

WENNER CONFIGURATION

NO.	a(m.)	F (m.)	C (m.)	2πa (u)	mV	mA	RESISTANCE (ohm.)	RESISTIVITY (ohm.m.)
1	1	0.5	1.50	6.283	1,892.00	40.10	47.182	296.445
2	2	1.0	3.00	12.570	650.00	49.90	13.026	163.737
3	3	1.5	4.50	18.850	556.00	49.90	11.142	210.032
4	5	2.5	7.50	31.420	418.00	49.90	8.377	263.198
5	10	5.0	15.00	62.850	246.00	49.90	4.930	309.842
6	15	7.5	22.50	94.280	74.60	49.90	1.495	140.948
7	20	10.0	30.00	125.710	36.80	49.90	0.737	92.708
8	25	12.5	37.50	157.140				
9	30	15.0	45.00	188.570				
10	40	20.0	60.00	251.420				
11	50	25.0	75.00	314.280				
12	60	30.0	90.00	376.990				
13	70	35.0	105.00	439.990				
14	80	40.0	120.00	502.850				
15	90	45.0	135.00	565.710				
16	100	50.0	150.00	628.570				
17								
18								
19								
20								

GEOPHYSICAL SURVEY



DATA SET: NSA-R1

CLIENT: JICA
LOCATION: BAN NAM GNAO
COUNTY: NAM GNAO, LAO P.D.R.
PROJECT: Water Supply & Sanitation
ELEVATION: 0.00
SOUNDING COORDINATES: X: 0.0000 Y: 0.0000

DATE: NOV., 1999
SOUNDING: -
AZIMUTH: -
EQUIPMENT: -

Wenner Configuration

FITTING ERROR: 39.121 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	253.7	0.610	-0.610	0.00241	154.9
2	1034.9	0.974	-1.58	9.414E-04	1008.3
3	997.6	1.15	-2.74	0.00116	1155.3
4	100.6	0.740	-3.48	0.00735	74.50
5	6.91	1.13	-4.61	0.164	7.85
6	0.250				

ALL PARAMETERS ARE FREE

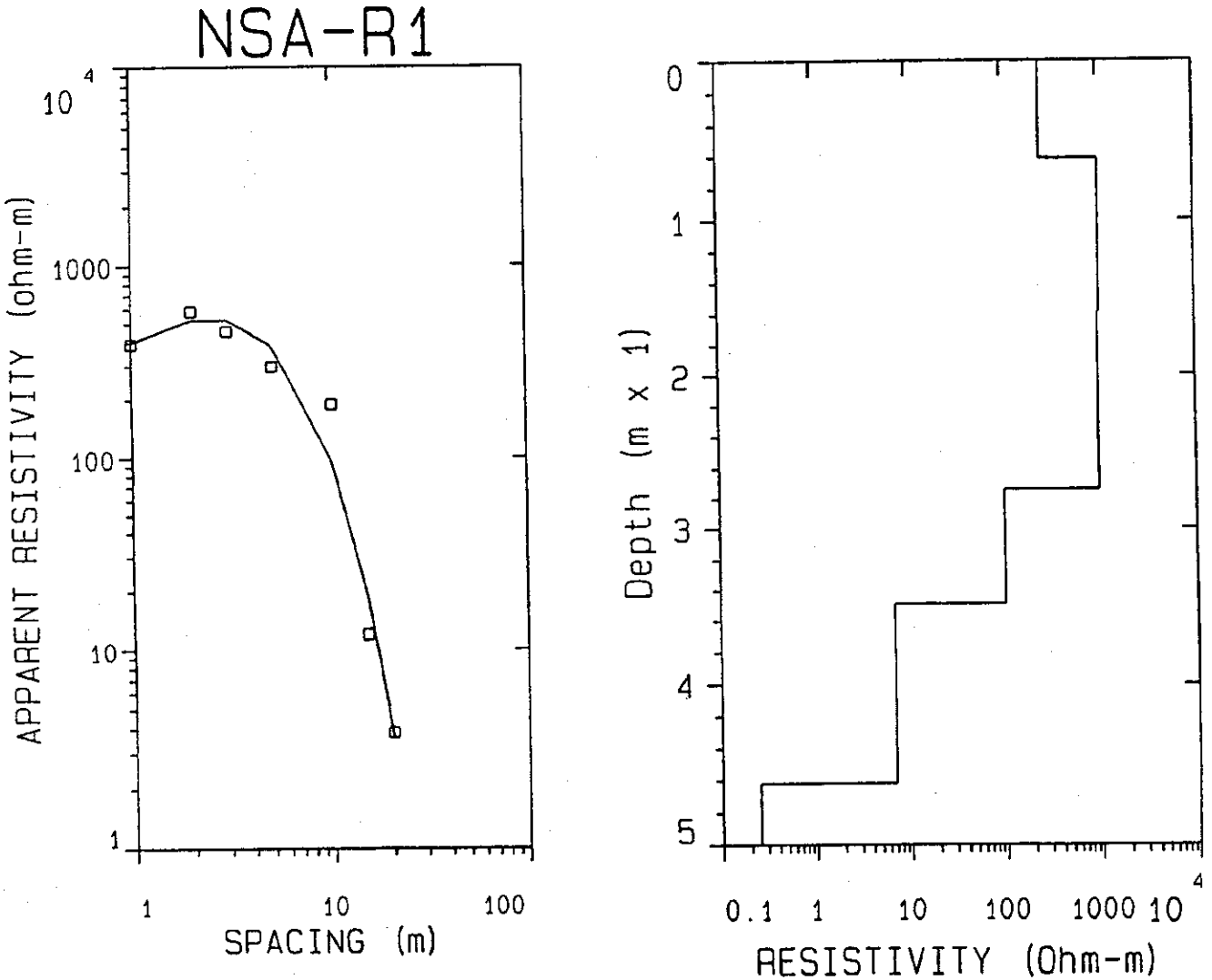
No.	SPACING (m)	RHO-A (ohm-m) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.00	392.3	399.6	-1.85
2	2.00	583.6	523.3	10.33
3	3.00	457.0	525.2	-14.90
4	5.00	298.4	383.9	-28.63
5	10.00	188.9	95.53	49.43
6	15.00	12.01	18.77	-56.27
7	20.00	3.80	3.57	6.07

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.88					
P 2	-0.14	0.67				
P 3	0.02	0.31	0.35			
P 4	0.01	0.00	0.01	0.00		
P 5	0.00	0.00	0.00	0.00	0.00	
P 6	0.02	0.01	-0.06	-0.01	0.00	0.77

* OYO CORPORATION *

T 1	-0.21	-0.28	0.11	0.01	0.00	0.03	0.64					
T 2	0.06	0.03	0.18	0.03	0.00	0.01	0.09	0.32				
T 3	0.08	0.00	0.19	0.03	0.01	0.04	0.11	0.38	0.46			
T 4	0.00	-0.02	0.00	0.00	0.00	0.00	0.00	0.04	0.05	0.01		
T 5	0.00	-0.01	-0.01	0.00	0.00	0.02	0.00	0.01	0.01	0.00	0.0	
	P 1	P 2	P 3	P 4	P 5	P 6	T 1	T 2	T 3	T 4	T	


NSA-R1
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
1
10
100
SPACING (m)
Depth (m x 1)
0
1
2
3
4
5
0.1
1
10
100
1000
10 4
RESISTIVITY (Ohm-m)

DATA SET: NSA-R2

CLIENT: JICA
LOCATION: NAM GNAO SCHOOL
COUNTY: HEOUXAY, LAO. P.D.R.
PROJECT: WATER SUPPLY & SANITATION
ELEVATION: 0.00
SOUNDING COORDINATES: X: 0.0000 Y: 0.0000

DATE: NOV., 1999
SOUNDING: -
AZIMUTH: -
EQUIPMENT: -

Wenner Configuration

FITTING ERROR: 2.344 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	783.2	0.500	-0.500	6.392E-04	392.1
2	253.0	0.909	-1.40	0.00359	230.1
3	253.1	2.75	-4.16	0.0108	697.8
4	184.6	10.08	-14.25	0.0546	1861.8
5	228.1				

ALL PARAMETERS ARE FREE

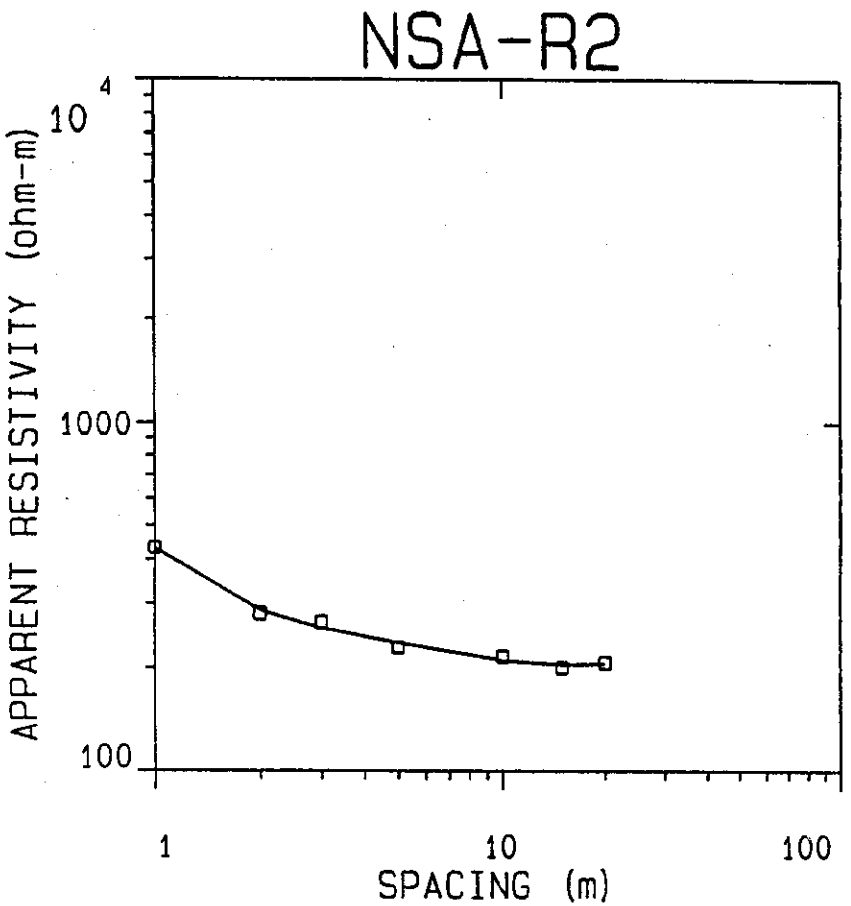
No.	SPACING (m)	RHO-A (ohm-m) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.00	431.6	430.2	0.322
2	2.00	282.3	287.5	-1.82
3	3.00	267.4	258.1	3.48
4	5.00	227.9	235.3	-3.25
5	10.00	215.3	209.9	2.53
6	15.00	200.2	204.4	-2.09
7	20.00	207.0	205.6	0.687

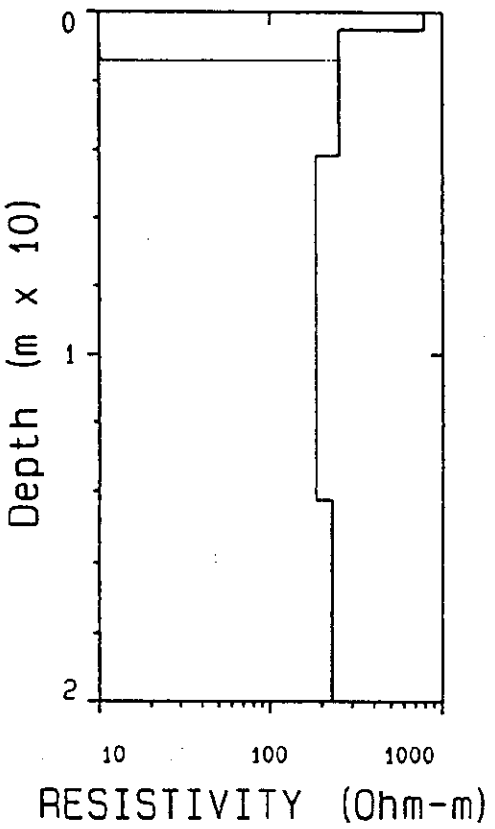
PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.38						
P 2	0.02	0.50					
P 3	-0.08	0.20	0.76				
P 4	0.02	-0.07	0.11	0.79			
P 5	-0.01	0.04	-0.08	0.25	0.36		
T 1	0.35	0.29	-0.02	0.01	0.00	0.50	
T 2	0.00	-0.01	0.04	0.03	-0.02	0.00	0.00

* OYO CORPORATION *

T 3	0.01	-0.03	0.11	0.08	-0.05	0.00	0.01	0.04	
T 4	0.00	-0.01	0.02	-0.07	-0.07	0.00	0.00	0.01	0.02
	P 1	P 2	P 3	P 4	P 5	T 1	T 2	T 3	T 4


NSA-R2
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
1
10
100
SPACING (m)


0
1
2
Depth (m x 10)
10
100
1000
RESISTIVITY (Ohm-m)

DATA SET: NSA-R3

CLIENT: JICA DATE: NOV., 1999
LOCATION: VILLANGE BAN NAM GNAO SOUNDING: -
COUNTY: BORKEAW, LAO. P.D.R. AZIMUTH: -
PROJECT: WATER SUPPLY & SANITATION EQUIPMENT: -
ELEVATION: 0.00
SOUNDING COORDINATES: X: 0.0000 Y: 0.0000

Wenner Configuration

FITTING ERROR: 12.544 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	321.9	1.13	-1.13	0.00353	365.7
2	55.92	1.79	-2.92	0.0320	100.1
3	1746.6	1.30	-4.22	7.449E-04	2272.6
4	89.48	1.22	-5.44	0.0136	109.2
5	0.0961				

ALL PARAMETERS ARE FREE

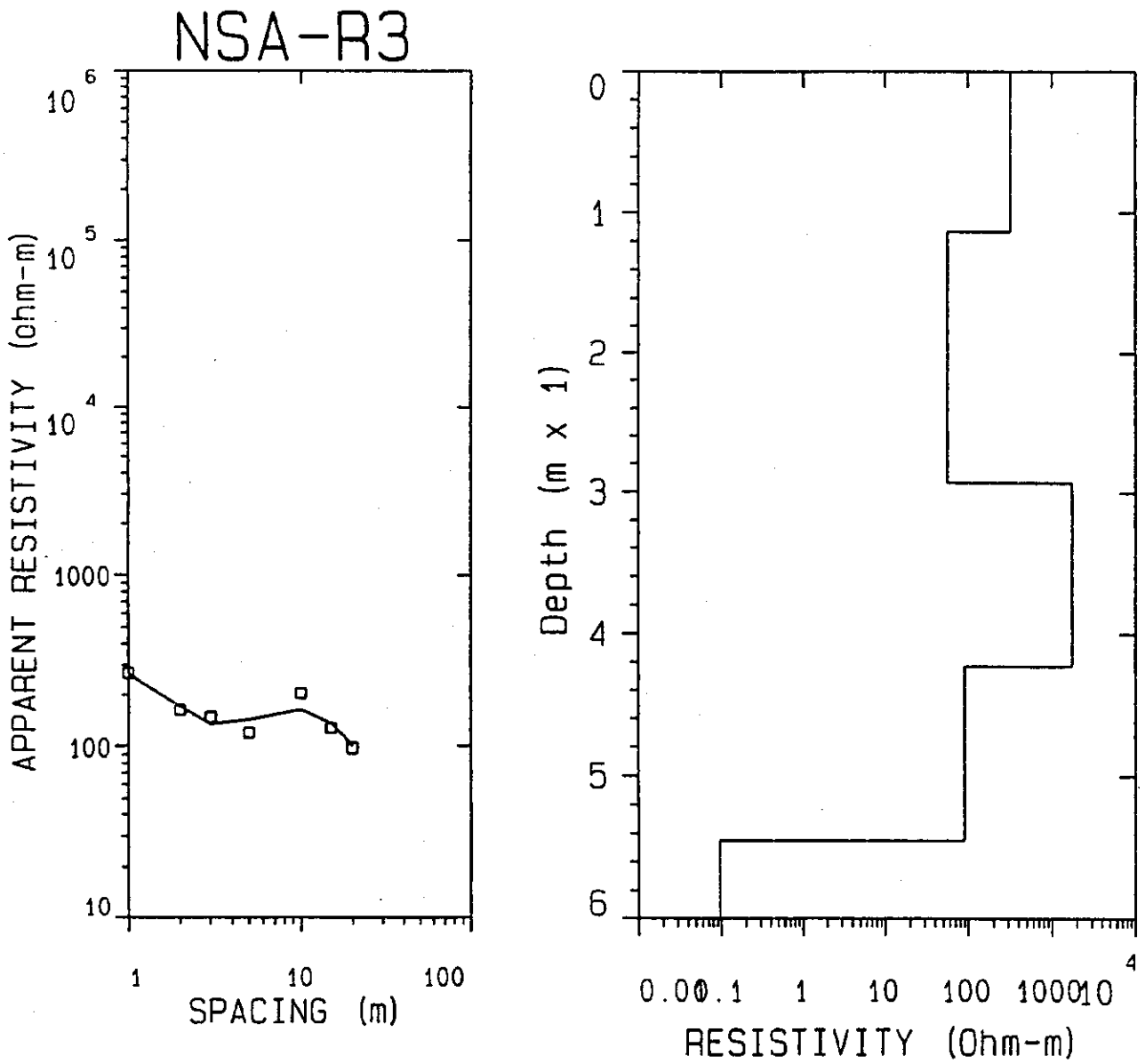
No.	SPACING (m)	RHO-A (ohm-m) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.00	269.0	266.2	1.05
2	2.00	162.9	170.7	-4.76
3	3.00	147.7	135.3	8.34
4	5.00	119.6	143.4	-19.89
5	10.00	204.0	163.2	19.97
6	15.00	127.5	136.6	-7.11
7	20.00	97.74	100.1	-2.42

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00						
P 2	-0.01	0.78					
P 3	0.00	0.00	0.50				
P 4	0.00	0.00	0.03	0.00			
P 5	0.00	0.00	0.00	0.00	0.00		
T 1	0.00	0.05	0.00	0.00	0.00	0.99	
T 2	-0.01	-0.23	0.00	0.00	0.00	0.05	0.76

* OYO CORPORATION *

T 3	0.00	0.00	0.50	0.03	0.00	0.00	0.01	0.50	
T 4	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.03	0.00
	P 1	P 2	P 3	P 4	P 5	T 1	T 2	T 3	T 4


NSA-R3
APPARENT RESISTIVITY (ohm-m)
10^6
10^5
10^4
1000
100
10
1
10
100
SPACING (m)
Depth (m x 1)
0
1
2
3
4
5
6
0.00
0.1
1
10
100
1000
10^4
RESISTIVITY (Ohm-m)

DATA SET: NSA-R4

CLIENT: JICA DATE: NOV., 1999
LOCATION: BAN NAM GNAO SOUNDING: -
COUNTY: BORKEAW, LAO. P.D.R. AZIMUTH: -
PROJECT: WATER SUPPLY & SANITATION EQUIPMENT: -
ELEVATION: 0.00
SOUNDING COORDINATES: X: 0.0000 Y: 0.0000

Wenner Configuration

FITTING ERROR: 16.019 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	1267.8	1.26	-1.26	9.990E-04	1605.9
2	88.06	0.730	-1.99	0.00829	64.32
3	358.2	2.94	-4.93	0.00821	1053.7
4	10.07	4.70	-9.64	0.467	47.36
5	63.03	3.50	-13.14	0.0555	220.6
6	575.2				

ALL PARAMETERS ARE FREE

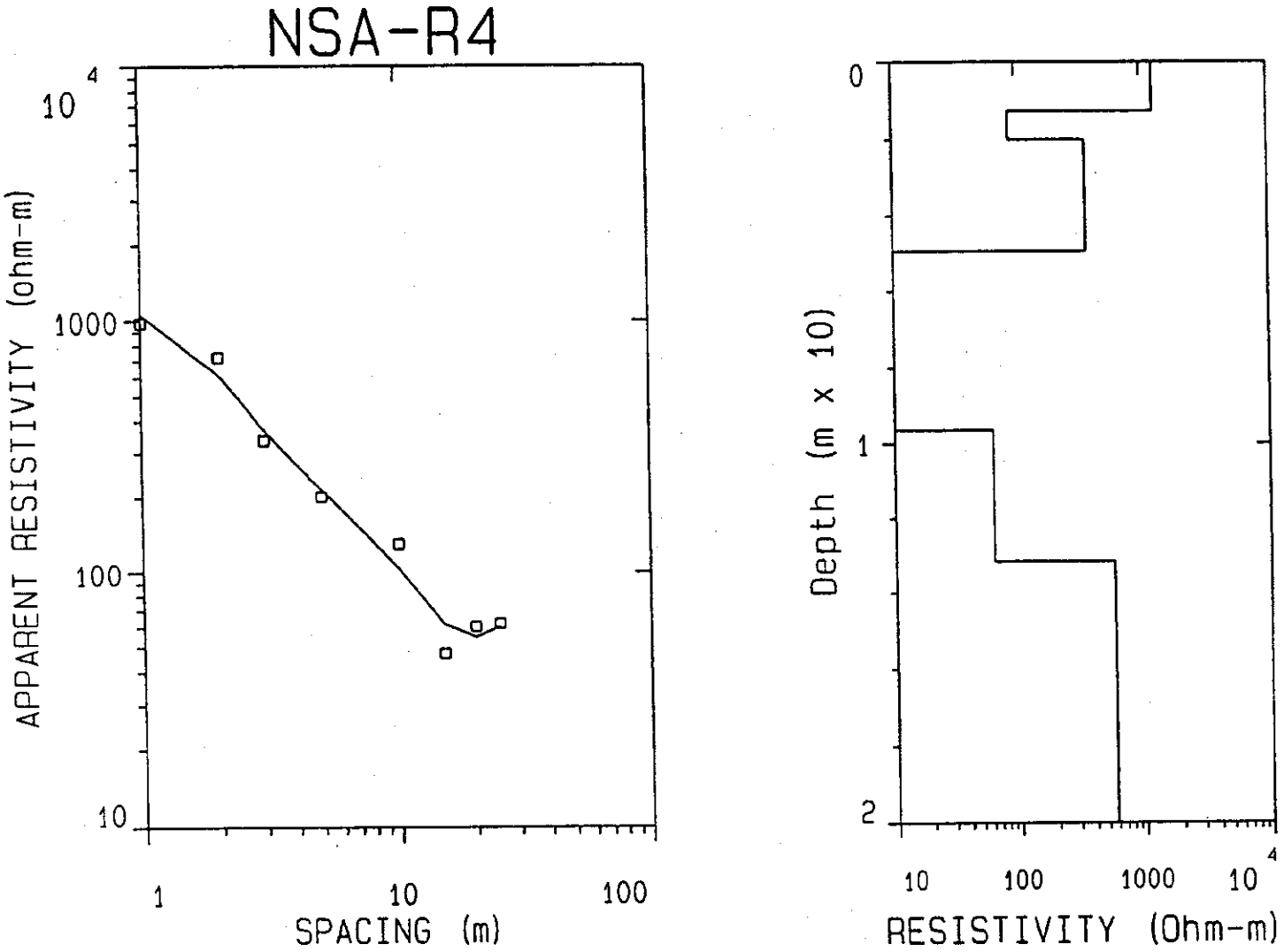
No.	SPACING (m)	RHO-A (ohm-m) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.00	979.5	1056.6	-7.86
2	2.00	722.9	616.5	14.71
3	3.00	336.9	369.8	-9.76
4	5.00	201.4	215.6	-7.02
5	10.00	129.7	103.3	20.34
6	15.00	47.23	61.61	-30.45
7	20.00	60.46	54.95	9.09
8	25.00	62.03	60.38	2.66

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.99				
P 2	-0.01	0.42			
P 3	0.00	0.15	0.61		
P 4	0.00	-0.01	0.00	0.48	
P 5	0.00	0.00	0.00	0.06	0.01

* OYO CORPORATION *

P 6	0.00	0.01	0.01	0.05	0.01	0.02						
T 1	0.01	0.05	-0.01	0.00	0.00	0.00	0.98					
T 2	0.01	-0.41	-0.14	0.02	0.00	-0.01	0.00	0.40				
T 3	-0.01	-0.16	0.42	0.02	0.00	-0.02	0.02	0.19	0.54			
T 4	0.00	-0.01	0.01	-0.49	-0.06	-0.05	0.00	0.01	0.01	0.50		
T 5	0.00	0.00	0.00	-0.06	-0.01	-0.01	0.00	0.00	0.00	0.06	0.(	
	P 1	P 2	P 3	P 4	P 5	P 6	T 1	T 2	T 3	T 4		


NSA-R4
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
10
100
SPACING (m)
Depth (m x 10)
0
1
2
10
100
1000
10 4
RESISTIVITY (Ohm-m)

DATA SET: NSA-R5

CLIENT: JICA
LOCATION: BAN NAM GNAO
COUNTY: BORKEAW, LAO. P.D.R.
PROJECT: WATER SUPPLY & SANITATION
ELEVATION: 0.00
SOUNDING COORDINATES: X: 0.0000 Y: 0.0000

DATE: NOV., 1999
SOUNDING: -
AZIMUTH: -
EQUIPMENT: -

Wenner Configuration

FITTING ERROR: 5.157 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	195.8	0.992	-0.992	0.00507	194.3
2	36.32	0.860	-1.85	0.0236	31.24
3	224.3	9.73	-11.58	0.0434	2184.6
4	2.79				

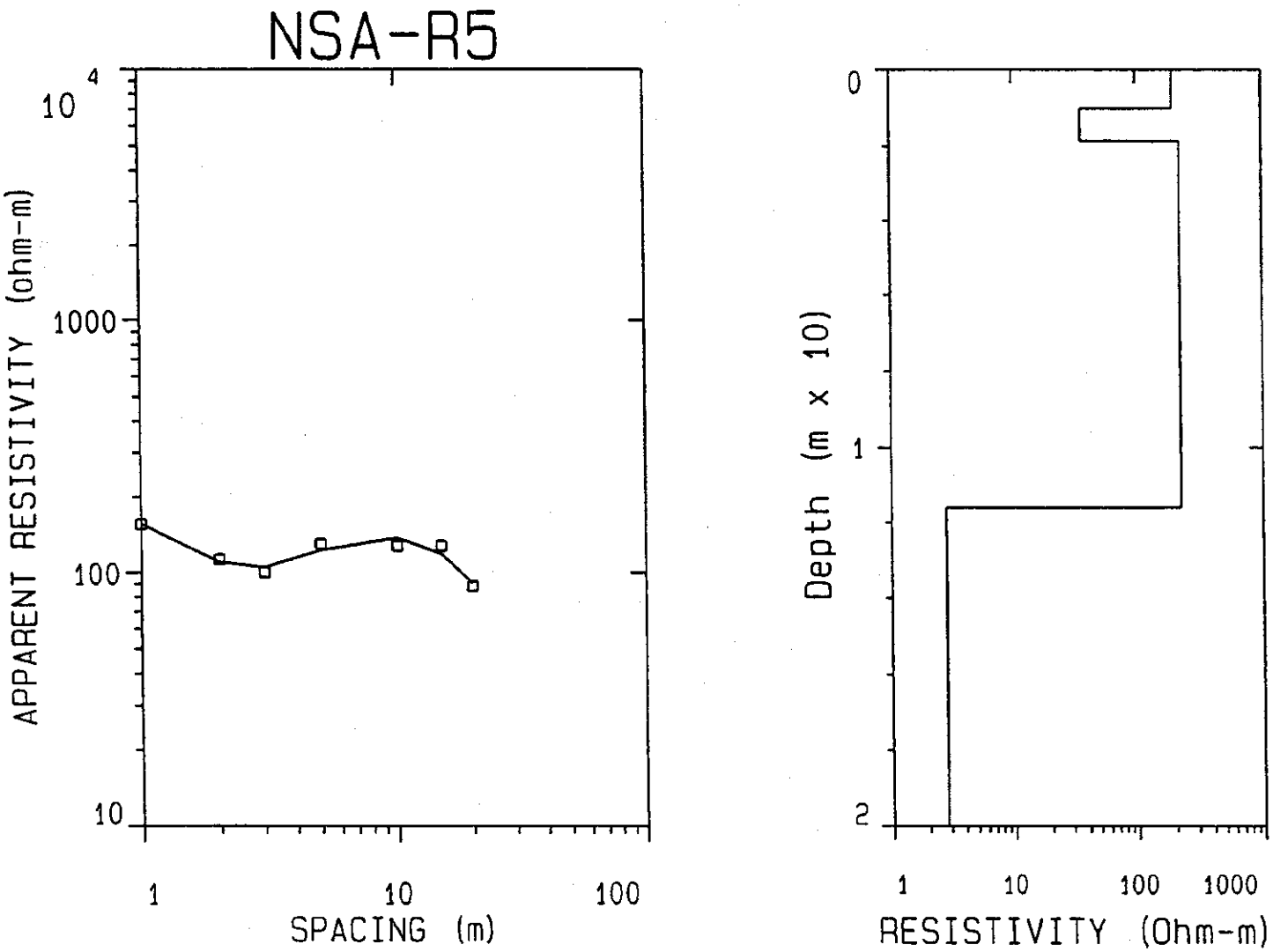
ALL PARAMETERS ARE FREE

No.	SPACING (m)	RHO-A (ohm-m) DATA	RHO-A (ohm-m) SYNTHETIC	DIFFERENCE (percent)
1	1.00	155.7	156.6	-0.554
2	2:00	112.8	110.2	2.29
3	3.00	100.4	105.0	-4.58
4	5.00	130.3	123.3	5.38
5	10.00	128.4	138.5	-7.81
6	15.00	128.4	119.1	7.22
7	20.00	88.67	91.19	-2.84

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00						
P 2	-0.01	0.54					
P 3	0.00	-0.02	0.99				
P 4	0.00	0.01	-0.02	0.03			
T 1	0.00	0.07	0.00	0.00	0.99		
T 2	-0.01	-0.49	-0.02	-0.01	0.08	0.48	
T 3	0.00	0.02	0.01	0.05	0.00	0.03	0.99
	P 1	P 2	P 3	P 4	T 1	T 2	T 3

* OYO CORPORATION *


NSA-R5
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
10
100
SPACING (m)
Depth (m x 10)
0
1
2
1
10
100
1000
RESISTIVITY (Ohm-m)

DATA SET: NSA-R6

CLIENT: JICA
LOCATION: BAN NAM GNAO
COUNTY: BORKEAW, LAO. P.D.R.
PROJECT: WATER SUPPLY & SANITATION
ELEVATION: 0.00
SOUNDING COORDINATES: X: 0.0000 Y: 0.0000

DATE: NOV., 1999
SOUNDING: -
AZIMUTH: -
EQUIPMENT: -

Wenner Configuration

FITTING ERROR: 10.632 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	7706.8	0.279	-0.279	3.622E-05	2151.2
2	22.09	0.288	-0.567	0.0130	6.36
3	282.7	0.351	-0.918	0.00124	99.30
4	2325.0	1.23	-2.15	5.324E-04	2878.1
5	69.80	1.12	-3.27	0.0160	78.18
6	0.285				

ALL PARAMETERS ARE FREE

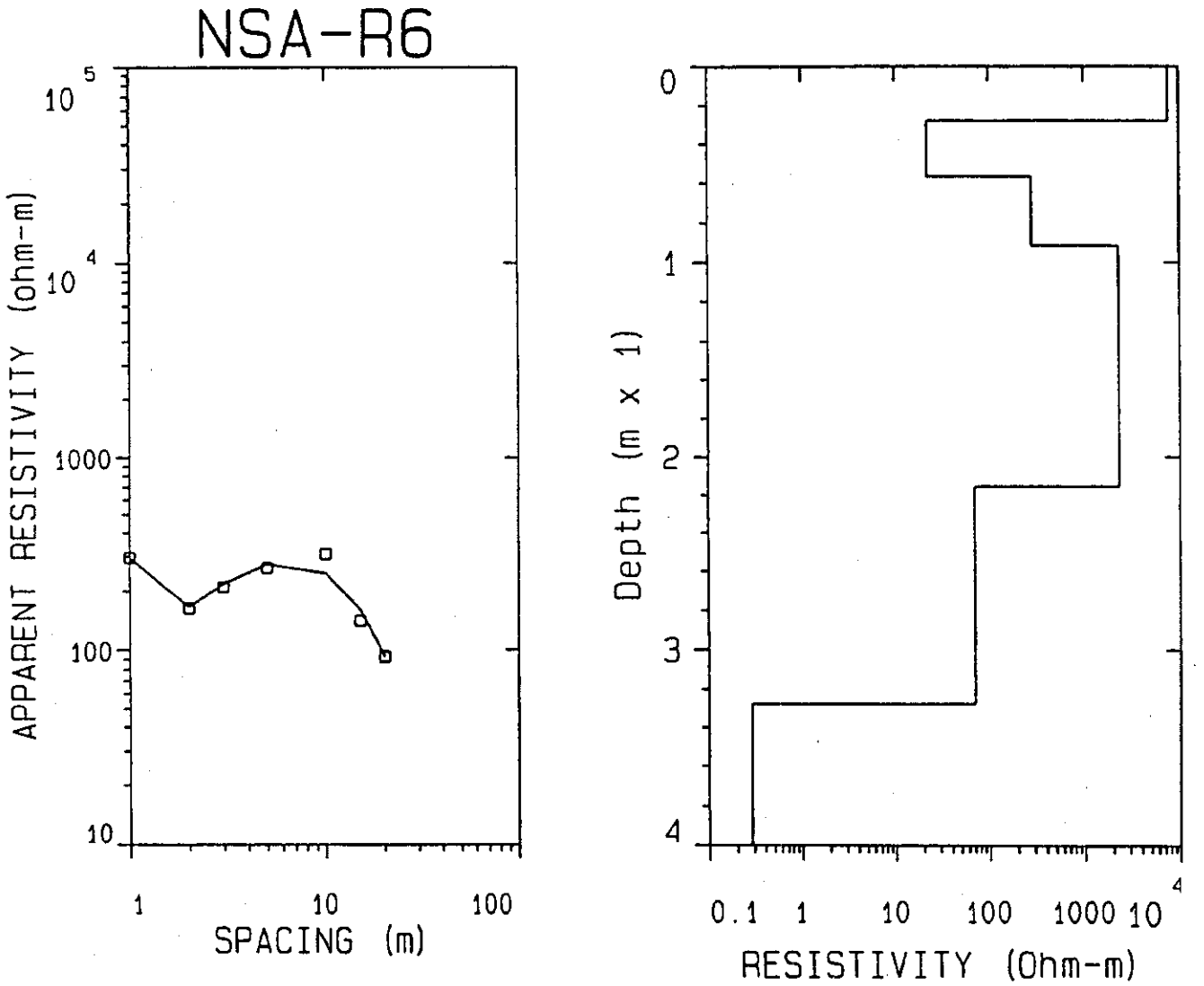
No.	SPACING (m)	RHO-A (ohm-m) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.00	296.4	296.3	0.0355
2	2.00	163.7	166.0	-1.40
3	3.00	210.0	218.6	-4.11
4	5.00	263.1	274.5	-4.31
5	10.00	309.8	247.3	20.16
6	15.00	140.9	160.6	-13.97
7	20.00	92.70	92.35	0.375

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.05					
P 2	0.00	0.49				
P 3	0.00	0.05	0.00			
P 4	0.00	0.00	0.02	0.50		
P 5	0.00	0.00	0.00	0.01	0.00	
P 6	0.00	0.00	0.00	0.00	0.00	0.00

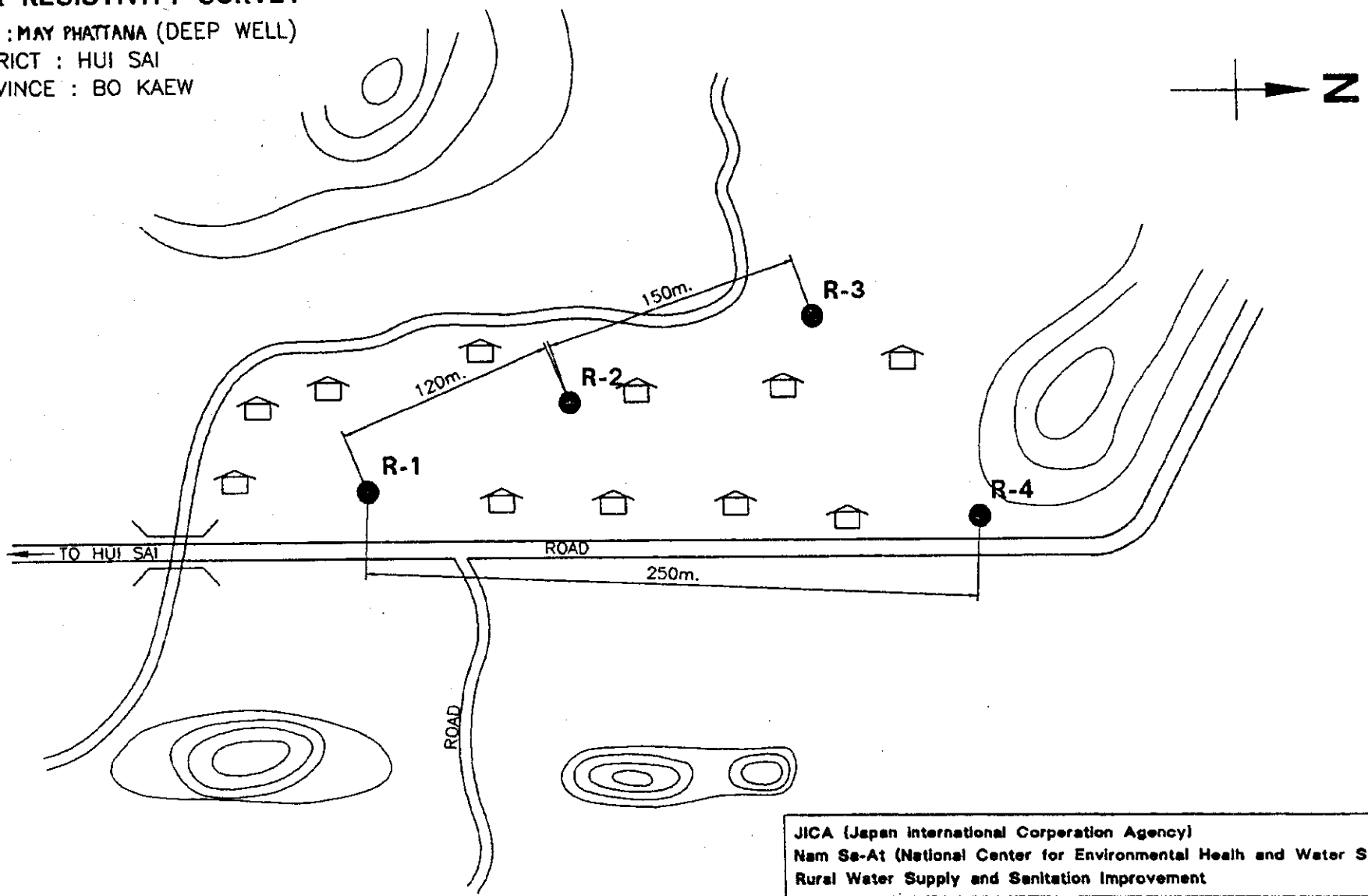
* OYO CORPORATION *

T 1	0.19	0.00	0.00	0.00	0.00	0.00	0.96				
T 2	0.00	-0.49	-0.05	-0.02	0.00	0.00	0.00	0.50			
T 3	0.00	-0.05	0.00	0.02	0.00	0.00	0.00	0.05	0.00		
T 4	0.00	-0.02	0.02	0.50	0.01	0.00	0.00	0.00	0.02	0.50	
T 5	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0
	P 1	P 2	P 3	P 4	P 5	P 6	T 1	T 2	T 3	T 4	


NSA-R6
APPARENT RESISTIVITY (ohm-m)
10^5
10^4
1000
100
10
1
10
100
SPACING (m)
Depth (m x 1)
0
1
2
3
4
0.1
1
10
100
1000
10^4
RESISTIVITY (Ohm-m)

SKETCH VILLAGE MAP
FOR RESISTIVITY SURVEY

BAN : MAY PHATTANA (DEEP WELL)
DISTRICT : HUI SAI
PROVINCE : BO KAEW



JICA (Japan International Corperation Agency)
Nam Se-At (National Center for Environmental Healh and Water Supply)
Rural Water Supply and Sanitation Improvement

PROJECT:
Phase II: Model Study-Groundwater Development

RESISTIVITY DATA

MISSION NO.	:	BPP-R2
LOCATION	:	BAN MAY NATTANA, HEOUXAY DISTRICT,
		BORKEAW PROVINCE, LAO P.D.R.
DATE OF SURVEY	:	23/11/1999
DATE OF REPORT	:	30/11/1999

HEAD OFFICE
5/15 MOO 6 (KM. 15)
BANGNA-TRAD ROAD
BANGPLEE, BANGCHALONG
SAMUTPRAKARN 10540
TEL. 3125281-300 FAX. (66-2) 3125304

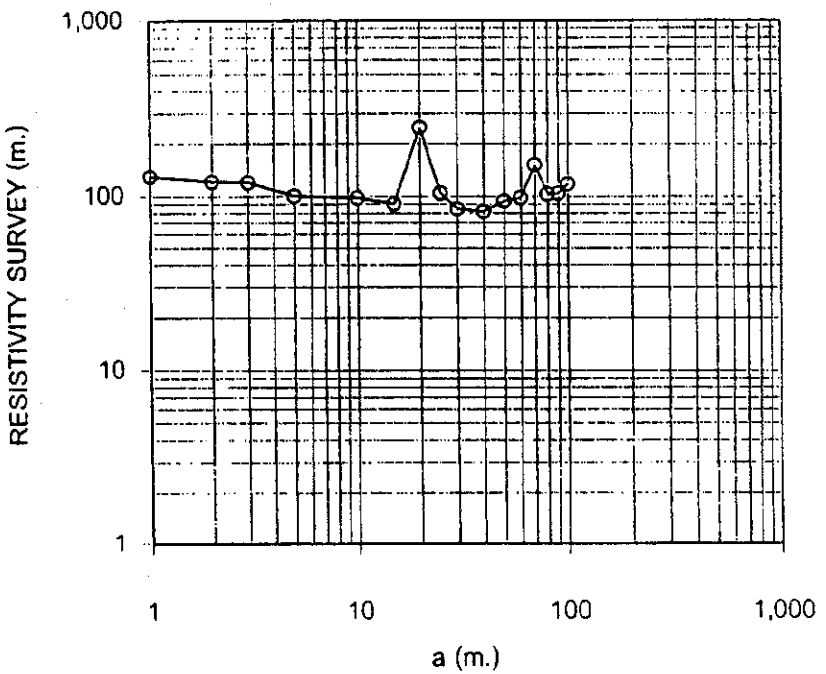
SIAM TONE CO.,LTD.
OYO-INSTRUMENTS
MODEL-2115

BANGPAKONG FACTORY
700/47 BANGPAKONG
INDUSTRIAL, PARK 2
CHONBURI 20000
TEL. (038) 213-073-7
FAX. (038) 213-078

WENNER CONFIGURATION

NO.	a(m.)	F (m.)	C (m.)	2πa (u)	mV	mA	RESISTANCE (ohm.)	RESISTIVITY (ohm.m.)
1	1	0.5	1.50	6.283	1,035.00	49.90	20.741	130.319
2	2	1.0	3.00	12.570	482.00	49.90	9.659	121.418
3	3	1.5	4.50	18.850	319.00	49.90	6.393	120.504
4	5	2.5	7.50	31.420	160.00	49.90	3.206	100.745
5	10	5.0	15.00	62.850	78.00	49.90	1.563	98.242
6	15	7.5	22.50	94.280	48.20	49.90	0.966	91.068
7	20	10.0	30.00	125.710	99.00	49.90	1.984	249.405
8	25	12.5	37.50	157.140	33.20	49.90	0.665	104.550
9	30	15.0	45.00	188.570	22.50	49.90	0.451	85.027
10	40	20.0	60.00	251.420	16.30	49.90	0.327	82.127
11	50	25.0	75.00	314.280	3.00	9.99	0.300	94.378
12	60	30.0	90.00	376.990	2.60	9.98	0.261	98.214
13	70	35.0	105.00	439.990	3.48	9.98	0.349	153.423
14	80	40.0	120.00	502.850	2.05	9.98	0.205	103.291
15	90	45.0	135.00	565.710	1.84	9.98	0.184	104.299
16	100	50.0	150.00	628.570	1.87	9.98	0.187	117.778
17								
18								
19								
20								

GEOPHYSICAL SURVEY



HEAD OFFICE
5/15 MOO 6 (KM. 15)
BANGNA-TRAD ROAD
BANGPLEE, BANGCHALONG
SAMUTPRAKARN 10540
TEL. 3125281-300 FAX. (66-2) 3125304

SIAM TONE CO.,LTD.
OYO-INSTRUMENTS
MODEL-2115

BANGPAKONG FACTORY
700/47 BANGPAKONG
INDUSTRIAL, PARK 2
CHONBURI 20000
TEL. (038) 213-073-7
FAX. (038) 213-078

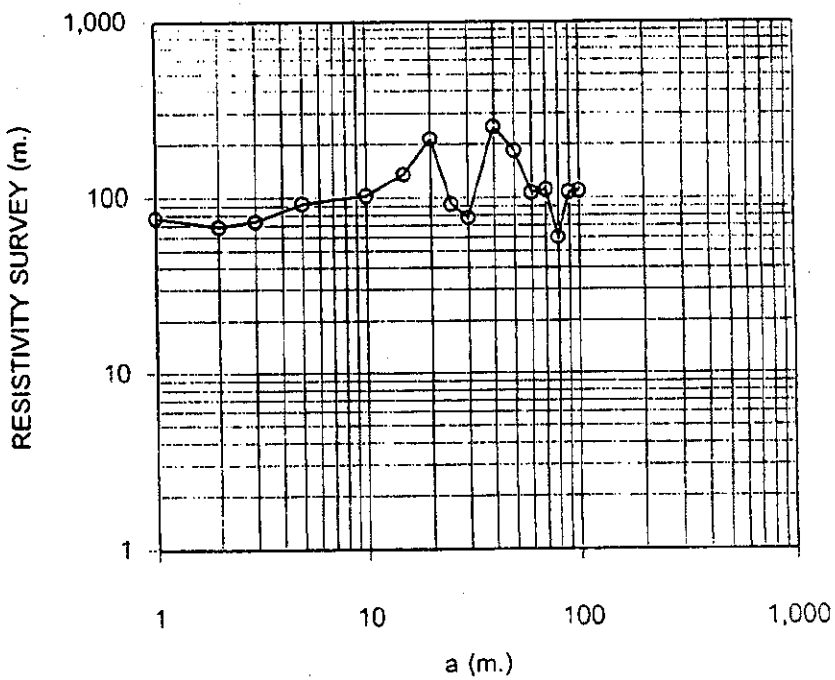
RESISTIVITY DATA

MISSION NO.	:	BPP-R1
LOCATION	:	BAN MAY PHOTHAMA, HEOUXAY DISTRICT,
		BORKEAW PROVINCE, LAO P.D.R.
DATE OF SURVEY	:	23/11/1999
DATE OF REPORT	:	30/11/1999

WENNER CONFIGURATION

NO.	a(m.)	F (m.)	C (m.)	2πa (u)	mV	mA	RESISTANCE (ohm.)	RESISTIVITY (ohm.m.)
1	1	0.5	1.50	6.283	614.00	50.00	12.280	77.155
2	2	1.0	3.00	12.570	274.00	50.00	5.480	68.884
3	3	1.5	4.50	18.850	197.00	50.00	3.940	74.269
4	5	2.5	7.50	31.420	148.00	50.00	2.960	93.003
5	10	5.0	15.00	62.850	81.80	50.00	1.636	102.823
6	15	7.5	22.50	94.280	13.80	9.59	1.439	135.669
7	20	10.0	30.00	125.710	17.10	10.00	1.710	214.964
8	25	12.5	37.50	157.140	5.91	10.00	0.591	92.870
9	30	15.0	45.00	188.570	4.13	10.00	0.413	77.879
10	40	20.0	60.00	251.420	10.00	10.00	1.000	251.420
11	50	25.0	75.00	314.280	5.85	10.00	0.585	183.854
12	60	30.0	90.00	376.990	2.83	10.00	0.283	106.688
13	70	35.0	105.00	439.990	2.53	10.00	0.253	111.317
14	80	40.0	120.00	502.850	1.20	9.99	0.120	60.402
15	90	45.0	135.00	565.710	1.90	9.99	0.190	107.592
16	100	50.0	150.00	628.570	1.74	9.99	0.174	109.481
17								
18								
19								
20								

GEOPHYSICAL SURVEY



RESISTIVITY DATA

MISSION NO.	:	BPP-R3
LOCATION	:	BAN [illegible], HEOUXAY DISTRICT,
		BORKEAW PROVINCE, LAO P.D.R.
DATE OF SURVEY	:	23/11/1999
DATE OF REPORT	:	30/11/1999

HEAD OFFICE
5/15 MOO 6 (KM. 15)
BANGNA-TRAD ROAD
BANGPLEE, BANGCHALONG
SAMUTPRAKARN 10540
TEL. 3125281-300 FAX. (66-2) 3125304

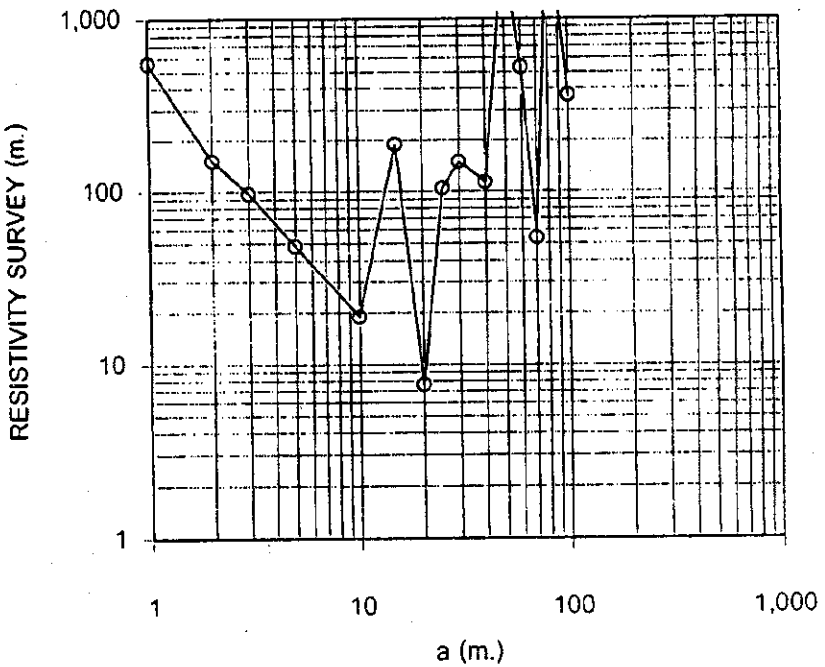
SIAM TONE CO.,LTD.
OYO-INSTRUMENTS
MODEL-2115

BANGPAKONG FACTORY
700/47 BANGPAKONG
INDUSTRIAL, PARK 2
CHONBURI 20000
TEL. (038) 213-073-7
FAX. (038) 213-078

WENNER CONFIGURATION

NO.	a(m.)	F (m.)	C (m.)	2πa (u)	mV	mA	RESISTANCE (ohm.)	RESISTIVITY (ohm.m.)
1	1	0.5	1.50	6.283	4,123.00	45.90	89.826	564.375
2	2	1.0	3.00	12.570	527.00	43.90	12.005	150.897
3	3	1.5	4.50	18.850	257.00	49.90	5.150	97.083
4	5	2.5	7.50	31.420	77.40	49.90	1.551	48.736
5	10	5.0	15.00	62.850	14.10	46.90	0.301	18.895
6	15	7.5	22.50	94.280	19.60	9.78	2.004	188.946
7	20	10.0	30.00	125.710	0.61	9.98	0.061	7.684
8	25	12.5	37.50	157.140	29.60	44.50	0.665	104.525
9	30	15.0	45.00	188.570	39.40	49.90	0.790	148.891
10	40	20.0	60.00	251.420	4.49	9.98	0.450	113.114
11	50	25.0	75.00	314.280	171.00	19.90	8.593	2700.597
12	60	30.0	90.00	376.990	70.90	49.90	1.421	535.643
13	70	35.0	105.00	439.990	5.90	47.90	0.123	54.195
14	80	40.0	120.00	502.850	57.60	9.98	5.772	2902.220
15	90	45.0	135.00	565.710	23.00	9.98	2.305	1303.740
16	100	50.0	150.00	628.570	5.42	9.24	0.587	368.707
17								
18								
19								
20								

GEOPHYSICAL SURVEY



RESISTIVITY DATA

MISSION NO.	:	BPP-R4
LOCATION	:	BAN [illegible], HEOUXAY DISTRICT,
		BORKEAW PROVINCE, LAO P.D.R.
DATE OF SURVEY	:	23/11/1999
DATE OF REPORT	:	30/11/1999

HEAD OFFICE
5/15 MOO 6 (KM. 15)
BANGNA-TRAD ROAD
BANGPLEE, BANGCHALONG
SAMUTPRAKARN 10540
TEL. 3125281-300 FAX. (66-2) 3125304

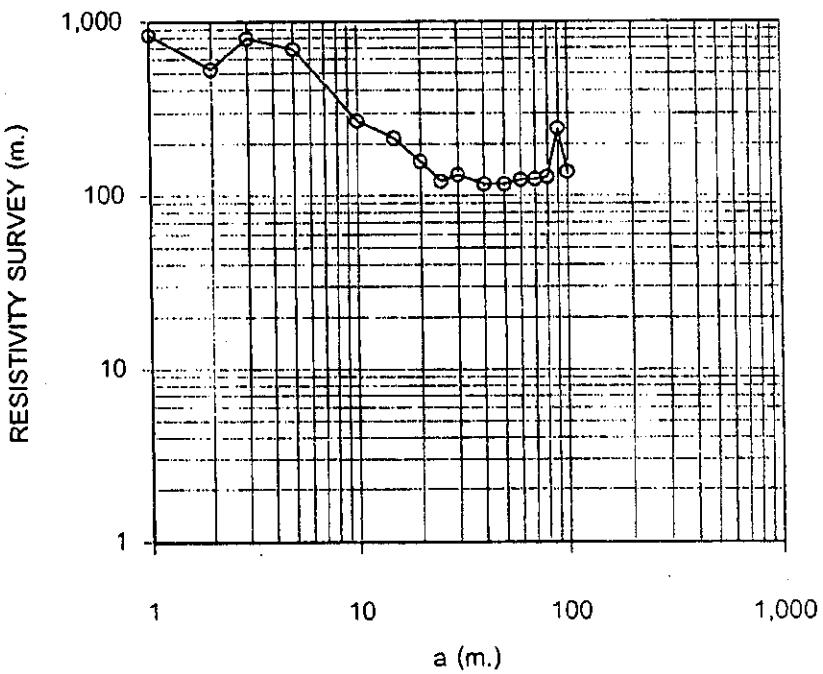
SIAM TONE CO.,LTD.
OYO-INSTRUMENTS
MODEL-2115

BANGPAKONG FACTORY
700/47 BANGPAKONG
INDUSTRIAL, PARK 2
CHONBURI 20000
TEL. (038) 213-073-7
FAX. (038) 213-078

WENNER CONFIGURATION

NO.	a(m.)	F (m.)	C (m.)	2πa (u)	mV	mA	RESISTANCE (ohm.)	RESISTIVITY (ohm.m.)
1	1	0.5	1.50	6.283	2,639.00	19.90	132.613	833.208
2	2	1.0	3.00	12.570	833.00	19.90	41.859	526.171
3	3	1.5	4.50	18.850	839.00	19.90	42.161	794.731
4	5	2.5	7.50	31.420	437.00	19.90	21.960	689.977
5	10	5.0	15.00	62.850	85.80	19.90	4.312	270.981
6	15	7.5	22.50	94.280	45.50	19.90	2.286	215.565
7	20	10.0	30.00	125.710	25.10	19.90	1.261	158.559
8	25	12.5	37.50	157.140	15.30	19.90	0.769	120.816
9	30	15.0	45.00	188.570	13.90	19.90	0.698	131.715
10	40	20.0	60.00	251.420	9.22	19.90	0.463	116.487
11	50	25.0	75.00	314.280	7.38	19.90	0.371	116.552
12	60	30.0	90.00	376.990	6.53	19.90	0.328	123.706
13	70	35.0	105.00	439.990	5.63	19.90	0.283	124.480
14	80	40.0	120.00	502.850	5.08	19.90	0.255	128.366
15	90	45.0	135.00	565.710	8.64	19.90	0.434	245.615
16	100	50.0	150.00	628.570	4.36	19.90	0.219	137.717
17								
18								
19								
20								

GEOPHYSICAL SURVEY



DATA SET: BPP-R1

CLIENT: JICA DATE: NOV., 1999
LOCATION: BAN MAY PHITTANA, HEOUXAY SOUNDING: -
COUNTY: BORKEE, LAO P.D.R. AZIMUTH: -
PROJECT: WATER SUPPLY & SANITATION EQUIPMENT: -
ELEVATION: 0.00
SOUNDING COORDINATES: X: 0.0000 Y: 0.0000

Wenner Configuration

FITTING ERROR: 31.600 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	70.67	3.45	-3.45	0.0489	244.4
2	144.9	8.70	-12.16	0.0600	1261.3
3	161.3	20.87	-33.03	0.129	3368.1
4	70.29	30.25	-63.29	0.430	2126.9
5	70.51	30.07	-93.36	0.426	2120.8
6	94.25				

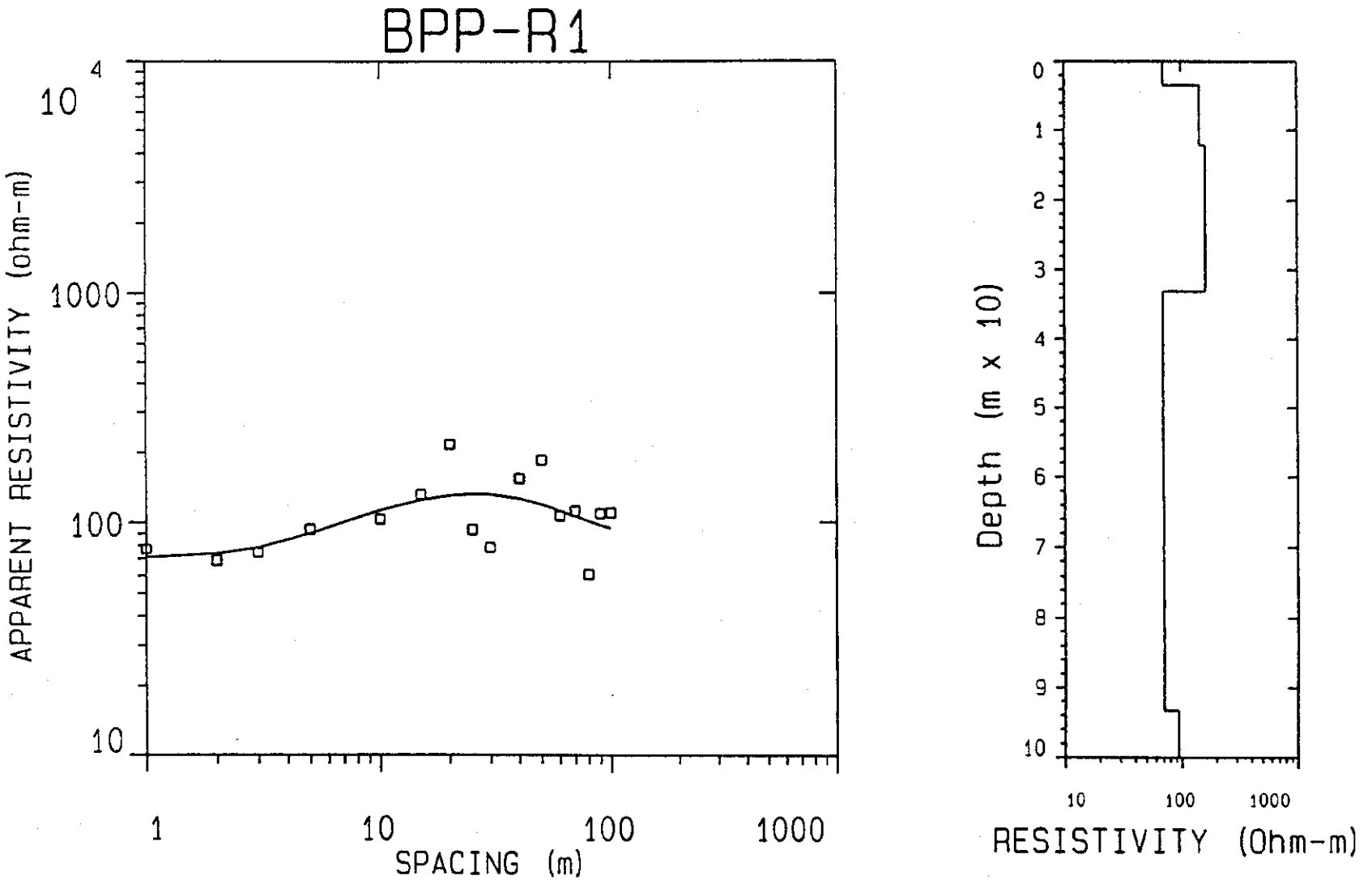
ALL PARAMETERS ARE FREE

No.	SPACING (m)	RHO-A (ohm-m) DATA	RHO-A (ohm-m) SYNTHETIC	DIFFERENCE (percent)
1	1.00	77.15	71.09	7.85
2	2.00	68.85	73.50	-6.74
3	3.00	74.36	78.02	-4.92
4	5.00	93.19	89.58	3.87
5	10.00	102.8	112.2	-9.20
6	15.00	130.4	124.0	4.91
7	20.00	215.2	129.6	39.76
8	25.00	92.87	131.4	-41.53
9	30.00	77.87	130.8	-68.02
10	40.00	153.3	125.7	17.99
11	50.00	183.8	118.6	35.44
12	60.00	106.3	111.7	-5.08
13	70.00	111.3	105.6	5.07
14	80.00	60.34	100.7	-67.00
15	90.00	108.6	96.98	10.71
16	100.0	109.3	94.13	13.92

* OYO CORPORATION *

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.93										
P 2	0.02	0.61									
P 3	-0.01	0.21	0.60								
P 4	0.01	-0.05	0.19	0.31							
P 5	0.00	-0.03	0.03	0.16	0.10						
P 6	0.00	-0.03	0.01	0.17	0.12	0.14					
T 1	-0.08	-0.28	0.05	0.03	0.01	0.00	0.28				
T 2	0.00	-0.05	0.06	0.09	0.04	0.03	0.02	0.03			
T 3	0.00	-0.02	0.25	0.21	0.08	0.07	0.04	0.07	0.18		
T 4	0.00	0.01	0.00	-0.03	-0.02	-0.02	0.00	-0.01	-0.01	0.00	
T 5	0.00	0.01	0.00	-0.03	-0.02	-0.02	0.00	-0.01	-0.01	0.00	0.0
	P 1	P 2	P 3	P 4	P 5	P 6	T 1	T 2	T 3	T 4	T


BPP-R1
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
10
100
1000
SPACING (m)
Depth (m x 10)
0
1
2
3
4
5
6
7
8
9
10
10
100
1000
RESISTIVITY (Ohm-m)

DATA SET: BPP-R2

CLIENT: JICA
LOCATION: BAN MAY PHATTANA, HEOUXAY
COUNTY: BORKEO, LAO P.D.R.
PROJECT: WATER SUPPLY & SANITATION
ELEVATION: 0.00
SOUNDING COORDINATES: X: 0.0000 Y: 0.0000

DATE: NOV., 1999
SOUNDING: -
AZIMUTH: -
EQUIPMENT: -

Wenner Configuration

FITTING ERROR: 26.974 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	136.3	1.99	-1.99	0.0146	272.6
2	74.16	4.31	-6.31	0.0582	320.3
3	255.6	8.36	-14.68	0.0327	2138.2
4	28.59	15.71	-30.39	0.549	449.3
5	370.5	27.59	-57.99	0.0744	10227.2
6	162.3				

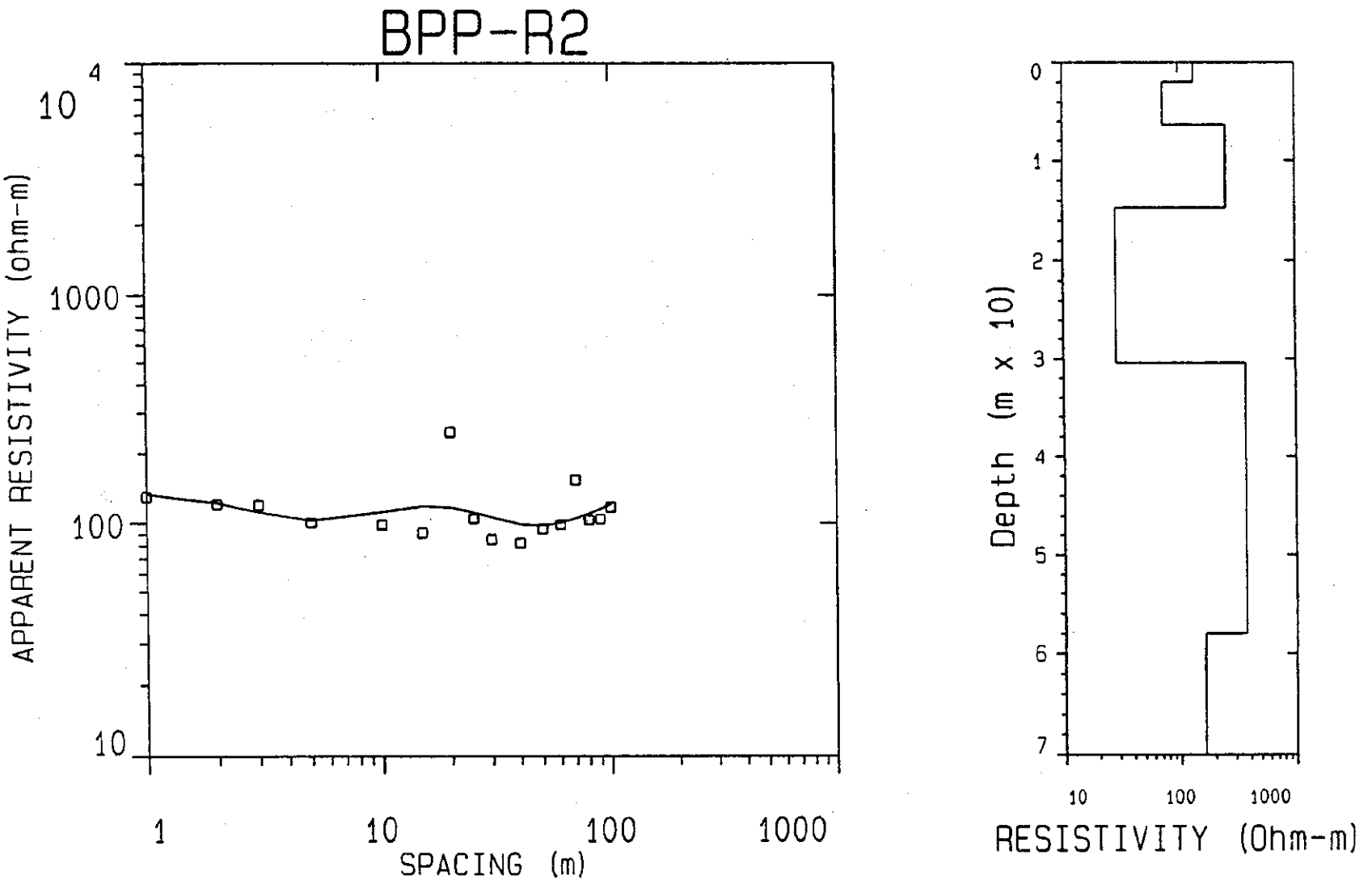
ALL PARAMETERS ARE FREE

No.	SPACING (m)	RHO-A (ohm-m) DATA	RHO-A (ohm-m) SYNTHETIC	DIFFERENCE (percent)
1	1.00	130.3	133.5	-2.47
2	2.00	121.4	123.1	-1.46
3	3.00	120.5	112.3	6.79
4	5.00	100.7	102.6	-1.91
5	10.00	98.24	112.5	-14.59
6	15.00	91.06	119.6	-31.36
7	20.00	249.4	117.8	52.76
8	25.00	104.5	112.2	-7.33
9	30.00	85.02	106.3	-25.05
10	40.00	82.12	98.70	-20.18
11	50.00	94.37	97.35	-3.15
12	60.00	98.21	100.1	-1.96
13	70.00	153.4	104.9	31.58
14	80.00	103.2	110.4	-6.96
15	90.00	104.2	115.9	-11.20
16	100.0	117.7	121.1	-2.84

* OYO CORPORATION *

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.99										
P 2	-0.01	0.83									
P 3	0.00	0.04	0.60								
P 4	0.00	0.01	0.04	0.50							
P 5	0.00	-0.01	0.01	0.07	0.15						
P 6	0.00	-0.02	0.02	-0.01	0.26	0.54					
T 1	0.02	0.18	-0.06	0.01	0.00	0.01	0.75				
T 2	-0.01	-0.26	-0.10	0.04	-0.04	-0.04	0.26	0.52			
T 3	0.00	-0.02	0.45	0.05	-0.05	-0.05	0.03	0.14	0.46		
T 4	0.00	0.00	0.02	-0.47	-0.10	-0.03	0.00	0.01	0.04	0.47	
T 5	0.00	-0.01	0.01	0.02	0.10	0.19	0.00	-0.02	-0.03	-0.04	0.(
	P 1	P 2	P 3	P 4	P 5	P 6	T 1	T 2	T 3	T 4	T


BPP-R2
APPARENT RESISTIVITY (ohm-m)
10^4
1000
100
10
1
10
100
1000
SPACING (m)
Depth (m x 10)
0
1
2
3
4
5
6
7
10
100
1000
RESISTIVITY (Ohm-m)

DATA SET: BPP-R3

CLIENT: JICA
LOCATION: BAN MAY PHATTANA, HEOUXAY
COUNTY: BORKEO, LAO P.D.R.
PROJECT: WATER SUPPLY & SANITATION
ELEVATION: 0.00
SOUNDING COORDINATES: X: 0.0000 Y: 0.0000

DATE: NOV., 1999
SOUNDING: -
AZIMUTH: -
EQUIPMENT: -

Wenner Configuration

FITTING ERROR: 236.576 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	640.3	1.07	-1.07	0.00168	687.3
2	29.33	7.37	-8.44	0.251	216.3
3	243.8	2.29	-10.74	0.00943	560.4
4	17951.5	8.10	-18.85	4.514E-04	145479.3
5	1.309E+06	185.2	-204.0	1.414E-04	2.425E+08
6	2114.3				

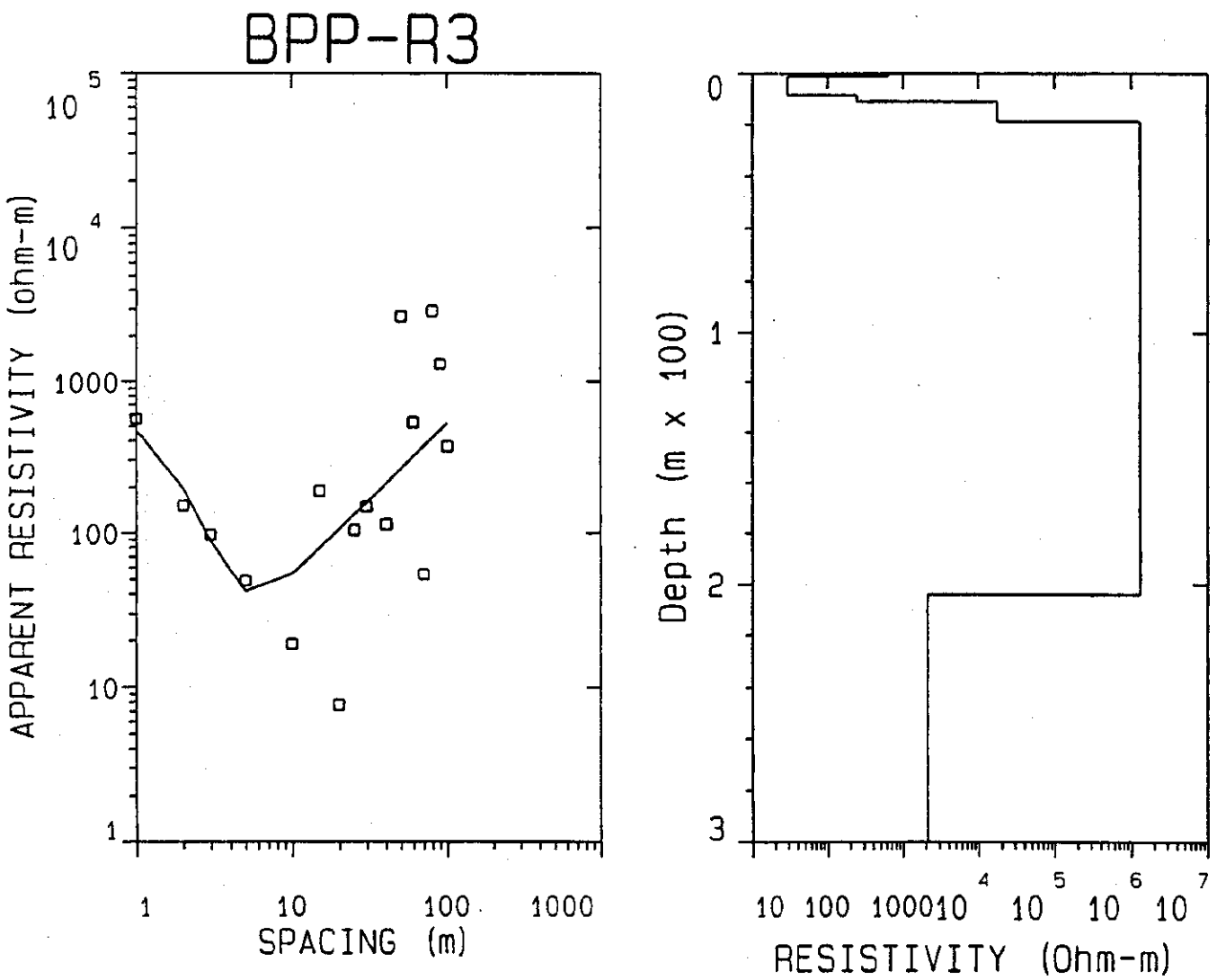
ALL PARAMETERS ARE FREE

No.	SPACING (m)	RHO-A (ohm-m) DATA	RHO-A (ohm-m) SYNTHETIC	DIFFERENCE (percent)
1	1.00	564.3	471.0	16.53
2	2.00	150.8	195.3	-29.47
3	3.00	97.08	88.06	9.29
4	5.00	48.73	41.35	15.13
5	10.00	18.89	54.69	-189.4
6	15.00	188.9	79.39	57.97
7	20.00	7.68	105.4	-1272.6
8	25.00	104.5	131.7	-26.07
9	30.00	148.8	158.1	-6.19
10	40.00	113.1	210.7	-86.35
11	50.00	2700.5	263.5	90.24
12	60.00	535.6	316.1	40.97
13	70.00	54.19	368.8	-580.5
14	80.00	2902.2	421.5	85.47
15	90.00	1303.7	474.1	63.63
16	100.0	368.7	526.7	-42.86

* OYO CORPORATION *

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00										
P 2	0.00	1.00									
P 3	0.00	0.00	0.00								
P 4	0.00	0.00	0.00	0.00							
P 5	0.00	0.00	0.00	0.00	0.00						
P 6	0.00	0.00	0.00	0.00	0.00	0.00					
T 1	0.00	0.00	0.00	0.00	0.00	0.00	1.00				
T 2	0.00	0.00	-0.03	0.00	0.00	0.00	0.00	1.00			
T 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00		
T 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
T 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	P 1	P 2	P 3	P 4	P 5	P 6	T 1	T 2	T 3	T 4	T


BPP-R3
APPARENT RESISTIVITY (ohm-m)
10^5
10^4
1000
100
10
1
1
10
100
1000
SPACING (m)
Depth (m x 100)
0
1
2
3
10 100 1000
10^4
10^5
10^6
10^7
RESISTIVITY (Ohm-m)

DATA SET: BPP-R4

CLIENT: JICA
LOCATION: BAN MAY PHATTANA, HEOUXAY
COUNTY: BORKEO, LAO P.D.R.
PROJECT: WATER SUPPLY & SANITATION
ELEVATION: 0.00
SOUNDING COORDINATES: X: 0.0000 Y: 0.0000

DATE: NOV., 1999
SOUNDING: -
AZIMUTH: -
EQUIPMENT: -

Wenner Configuration

FITTING ERROR: 18.862 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	721.3	1.10	-1.10	0.00153	795.6
2	792.7	3.52	-4.62	0.00445	2793.3
3	158.2	15.75	-20.38	0.0995	2494.6
4	55.57	25.89	-46.27	0.465	1438.9
5	476.7	37.87	-84.15	0.0794	18056.8
6	416.4				

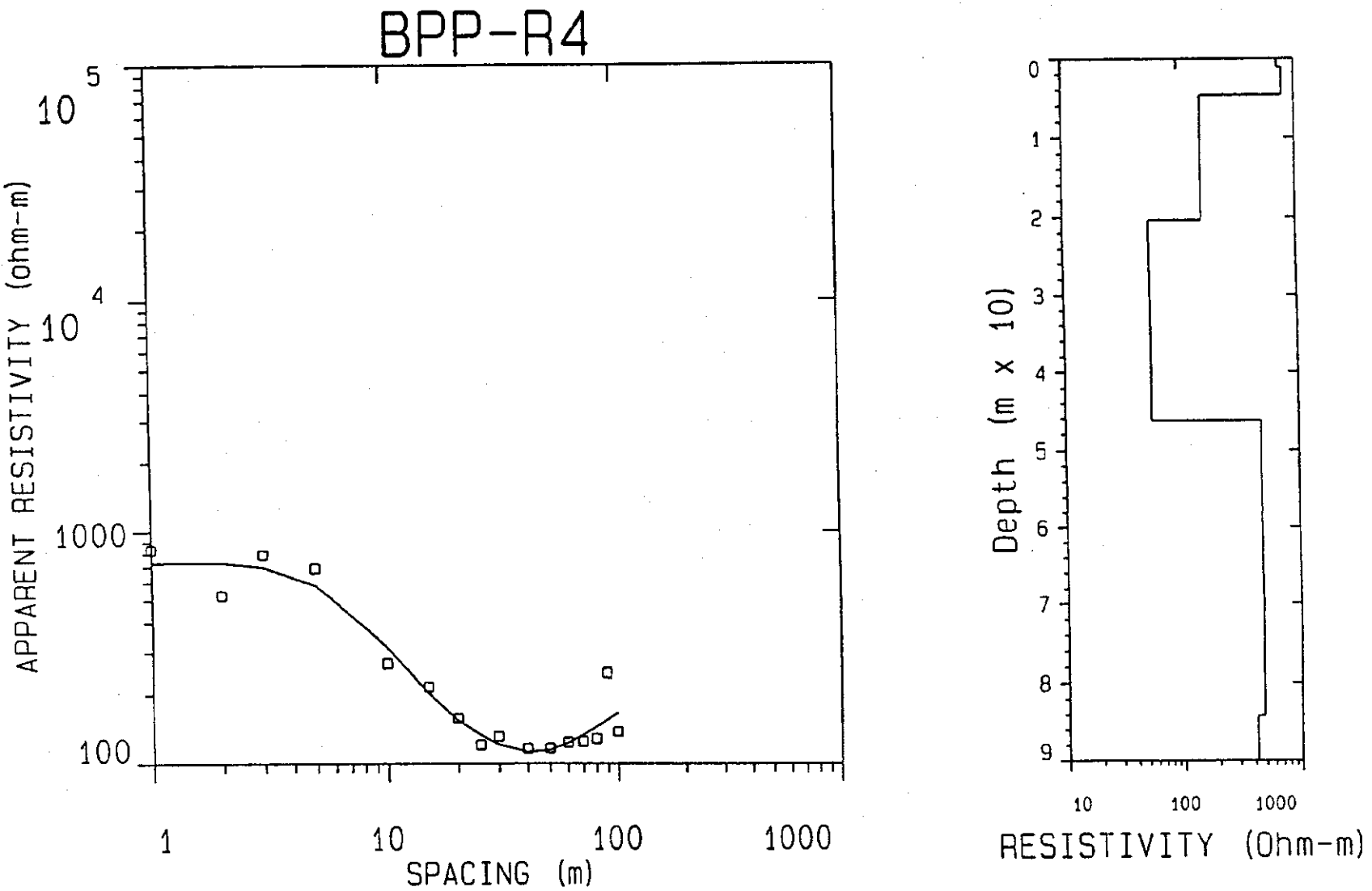
ALL PARAMETERS ARE FREE

No.	SPACING (m)	RHO-A (ohm-m) DATA	RHO-A (ohm-m) SYNTHETIC	DIFFERENCE (percent)
1	1.00	833.2	728.3	12.58
2	2.00	526.1	729.4	-38.63
3	3.00	794.7	700.3	11.87
4	5.00	689.9	583.9	15.36
5	10.00	270.9	316.8	-16.92
6	15.00	215.5	202.1	6.22
7	20.00	158.5	155.7	1.76
8	25.00	120.8	133.3	-10.39
9	30.00	131.7	121.2	7.97
10	40.00	116.4	112.4	3.49
11	50.00	116.5	115.0	1.33
12	60.00	123.7	123.1	0.464
13	70.00	124.4	133.6	-7.35
14	80.00	128.3	144.9	-12.88
15	90.00	245.6	156.1	36.42
16	100.0	137.7	167.0	-21.27

* OYO CORPORATION *

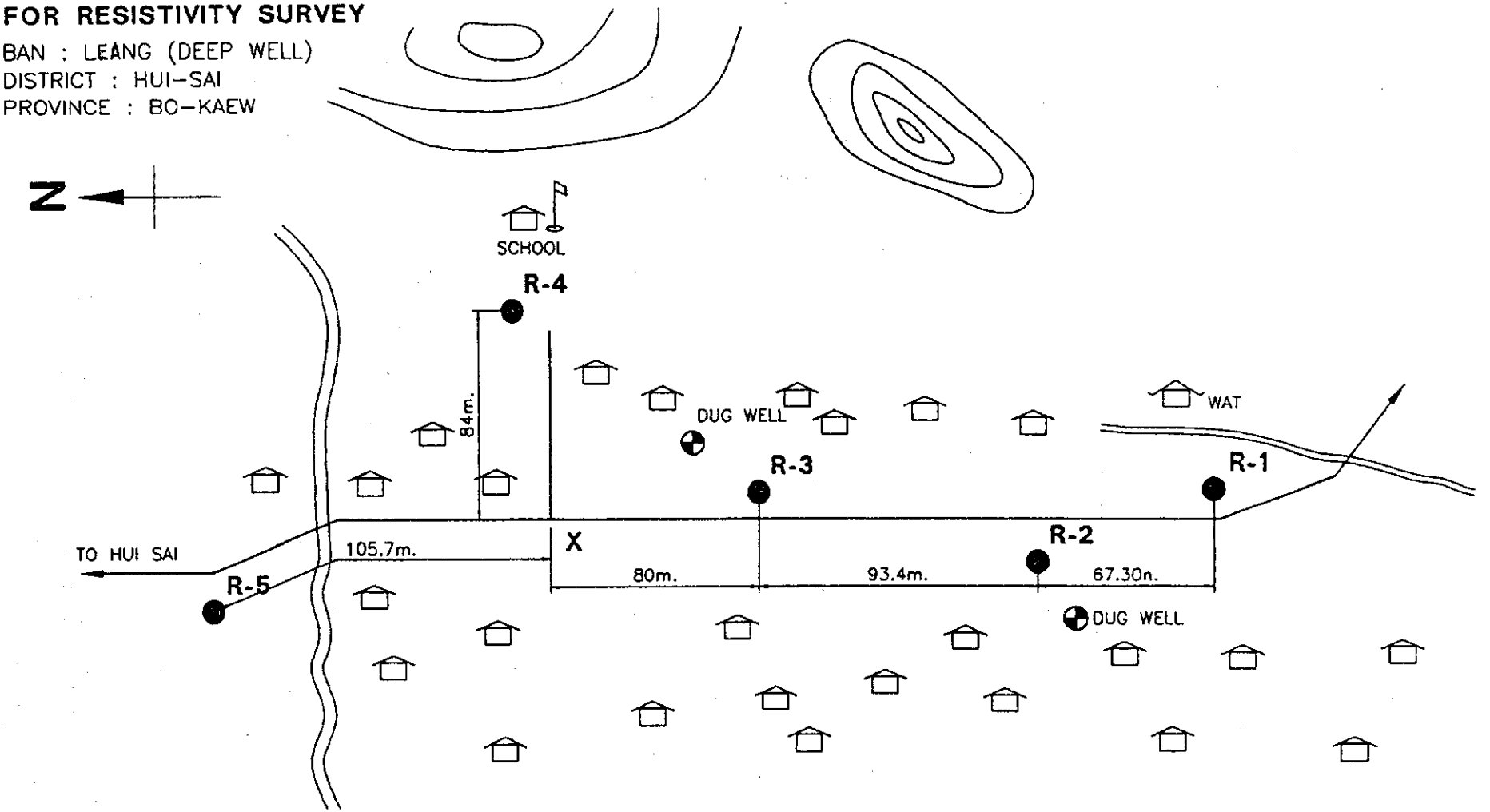
PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.99										
P 2	0.01	0.99									
P 3	0.01	-0.01	0.93								
P 4	0.00	0.01	0.02	0.72							
P 5	0.00	0.00	0.03	0.04	0.12						
P 6	0.00	0.01	0.06	-0.07	0.18	0.37					
T 1	-0.01	0.00	-0.02	0.01	0.00	0.00	0.07				
T 2	-0.01	0.02	0.05	-0.02	-0.01	-0.03	0.23	0.90			
T 3	-0.01	0.02	0.12	0.17	-0.14	-0.15	0.00	-0.07	0.56		
T 4	0.00	0.00	0.00	-0.36	-0.16	-0.13	0.00	0.00	0.25	0.42	
T 5	0.00	0.00	0.01	0.00	0.03	0.05	0.00	0.00	-0.03	-0.02	0.
	P 1	P 2	P 3	P 4	P 5	P 6	T 1	T 2	T 3	T 4	


BPP-R4
APPARENT RESISTIVITY (ohm-m)
10^5
10^4
1000
100
1
10
100
1000
SPACING (m)
Depth (m x 10)
0
1
2
3
4
5
6
7
8
9
10
100
1000
RESISTIVITY (Ohm-m)

SKETCH VILLAGE MAP FOR RESISTIVITY SURVEY

BAN : LEANG (DEEP WELL)
DISTRICT : HUI-SAI
PROVINCE : BO-KAEW



JICA (Japan International Corperation Agency)
Nam Sa-At (National Center for Environmental Healh and Water Supply)
Rural Water Supply and Sanitation Improvement

PROJECT:
Phase II: Model Study-Groundwater Development

RESISTIVITY DATA

MISSION NO. : BL-R1
LOCATION : BAN LEANG, HEOUXAY DISTRICT,
BORKEAW PROVINCE, LAO P.D.R.
DATE OF SURVEY : 23/11/1999
DATE OF REPORT : 30/11/1999

HEAD OFFICE
5/15 MOO 6 (KM. 15)
BANGNA-TRAD ROAD
BANGPLEE, BANGCHALONG
SAMUTPRAKARN 10540
TEL. 3125281-300 FAX. (66-2) 3125304

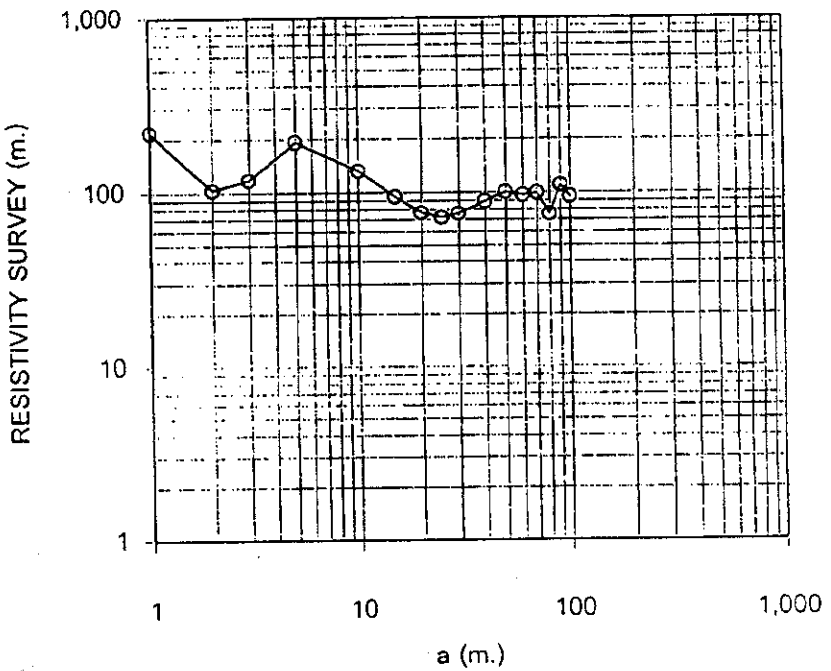
SIAM TONE CO.,LTD.
OYO-INSTRUMENTS
MODEL-2115

BANGPAKONG FACTORY
700/47 BANGPAKONG
INDUSTRIAL, PARK 2
CHONBURI 20000
TEL. (038) 213-073-7
FAX. (038) 213-078

WENNER CONFIGURATION

NO.	a(m.)	F (m.)	C (m.)	2πa (u)	mV	mA	RESISTANCE (ohm.)	RESISTIVITY (ohm.m.)
1	1	0.5	1.50	6.283	1,737.00	50.00	34.740	218.271
2	2	1.0	3.00	12.570	412.00	49.90	8.257	103.784
3	3	1.5	4.50	18.850	314.00	49.90	6.293	118.615
4	5	2.5	7.50	31.420	308.00	49.90	6.172	193.935
5	10	5.0	15.00	62.850	106.00	49.90	2.124	133.509
6	15	7.5	22.50	94.280	50.40	49.90	1.010	95.225
7	20	10.0	30.00	125.710	30.60	49.90	0.613	77.089
8	25	12.5	37.50	157.140	22.90	49.90	0.459	72.114
9	30	15.0	45.00	188.570	20.20	49.90	0.405	76.335
10	40	20.0	60.00	251.420	17.80	49.90	0.357	89.685
11	50	25.0	75.00	314.280	16.00	49.90	0.321	100.771
12	60	30.0	90.00	376.990	12.80	49.90	0.257	96.703
13	70	35.0	105.00	439.990	11.30	49.90	0.226	99.637
14	80	40.0	120.00	502.850	7.50	49.90	0.150	75.579
15	90	45.0	135.00	565.710	9.74	49.90	0.195	110.421
16	100	50.0	150.00	628.570	7.55	49.90	0.151	95.104
17								
18								
19								
20								

GEOPHYSICAL SURVEY



RESISTIVITY DATA

MISSION NO.	:	BL-R2
LOCATION	:	BAN LEANG, HEOUXAY DISTRICT,
		BORKEAW PROVINCE, LAO P.D.R.
DATE OF SURVEY	:	23/11/1999
DATE OF REPORT	:	30/11/1999

HEAD OFFICE
5/15 MOO 6 (KM. 15)
BANGNA-TRAD ROAD
BANGPLEE, BANGCHALONG
SAMUTPRAKARN 10540
TEL. 3125281-300 FAX. (66-2) 3125304

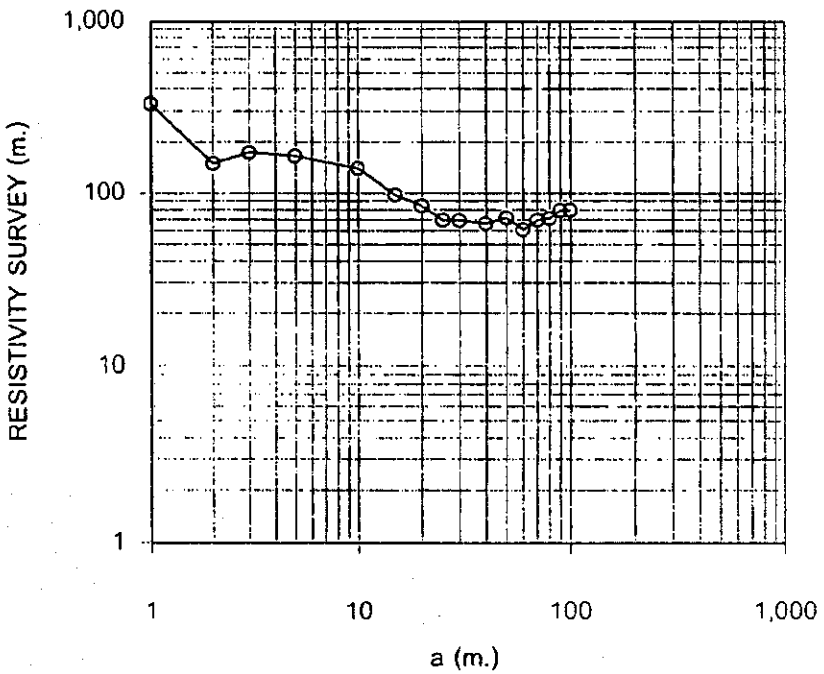
SIAM TONE CO.,LTD.
STC
OYO-INSTRUMENTS
MODEL-2115

BANGPAKONG FACTORY
700/47 BANGPAKONG
INDUSTRIAL, PARK 2
CHONBURI 20000
TEL. (038) 213-073-7
FAX. (038) 213-078

WENNER CONFIGURATION

NO.	a(m.)	F (m.)	C (m.)	2πa (u)	mV	mA	RESISTANCE (ohm.)	RESISTIVITY (ohm.m.)
1	1	0.5	1.50	6.283	2,627.00	49.90	52.645	330.770
2	2	1.0	3.00	12.570	595.00	49.90	11.924	149.883
3	3	1.5	4.50	18.850	459.00	49.90	9.198	173.390
4	5	2.5	7.50	31.420	263.00	49.90	5.271	165.600
5	10	5.0	15.00	62.850	111.00	49.90	2.224	139.807
6	15	7.5	22.50	94.280	52.00	49.90	1.042	98.248
7	20	10.0	30.00	125.710	33.60	49.90	0.673	84.646
8	25	12.5	37.50	157.140	22.10	49.90	0.443	69.595
9	30	15.0	45.00	188.570	18.30	49.90	0.367	69.155
10	40	20.0	60.00	251.420	13.20	49.90	0.265	66.508
11	50	25.0	75.00	314.280	11.40	49.90	0.228	71.799
12	60	30.0	90.00	376.990	8.09	49.90	0.162	61.119
13	70	35.0	105.00	439.990	7.90	49.90	0.158	69.658
14	80	40.0	120.00	502.850	5.68	40.00	0.142	71.405
15	90	45.0	135.00	565.710	7.00	49.90	0.140	79.358
16	100	50.0	150.00	628.570	6.32	49.90	0.127	79.610
17								
18								
19								
20								

GEOPHYSICAL SURVEY



RESISTIVITY DATA

MISSION NO.	:	BL-R3
LOCATION	:	BAN LEANG, HEOUXAY DISTRICT,
		BORKEAW PROVINCE, LAO P.D.R.
DATE OF SURVEY	:	23/11/1999
DATE OF REPORT	:	30/11/1999

HEAD OFFICE
5/15 MOO 6 (KM. 15)
BANGNA-TRAD ROAD
BANGPLEE, BANGCHALONG
SAMUTPRAKARN 10540
TEL. 3125281-300 FAX. (66-2) 3125304

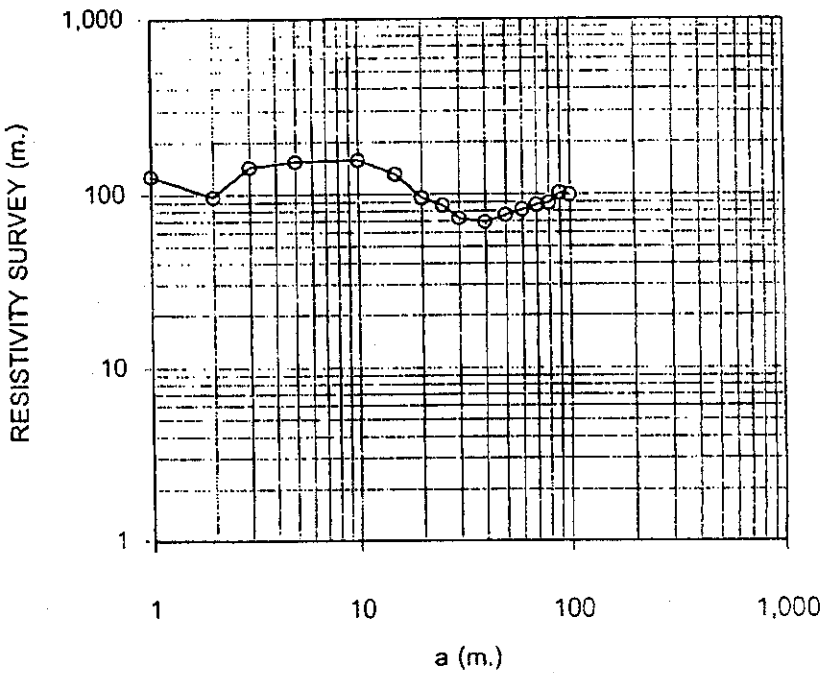
SIAM TONE CO.,LTD.
STC
OYO-INSTRUMENTS
MODEL-2115

BANGPAKONG FACTORY
700/47 BANGPAKONG
INDUSTRIAL, PARK 2
CHONBURI 20000
TEL. (038) 213-073-7
FAX. (038) 213-078

WENNER CONFIGURATION

NO.	a(m.)	F (m.)	C (m.)	2πa (u)	mV	mA	RESISTANCE (ohm.)	RESISTIVITY (ohm.m.)
1	1	0.5	1.50	6.283	1,012.00	49.90	20.281	127.423
2	2	1.0	3.00	12.570	386.00	49.90	7.735	97.235
3	3	1.5	4.50	18.850	381.00	49.90	7.635	143.925
4	5	2.5	7.50	31.420	247.00	49.90	4.950	155.526
5	10	5.0	15.00	62.850	126.00	49.90	2.525	158.699
6	15	7.5	22.50	94.280	69.40	49.90	1.391	131.123
7	20	10.0	30.00	125.710	38.00	49.90	0.762	95.731
8	25	12.5	37.50	157.140	27.50	49.90	0.551	86.600
9	30	15.0	45.00	188.570	19.30	49.90	0.387	72.934
10	40	20.0	60.00	251.420	13.20	48.00	0.275	69.141
11	50	25.0	75.00	314.280	12.10	49.90	0.242	76.208
12	60	30.0	90.00	376.990	10.80	49.90	0.216	81.593
13	70	35.0	105.00	439.990	9.13	46.20	0.198	86.950
14	80	40.0	120.00	502.850	8.84	49.90	0.177	89.082
15	90	45.0	135.00	565.710	8.98	49.90	0.180	101.805
16	100	50.0	150.00	628.570	7.58	47.90	0.158	99.469
17								
18								
19								
20								

GEOPHYSICAL SURVEY



RESISTIVITY DATA

MISSION NO.	:	BL-R4
LOCATION	:	BAN LEANG, HEOUXAY DISTRICT,
		BORKEAW PROVINCE, LAO P.D.R.
DATE OF SURVEY	:	23/11/1999
DATE OF REPORT	:	30/11/1999

HEAD OFFICE
5/15 MOO 6 (KM. 15)
BANGNA-TRAD ROAD
BANGPLEE, BANGCHALONG
SAMUTPRAKARN 10540
TEL. 3125281-300 FAX. (66-2) 3125304

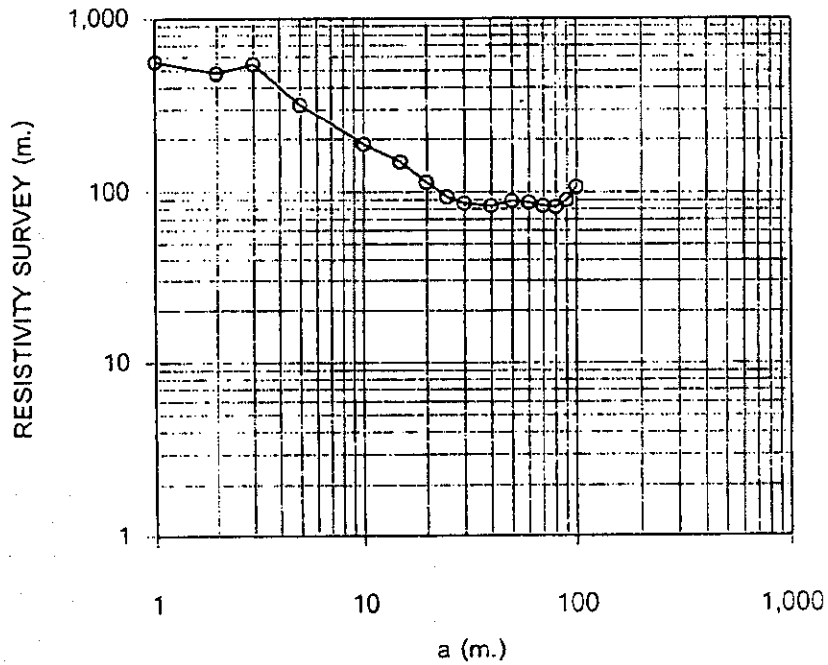
SIAM TONE CO.,LTD.
OYO-INSTRUMENTS
MODEL-2115

BANGPAKONG FACTORY
700/47 BANGPAKONG
INDUSTRIAL, PARK 2
CHONBURI 20000
TEL. (038) 213-073-7
FAX. (038) 213-078

WENNER CONFIGURATION

NO.	a(m.)	F (m.)	C (m.)	2πa (u)	mV	mA	RESISTANCE (ohm.)	RESISTIVITY (ohm.m.)
1	1	0.5	1.50	6.283	4,464.00	49.90	89.459	562.070
2	2	1.0	3.00	12.570	1,915.00	49.90	38.377	482.396
3	3	1.5	4.50	18.850	1,444.00	49.90	28.938	545.479
4	5	2.5	7.50	31.420	507.00	49.90	10.160	319.237
5	10	5.0	15.00	62.850	131.00	43.80	2.991	187.976
6	15	7.5	22.50	94.280	78.20	49.90	1.567	147.749
7	20	10.0	30.00	125.710	39.60	43.80	0.904	113.656
8	25	12.5	37.50	157.140	29.80	49.90	0.597	93.843
9	30	15.0	45.00	188.570	22.90	49.90	0.459	86.538
10	40	20.0	60.00	251.420	16.60	49.90	0.333	83.639
11	50	25.0	75.00	314.280	14.20	49.90	0.285	89.434
12	60	30.0	90.00	376.990	11.60	49.90	0.232	87.637
13	70	35.0	105.00	439.990	9.46	49.90	0.190	83.413
14	80	40.0	120.00	502.850	8.18	49.90	0.164	82.431
15	90	45.0	135.00	565.710	7.97	49.90	0.160	90.355
16	100	50.0	150.00	628.570	8.49	49.90	0.170	106.945
17								
18								
19								
20								

GEOPHYSICAL SURVEY



D4-80

RESISTIVITY DATA

MISSION NO.	:	BL-R5
LOCATION	:	BAN LEANG, HEOUXAY DISTRICT,
		BORKEAW PROVINCE, LAO P.D.R.
DATE OF SURVEY	:	23/11/1999
DATE OF REPORT	:	30/11/1999

HEAD OFFICE
5/15 MOO 6 (KM. 15)
BANGNA-TRAD ROAD
BANGPLEE, BANGCHALONG
SAMUTPRAKARN 10540
TEL. 3125281-300 FAX. (66-2) 3125304

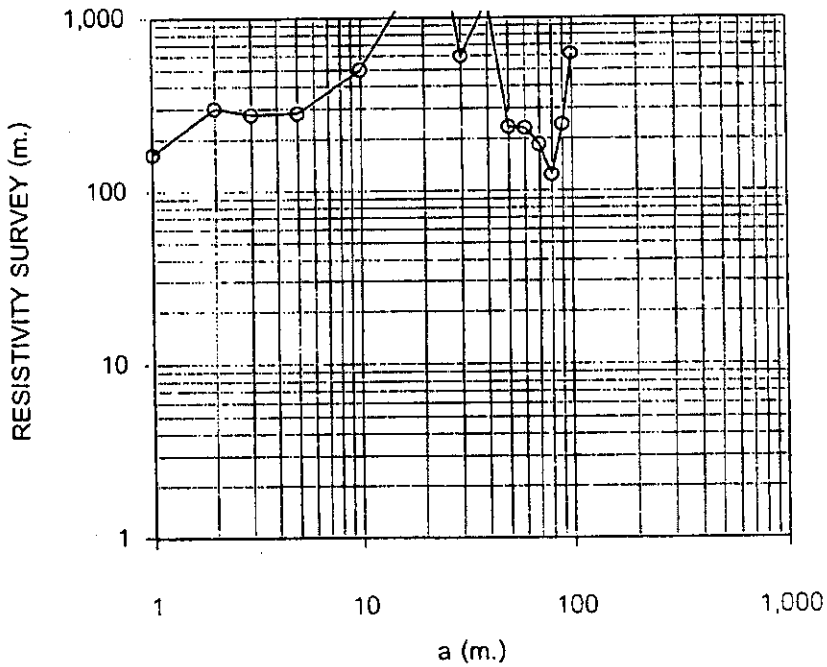
SIAM TONE CO.,LTD.
OYO-INSTRUMENTS
MODEL-2115

BANGPAKONG FACTORY
700/47 BANGPAKONG
INDUSTRIAL, PARK 2
CHONBURI 20000
TEL. (038) 213-073-7
FAX. (038) 213-078

WENNER CONFIGURATION

NO.	a(m.)	F (m.)	C (m.)	2πa (u)	mV	mA	RESISTANCE (ohm.)	RESISTIVITY (ohm.m.)
1	1	0.5	1.50	6.283	1,309.00	49.90	26.232	164.819
2	2	1.0	3.00	12.570	1,197.00	49.90	23.988	301.529
3	3	1.5	4.50	18.850	735.00	49.90	14.729	277.650
4	5	2.5	7.50	31.420	451.00	49.90	9.038	283.976
5	10	5.0	15.00	62.850	399.00	49.90	7.996	502.548
6	15	7.5	22.50	94.280	595.00	49.90	11.924	1124.180
7	20	10.0	30.00	125.710	957.00	49.90	19.178	2410.911
8	25	12.5	37.50	157.140	680.00	49.90	13.627	2141.387
9	30	15.0	45.00	188.570	159.00	49.90	3.186	600.854
10	40	20.0	60.00	251.420	250.00	49.90	5.010	1259.619
11	50	25.0	75.00	314.280	37.20	49.90	0.745	234.293
12	60	30.0	90.00	376.990	30.60	49.90	0.613	231.180
13	70	35.0	105.00	439.990	21.10	49.90	0.423	186.048
14	80	40.0	120.00	502.850	12.30	49.90	0.246	123.949
15	90	45.0	135.00	565.710	21.40	49.90	0.429	242.609
16	100	50.0	150.00	628.570	49.20	49.90	0.986	619.752
17								
18								
19								
20								

GEOPHYSICAL SURVEY



DATA SET: BL-R1

CLIENT: JICA
LOCATION: BAN LAENG, HEOUXAY
COUNTY: BOR KEO, LAO P.D.R.
PROJECT: WATER SUPPLY & SANITATION
ELEVATION: 0.00
SOUNDING COORDINATES: X: 0.0000 Y: 0.0000

DATE: NOV., 1999
SOUNDING: -
AZIMUTH: -
EQUIPMENT: -

Wenner Configuration

FITTING ERROR: 19.336 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	145.1	3.92	-3.92	0.0270	569.2
2	832.6	1.11	-5.03	0.00134	931.5
3	8.78	3.46	-8.50	0.394	30.46
4	414.0	18.14	-26.65	0.0438	7513.8
5	63.65	21.77	-48.43	0.342	1386.2
6	37.40				

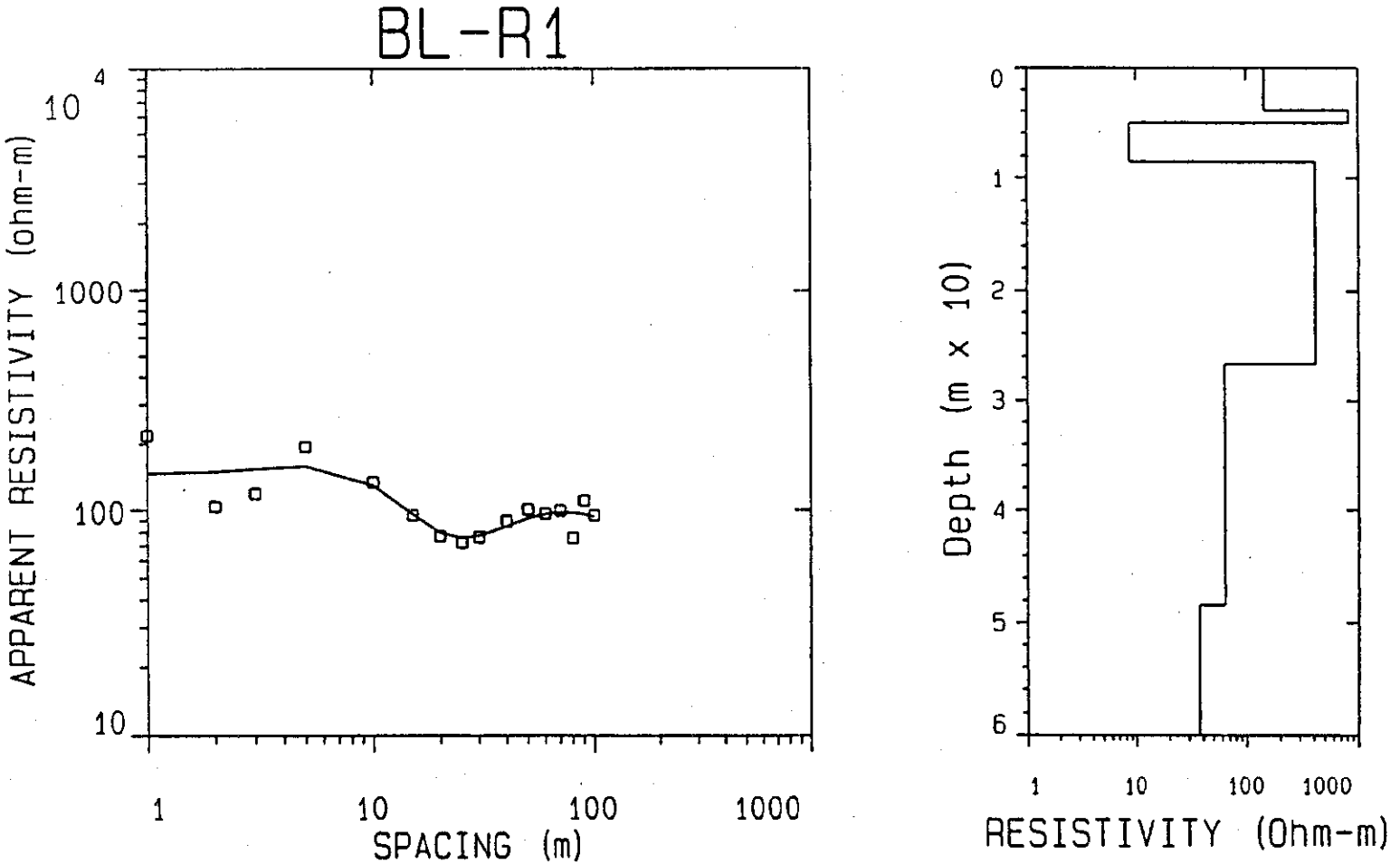
ALL PARAMETERS ARE FREE

No.	SPACING (m)	RHO-A (ohm-m) DATA	RHO-A (ohm-m) SYNTHETIC	DIFFERENCE (percent)
1	1.00	218.2	145.7	33.24
2	2.00	103.7	148.5	-43.12
3	3.00	118.6	152.8	-28.88
4	5.00	193.8	157.3	18.85
5	10.00	133.5	129.2	3.19
6	15.00	95.22	95.83	-0.644
7	20.00	77.08	79.53	-3.16
8	25.00	72.11	75.43	-4.60
9	30.00	76.33	77.19	-1.12
10	40.00	89.68	85.27	4.91
11	50.00	100.7	92.16	8.54
12	60.00	96.70	96.21	0.502
13	70.00	99.63	97.81	1.82
14	80.00	75.57	97.58	-29.11
15	90.00	110.4	96.04	13.01
16	100.0	95.10	93.64	1.52

* OYO CORPORATION *

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00										
P 2	0.00	0.51									
P 3	0.00	0.01	0.50								
P 4	0.00	0.00	0.00	0.51							
P 5	0.00	0.00	-0.01	0.10	0.03						
P 6	0.00	0.00	0.00	0.00	0.06	0.73					
T 1	0.00	-0.02	0.01	-0.01	0.00	0.01	0.99				
T 2	0.00	0.50	0.01	0.00	0.00	0.00	0.02	0.49			
T 3	0.00	0.01	-0.49	-0.04	0.01	0.02	0.01	0.01	0.51		
T 4	0.00	0.00	-0.03	0.47	0.10	0.07	0.00	0.00	0.00	0.45	
T 5	0.00	0.00	0.00	0.03	0.01	0.08	0.00	0.00	0.00	0.03	0
	P 1	P 2	P 3	P 4	P 5	P 6	T 1	T 2	T 3	T 4	


BL-R1
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
10
100
1000
SPACING (m)
Depth (m x 10)
0
1
2
3
4
5
6
1
10
100
1000
RESISTIVITY (Ohm-m)

DATA SET: BL-R2

CLIENT: JICA DATE: NOV., 1999
LOCATION: BAN LAENG, HEOUXAY SOUNDING: -
COUNTY: BOR KEAW, LAO, P.D.R. AZIMUTH: -
PROJECT: WATER SUPPLY & SANITATION EQUIPMENT: -
ELEVATION: 0.00
SOUNDING COORDINATES: X: 0.0000 Y: 0.0000

Wenner Configuration

FITTING ERROR: 5.409 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	977936.6	0.138	-0.138	1.415E-07	135289.1
2	167.1	9.15	-9.29	0.0548	1530.5
3	46.02	11.69	-20.99	0.254	538.3
4	65.05	82.70	-103.6	1.27	5380.3
5	89.37	18.70	-122.4	0.209	1672.0
6	410.8				

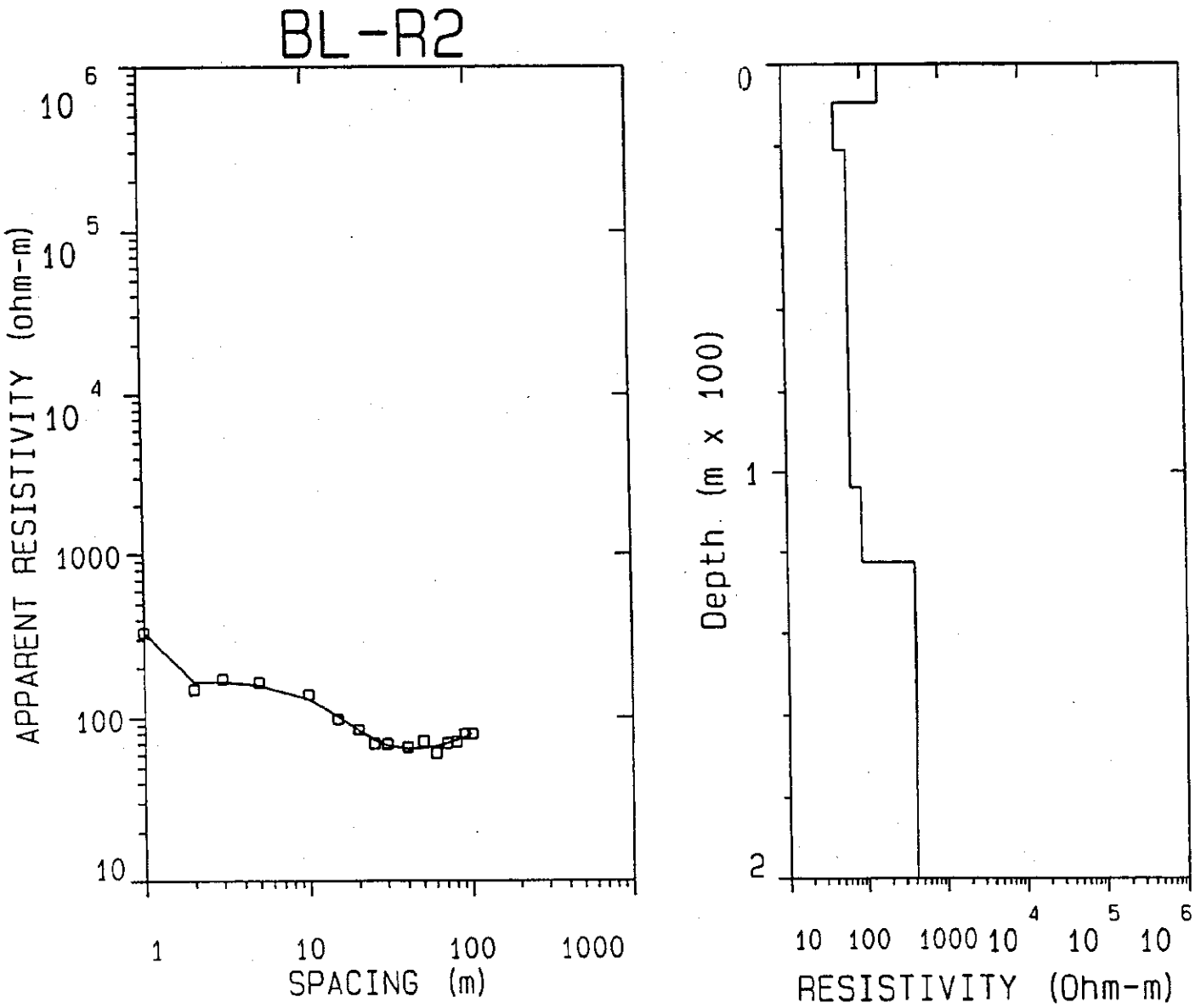
ALL PARAMETERS ARE FREE

No.	SPACING (m)	RHO-A (ohm-m) DATA	RHO-A (ohm-m) SYNTHETIC	DIFFERENCE (percent)
1	1.00	330.7	333.3	-0.770
2	2.00	149.8	166.4	-11.07
3	3.00	173.3	166.4	4.01
4	5.00	165.6	159.2	3.83
5	10.00	139.8	130.6	6.55
6	15.00	98.24	102.2	-4.07
7	20.00	84.64	83.65	1.17
8	25.00	69.59	73.30	-5.32
9	30.00	69.15	68.08	1.54
10	40.00	66.50	64.98	2.29
11	50.00	71.79	65.58	8.64
12	60.00	61.11	67.51	-10.46
13	70.00	69.65	70.02	-0.532
14	80.00	71.40	72.91	-2.11
15	90.00	79.35	76.11	4.08
16	100.0	79.61	79.62	-0.0153

* OYO CORPORATION *

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.04										
P 2	0.00	0.99									
P 3	0.00	-0.01	0.67								
P 4	0.00	0.00	0.13	0.89							
P 5	0.00	0.00	-0.03	0.03	0.02						
P 6	0.00	0.00	-0.04	0.03	0.03	0.04					
T 1	0.09	0.00	0.00	0.00	0.00	0.00	0.99				
T 2	0.00	0.01	0.16	-0.06	0.01	0.02	0.00	0.91			
T 3	0.00	0.00	-0.15	-0.12	0.00	0.00	0.00	0.03	0.06		
T 4	0.00	0.00	0.18	-0.17	-0.10	-0.14	0.00	-0.07	-0.02	0.52	
T 5	0.00	0.00	0.03	-0.03	-0.02	-0.02	0.00	-0.01	0.00	0.08	0
	P 1	P 2	P 3	P 4	P 5	P 6	T 1	T 2	T 3	T 4	


BL-R2
APPARENT RESISTIVITY (ohm-m)
10^6
10^5
10^4
1000
100
10
1
10
100
1000
SPACING (m)
Depth (m x 100)
0
1
2
10
100
1000
10^4
10^5
10^6
RESISTIVITY (Ohm-m)

DATA SET: BL-R3

CLIENT: JICA DATE: NOV., 1999
LOCATION: BAN LAENG, HEOUXAY SOUNDING: -
COUNTY: BOR KEAW, LAO, P.D.R. AZIMUTH: -
PROJECT: WATER SUPPLY & SANITATION EQUIPMENT: -
ELEVATION: 0.00
SOUNDING COORDINATES: X: 0.0000 Y: 0.0000

Wenner Configuration

FITTING ERROR: 7.131 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	111.7	3.39	-3.39	0.0303	379.5
2	1137.5	1.40	-4.80	0.00124	1600.7
3	25.57	14.34	-19.14	0.561	366.8
4	162.4	30.34	-49.49	0.186	4927.9
5	155.0	21.30	-70.80	0.137	3303.3
6	153.4	21.58	-92.38	0.140	3312.8
7	127.8				

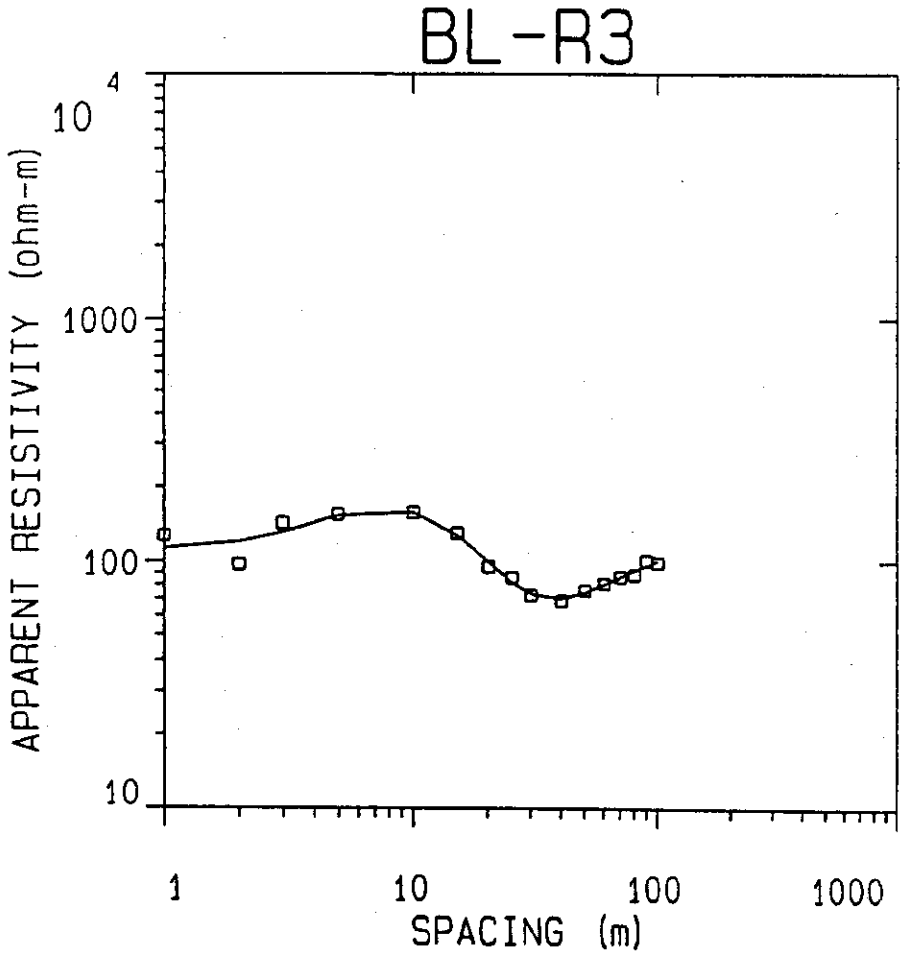
ALL PARAMETERS ARE FREE

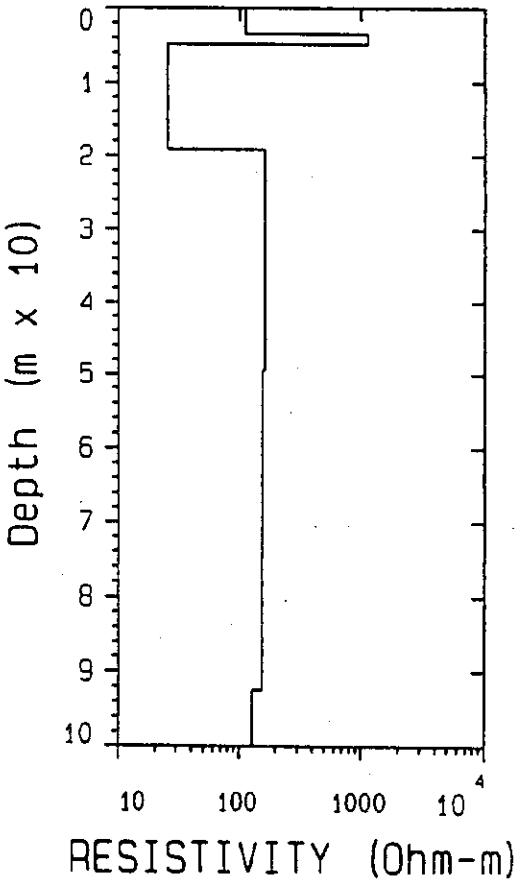
No.	SPACING (m)	RHO-A (ohm-m) DATA	RHO-A (ohm-m) SYNTHETIC	DIFFERENCE (percent)
1	1.00	127.4	113.0	11.28
2	2.00	97.23	120.0	-23.42
3	3.00	143.9	131.7	8.43
4	5.00	155.5	154.6	0.533
5	10.00	158.6	159.2	-0.357
6	15.00	131.1	128.6	1.87
7	20.00	95.73	100.5	-5.03
8	25.00	86.60	82.73	4.46
9	30.00	72.93	73.65	-0.988
10	40.00	69.14	70.35	-1.75
11	50.00	76.20	74.91	1.69
12	60.00	81.59	81.14	0.546
13	70.00	86.95	87.16	-0.245
14	80.00	89.08	92.50	-3.84
15	90.00	101.8	97.12	4.60
16	100.0	99.46	101.0	-1.63

* OYO CORPORATION *

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00										
P 2	0.00	0.50									
P 3	0.00	0.01	0.80								
P 4	0.00	0.01	-0.11	0.67							
P 5	0.00	0.00	-0.02	0.29	0.21						
P 6	0.00	0.00	0.01	0.11	0.13	0.10					
P 7	0.00	-0.01	0.05	0.00	0.19	0.23	0.76				
T 1	0.00	-0.02	0.01	0.00	0.00	0.00	0.00	1.00			
T 2	0.00	0.50	0.02	0.00	0.00	0.00	0.00	0.01	0.49		
T 3	0.00	0.02	-0.25	-0.21	0.03	0.04	0.07	0.01	0.02	0.67	
T 4	0.00	0.00	0.00	0.05	0.04	0.03	0.07	0.00	0.00	0.01	0.
T 5	0.00	0.00	0.00	0.01	0.02	0.02	0.04	0.00	0.00	0.01	0.
T 6	0.00	0.00	0.00	0.01	0.02	0.02	0.04	0.00	0.00	0.01	0.
	P 1	P 2	P 3	P 4	P 5	P 6	P 7	T 1	T 2	T 3	


BL-R3
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
10
100
1000
SPACING (m)


Depth (m x 10)
0
1
2
3
4
5
6
7
8
9
10
10
100
1000
10 4
RESISTIVITY (Ohm-m)

DATA SET: BL-R4

CLIENT: JICA
LOCATION: BAN LAENG, HEOUXAY
COUNTY: BOR KEAW, LAO, P.D.R.
PROJECT: WATER SUPPLY & SANITATION
ELEVATION: 0.00
SOUNDING COORDINATES: X: 0.0000 Y: 0.0000

DATE: NOV., 1999
SOUNDING: -
AZIMUTH: -
EQUIPMENT: -

Wenner Configuration

FITTING ERROR: 6.678 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	576.9	2.83	-2.83	0.00491	1634.9
2	187.0	9.69	-12.52	0.0518	1813.3
3	33.87	8.00	-20.52	0.236	271.0
4	182.1	15.21	-35.74	0.0835	2772.7
5	22.30	24.84	-60.59	1.11	554.1
6	1738.2				

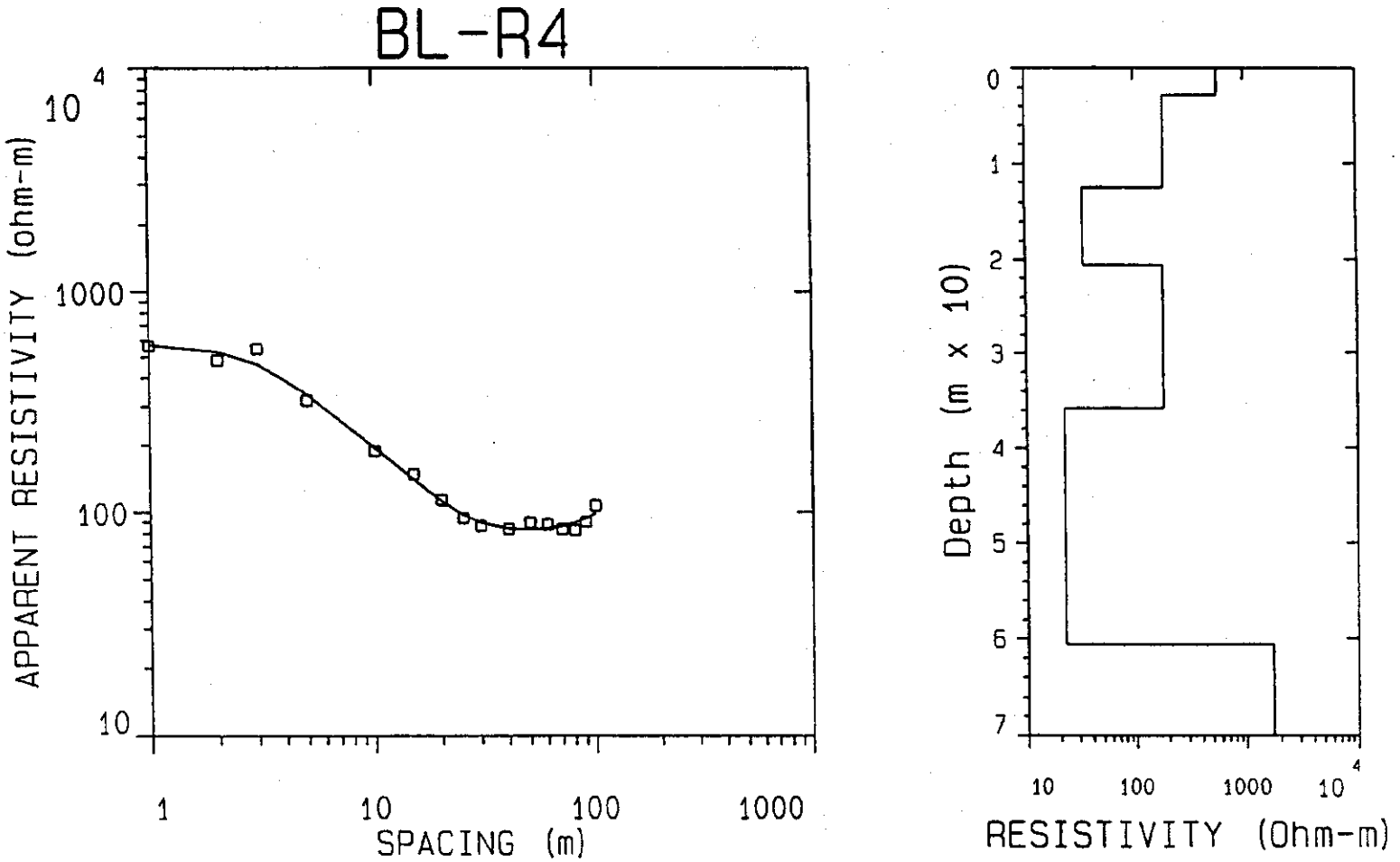
ALL PARAMETERS ARE FREE

No.	SPACING (m)	RHO-A (ohm-m) DATA	RHO-A (ohm-m) SYNTHETIC	DIFFERENCE (percent)
1	1.00	562.0	568.6	-1.16
2	2.00	482.3	527.8	-9.42
3	3.00	545.4	463.7	14.97
4	5.00	319.2	340.5	-6.67
5	10.00	187.9	193.8	-3.11
6	15.00	147.7	139.9	5.28
7	20.00	113.6	111.9	1.51
8	25.00	93.84	96.98	-3.35
9	30.00	86.53	89.43	-3.34
10	40.00	83.63	84.20	-0.672
11	50.00	89.43	83.47	6.66
12	60.00	87.63	84.31	3.79
13	70.00	83.41	86.29	-3.45
14	80.00	82.43	89.41	-8.46
15	90.00	90.35	93.58	-3.57
16	100.0	106.9	98.65	7.75

* OYO CORPORATION *

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00										
P 2	-0.01	0.91									
P 3	0.00	-0.04	0.45								
P 4	0.00	0.01	0.12	0.51							
P 5	0.00	0.01	-0.02	0.07	0.49						
P 6	0.00	0.00	0.01	-0.01	0.03	0.00					
T 1	0.01	0.06	0.02	-0.01	0.00	0.00	0.94				
T 2	0.00	0.10	0.15	-0.05	0.00	0.00	-0.06	0.84			
T 3	0.00	0.04	-0.40	-0.09	0.01	-0.01	-0.02	-0.04	0.36		
T 4	0.00	0.02	0.02	0.44	0.03	-0.02	-0.01	-0.05	0.01	0.40	
T 5	0.00	0.00	0.01	0.01	-0.49	-0.04	0.00	0.00	0.01	0.05	0
	P 1	P 2	P 3	P 4	P 5	P 6	T 1	T 2	T 3	T 4	


BL-R4
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
10
100
1000
SPACING (m)
Depth (m x 10)
0
1
2
3
4
5
6
7
10
100
1000
10 4
RESISTIVITY (Ohm-m)

DATA SET: BL-R5

CLIENT: JICA DATE: NOV., 1999
LOCATION: BAN LAENG, HEOUXAY SOUNDING: -
COUNTY: BOR KEAW, LAO, P.D.R. AZIMUTH: -
PROJECT: WATER SUPPLY & SANITATION EQUIPMENT: -
ELEVATION: 0.00
SOUNDING COORDINATES: X: 0.0000 Y: 0.0000

Wenner Configuration

FITTING ERROR: 76.161 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	129.7	1.32	-1.32	0.0101	171.5
2	3996.8	1.79	-3.12	4.503E-04	7193.5
3	7260.4	2.65	-5.77	3.658E-04	19285.0
4	15.09	8.41	-14.19	0.557	127.0
5	276.6	11.99	-26.18	0.0433	3317.8
6	11175.3				

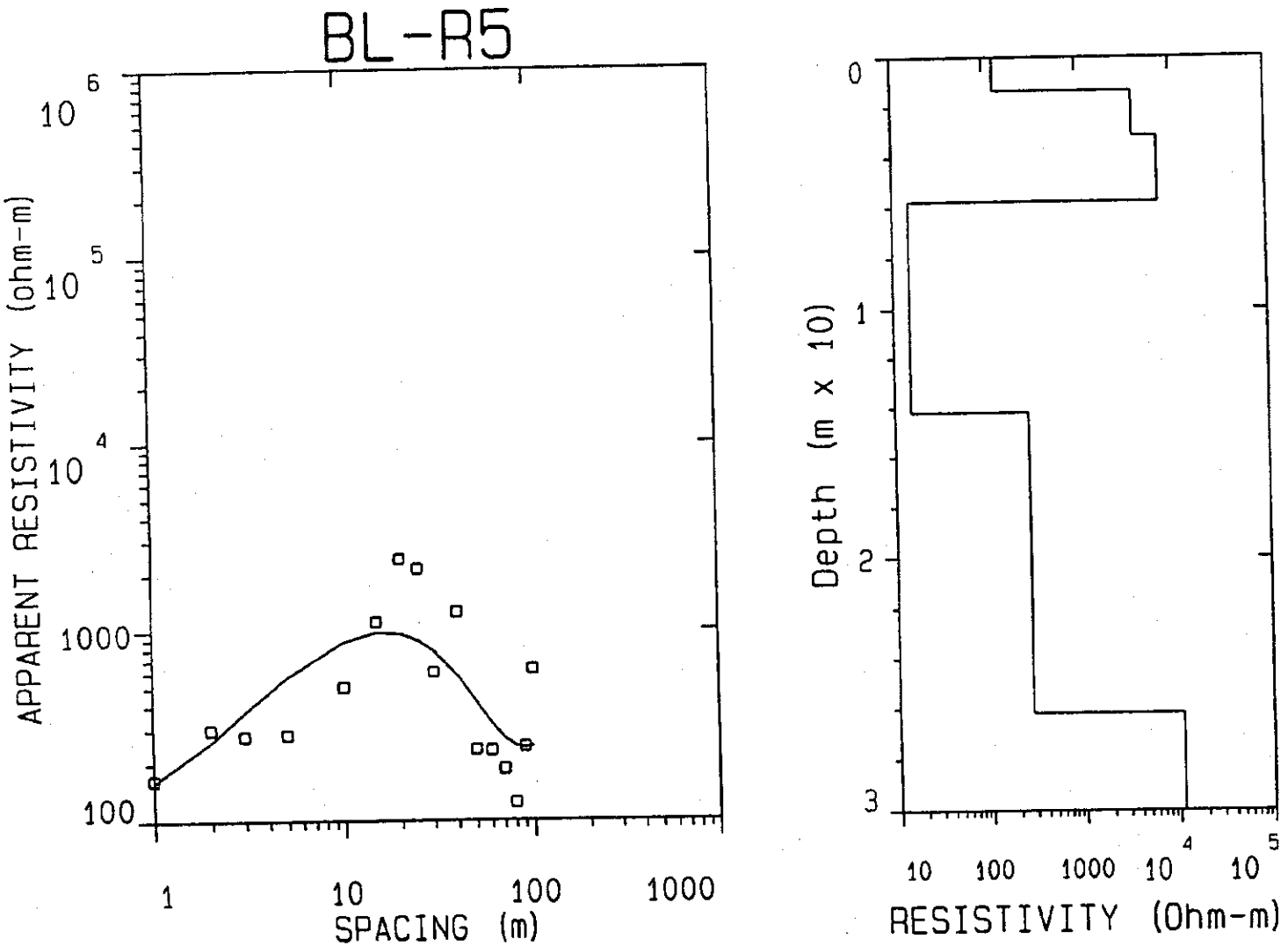
ALL PARAMETERS ARE FREE

No.	SPACING (m)	RHO-A (ohm-m) DATA	RHO-A (ohm-m) SYNTHETIC	DIFFERENCE (percent)
1	1.00	164.8	161.3	2.10
2	2.00	301.5	259.4	13.95
3	3.00	277.6	369.2	-32.97
4	5.00	283.9	564.5	-98.79
5	10.00	502.5	874.8	-74.09
6	15.00	1124.1	982.3	12.61
7	20.00	2410.9	965.8	59.93
8	25.00	2141.3	885.8	58.63
9	30.00	600.8	780.9	-29.97
10	40.00	1259.6	575.2	54.33
11	50.00	234.2	421.4	-79.86
12	60.00	231.1	324.2	-40.23
13	70.00	186.0	270.3	-45.29
14	80.00	123.9	245.6	-98.17
15	90.00	242.6	239.6	1.22
16	100.0	619.7	244.8	60.49

* OYO CORPORATION *

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.61										
P 2	0.01	0.06									
P 3	-0.01	0.16	0.41								
P 4	0.00	0.01	0.03	0.41							
P 5	0.00	0.00	0.00	0.03	0.00						
P 6	0.00	0.00	0.00	0.01	0.00	0.00					
T 1	-0.37	-0.03	-0.01	0.03	0.00	0.00	0.53				
T 2	-0.01	0.06	0.15	0.01	0.00	0.00	0.01	0.06			
T 3	-0.01	0.15	0.40	0.03	0.00	0.00	0.00	0.16	0.40		
T 4	-0.01	0.00	-0.03	-0.41	-0.03	-0.01	-0.03	-0.01	-0.03	0.41	
T 5	0.00	0.00	0.00	-0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.
	P 1	P 2	P 3	P 4	P 5	P 6	T 1	T 2	T 3	T 4	


BL-R5
APPARENT RESISTIVITY (ohm-m)
10^6
10^5
10^4
1000
100
1
10
100
1000
SPACING (m)
Depth (m x 10)
0
1
2
3
10
100
1000
10^4
10^5
RESISTIVITY (Ohm-m)