APPENDIX-12

EXPLORATORY WELL DRILLING WORK REPORT

The Exploratory Well Drilling Work
for
The Master Plan Study on Urban Facilities Restoration and Improvement in Monrovia In Liberia

Report

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GOL/JICA

CONTENT

1.0 General Introduction

1.1 Purpose

The purpose of the report is to provide the JICA study team with information on the exploratory wells that would assist them in the "Master Plan Study on urban facilities Restoration and improvement in Monrovia, in the Republic of Liberia".

1.2 Exploratory Well Locations

For the purpose of the study four (4) wells were drilled.Three (3) of the drilling site are located in the Devonian Paynesville Sandstone and one (1) in the Late Precambrian Gneiss. The drilling points are shown in table-1.1 and Figure-1.1

1.3 Work Items and Duration

The main work items and the actual conducted duration are shown in table-1.2.

Table-1.1: Location of Exploratory Wells

No	Drilling Target	Area	Coordinate		
			Easting	Northing	Elevation (m)
J1	Paynesville Sandstone	Gardnersville Zone, Monrovia Transit Authority Community	308146	699298	6
J2	Paynesville Sandstone	Paynesville Zone, Neezoe Community	311080	697096	5
J3	Paynesville Sandstone	Paynesville Zone, ZBarrard Farm Community	316090	699446	10
J4	Gneiss	Johnsonville Zone, Johnsonville Township Community	313545	703713	19

Figure-1.1: Location of Exploratory Wells

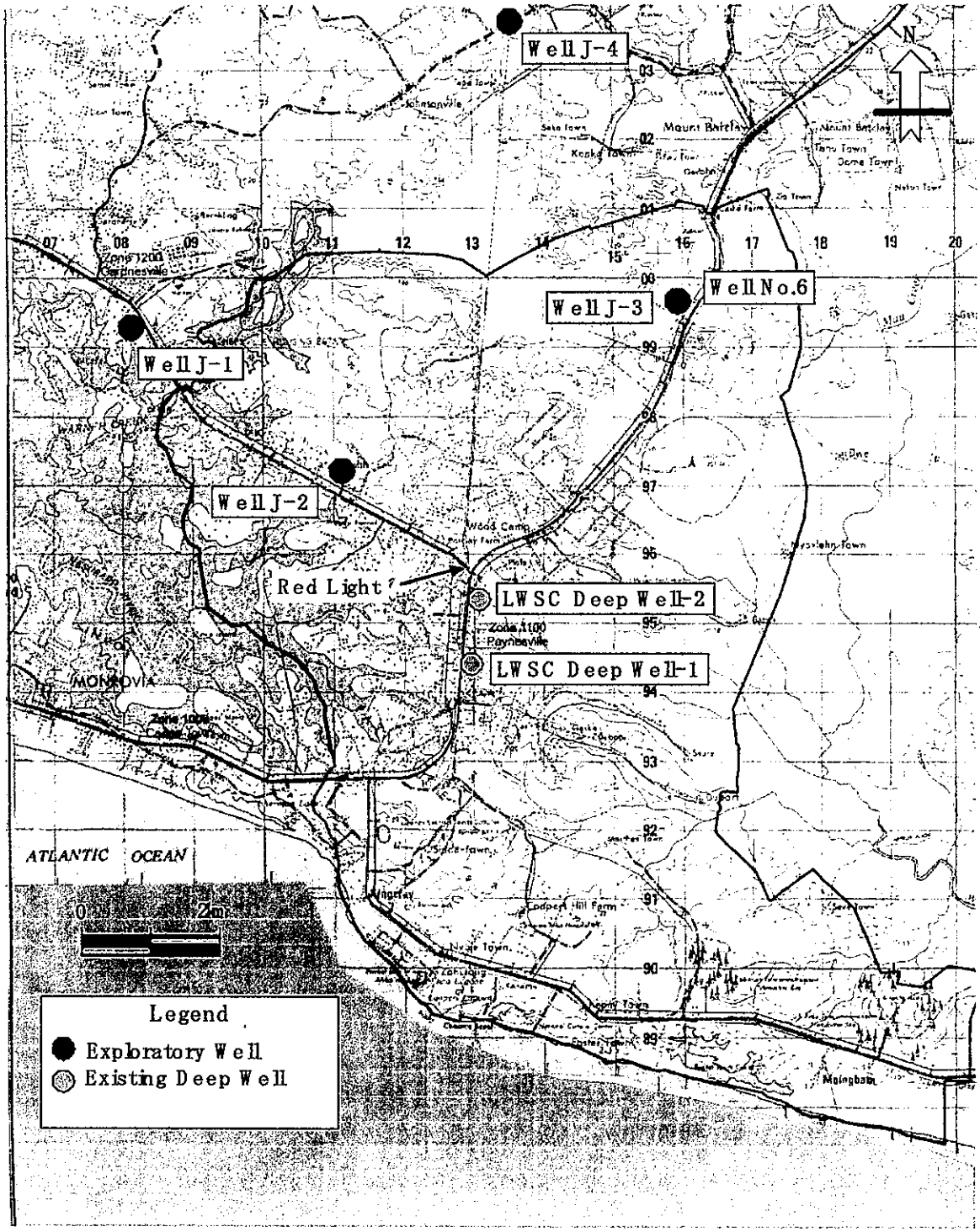


Table-1.2: Main Work Items and Work Duration

Work Items	J1	J2	J3	J4
Rig mobilization and Shift	Mar.17-18	Apr.13-14	May1	Mar 30-31
Drilling	Mar19-23	Apr.14-17	May1-6	Mar31-Apr2
Geophysical logging	Mar24	Apr.20	May7	Apr.4
Casing/Screen Installation	Mar.25-26	Apr.21	May8	Apr.4
Gravel pack and grouting	Mar.27	Apr.21	May8	Apr.4
Well development	Mar 28	Apr.12-13	May 9	Apr.5
Pre-pumping test	Apr.6	May 1	May 11	Apr.11
Multi-stage pumping test	Apr.7	May 2	May 12	Apr.12
Constant discharge pumping test	Apr.8-11	May 3-6	May 14-17	Apr.13
Recovery test	Apr.11-15	May 6-9	May 17-19	Apr.13-14
Well head cover installation	Apr.27-29	May 22-25	May 29-Jun.3	Apr.30-May 2

(Work year: 2009)

2.0 Drilling Works

2.1 Mobilization, Site Preparation and Drilling

The drilling of each well (J1-J4) was preceded by mobilization of Equipment /materials – Compressor, Drilling rig, Gravel, Casings and Screens and other necessary facilities related to drilling and subsequent well development. The area for drilling was cleared and mud pit dug and plastered to retain water for the drilling works.

The mobilization and site preparation at each location took between two (2) to three (3) days. Drilling was carried out using TRICOR bit with a down the hole hammer bit of 11 ¼", (14 ½"). The Total depth of the wells is 266m.Table - 2.1 below show a summary of drilling activities as per each location.

Table – 2.1: Drilling Work Quantity and Duration

No.	Mobilization &Site Preparation		Drilling		Total Duration in days	Depth(m)
	Date	No .of days	Date	No .of days		
J1	March 17-18, 2009	2	March 19-24	6	8	73
J2	April 18-20, 2009	3	April 21-25, 2009	5	8	60
J3	April 30 – May 1, 2009	2	May 2-5, 2009	4	6	63
J4	March 30-31, 2009	2	March 31-April 3, 2009	4	5	70

2.2 Lithology and Geo-physical logging

During the drilling process drill-out samples were collected at an interval of every one (1) meters and every change of formation encountered at the drilled wells. The collected samples were used in mapping the composition of the substrata and development of a casing program.

Upon completion of well drilling, geo-physical logging was carried out for the confirmation of Aquifer structure and determination of screen installation depth.

The electric resistivity logging was conducted as geophysical logging using the following devices / equipment:

- TONEY Drilling Supplies INC. Electrical Logging System Hohnson-Keck Model DR-74

See Figure-2.1 below for lithological logs and results of geo-physical logging of the different exploratory wells drilled (J1-J4), and Table- 2.2 Geophysical logging records of exploratory wells (J1-J4).

The composition of lothology of the exploratory wells is summarized as follows;

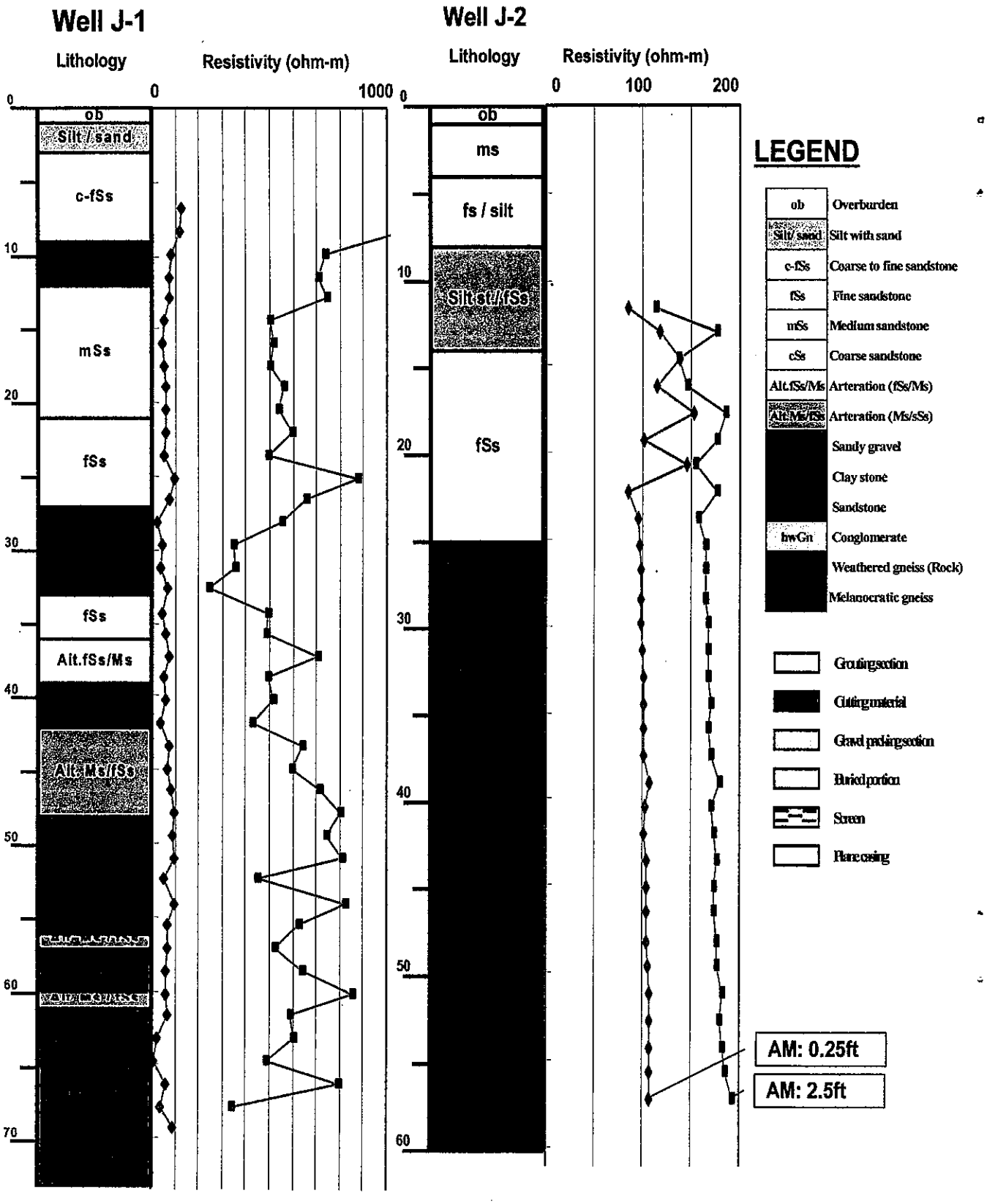
Well J-1: J-1 taps Pynesville sandstone. Upper portion is Sandstone, middle to lower is alternation and mudstone, and bottom portion contains intrusive rock diabase.

Well J-2: J-2 also taps Pynesville Sandstone. Upper portion is Sandstone, middle to lower potion is mudstone, and bottom portion is intrusive rock diabase.

Well J-3: J-3 taps also Pynesville Sandstone. Upper portion is Sandstone, and middle to Lower portion is alternation and mudstone.

Well J-4: J-4 taps Precambrian melanocratic gneiss. Upper portion is highly weathered fine soil and crackly zone, and middle to lower portion is hard rock.

Figure- 2.1: Lithology & Resistivity of Drilled Wells



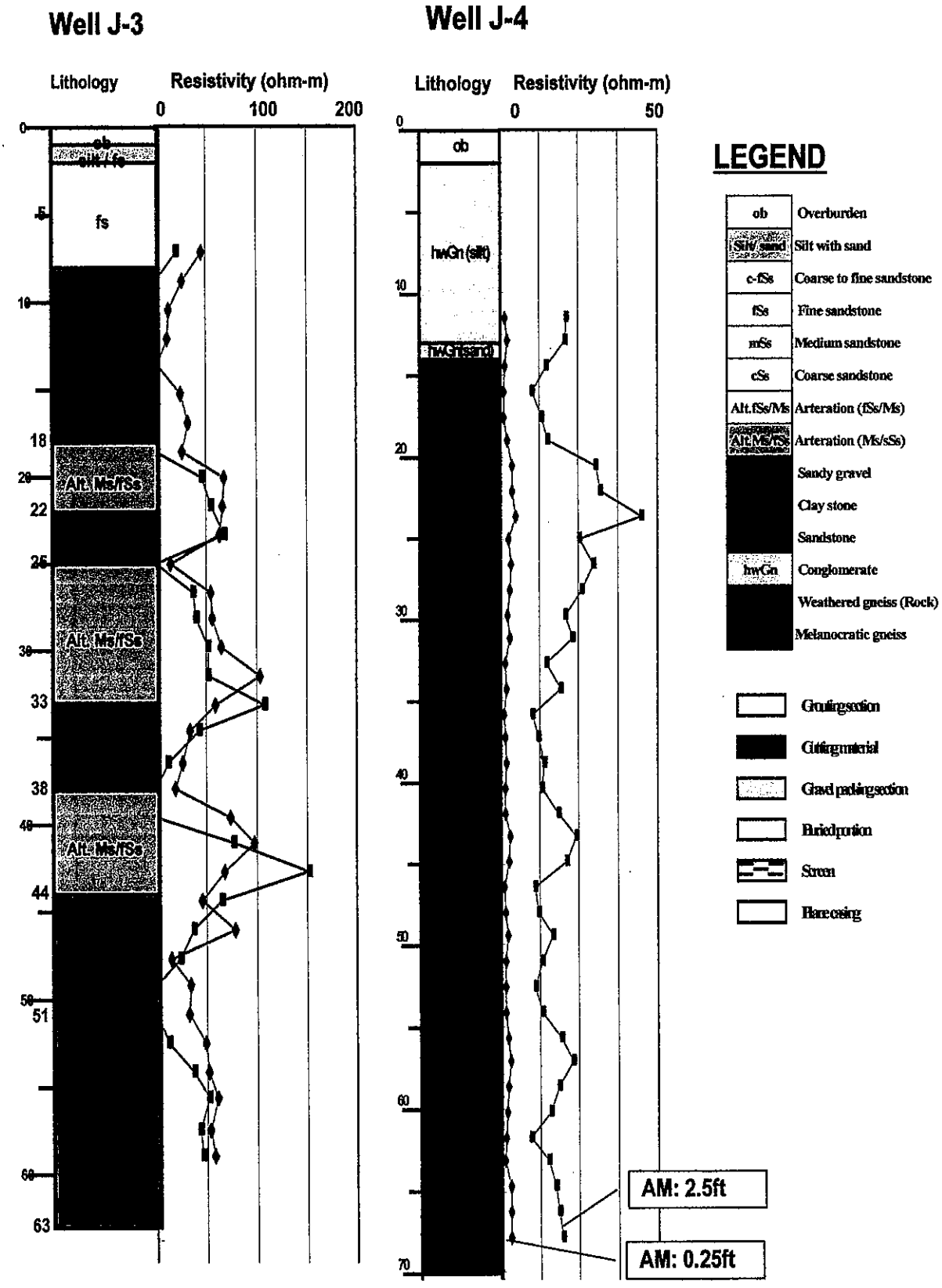

Well J-3
Lithology
Resistivity (ohm-m)
0
100
200
ob
fs
Alt. Ms/fSs
Alt. Ms/fSs
Alt. Ms/fSs
Well J-4
Lithology
Resistivity (ohm-m)
0
50
ob
hwGn (silt)
hwGn (sand)
AM: 2.5ft
AM: 0.25ft
LEGEND
ob Overburden
Silt/ sand Silt with sand
c-fSs Coarse to fine sandstone
fSs Fine sandstone
mSs Medium sandstone
cSs Coarse sandstone
Alt.fSs/Ms Arteration (fSs/Ms)
Alt.Ms/fSs Arteration (Ms/sSs)
Sandy gravel
Clay stone
Sandstone
hwGn Conglomerate
Weathered gneiss (Rock)
Melanocratic gneiss
Grouting section
Gitting material
Gravel packing section
Buried portion
Screen
Bare casing

Table – 2.2: Geophysical Logging Record

Geopysical Logging Record							
Well No.	J-1		Type of logging	Electric Resistivity		Date	24-Mar-09
Device	Toney Inc. DR-74		Measuring point hight	0.80 m		Operator	Mr. Igho Opuama
Reading Value				Correction Value			
Depth (ft)	Resistivity (Ohm-ft)			Depth (m)	Resistivty (Ohm-m)		Remacks
	AM=0.25ft	AM=2.5ft	AM=2.5ft (collection)		AM=0.25ft	AM=2.5ft	
20				5.3			Casing portion
25	412	451	4510	6.8	126	1375	
30	386	352	3520	8.3	118	1073	
35	255	240	2400	9.9	78	732	
40	232	231	2310	11.4	71	704	
45	234	244	2440	12.9	71	744	
50	167	165	1650	14.4	51	503	
55	146	168	1680	16.0	45	512	
60	162	164	1640	17.5	49	500	
65	195	184	1840	19.0	59	561	
70	186	176	1760	20.5	57	536	
75	200	195	1950	22.1	61	594	
80	163	161	1610	23.6	50	491	
85	317	287	2870	25.1	97	875	
90	235	214	2140	26.6	72	652	
95	74	181	1810	28.2	23	552	
100	133	114	1140	29.7	41	347	
105	131	115	1150	31.2	40	351	
110	216	80	800	32.7	66	244	
115	150	161	1610	34.3	46	491	
120	184	159	1590	35.8	56	485	
125	245	231	2310	37.3	75	704	
130	170	161	1610	38.8	52	491	
135	185	170	1700	40.3	56	518	
140	116	140	1400	41.9	35	427	
145	231	210	2100	43.4	70	640	
150	226	196	1960	44.9	69	597	
155	255	235	2350	46.4	78	716	
160	312	263	2630	48.0	95	802	
165	280	243	2430	49.5	85	741	
170	310	265	2650	51.0	94	808	
175	164	146	1460	52.5	50	445	
180	323	270	2700	54.1	98	823	
185	216	206	2060	55.6	66	628	
190	207	171	1710	57.1	63	521	
195	195	209	2090	58.6	59	637	
200	196	280	2800	60.2	60	853	
205	210	192	1920	61.7	64	585	
210	62	198	1980	63.2	19	604	
215	12	158	1580	64.7	4	482	
220	200	260	2600	66.3	61	792	
225	123	110	1100	67.8	37	335	
230	280			69.3	85		Bottom

Geopysical Logging Record							
Well No.	J-2		**Type of logging**	Electric Resistivity		**Date**	20-Apr-09
Device	Toney Inc. DR-74		**Measuring point high**	0.60 m		**Operator**	Mr. Igho Opuama
Reading Value				**Correction Value**			**Remaeks**
Depth (ft)	**Resistivity (Ohm-ft)**			**Depth (m)**	**Resistivty (Ohm-m)**		
	AM=0.25ft	**AM=2.5ft**	**AM=2.5ft (collection**		**AM=0.25ft**	**AM=2.5ft**	
20				5.5			Casing portion
25				7.0			Dry portion
30				8.5			Dry portion
35				10.1			Dry portion
40	282	37	370	11.6	86	113	
45	384	58	580	13.1	117	177	
50	454	45	450	14.6	138	137	
55	373	48	480	16.2	114	146	
60	501	61	610	17.7	153	186	
65	335	58	580	19.2	102	177	
70	479	51	510	20.7	146	155	
75	281	58	580	22.3	86	177	
80	314	52	520	23.8	96	158	
85	319	54	540	25.3	97	165	
90	320	54	540	26.8	98	165	
95	323	54	540	28.4	98	165	
100	324	55	550	29.9	99	168	
105	329	55	550	31.4	100	168	
110	330	55	550	32.9	101	168	
115	333	56	560	34.5	101	171	
120	333	55	550	36.0	101	168	
125	336	56	560	37.5	102	171	
130	353	59	590	39.0	108	180	
135	337	56	560	40.5	103	171	
140	334	57	570	42.1	102	174	
145	343	58	580	43.6	105	177	
150	343	57	570	45.1	105	174	
155	343	57	570	46.6	105	174	
160	346	58	580	48.2	105	177	
165	349	58	580	49.7	106	177	
170	350	60	600	51.2	107	183	
175	352	59	590	52.7	107	180	
180	350	60	600	54.3	107	183	
185	351	61	610	55.8	107	186	
190	355	63	630	57.3	108	192	Bottom

Geopysical Logging Record							
Well No.	J-3		**Type of logging**	Electric Resistivity		**Date**	7-May-09
Device	Toney Inc. DR-74		**Measuring point hight**	0.80 m		**Operator**	Mr. John Clements
Reading Value				**Correction Value**		**Remaeks**	
Depth (ft)	**Resistivity (Ohm-ft)**			**Depth (m)**	**Resistivty (Ohm-m)**		
	AM=0.25ft	**AM=2.5ft**	**AM=2.5ft (collection**		**AM=0.25ft**	**AM=2.5ft**	
20	179	128	1280	5.3			Casing portion
25	188	49	490	6.8	57	149	
30	129	35	350	8.3	39	107	
35	69	16	160	9.9	21	49	
40	65	0	0	11.4	20	0	
45	29	0	0	12.9	9	0	
50	115	9	90	14.4	35	27	
55	139	17	170	16.0	42	52	
60	120	23	230	17.5	37	70	
65	254	40	400	19.0	77	122	
70	251	46	460	20.5	77	140	
75	237	48	480	22.1	72	146	
80	79	23	230	23.6	24	70	
85	210	41	410	25.1	64	125	
90	217	43	430	26.6	66	131	
95	248	45	450	28.2	76	137	
100	369	59	590	29.7	112	180	
105	228	16	160	31.2	69	49	
110	144	37	370	32.7	44	113	
115	125	31	310	34.3	38	94	
120	98	28	280	35.8	30	85	
125	270	59	590	37.3	82	180	
130	338	77	770	38.8	103	235	
135	252	56	560	40.3	77	171	
140	181	42	420	41.9	55	128	
145	288	36	360	43.4	88	110	
150	78	22	220	44.9	24	67	
155	134	26	260	46.4	41	79	
160	137	28	280	48.0	42	85	
165	194	38	380	49.5	59	116	
170	196	41	410	51.0	60	125	
175	229	43	430	52.5	70	131	
180	203	39	390	54.1	62	119	
185	203	37	370	55.6	62	113	Bottom

Geopysical Logging Record							
Well No.	J-4		**Type of logging**	Electric Resistivity		**Date**	4-Apr-09
Device	Toney Inc. DR-74		**Measuring point high**	0.80 m		**Operator**	Mr. Igho Opuama
Reading Value				**Correction Value**			
Depth (ft)	**Resistivity (Ohm-ft)**			**Depth (m)**	**Resistivty (Ohm-m)**		**Remaeks**
	AM=0.25ft	**AM=2.5ft**	**AM=2.5ft (collection)**		**AM=0.25ft**	**AM=2.5ft**	
20				5.3			Casing portion
25				6.8			Dry portion
30				8.3			Dry portion
35				9.9			Dry portion
40	2.42	2.80	28.00	11.4	0.7	8.5	
45	3.73	2.73	27.30	12.9	1.1	8.3	
50	2.50	1.96	19.60	14.4	0.8	6.0	
55	1.93	1.35	13.50	16.0	0.6	4.1	
60	2.00	1.76	17.60	17.5	0.6	5.4	
65	3.67	2.00	20.00	19.0	1.1	6.1	
70	5.10	4.00	40.00	20.5	1.6	12.2	
75	5.40	4.20	42.00	22.1	1.6	12.8	
80	6.86	5.91	59.10	23.6	2.1	18.0	
85	3.94	3.30	33.00	25.1	1.2	10.1	
90	4.95	3.90	39.00	26.6	1.5	11.9	
95	4.42	3.41	34.10	28.2	1.3	10.4	
100	3.47	2.72	27.20	29.7	1.1	8.3	
105	4.12	3.02	30.20	31.2	1.3	9.2	
110	2.69	1.95	19.50	32.7	0.8	5.9	
115	2.90	2.54	25.40	34.3	0.9	7.7	
120	2.00	1.33	13.30	35.8	0.6	4.1	
125	2.67	1.62	16.20	37.3	0.8	4.9	
130	2.95	1.85	18.50	38.8	0.9	5.6	
135	2.47	1.76	17.60	40.3	0.8	5.4	
140	2.38	2.44	24.40	41.9	0.7	7.4	
145	4.59	3.14	31.40	43.4	1.4	9.6	
150	3.86	2.77	27.70	44.9	1.2	8.4	
155	2.01	1.43	14.30	46.4	0.6	4.4	
160	2.51	1.61	16.10	48.0	0.8	4.9	
165	3.19	2.15	21.50	49.5	1.0	6.6	
170	2.28	1.78	17.80	51.0	0.7	5.4	
175	2.20	1.44	14.40	52.5	0.7	4.4	
180	2.77	1.76	17.60	54.1	0.8	5.4	
185	3.38	2.51	25.10	55.6	1.0	7.7	
190	4.50	3.03	30.30	57.1	1.4	9.2	
195	3.25	2.44	24.40	58.6	1.0	7.4	
200	2.85	2.10	21.00	60.2	0.9	6.4	
205	2.30	1.24	12.40	61.7	0.7	3.8	
210	2.02	2.00	20.00	63.2	0.6	6.1	
215	4.52	2.28	22.80	64.7	1.4	6.9	
220	4.61	2.44	24.40	66.3	1.4	7.4	
225	4.66	2.57	25.70	67.8	1.4	7.8	Bottom

2.3 Casing and Screen Installation

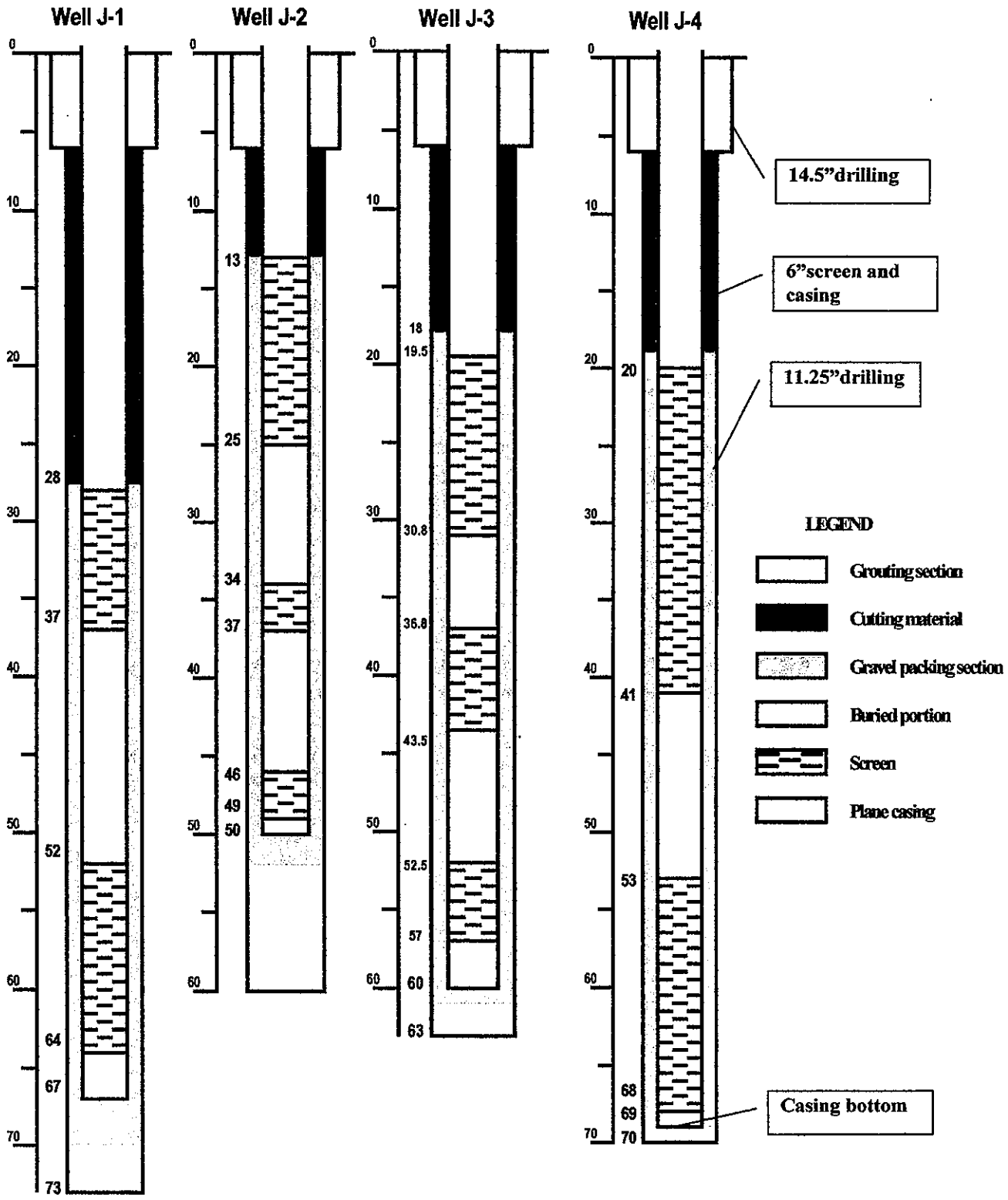
On the basis of the results obtained from the lithological and borehole logs and so forth a consideration made by the supervising Engineer, a casing program was designed. In accordance with the Engineer's instruction on casing program, bottom plug screens and blank casing were installed into the drilled well.

See Figure -2.2 and table-2.3 below for the well section with number screens and casing installed.

Table -2.3: Quantity of Casing and Screen Installed

S/N	Casing			Screen			Total Length (m)		Type
	Number	Diameter Inch, (mm)	Length (mm)	Number	Diameter Inch, (mm)	Length (mm)	Casing	Screen	
J1	15+1.5m	6"(150)	3000	7	6"(150)	3000	46.5	21	UPVC
J2	10+2.5m	6"(150)	3000	6	6"(150)	3000	32.5	18	UPVC
J3	12+2m	6"(150)	3000	10	6"(150)	2250	38	22.5	UPVC
J4	11+0.5m	6"(150)	3000	12	6"(150)	3000	33.5	36	UPVC
TOTAL							150.5	97.5	

Figure -2.2: Screen and Casing Section of Drilled Wells



2.4 Gravel-packing and Grout-sealing

2.4.1 Gravel-packing

Immediately after the casing installation gravel-packing was carried out into the annular space between the pipes and the hole.

The packing gravel was composed of siliceous materials and selected gradation approved by the supervising Engineer.

Adequate care was taken in dropping gravel at equal rate and shaking the pipes to avoid sticking and bridging of gravel at the space.

2.4.2 Grout-sealing

Cement grouting of the annular space between the hole and the casing pipes was carried out at the uppermost six (6) meter portion of all the wells. (See figure -2.2 above)

2.5 Well Development

Upon installation of the casings and screens and completion of gravel-packing the wells were developed by jetting the water from the well out.

Well development was lasted until when lifted water was judged to be free from mud, sand and other suspensions, and otherwise instructed by the supervising engineer.

3.0 Pumping Test

3.1 Equipment and Devices

The pumping test was conducted using the following devices / Equipment:

- A 7.5HP (5.5KW) submersible pump which has a capacity of 180L/min at 40m total head.
- A 1.0Hp(1.1kw) submersible pump which has a capacity of 50L/min at 42m total head
- A 90° V-notch Orifice for the measurement of discharge.
- Electric deep meter for measurements of water level in well during pumping and recovery tests.
- A 22.5KVA generator (50Hz) for power supply to the submersible pump.

Table – 3.1: Characteristics of Pump & Generator

Submersible Pump						Generator	
Name	Model	Power Rating		Head	Capacity	Power Rating	Frequency
		HP	KW	M	L/min	KVA	Hz
Rock Electro pump	4SD8/38 4SD5500T	7.5	5.5	40 21	100 160	22.5	50
Q & P Sumoto	QSP4E-8 OPM100	1.0	1.1	40 6	50 190	0.75	50

3.2 Preliminary Test

In all well locations (J1-J4) after setting all equipment and devices, the pumping equipment were calibrated at various pumping rate in order to assure that all equipment was functioning properly and to choose the pumping rate for the subsequent step – drawn down test. The drawn down and yield were presumed throughout the test.

The pumping rate was modified by the supervising Engineer according to the drawn down at the well, and the preliminary pumping was continued for six (6) hours.

The natural water level of the wells were carefully measured before and after pumping, and the tests described below were started after the water level recovered to the original water or approximate value.

3.3 Multi-Stage Test

The water from the well was pumped continuously for at least four (4) increasing discharge rates, maintaining each rate at a stable water level for two hours.
The pumping rate of each step was fixed by the supervising Engineer based on the result of the preliminary test. For each pump discharge, the water level was measured and recorded in the manner shown in the table below

3.4 Constant Discharge and Recovery Test

Pumping was continued for at least 72 Hours without any interruption (Except for J4 where the water yield was very small) .The constant discharge rate was fixed as per the Engineer's instruction.
Water level of the wells were measured and recorded during full pumping, and recorded period. The recovery test was started immediately the 72 hours pumping elapsed and was continued for at least six (6) hours.

3.5 Pumping Test Record

The pumping test records is summarized as shown in table- 3.2 and table -3.3. The pumping test records for the wells (J1 – J4) are shown in Table -3.4 attached on the following pages.

Table-3.2 Summary of Multi-stage Pumping Test

NO.	Stage	1	2	3	4	5
J1	Yield (L/min)	32.2	66.6	97.6	129.4	152.1
	Drawdown (m)	1.94	5.17	9.60	16.14	22.56
J2	Yield (L/min)	12.0	20.7	33.2	41.3	-
	Drawdown (m)	3.28	7.95	14.51	33.9	-
J3	Yield (L/min)	10.5	22.9	36.0	47.0	-
	Drawdown (m)	3.44	5.71	6.37	40.42	-
J4	Yield (L/min)	6.0	11.0	14.2	-	-
	Drawdown (m)	6.09	25.18	33.76	-	-

Table-3.3 Summary of Constant Discharge Pumping Test and Recovery Test

No.	Constant Discharge Pumping Test			Recovery Test	
	Yield(L/min)	Duration (min)	Drawdown(m)	Duration (min)	Drawdown(m)
J1	108.9	4320	16.85	5760	0.04
J2	19.3	4320	17.32	4320	0.16
J3	18.6	4320	6.64	2580	-0.05
J4	8.7	300	33.62	1020	0.04

Table-3.4: Pumping Test Record

PUMPING TEST RECORD								
Well No.: J-1			Test Type: Multi-Stage Pumping Test				Date:	7th Apr. 2009
Pump Type & Name:		Rock electropump 4SD8/38 (5.5kw)			Pump Capacity: 160lit/m		Set Depth:	30m
Discharge Pipe: Dia.		2"	Observation Point Hight: 0.75m			Measurment Device:		V-notch tank
Test Record (1 / 3)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
14:00	0	0	6.26	5.51				Stage1
	0.5	0.5	6.35	5.60				
14:01	1	1	6.40	5.65				
	1.5	1.5	6.45	5.70				
14:02	2	2	6.46	5.71				
	2.5	2.5	6.81	6.06				
14:03	3	3	6.92	6.17	86	43	32.2	
	3.5	3.5	6.97	6.22				
14:04	4	4	7.01	6.26				
	4.5	4.5	7.08	6.33				
14:05	5	5	7.13	6.38				
14:06	6	6	7.24	6.49				
14:07	7	7	7.36	6.61				
14:08	8	8	7.46	6.71				
14:09	9	9	7.52	6.77				
14:10	10	10	7.56	6.81	86	43	32.2	
14:11	11	11	7.57	6.82				
14:12	12	12	7.59	6.84				
14:13	13	13	7.60	6.85				
14:14	14	14	7.61	6.86				
14:15	15	15	7.62	6.87	86	43	32.2	
14:20	20	20	7.68	6.93				
14:25	25	25	7.72	6.97				
14:30	30	30	7.78	7.03				
14:40	40	40	7.88	7.13				
14:50	50	50	7.95	7.20	86	43	32.2	
15:00	60	60	7.99	7.24				
15:10	70	70	8.04	7.29				
15:20	80	80	8.09	7.34				
15:30	90	90	8.11	7.36				
15:40	100	100	8.15	7.40	86	43	32.2	
15:50	110	110	8.17	7.42				
16:00	120	120	8.20	7.45				
	0							Stage2
	0.5	120.5	8.23	7.48				
16:01	1	121	8.70	7.95				
	1.5	121.5	8.90	8.15				
16:02	2	122	9.00	8.25				
	2.5	122.5	9.17	8.42				
16:03	3	123	9.30	8.55				
	3.5	123.5	9.34	8.59				
16:04	4	124	9.50	8.75	115	57.5	66.6	
	4.5	124.5	9.65	8.90				
16:05	5	125	9.75	9.00				
16:06	6	126	9.91	9.16				
16:07	7	127	10.07	9.32				
16:08	8	128	10.28	9.53				
16:09	9	129	10.38	9.63				
16:10	10	130	10.40	9.65				
16:11	11	131	10.41	9.66				
16:12	12	132	10.43	9.68				
16:13	13	133	10.40	9.65				
16:14	14	134	10.41	9.66				
16:15	15	135	10.42	9.67	115	57.5	66.6	
16:20	20	140	10.44	9.69				
16:25	25	145	10.45	9.70				
16:30	30	150	10.54	9.79				

PUMPING TEST RECORD								
Well No.: J-1			Test Type: Multi-Stage Pumping Test				Date:	7th Apr. 2009
Pump Type & Name:		Rock electropump 4SD8/38 (5.5kw)			Pump Capacity: 160lit/m		Set Depth:	30m
Discharge Pipe: Dia.		2"	Observation Point Hight: 0.75m			Measurment Device:		V-notch tank
Test Record (2 / 3)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
16:40	40	160	10.71	9.96				
16:50	50	170	10.84	10.09	115	57.5	66.6	
17:00	60	180	10.94	10.19				
17:10	70	190	10.98	10.23				
17:20	80	200	11.14	10.39				
17:30	90	210	11.20	10.45				
17:40	100	220	11.29	10.54				
17:50	110	230	11.37	10.62	115	57.5	66.6	
18:00	120	240	11.43	10.68				
	0							Stage3
	0.5	240.5	12.24	11.49				
18:01	1	241	12.80	12.05				
	1.5	241.5	13.03	12.28				
18:02	2	242	13.20	12.45				
	2.5	242.5	13.65	12.90				
18:03	3	243	13.95	13.20				
	3.5	243.5	14.07	13.32				
18:04	4	244	14.18	13.43	134	67	97.6	
	4.5	244.5	14.22	13.47				
18:05	5	245	14.30	13.55				
18:06	6	246	14.33	13.58				
18:07	7	247	14.36	13.61				
18:08	8	248	14.40	13.65				
18:09	9	249	14.47	13.72				
18:10	10	250	14.53	13.78	134	67	97.6	
18:11	11	251	14.58	13.83				
18:12	12	252	14.62	13.87				
18:13	13	253	14.67	13.92				
18:14	14	254	14.70	13.95				
18:15	15	255	14.74	13.99				
18:20	20	260	14.79	14.04	134	67	97.6	
18:25	25	265	14.28	14.08				
18:30	30	270	14.42	14.11				
18:40	40	280	14.63	14.16				
18:50	50	290	14.80	14.21				
19:00	60	300	15.00	14.25	134	67	97.6	
19:10	70	310	15.15	14.40				
19:20	80	320	15.34	14.59				
19:30	90	330	15.52	14.77				
19:40	100	340	15.69	14.94	134	67	97.6	
19:50	110	350	15.76	15.01				
20:00	120	360	15.86	15.11				
	0							Stage4
	0.5	360.5	15.98	15.23				
20:01	1	361	16.46	15.71				
	1.5	361.5	16.67	15.92				
20:02	2	362	16.91	16.16				
	2.5	362.5	17.53	16.78				
20:03	3	363	17.94	17.19	150	75	129.4	
	3.5	363.5	18.06	17.31				
20:04	4	364	18.10	17.35				
	4.5	364.5	18.34	17.59				
20:05	5	365	18.50	17.75				
20:06	6	366	18.66	17.91				
20:07	7	367	18.90	18.15				
20:08	8	368	19.05	18.30				
20:09	9	369	19.22	18.47				

PUMPING TEST RECORD								
Well No.: J-1			Test Type: Multi-Stage Pumping Test				Date:	7th Apr. 2009
Pump Type & Name:		Rock electropump 4SD8/38 (5.5kw)			Pump Capacity: 160lit/m		Set Depth:	30m
Discharge Pipe: Dia.		2"	Observation Point Hight: 0.75m			Measurment Device:		V-notch tank
Test Record (3 / 3)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
20:10	10	370	19.30	18.55				
20:11	11	371	19.37	18.62				
20:12	12	372	19.47	18.72				
20:13	13	373	19.54	18.79				
20:14	14	374	19.62	18.87				
20:15	15	375	19.69	18.94				
20:20	20	380	19.96	19.21	150	75	129.4	
20:25	25	385	20.21	19.46				
20:30	30	390	20.40	19.65				
20:40	40	400	20.72	19.97				
20:50	50	410	20.97	20.22	150	75	129.4	
21:00	60	420	21.25	20.50				
21:10	70	430	21.49	20.74				
21:20	80	440	21.65	20.90				
21:30	90	450	21.85	21.10				
21:40	100	460	22.02	21.27	150	75	129.4	
21:50	110	470	22.25	21.50				
22:00	120	480	22.40	21.65				
	0							Stage5
	0.5	480.5	23.94	23.19				
22:01	1	481	25.37	24.62				
	1.5	481.5	25.62	24.87				
22:02	2	482	25.80	25.05	162	81	156.9	
	2.5	482.5	25.94	25.19				
22:03	3	483	26.05	25.30				
	3.5	483.5	26.15	25.40				
22:04	4	484	26.23	25.48				
	4.5	484.5	26.31	25.56				
22:05	5	485	26.38	25.63				
22:06	6	486	26.49	25.74				
22:07	7	487	26.59	25.84				
22:08	8	488	26.68	25.93				
22:09	9	489	26.76	26.01				
22:10	10	490	26.83	26.08	160	80	152.1	
22:11	11	491	26.89	26.14				
22:12	12	492	26.95	26.20				
22:13	13	493	27.00	26.25				
22:14	14	494	27.05	26.30				
22:15	15	495	27.10	26.35				
22:20	20	500	27.30	26.55				
22:25	25	505	27.47	26.72				
22:30	30	510	27.60	26.85				
22:40	40	520	27.82	27.07				
22:50	50	530	28.00	27.25				
23:00	60	540	28.16	27.41	160	80	152.1	
23:10	70	550	28.29	27.54				
23:20	80	560	28.41	27.66				
23:30	90	570	28.52	27.77				
23:40	100	580	28.62	27.87				
23:50	110	590	28.71	27.96	160	80	152.1	
0:00	120	600	28.82	28.07				

PUMPING TEST RECORD								
Well No.: J-1			Test Type: Constant Discharge Pumping Test				Date:	8th-11th Apr. 2009
Pump Type & Name:		Rock electropump 4SD8/38 (5.5kw)			Pump Capacity: 160lit/m		Set Depth:	30m
Discharge Pipe: Dia.		2"	Observation Point Hight: 0.75m			Measurment Device:		V-notch tank
Test Record (1 / 2)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
13:00	0	0	7.31	6.56				8th Apr. 2009
	0.5	0.5	10.50	9.75				
13:01	1	1	11.05	10.30				
	1.5	1.5	11.20	10.45				
13:02	2	2	11.31	10.56	140	70	108.9	
	2.5	2.5	11.55	10.80				
13:03	3	3	11.95	11.20				
	3.5	3.5	12.10	11.35				
13:04	4	4	12.40	11.65				
	4.5	4.5	12.56	11.81				
13:05	5	5	12.69	11.94	140	70	108.9	
13:05	6	6	12.71	11.96				
13:07	7	7	12.70	11.95				
13:08	8	8	12.76	12.01				
13:09	9	9	12.83	12.08				
13:10	10	10	12.93	12.18	140	70	108.9	
13:11	11	11	13.01	12.26				
13:12	12	12	13.10	12.35				
13:13	13	13	13.18	12.43				
13:14	14	14	13.27	12.52				
13:15	15	15	13.35	12.60				
13:20	20	20	13.70	12.95				
13:25	25	25	13.94	13.19				
13:30	30	30	14.20	13.45	140	70	108.9	
13:45	45	45	14.82	14.07				
14:00	1:00	60	15.20	14.45	140	70	108.9	
14:15	1:15	75	15.58	14.83				
14:30	1:30	90	15.87	15.12				
14:45	1:45	105	16.13	15.38				
15:00	2:00	120	16.38	15.63	140	70	108.9	
14:15	2:15	135	16.57	15.82				
15:30	2:30	150	16.76	16.01				
15:45	2:45	165	16.89	16.14				
16:00	3:00	180	17.50	16.75				
16:30	3:30	210	17.36	16.61				
17:00	4:00	240	17.52	16.77				
17:30	4:30	270	17.75	17.00				
18:00	5:00	300	17.89	17.14				
18:30	5:30	330	18.11	17.36				
19:00	6:00	360	18.34	17.59	140	70	108.9	
20:00	7:00	420	18.67	17.92				
21:00	8:00	480	18.79	18.04				
22:00	9:00	540	19.16	18.41				
23:00	10:00	600	19.44	18.69				
0:00	11:00	660	19.78	19.03				9th Aor.2009
1:00	12:00	720	19.99	19.24	140	70	108.9	
2:00	13:00	780	20.20	19.45				
3:00	14:00	840	20.39	19.64				
4:00	15:00	900	20.55	19.80				
5:00	16:00	960	20.65	19.90				
6:00	17:00	1020	20.80	20.05				
7:00	18:00	1080	20.98	20.23	140	70	108.9	
8:00	19:00	1140	21.13	20.38				
9:00	20:00	1200	21.16	20.41				
10:00	21:00	1260	21.35	20.60				
11:00	22:00	1320	21.48	20.73				
12:00	23:00	1380	21.55	20.80				
13:00	24:00	1440	21.68	20.93	140	70	108.9	
14:00	25:00	1500	21.76	21.01				

PUMPING TEST RECORD								
Well No.: J-1			Test Type: Constant Discharge Pumping Test				Date:	8th-11th Apr. 2009
Pump Type & Name:		Rock electropump 4SD8/38 (5.5kw)			Pump Capacity: 160lit/m		Set Depth:	30m
Discharge Pipe: Dia.		2"	Observation Point Hight: 0.75m			Measurment Device:		V-notch tank
Test Record (2 / 2)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
15:00	26:00	1560	21.83	21.08				
16:00	27:00	1620	21.91	21.16				
17:00	28:00	1680	21.99	21.24	140	70	108.9	
18:00	29:00	1740	22.00	21.25				
19:00	30:00	1800	22.01	21.26				
20:00	31:00	1860	22.08	21.33				
21:00	32:00	1920	22.27	21.52				
22:00	33:00	1980	22.33	21.58				
23:00	34:00	2040	22.33	21.58				
0:00	35:00	2100	22.40	21.65	140	70	108.9	10th Apr.2009
1:00	36:00	2160	22.47	21.72				
2:00	37:00	2220	22.50	21.75				
3:00	38:00	2280	22.61	21.86				
4:00	39:00	2340	22.74	21.99				
5:00	40:00	2400	22.76	22.01				
6:00	41:00	2460	22.85	22.10	140	70	108.9	
7:00	42:00	2520	22.91	22.16				
8:00	43:00	2580	22.97	22.22				
9:00	44:00	2640	23.01	22.26				
10:00	45:00	2700	23.05	22.30				
11:00	46:00	2760	23.13	22.38				
12:00	47:00	2820	23.18	22.43	140	70	108.9	
13:00	48:00	2880	23.10	22.35				
14:00	49:00	2940	23.14	22.39				
15:00	50:00	3000	23.12	22.37				
16:00	51:00	3060	23.20	22.45				
17:00	52:00	3120	23.23	22.48				
18:00	53:00	3180	23.27	22.52	140	70	108.9	
19:00	54:00	3240	23.28	22.53				
20:00	55:00	3300	23.32	22.57				
21:00	56:00	3360	23.38	22.63				
22:00	57:00	3420	23.34	22.59				
23:00	58:00	3480	23.39	22.64				
0:00	59:00	3540	23.44	22.69	140	70	108.9	11th Apr.2009
1:00	60:00	3600	23.45	22.70				
2:00	61:00	3660	23.50	22.75				
3:00	62:00	3720	23.53	22.78				
4:00	63:00	3780	23.60	22.85				
5:00	64:00	3840	23.64	22.89				
6:00	65:00	3900	23.69	22.94	140	70	108.9	
7:00	66:00	3960	23.75	23.00				
8:00	67:00	4020	23.75	23.00				
9:00	68:00	4080	23.77	23.02				
10:00	69:00	4140	23.82	23.07				
11:00	70:00	4200	24.02	23.27				
12:00	71:00	4260	24.11	23.36	140	70	108.9	
13:00	72:00	4320	24.16	23.41				

PUMPING TEST RECORD								
Well No.: J-1			Test Type: Recovery Test				Date:	11th-15th Apr. 2009
Pump Type & Name:		Rock electropump 4SD8/38 (5.5kw)			Pump Capacity: 160lit/m		Set Depth:	30m
Discharge Pipe: Dia.		2"	Observation Point Hight: 0.75m		Measurment Device:			V-notch tank
Test Record (1 / 2)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
13:00	0	4320	24.16	23.41				11th Apr.2009
	0.5	4320.5	20.91	20.16				
13:01	1	4321	20.17	19.42				
	1.5	4321.5	19.84	19.09				
13:02	2	4322	18.30	17.55				
	2.5	4322.5	18.99	18.24				
13:03	3	4323	18.83	18.08				
	3.5	4323.5	18.75	18.00				
13:04	4	4324	18.61	17.86				
	4.5	4324.5	18.39	17.64				
13:05	5	4325	18.23	17.48				
13:05	6	4326	18.07	17.32				
13:07	7	4327	17.84	17.09				
13:08	8	4328	17.51	16.76				
13:09	9	4329	17.41	16.66				
13:10	10	4330	17.37	16.62				
13:11	11	4331	17.28	16.53				
13:12	12	4332	17.15	16.40				
13:13	13	4333	17.07	16.32				
13:14	14	4334	16.89	16.14				
13:15	15	4335	16.85	16.10				
13:20	20	4340	16.38	15.63				
13:25	25	4345	16.23	15.48				
13:30	30	4350	16.05	15.30				
13:45	45	4365	15.55	14.80				
14:00	1:00	4380	15.17	14.42				
14:15	1:15	4395	14.85	14.10				
14:30	1:30	4410	14.58	13.83				
14:45	1:45	4425	14.26	13.51				
15:00	2:00	4440	14.10	13.35				
14:15	2:15	4449	13.92	13.17				
15:30	2:30	4470	13.75	13.00				
15:45	2:45	4485	13.58	12.83				
16:00	3:00	4500	13.43	12.68				
16:30	3:30	4530	13.17	12.42				
17:00	4:00	4560	12.93	12.18				
17:30	4:30	4590	12.72	11.97				
18:00	5:00	4620	12.54	11.79				
18:30	5:30	4650	12.37	11.62				
19:00	6:00	4680	12.20	11.45				
20:00	7:00	4740	12.08	11.33				
21:00	8:00	4800	11.96	11.21				
22:00	9:00	4860	11.84	11.09				
23:00	10:00	4920	11.72	10.97				
0:00	11:00	4980	11.60	10.85				12th Apr. 2009
1:00	12:00	5040	11.48	10.73				
2:00	13:00	5100	11.35	10.60				
3:00	14:00	5160	11.23	10.48				
4:00	15:00	5220	11.11	10.36				
5:00	16:00	5280	10.98	10.23				
6:00	17:00	5340	10.86	10.11				
7:00	18:00	5400	10.74	9.99				
8:00	19:00	5460	10.62	9.87				
9:00	20:00	5520	10.50	9.75				
10:00	21:00	5580	10.39	9.64				
11:00	22:00	5640	10.28	9.53				
12:00	23:00	5700	10.17	9.42				
13:00	24:00	5760	10.06	9.31				
14:00	25:00	5820	9.95	9.20				

PUMPING TEST RECORD								
Well No.: J-1			Test Type: Recovery Test				Date:	11th-15th Apr. 2009
Pump Type & Name:		Rock electropump 4SD8/38 (5.5kw)			Pump Capacity: 160lit/m		Set Depth:	30m
Discharge Pipe: Dia.		2"	Observation Point Hight: 0.75m			Measurment Device:		V-notch tank
Test Record (2 / 2)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
19:00	30:00	6180	9.50	8.75				12th Apr.2009
13:00	48:00	7200	7.49	6.74				13th Apr.2009
9:00	68:00	8400	6.91	6.16				14th Apr.2009
17:00	76:00	8880	6.78	6.03				
13:00	96:00	10080	6.30	5.55				15th Apr.2009

PUMPING TEST RECORD								
Well No.: J-2			Test Type: Multi-Stage Pumping Test				Date:	2nd May 2009
Pump Type & Name:		Rock electropump 4SD8/38 (5.5kw)			Pump Capacity: 160lit/m		Set Depth:	39m
Discharge Pipe: Dia.		2"	Observation Point Hight: 0.68m			Measurment Device:		V-notch tank
Test Record (1 / 3)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
7:49	0	0	5.01	4.33				Stage1
	0.5	0.5	5.21	4.53				
7:50	1	1	5.32	4.64				
	1.5	1.5	5.43	4.75				
7:51	2	2	5.55	4.87	58	29	12.0	
	2.5	2.5	5.60	4.92				
7:52	3	3	5.72	5.04				
	3.5	3.5	6.01	5.33				
7:53	4	4	6.25	5.57				
	4.5	4.5	6.42	5.74				
7:54	5	5	6.64	5.96	58	29	12.0	
7:55	6	6	6.71	6.03				
7:56	7	7	6.75	6.07				
7:57	8	8	6.82	6.14				
7:58	9	9	6.86	6.18				
7:59	10	10	6.70	6.02	57	28.5	11.5	
8:00	11	11	6.57	5.89				
8:01	12	12	6.50	5.82				
8:02	13	13	6.48	5.80				
8:03	14	14	6.49	5.81				
8:04	15	15	6.79	6.11	57	28.5	11.5	
8:09	20	20	7.16	6.48				
8:14	25	25	7.22	6.54				
8:19	30	30	7.25	6.57	57	28.5	11.5	
8:29	40	40	7.20	6.52				
8:39	50	50	7.22	6.54				
8:49	60	60	7.29	6.61	57	28.5	11.5	
8:59	70	70	7.32	6.64				
9:09	80	80	7.37	6.69				
9:19	90	90	7.42	6.74				
9:29	100	100	7.45	6.77	57	28.5	11.5	
9:39	110	110	7.58	6.90				
9:49	120	120	7.61	6.93				
	0							Stage2
	0.5	120.5	8.23	7.55				
9:50	1	121	8.28	7.60				
	1.5	121.5	8.90	8.22				
9:51	2	122	9.22	8.54	68	34	17.9	
	2.5	122.5	9.17	8.49				
9:52	3	123	9.75	9.07				
	3.5	123.5	9.34	8.66				
9:53	4	124	9.90	9.22	70	35	19.3	
	4.5	124.5	9.65	8.97				
9:54	5	125	9.54	8.86				
9:55	6	126	9.34	8.66				
9:56	7	127	9.27	8.59				
9:57	8	128	9.20	8.52				
9:58	9	129	9.22	8.54				
9:59	10	130	9.32	8.64	72	36	20.7	
10:00	11	131	9.38	8.70				
10:01	12	132	9.45	8.77				
10:02	13	133	9.56	8.88				
10:03	14	134	9.61	8.93				
10:04	15	135	9.69	9.01	72	36	20.7	
10:09	20	140	9.93	9.25				
10:14	25	145	10.12	9.44				
10:19	30	150	10.34	9.66	72	36	20.7	

PUMPING TEST RECORD								
Well No.: J-2			Test Type: Multi-Stage Pumping Test				Date:	2nd May 2009
Pump Type & Name:		Rock electropump 4SD8/38 (5.5kw)			Pump Capacity: 160lit/m		Set Depth:	39m
Discharge Pipe: Dia.		2"	Observation Point Hight: 0.68m			Measurment Device:		V-notch tank
Test Record (2 / 3)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
10:29	40	160	11.02	10.34				
10:39	50	170	10.80	10.12	72	36	20.7	
10:49	60	180	10.70	10.02				
10:59	70	190	11.56	10.88				
10:09	80	200	11.77	11.09				
10:19	90	210	11.78	11.10				
10:29	100	220	12.21	11.53				
10:39	110	230	12.70	12.02	72	36	20.7	
10:49	120	240	12.96	12.28				
	0							Stage3
	0.5	240.5	13.04	12.36				
10:50	1	241	13.66	12.98				
	1.5	241.5	13.85	13.17				
10:51	2	242	14.09	13.41	84	42	30.4	
	2.5	242.5	14.17	13.49				
10:52	3	243	14.26	13.58				
	3.5	243.5	14.46	13.78				
10:53	4	244	14.55	13.87				
	4.5	244.5	14.22	13.54				
10:54	5	245	14.54	13.86	85	42.5	31.3	
10:55	6	246	14.71	14.03				
10:56	7	247	14.90	14.22				
10:57	8	248	15.12	14.44				
10:58	9	249	15.17	14.49				
10:59	10	250	15.21	14.53	86	43	32.2	
11:00	11	251	15.27	14.59				
11:01	12	252	15.70	15.02				
11:02	13	253	16.60	15.92				
11:03	14	254	16.20	15.52				
11:04	15	255	16.32	15.64	86	43	33.2	
11:09	20	260	16.44	15.76				
11:14	25	265	17.21	16.53				
11:19	30	270	17.63	16.95	86	43	33.2	
11:29	40	280	17.82	17.14				
11:39	50	290	17.85	17.17				
11:49	60	300	17.95	17.27	86	43	33.2	
11:59	70	310	18.33	17.65				
12:09	80	320	18.60	17.92				
12:19	90	330	18.92	18.24				
12:29	100	340	19.25	18.57	86	43	33.2	
12:39	110	350	19.47	18.79				
12:49	120	360	19.52	18.84				
	0							Stage4
	0.5	360.5	20.75	20.07				
12:50	1	361	20.75	20.07				
	1.5	361.5	21.07	20.39				
12:51	2	362	21.38	20.70				
	2.5	362.5	21.52	20.84				
12:52	3	363	21.69	21.01	96	48	42.4	
	3.5	363.5	21.77	21.09				
12:53	4	364	21.87	21.19				
	4.5	364.5	21.91	21.23				
12:54	5	365	22.00	21.32				
12:55	6	366	22.05	21.37	96	48	42.4	
12:56	7	367	22.09	21.41				
12:57	8	368	22.14	21.46				
12:58	9	369	22.17	21.49				

PUMPING TEST RECORD								
Well No.: J-2			Test Type: Multi-Stage Pumping Test				Date:	2nd May 2009
Pump Type & Name:		Rock electropump 4SD8/38 (5.5kw)			Pump Capacity: 160lit/m		Set Depth:	39m
Discharge Pipe: Dia.		2"	Observation Point Hight: 0.68m			Measurment Device:		V-notch tank
Test Record (3 / 3)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
12:59	10	370	22.20	21.52	95	47.5	41.3	
13:00	11	371	22.25	21.57				
13:01	12	372	22.54	21.86				
13:02	13	373	22.81	22.13				
13:03	14	374	22.86	22.18				
13:04	15	375	22.85	22.17	95	47.5	41.3	
13:09	20	380	23.66	22.98				
13:14	25	385	23.82	23.14				
13:19	30	390	23.89	23.21	95	47.5	41.3	
13:29	40	400	28.70	28.02				
13:39	50	410	35.70	35.02	95	47.5	41.3	
13:49	60	420	39.00	38.32				
	70							
	80							
	90							
	100							
	110							
	120							
	0							Stage5
	0.5							
	1							
	1.5							
	2							
	2.5							
	3							
	3.5							
	4							
	4.5							
	5							
	6							
	7							
	8							
	9							
	10							
	11							
	12							
	13							
	14							
	15							
	20							
	25							
	30							
	40							
	50							
	60							
	70							
	80							
	90							
	100							
	110							
	120							

PUMPING TEST RECORD								
Well No.: J-2			Test Type: Constant Discharge Pumping Test				Date:	3rd-6th May 2009
Pump Type & Name:		Rock electropump 4SD8/38 (5.5kw)			Pump Capacity: 160lit/m		Set Depth:	39m
Discharge Pipe: Dia.		2"	Observation Point Hight: 1.19m			Measurment Device:		V-notch tank
Test Record (1 / 2)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
11:56	0	0	5.99	4.80				3rd May 2009
	0.5	0.5	6.15	4.96				
11:57	1	1	7.98	6.79				
	1.5	1.5	8.19	7.00				
11:58	2	2	8.20	7.01				
	2.5	2.5	8.65	7.46				
11:59	3	3	9.05	7.86	75	37.5	22.9	
	3.5	3.5	9.35	8.16				
12:00	4	4	9.58	8.39				
	4.5	4.5	9.65	8.46				
12:01	5	5	9.87	8.68				
12:02	6	6	9.97	8.78	75	37.5	22.9	
12:03	7	7	9.84	8.65				
12:04	8	8	10.18	8.99				
12:05	9	9	10.50	9.31				
12:06	10	10	10.76	9.57	75	37.5	22.9	
12:07	11	11	11.00	9.81				
12:08	12	12	11.11	9.92				
12:09	13	13	11.26	10.07				
12:10	14	14	11.38	10.19				
12:11	15	15	11.50	10.31				
12:16	20	20	12.02	10.83				
12:21	25	25	12.40	11.21				
12:26	30	30	12.65	11.46	75	37.5	22.9	
12:41	45	45	13.38	12.19				
12:56	1:00	60	13.92	12.73	75	37.5	22.9	
13:11	1:15	75	14.32	13.13				
13:26	1:30	90	14.57	13.38				
13:41	1:45	105	14.89	13.70				
13:56	2:00	120	15.13	13.94	72	36	19.9	
14:11	2:15	129	15.32	14.13				
14:26	2:30	150	15.50	14.31				
14:41	2:45	165	15.61	14.42				
14:56	3:00	180	15.73	14.54	72	36	19.9	
15:26	3:30	210	16.03	14.84				
15:56	4:00	240	16.22	15.03				
16:26	4:30	270	16.42	15.23				
16:56	5:00	300	16.60	15.41				
17:26	5:30	330	16.83	15.64				
17:56	6:00	360	16.97	15.78	72	36	19.9	
18:56	7:00	420	17.28	16.09				
19:56	8:00	480	17.46	16.27				
20:56	9:00	540	17.70	16.51				
21:56	10:00	600	17.95	16.76				
22:56	11:00	660	18.16	16.97	72	36	19.9	
23:56	12:00	720	18.30	17.11				
0:56	13:00	780	18.33	17.14				4th May 2009
1:56	14:00	840	18.41	17.22				
2:56	15:00	900	18.62	17.43				
3:56	16:00	960	18.72	17.53				
4:56	17:00	1020	18.83	17.64				
5:56	18:00	1080	18.91	17.72	72	36	19.9	
6:56	19:00	1140	19.02	17.83				
7:56	20:00	1200	19.24	18.05				
8:56	21:00	1260	19.36	18.17				
9:56	22:00	1320	19.46	18.27				
10:56	23:00	1380	19.53	18.34				
11:56	24:00	1440	20.00	18.81	72	36	19.9	
12:56	25:00	1500	20.35	19.16				

PUMPING TEST RECORD								
Well No.: J-2			Test Type: Constant Discharge Pumping Test				Date:	3rd-6th May 2009
Pump Type & Name:		Rock electropump 4SD8/38 (5.5kw)			Pump Capacity: 160lit/m		Set Depth:	39m
Discharge Pipe: Dia.		2"	Observation Point Hight: 1.19m			Measurment Device:		V-notch tank
Test Record (2 / 2)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
13:56	26:00	1560	21.71	20.52				
14:56	27:00	1620	21.95	20.76				
15:56	28:00	1680	22.14	20.95				
16:56	29:00	1740	22.30	21.11	70	35	19.3	
17:56	30:00	1800	22.39	21.20				
18:56	31:00	1860	22.44	21.25				
19:56	32:00	1920	22.47	21.28	70	35	19.3	
20:56	33:00	1980	22.50	21.31				
21:56	34:00	2040	22.55	21.36				
22:56	35:00	2100	22.58	21.39				
23:56	36:00	2160	22.61	21.42	70	35	19.3	
0:56	37:00	2220	22.67	21.48				5th May 2006
1:56	38:00	2280	22.73	21.54				
2:56	39:00	2340	22.81	21.62				
3:56	40:00	2400	22.87	21.68				
4:56	41:00	2460	22.87	21.68				
5:56	42:00	2520	22.95	21.76	70	35	19.3	
6:56	43:00	2580	22.95	21.76				
7:56	44:00	2640	22.95	21.76				
8:56	45:00	2700	22.95	21.76				
9:56	46:00	2760	22.93	21.74				
10:56	47:00	2820	22.96	21.77				
11:56	48:00	2880	23.00	21.81	70	35	19.3	
12:56	49:00	2940	23.01	21.82				
13:56	50:00	3000	22.09	21.81				
14:56	51:00	3060	23.02	21.83				
15:56	52:00	3120	23.00	21.81				
16:56	53:00	3180	22.02	21.86				
17:56	54:00	3240	23.16	21.97	70	35	19.3	
18:56	55:00	3300	23.21	22.02				
19:56	56:00	3360	23.23	22.04				
20:56	57:00	3420	23.24	22.05				
21:56	58:00	3480	23.25	22.06				
22:56	59:00	3540	23.28	22.09				
23:56	60:00	3600	23.28	22.09	70	35	19.3	
0:56	61:00	3660	23.30	22.11				6th May 2009
1:56	62:00	3720	23.29	22.10				
2:56	63:00	3780	23.28	22.09				
3:56	64:00	3840	23.29	22.10				
4:56	65:00	3900	23.28	22.09				
5:56	66:00	3960	23.28	22.09	70	35	19.3	
6:56	67:00	4020	23.27	22.08				
7:56	68:00	4080	23.27	22.08				
8:56	69:00	4140	23.28	22.09				
9:56	70:00	4200	23.30	22.11				
10:56	71:00	4260	23.30	22.11				
11:56	72:00	4320	23.31	22.12	70	35	19.3	

PUMPING TEST RECORD								
Well No.: J-2			Test Type: Recovery Test				Date:	6th-9th May 2009
Pump Type & Name:		Rock electropump 4SD8/38 (5.5kw)			Pump Capacity: 160lit/m		Set Depth:	39m
Discharge Pipe: Dia.		2"	Observation Point Hight: 1.19m		Measurment Device:			V-notch tank
Test Record (1 / 2)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
11:56	0	4320	23.31	22.12				6th May 2009
	0.5	4320.5	23.18	21.99				
11:57	1	4321	22.87	21.68				
	1.5	4321.5	22.71	21.52				
11:58	2	4322	22.69	21.50				
	2.5	4322.5	22.67	21.48				
11:59	3	4323	22.64	21.45				
	3.5	4323.5	22.63	21.44				
12:00	4	4324	22.62	21.43				
	4.5	4324.5	22.60	21.41				
12:01	5	4325	22.59	21.40				
12:02	6	4326	22.55	21.36				
12:03	7	4327	22.51	21.32				
12:04	8	4328	22.25	21.06				
12:05	9	4329	21.92	20.73				
12:06	10	4330	21.60	20.41				
12:07	11	4331	21.33	20.14				
12:08	12	4332	21.06	19.87				
12:09	13	4333	20.84	19.65				
12:10	14	4334	20.52	19.33				
12:11	15	4335	20.26	19.07				
12:16	20	4340	19.12	17.93				
12:21	25	4345	18.41	17.22				
12:26	30	4350	17.32	16.13				
12:41	45	4365	16.30	15.11				
12:56	1:00	4380	15.09	13.90				
13:11	1:15	4395	14.25	13.06				
13:26	1:30	4410	13.68	12.49				
13:41	1:45	4425	13.18	11.99				
13:56	2:00	4440	12.70	11.51				
14:11	2:15	4449	12.37	11.18				
14:26	2:30	4470	11.99	10.80				
14:41	2:45	4485	11.83	10.64				
14:56	3:00	4500	11.62	10.43				
15:26	3:30	4530	11.26	10.07				
15:56	4:00	4560	10.97	9.78				
16:26	4:30	4590	10.70	9.51				
16:56	5:00	4620	10.49	9.30				
17:26	5:30	4650	10.16	8.97				
17:56	6:00	4680	9.98	8.79				
18:56	7:00	4740	9.79	8.60				
19:56	8:00	4800	9.58	8.39				
20:56	9:00	4860	9.40	8.21				
21:56	10:00	4920	9.23	8.04				
22:56	11:00	4980	9.05	7.86				
23:56	12:00	5040	8.83	7.64				
0:56	13:00	5100	8.65	7.46				7th May 2009
1:56	14:00	5160	8.48	7.29				
2:56	15:00	5220	8.30	7.11				
3:56	16:00	5280	8.12	6.93				
4:56	17:00	5340	7.95	6.76				
5:56	18:00	5400	7.76	6.57				
6:56	19:00	5460	7.59	6.40				
7:56	20:00	5520	7.42	6.23				
8:56	21:00	5580	7.32	6.13				
9:56	22:00	5640	7.21	6.02				
10:56	23:00	5700	7.12	5.93				
11:56	24:00	5760	7.04	5.85				
12:56	26:00	5880	6.97	5.78				

PUMPING TEST RECORD								
Well No.: J-2			Test Type: Recovery Test				Date:	6th-9th May 2009
Pump Type & Name:		Rock electropump 4SD8/38 (5.5kw)			Pump Capacity: 160lit/m		Set Depth:	39m
Discharge Pipe: Dia.		2"	Observation Point Hight: 1.19m			Measurment Device:		V-notch tank
Test Record (2 / 2)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
19:56	32:00	6240	6.67	5.48				
7:56	44:00	6960	6.21	5.02				8-May-09
12:56	49:00	7260	6.13	4.94				
18:56	55:00	7620	6.01	4.82				
7:56	68:00	8400	5.60	4.41				9-May-09
10:56	71:00	8580	5.67	4.48				
11:56	72:00	8640	5.68	4.49				

PUMPING TEST RECORD								
Well No.: J-3			Test Type: Multi-Stage Pumping Test				Date:	12th May 2009
Pump Type & Name:		Rock electropump 4SD8/38 (5.5kw)			Pump Capacity: 160lit/m		Set Depth:	45m
Discharge Pipe: Dia.		2"	Observation Point Hight: 1.00m		Measurment Device:			V-notch tank
Test Record (1 / 3)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
11:56	0	0	3.58	2.98				Stage1
	0.5	0.5	3.98	3.38				
11:57	1	1	4.30	3.70				
	1.5	1.5	4.35	3.75				
11:58	2	2	4.38	3.78	55	27.5	10.5	
	2.5	2.5	4.47	3.87				
11:59	3	3	4.52	3.92				
	3.5	3.5	4.66	4.06				
12:00	4	4	4.74	4.14	55	27.5	10.5	
	4.5	4.5	4.76	4.16				
12:01	5	5	4.77	4.17				
12:02	6	6	4.82	4.22				
12:03	7	7	4.95	4.35				
12:04	8	8	5.11	4.51				
12:05	9	9	5.24	4.64				
12:06	10	10	5.34	4.74				
12:07	11	11	5.54	4.94	55	27.5	10.5	
12:08	12	12	5.52	4.92				
12:09	13	13	5.57	4.97				
12:10	14	14	5.62	5.02				
12:11	15	15	5.65	5.05				
12:16	20	20	5.78	5.18	55	27.5	10.5	
12:21	25	25	5.85	5.25				
12:26	30	30	5.92	5.32				
12:36	40	40	5.92	5.32				
12:46	50	50	5.94	5.34				
12:56	60	60	5.97	5.37	55	27.5	10.5	
13:06	70	70	5.98	5.38				
13:16	80	80	5.97	5.37				
13:26	90	90	6.01	5.41				
13:36	100	100	6.01	5.41				
13:46	110	110	6.02	5.42	55	27.5	10.5	
13:56	120	120	6.02	5.42				
	0							Stage2
	0.5	120.5	6.10	5.50				
13:57	1	121	6.21	5.61				
	1.5	121.5	6.25	5.65				
13:58	2	122	6.30	5.70				
	2.5	122.5	6.35	5.75				
13:59	3	123	6.39	5.79				
	3.5	123.5	6.43	5.83				
14:00	4	124	6.45	5.85	75	37.5	22.9	
	4.5	124.5	6.51	5.91				
14:01	5	125	6.58	5.98				
14:02	6	126	6.90	6.30				
14:03	7	127	7.03	6.43				
14:04	8	128	7.25	6.65				
14:05	9	129	7.50	6.90				
14:06	10	130	7.65	7.05				
14:07	11	131	7.80	7.20	75	37.5	22.9	
14:08	12	132	7.94	7.34				
14:09	13	133	8.04	7.44				
14:10	14	134	8.12	7.52				
14:11	15	135	8.13	7.53				
14:16	20	140	8.55	7.95	75	37.5	22.9	
14:21	25	145	8.68	8.08				
14:26	30	150	8.91	8.31				

PUMPING TEST RECORD								
Well No.: J-3			Test Type: Multi-Stage Pumping Test				Date:	12th May 2009
Pump Type & Name:		Rock electropump 4SD8/38 (5.5kw)			Pump Capacity: 160lit/m		Set Depth:	45m
Discharge Pipe: Dia.		2"	Observation Point Hight: 1.00m			Measurment Device:		V-notch tank
Test Record (2 / 3)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
14:36	40	160	9.19	8.19				
14:46	50	170	9.35	8.35				
14:56	60	180	9.45	8.45	75	37.5	22.9	
15:06	70	190	9.51	8.51				
15:16	80	200	9.55	8.55				
15:26	90	210	9.60	8.60				
15:36	100	220	9.63	8.63				
15:46	110	230	9.65	8.65	75	37.5	22.9	
15:56	120	240	9.69	8.69				
	0							Stage3
	0.5	240.5	9.78	8.78				
15:57	1	241	9.98	8.98				
	1.5	241.5	10.10	9.10				
15:58	2	242	10.03	9.03				
	2.5	242.5	10.04	9.04				
15:59	3	243	10.05	9.05				
	3.5	243.5	10.06	9.06				
16:00	4	244	10.06	9.06	90	45	36.1	
	4.5	244.5	10.06	9.06				
16:01	5	245	10.07	9.07				
16:02	6	246	10.07	9.07				
16:03	7	247	10.09	9.09				
16:04	8	248	10.09	9.09				
16:05	9	249	10.10	9.10				
16:06	10	250	10.11	9.11	90	45	36.1	
16:07	11	251	10.12	9.12				
16:08	12	252	10.12	9.12				
16:09	13	253	10.13	9.13				
16:10	14	254	10.13	9.13				
16:11	15	255	10.05	9.05				
16:16	20	260	10.10	9.10	90	45	36.1	
16:21	25	265	10.17	9.17				
16:26	30	270	10.19	9.19				
16:36	40	280	10.19	9.19				
16:46	50	290	10.21	9.21				
16:56	60	300	10.22	9.22	90	45	36.1	
17:06	70	310	10.25	9.25				
17:16	80	320	10.26	9.26				
17:26	90	330	10.28	9.28				
17:36	100	340	10.30	9.30				
17:46	110	350	10.33	9.33				
17:56	120	360	10.35	9.35				
								Stage4
	0.5	360.5	10.38	9.38				
17:57	1	361	10.40	9.40				
	1.5	361.5	10.41	9.41				
17:58	2	362	10.42	9.42				
	2.5	362.5	10.42	9.42				
17:59	3	363	10.42	9.42	100	50	47.0	
	3.5	363.5	10.43	9.43				
17:00	4	364	10.43	9.43				
	4.5	364.5	10.43	9.43				
18:01	5	365	10.43	9.43				
18:02	6	366	10.46	9.46				
18:03	7	367	10.43	9.43				
18:04	8	368	10.45	9.45				
18:05	9	369	10.46	9.46				

PUMPING TEST RECORD

Well No.: J-3	Test Type: Multi-Stage Pumping Test		Date:	12th May 2009
Pump Type & Name:	Rock electropump 4SD8/38 (5.5kw)	Pump Capacity: 160lit/m	Set Depth:	45m
Discharge Pipe: Dia.	2"	Observation Point Hight: 1.00m	Measurment Device:	V-notch tank

Test Record (3 / 3)

Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
18:06	10	370	10.47	9.47	100	50	47.0	
18:07	11	371	10.48	9.48				
18:08	12	372	10.49	9.49				
18:09	13	373	10.52	9.52				
18:10	14	374	10.53	9.53				
18:11	15	375	10.54	9.54				
18:16	20	380	10.62	9.62	100	50	47.0	
18:21	25	385	10.72	9.72				
18:26	30	390	10.82	9.82				
18:36	40	400	12.70	11.70				
18:46	50	410	24.20	23.20	100	50	47.0	
18:56	60	420	40.40	39.40				
19:06	70	430	44.40	43.40				

PUMPING TEST RECORD								
Well No.: J-3			Test Type: Constant Discharge Pumping Test				Date:	14th-17th May 2009
Pump Type & Name:		Quality & Pump QPS4E-8 (1.1kw)			Pump Capacity: 50lit/m		Set Depth:	31m
Discharge Pipe: Dia.		1.5"	Observation Point Hight:		1.10	Measurment Device:		V-notch tank
Test Record (1 / 2)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
13:20	0	0	3.70	2.60				14th May 2009
	0.5	0.5	5.09	3.99				
13:21	1	1	5.95	4.85				
	1.5	1.5	6.21	5.11				
13:22	2	2	6.45	5.35				
	2.5	2.5	6.48	5.38				
13:23	3	3	6.50	5.40	70	35.0	19.3	
	3.5	3.5	6.50	5.40				
13:24	4	4	6.49	5.39				
	4.5	4.5	6.49	5.39				
13:25	5	5	6.49	5.39				
13:26	6	6	6.49	5.39	70	35.0	19.3	
13:27	7	7	6.55	5.45				
13:28	8	8	6.83	5.73				
13:29	9	9	7.18	6.08				
13:30	10	10	7.41	6.31				
13:31	11	11	7.46	6.36	70	35.0	19.3	
13:32	12	12	7.29	6.19				
13:33	13	13	7.19	6.09				
13:34	14	14	7.21	6.11				
13:35	15	15	7.24	6.14				
13:40	20	20	7.38	6.28				
13:45	25	25	7.53	6.43				
13:50	30	30	7.56	6.46	69	34.5	18.6	
14:05	45	45	7.83	6.73				
14:20	1:00	60	8.02	6.92				
14:35	1:15	75	8.12	7.02	69	34.5	18.6	
14:50	1:30	90	8.20	7.10				
16:05	1:45	105	8.20	7.10				
15:20	2:00	120	8.18	7.12	69	34.5	18.6	
15:35	2:15	129	8.05	7.21				
15:50	2:30	150	8.02	6.92				
16:05	2:45	165	8.01	6.91				
16:20	3:00	180	8.02	6.92				
16:50	3:30	210	8.06	6.96				
17:20	4:00	240	8.08	6.98	69	34.5	18.6	
17:50	4:30	270	8.10	7.00				
18:20	5:00	300	8.12	7.02				
18:50	5:30	330	8.14	7.04				
19:20	6:00	360	8.15	7.05				
20:20	7:00	420	8.02	6.92	69	34.5	18.6	
21:20	8:00	480	7.83	6.73				
22:20	9:00	540	7.78	6.68				
23:20	10:00	600	7.74	6.64				
0:20	11:00	660	7.69	6.59				15th May 2009
1:20	12:00	720	7.65	6.55				
2:20	13:00	780	7.08	5.98				
3:20	14:00	840	7.81	6.71				
4:20	15:00	900	7.83	6.73	69	34.5	18.6	
5:20	16:00	960	7.81	6.71				
6:20	17:00	1020	7.80	6.70				
7:20	18:00	1080	7.85	6.75				
8:20	19:00	1140	7.84	6.74				
9:20	20:00	1200	7.85	6.75				
10:20	21:00	1260	7.85	6.75	69	34.5	18.6	
11:20	22:00	1320	9.84	8.74				
12:20	23:00	1380	9.82	8.72				
13:20	24:00	1440	9.85	8.75	69	34.5	18.6	
14:20	25:00	1500	9.92	8.82				

PUMPING TEST RECORD

Well No.: J-3	Test Type: Constant Discharge Pumping Test			Date:	14th-17th May 2009
Pump Type & Name:	Quality & Pump QPS4E-8 (1.1kw)		Pump Capacity: 50lit/m	Set Depth:	31m
Discharge Pipe: Dia.	1.5"	Observation Point Hight:	1.10	Measurment Device:	V-notch tank

Test Record (2/2)

Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
15:20	26:00	1560	9.93	8.83				
16:20	27:00	1620	9.90	8.80				
17:20	28:00	1680	9.98	8.88				
18:20	29:00	1740	9.94	8.84				
19:20	30:00	1800	9.96	8.86	69	34.5	18.6	
20:20	31:00	1860	9.93	8.83				
21:20	32:00	1920	9.95	8.85				
22:20	33:00	1980	9.95	8.85				
23:20	34:00	2040	9.98	8.88				
0:20	35:00	2100	9.98	8.88				16th May 2009
1:20	36:00	2160	9.98	8.88	69	34.5	18.6	
2:20	37:00	2220	9.98	8.88				
3:20	38:00	2280	9.97	8.87				
4:20	39:00	2340	9.99	8.89				
5:20	40:00	2400	9.99	8.89				
6:20	41:00	2460	10.00	8.90				
7:20	42:00	2520	10.00	8.90	69	34.5	18.6	
8:20	43:00	2580	9.96	8.86				
9:20	44:00	2640	10.02	8.92				
10:20	45:00	2700	10.07	8.97				
11:20	46:00	2760	10.10	9.00				
12:20	47:00	2820	10.10	9.00				
13:20	48:00	2880	10.12	9.02	69	34.5	18.6	
14:20	49:00	2940	10.14	9.04				
15:20	50:00	3000	10.14	9.04				
16:20	51:00	3060	10.14	9.04				
17:20	52:00	3120	10.15	9.05				
18:20	53:00	3180	10.18	9.08				
19:20	54:00	3240	10.20	9.10	69	34.5	18.6	
20:20	55:00	3300	10.19	9.09				
21:20	56:00	3360	10.20	9.10				
22:20	57:00	3420	10.22	9.12				
23:20	58:00	3480	10.20	9.10				
0:20	59:00	3540	10.23	9.13				17th May 2009
1:20	60:00	3600	10.21	9.11	69	34.5	18.6	
2:20	61:00	3660	10.24	9.14				
3:20	62:00	3720	10.24	9.14				
4:20	63:00	3780	10.25	9.15				
5:20	64:00	3840	10.26	9.16				
6:20	65:00	3900	10.26	9.16				
7:20	66:00	3960	10.27	9.17	69	34.5	18.6	
8:20	67:00	4020	10.26	9.16				
9:20	68:00	4080	10.32	9.22				
10:20	69:00	4140	10.33	9.23				
11:20	70:00	4200	10.31	9.21				
12:20	71:00	4260	10.31	9.21	69	34.5	18.6	
13:20	72:00	4320	10.34	9.24				

PUMPING TEST RECORD								
Well No.: J-3			Test Type: Recovery Test				Date:	17th-19th May 2009
Pump Type & Name:		Quality & Pump QPS4E-8 (1.1kw)			Pump Capacity: 50lit/m		Set Depth:	31m
Discharge Pipe: Dia.		1.5"	Observation Point Hight:		1.10	Measurment Device:		V-notch tank
Test Record (1 / 2)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
13:20	0	4320	10.34	9.24				17th May 2009
	0.5	4320.5	10.37	9.27				
13:21	1	4321	9.74	8.64				
	1.5	4321.5	9.49	8.39				
13:22	2	4322	9.37	8.27				
	2.5	4322.5	9.25	8.15				
13:23	3	4323	9.13	8.03				
	3.5	4323.5	9.03	7.93				
13:24	4	4324	8.90	7.80				
	4.5	4324.5	8.79	7.69				
13:25	5	4325	8.67	7.57				
13:26	6	4326	8.44	7.34				
13:27	7	4327	8.28	7.18				
13:28	8	4328	8.14	7.04				
13:29	9	4329	8.06	6.96				
13:30	10	4330	7.97	6.87				
13:31	11	4331	7.89	6.79				
13:32	12	4332	7.83	6.73				
13:33	13	4333	7.75	6.65				
13:34	14	4334	7.66	6.56				
13:35	15	4335	7.59	6.49				
13:40	20	4340	7.32	6.22				
13:45	25	4345	7.12	6.02				
13:50	30	4350	6.97	5.87				
14:05	45	4365	6.68	5.58				
14:20	1:00	4380	6.54	5.44				
14:35	1:15	4395	6.44	5.34				
14:50	1:30	4410	6.35	5.25				
16:05	1:45	4425	6.28	5.18				
15:20	2:00	4440	6.17	5.07				
15:35	2:15	4449	6.13	5.03				
15:50	2:30	4470	6.04	4.94				
16:05	2:45	4485	5.92	4.82				
16:20	3:00	4500	5.66	4.56				
16:50	3:30	4530	4.91	3.81				
17:20	4:00	4560	4.69	3.59				
17:50	4:30	4590	4.49	3.39				
18:20	5:00	4620	4.41	3.31				
18:50	5:30	4650	4.33	3.23				
19:20	6:00	4680	4.27	3.17				
20:20	7:00	4740	4.24	3.14				
21:20	8:00	4800	4.19	3.09				
22:20	9:00	4860	4.17	3.07				
23:20	10:00	4920	4.15	3.05				
0:20	11:00	4980	4.13	3.03				18th May 2009
1:20	12:00	5040	4.08	2.98				
2:20	13:00	5100	4.06	2.96				
3:20	14:00	5160	4.02	2.92				
4:20	15:00	5220	3.98	2.88				
5:20	16:00	5280	3.93	2.83				
6:20	17:00	5340	3.90	2.80				
7:20	18:00	5400	3.86	2.76				
8:20	19:00	5460	3.83	2.73				
9:20	20:00	5520	3.82	2.72				
10:20	21:00	5580	3.81	2.71				
11:20	22:00	5640	3.80	2.70				
12:20	23:00	5700	3.79	2.69				
13:20	24:00	5760	3.79	2.69				
14:20	29:00	6060	3.76	2.66				

PUMPING TEST RECORD

Well No.: J-3	Test Type: Recovery Test			Date:	17th-19th May 2009
Pump Type & Name:	Quality & Pump QPS4E-8 (1.1kw)	Pump Capacity: 50lit/m		Set Depth:	31m
Discharge Pipe: Dia.	1.5"	Observation Point Hight:	1.10	Measurment Device:	V-notch tank

Test Record (2 / 2)

Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
8:23	43:00	6900	3.65	2.55				19th May 2009

PUMPING TEST RECORD								
Well No.: J-4			Test Type: Multi-Stage Pumping Test				Date:	12th Apr. 2009
Pump Type & Name:		Quality & Pump QPS4E-8 (1.1kw)			Pump Capacity: 50lit/m		Set Depth:	45m
Discharge Pipe: Dia.		1.5"	Observation Point Hight: 0.60m			Measurment Device:		V-notch tank
Test Record (1 / 2)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
14:00	0	0	10.40	9.80				Stage1
	0.5	0.5	10.60	10.00				
14:01	1	1	10.80	10.20				
	1.5	1.5	10.95	10.35				
14:02	2	2	11.05	10.45				
	2.5	2.5	11.05	10.45				
14:03	3	3	11.01	10.41	44	22	6.0	
	3.5	3.5	11.01	10.41				
14:04	4	4	11.01	10.41				
	4.5	4.5	11.01	10.41				
14:05	5	5	11.03	10.43				
14:06	6	6	11.04	10.44				
14:07	7	7	11.06	10.46				
14:08	8	8	11.07	10.47				
14:09	9	9	11.09	10.49				
14:10	10	10	11.11	10.51	44	22	6.0	
14:11	11	11	11.12	10.52				
14:12	12	12	11.14	10.54				
14:13	13	13	11.15	10.55				
14:14	14	14	11.17	10.57				
14:15	15	15	11.18	10.58	44	22	6.0	
14:20	20	20	11.55	10.95				
14:25	25	25	11.85	11.25				
14:30	30	30	12.08	11.48				
14:40	40	40	12.60	12.00				
14:50	50	50	14.18	13.58	44	22	6.0	
15:00	60	60	15.17	14.57				
15:10	70	70	15.99	15.39				
15:20	80	80	16.32	15.72				
15:30	90	90	16.43	15.83				
15:40	100	100	16.47	15.87	44	22	6.0	
15:50	110	110	16.50	15.90				
16:00	120	120	16.49	15.89				
	0							Stage2
	0.5	120.5	17.00	16.40				
16:01	1	121	17.50	16.90				
	1.5	121.5	17.80	17.20				
16:02	2	122	18.00	17.40				
	2.5	122.5	18.10	17.50				
16:03	3	123	18.20	17.60				
	3.5	123.5	18.30	17.70				
16:04	4	124	18.40	17.80	56	28	11.0	
	4.5	124.5	18.50	17.90				
16:05	5	125	18.84	18.24				
16:06	6	126	19.20	18.60				
16:07	7	127	19.70	19.10				
16:08	8	128	19.88	19.28				
16:09	9	129	20.04	19.44				
16:10	10	130	20.12	19.52				
16:11	11	131	20.19	19.59				
16:12	12	132	20.28	19.68				
16:13	13	133	20.37	19.77				
16:14	14	134	20.49	19.89				
16:15	15	135	20.59	19.99	56	28	11.0	
16:20	20	140	21.14	20.54				
16:25	25	145	21.95	21.35				
16:30	30	150	27.40	26.80				

PUMPING TEST RECORD								
Well No.: J-4			Test Type: Multi-Stage Pumping Test				Date:	12th Apr. 2009
Pump Type & Name:		Quality & Pump QPS4E-8 (1.1kw)			Pump Capacity: 50lit/m		Set Depth:	45m
Discharge Pipe: Dia.		1.5"	Observation Point Hight: 0.60m		Measurment Device:			V-notch tank
Test Record (2 / 2)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
16:40	40	160	28.00	27.40				
16:50	50	170	29.18	28.58	56	28	11.0	
17:00	60	180	30.04	29.44				
17:10	70	190	30.98	30.38				
17:20	80	200	31.94	31.34				
17:30	90	210	33.40	32.80				
17:40	100	220	33.89	33.29				
17:50	110	230	34.69	34.09	56	28	11.0	
18:00	120	240	35.58	34.98				
	0							Stage3
	0.5	240.5	35.58	34.98				
18:01	1	241	35.61	35.01				
	1.5	241.5	35.87	35.27				
18:02	2	242	35.87	35.27				
	2.5	242.5	35.87	35.27				
18:03	3	243	35.96	35.36				
	3.5	243.5	36.10	35.50				
18:04	4	244	36.15	35.55	61	30.5	14.2	
	4.5	244.5	36.20	35.60				
18:05	5	245	36.25	35.65				
18:06	6	246	36.41	35.81				
18:07	7	247	36.54	35.94				
18:08	8	248	36.69	36.09				
18:09	9	249	36.82	36.22				
18:10	10	250	36.98	36.38	61	30.5	14.2	
18:11	11	251	37.10	36.50				
18:12	12	252	37.24	36.64				
18:13	13	253	37.37	36.77				
18:14	14	254	37.51	36.91				
18:15	15	255	37.65	37.05				
18:20	20	260	38.32	37.72	61	30.5	14.2	
18:25	25	265	39.18	38.58				
18:30	30	270	39.61	39.01				
18:40	40	280	40.87	40.27				
18:50	50	290	41.92	41.32				
19:00	60	300	42.91	42.31	61	30.5	14.2	
19:10	70	310	44.10	43.50				
19:20	80	320	44.16	43.56				

PUMPING TEST RECORD								
Well No.: J-4			Test Type: Constant Discharge Pumping Test				Date:	13th Apr. 2009
Pump Type & Name:		Quality & Pump QPS4E-8 (1.1kw)			Pump Capacity: 50lit/m		Set Depth:	45m
Discharge Pipe: Dia.		1.5"	Observation Point Hight: 0.60m			Measurment Device:		V-notch tank
Test Record (1 / 1)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
11:00	0	0	10.53	9.94				
	0.5	0.5	11.48	10.89				
11:01	1	1	11.60	11.01				
	1.5	1.5	12.03	11.44				
11:02	2	2	12.32	11.73	51	25.5	8.7	
	2.5	2.5	12.36	11.77				
11:03	3	3	12.49	11.90				
	3.5	3.5	12.59	12.00				
11:04	4	4	12.67	12.08				
	4.5	4.5	12.74	12.15				
11:05	5	5	12.90	12.31	51	25.5	8.7	
11:06	6	6	13.08	12.49				
11:07	7	7	13.23	12.64				
11:08	8	8	13.52	12.93				
11:09	9	9	13.63	13.04				
11:10	10	10	13.75	13.16	51	25.5	8.7	
11:11	11	11	13.91	13.32				
11:12	12	12	14.03	13.44				
11:13	13	13	14.18	13.59				
11:14	14	14	14.31	13.72				
11:15	15	15	14.54	13.95				
11:20	20	20	14.82	14.23				
11:25	25	25	15.48	14.89				
13:30	30	30	15.73	15.14	51	25.5	8.7	
11:45	45	45	17.53	16.94				
12:00	1:00	60	19.05	18.46	51	25.5	8.7	
12:15	1:15	75	20.50	19.91				
12:30	1:30	90	21.58	20.99				
12:45	1:45	105	22.49	21.90				
13:00	2:00	120	23.32	22.73	51	25.5	8.7	
13:15	2:15	135	25.16	24.57				
13:30	2:30	150	26.43	25.84				
13:45	2:45	165	28.73	28.14				
14:00	3:00	180	32.85	32.26				
14:30	3:30	210	37.74	37.15				
15:00	4:00	240	39.74	39.15	51	25.5	8.7	
15:30	4:30	270	41.37	40.78				
16:00	5:00	300	44.15	43.56				

PUMPING TEST RECORD								
Well No.: J-4			Test Type: Recovery Test				Date:	13-14th Apr. 2009
Pump Type & Name:		Quality & Pump QPS4E-8 (1.1kw)			Pump Capacity: 50lit/m		Set Depth:	45m
Discharge Pipe: Dia.		1.5"	Observation Point Hight: 0.60m		Measurment Device:			V-notch tank
Test Record (1 / 1)								
Time (hh:mm / min)			Water level (m)		Discharge (mm , lit/min)			Remarks
Watch Time	After Start 1	After Start 2	M. Depth	C. Depth	V.Wideth	V. Depth	Flow Rate	
16:00	0	300	44.15	43.56				13th Apr.2009
	0.5	300.5	43.90	43.31				
16:01	1	301	43.68	43.09				
	1.5	301.5	43.55	42.96				
16:02	2	302	43.53	42.94				
	2.5	302.5	43.45	42.86				
16:03	3	303	43.39	42.80				
	3.5	303.5	43.32	42.73				
16:04	4	304	43.26	42.67				
	4.5	304.5	43.20	42.61				
16:05	5	305	43.14	42.55				
16:06	6	306	43.00	42.41				
16:07	7	307	42.90	42.31				
16:08	8	308	42.76	42.17				
16:09	9	309	42.66	42.07				
16:10	10	310	42.53	41.94				
16:11	11	311	42.39	41.80				
16:12	12	312	42.29	41.70				
16:13	13	313	42.15	41.56				
16:14	14	314	42.15	41.56				
16:15	15	315	41.92	41.33				
16:20	20	320	41.73	41.14				
16:25	25	325	40.52	39.93				
16:30	30	330	39.93	39.34				
16:45	45	345	37.99	37.40				
17:00	1:00	360	36.62	36.03				
17:15	1:15	375	34.44	33.85				
17:30	1:30	390	33.90	33.31				
17:45	1:45	405	31.21	30.62				
18:00	2:00	420	29.47	28.88				
18:15	2:15	429	27.77	27.18				
18:30	2:30	450	25.99	25.40				
18:45	2:45	465	24.28	23.69				
19:00	3:00	480	22.56	21.97				
19:30	3:30	510	19.50	18.91				
20:00	4:00	540	16.20	15.61				
20:30	4:30	570	12.89	12.30				
21:00	5:00	600	12.30	11.71				
21:30	5:30	630	11.43	10.84				
22:00	6:00	660	11.25	10.66				
23:00	7:00	720	11.19	10.60				
0:00	8:00	780	11.13	10.54				14th Apr.2009
1:00	9:00	840	11.07	10.48				
2:00	10:00	900	11.01	10.42				
3:00	11:00	960	10.95	10.36				
4:00	12:00	1020	10.89	10.30				
5:00	13:00	1080	10.83	10.24				
6:00	14:00	1140	10.77	10.18				
7:00	15:00	1200	10.71	10.12				
8:00	16:00	1260	10.65	10.06				
9:00	17:00	1320	10.57	9.98				

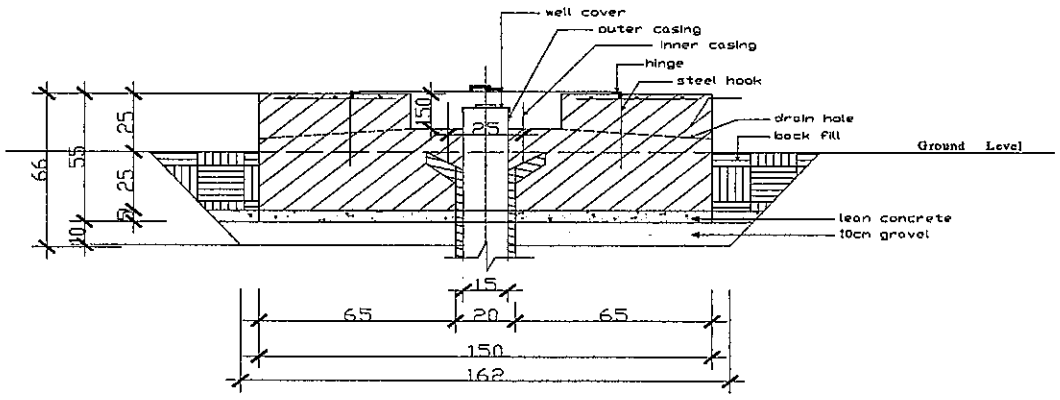
4.0 Well Head Cover Installation

The contractor upon completion of all works specified above placed concrete plug, well cap/cover, and concrete box in the following manner as par design submitted and approved by the supervising engineer.

4.1 Concrete Plug

The dimension of concrete plug for J1 was 1.5m x 1.5m, both centered by the well; and 0.25m deep.

The concrete plug for J2 – J4 was 1.2m x 1.2m and 0.25m deep.
Before the concrete plug is a 5cm thick lean concrete on a 10cm thick compacted crushed stone.



Well Head Portion

The concrete mix of Portland cement, fine and coarse aggregates, by volume was 1:2:4 or as instructed by the Engineer.

4.2 Well Cap

All completed wells have a plastic cover around the 6" (150mm) casing inside the concrete box. The opening into the concrete box is controlled by a steel plate with handle and provision for lock firmly fixed into concrete.
The design, dimension, size and type of cap were approved by the supervising engineer prior to purchase/fabrication.

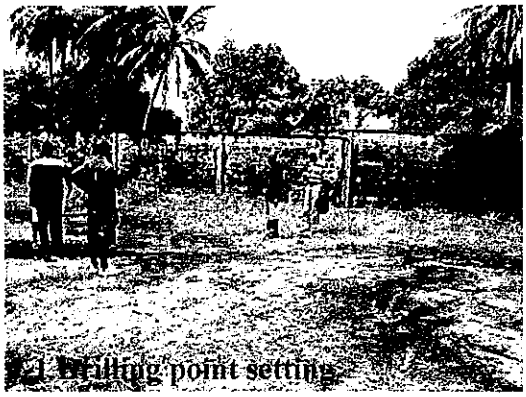
5.0 Conclusion

The results from the borehole logging and pumping tests indicates low water yield in wells J2 – J4 (especially J4 which had less 0.3L/s, which is the minimum requirement for installation for hand pump according to JICA study team criteria). However, a significant yield of less than 15L/s is obtained in J1.

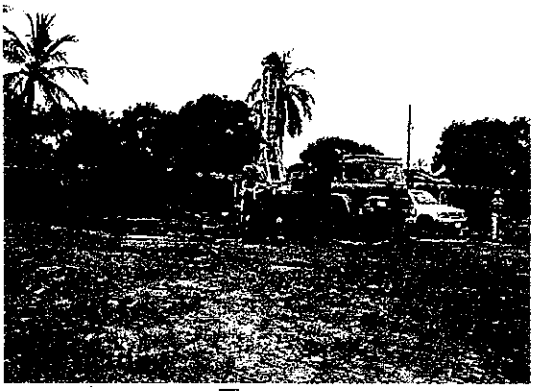
APPENDIX-1 Work Photos

J-1

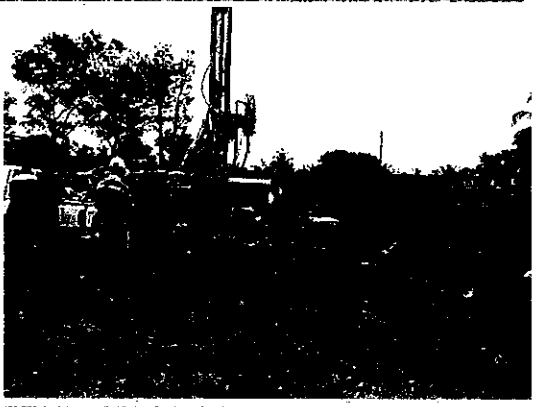
J-1 Drilling yard

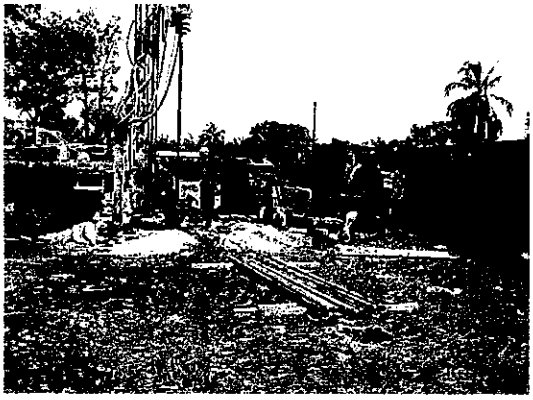


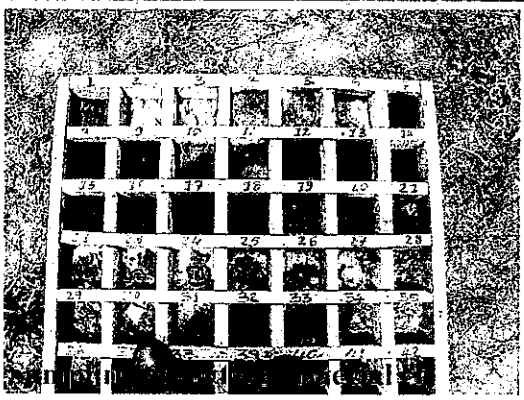
J-1 Drilling point setting

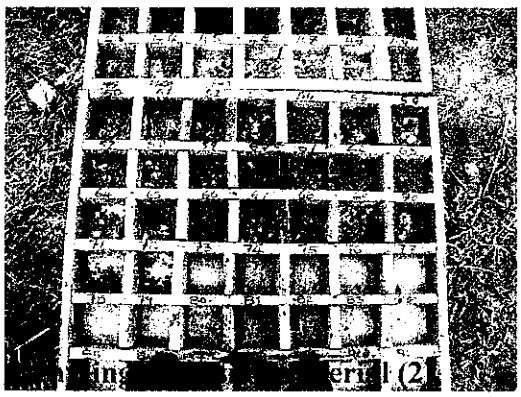


Mud pit digging

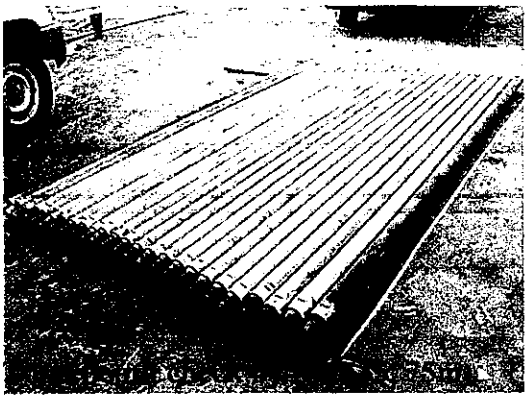


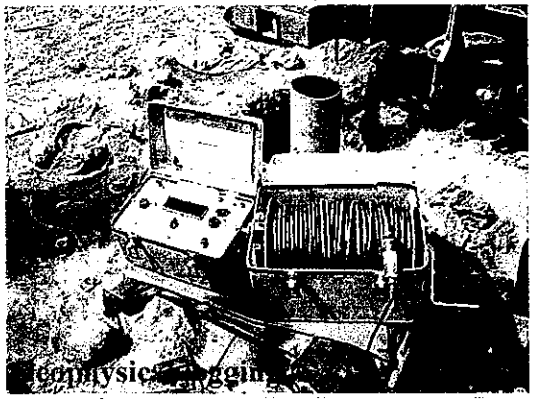




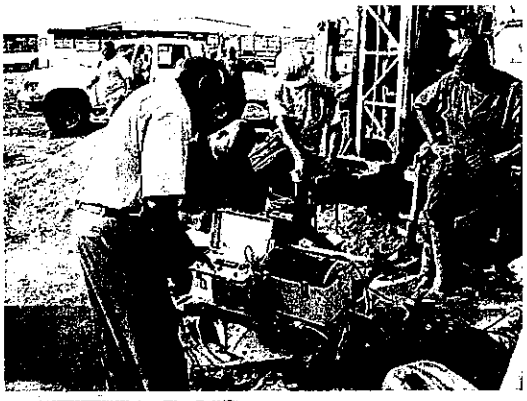


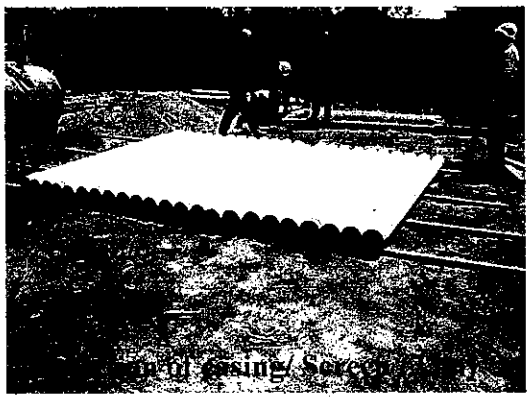
Bottom cleaning/ Stick-up 2.0m



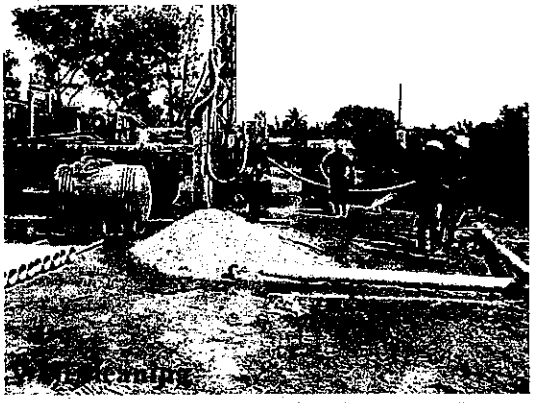


Geophysical logging

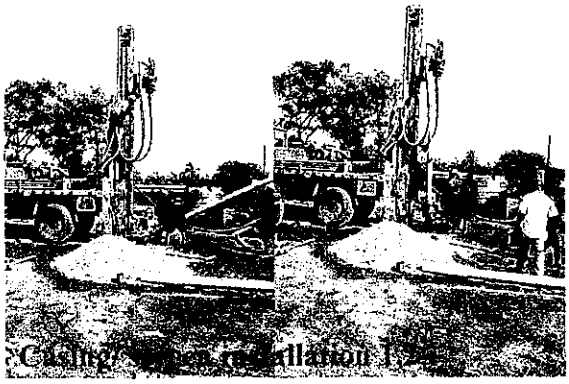




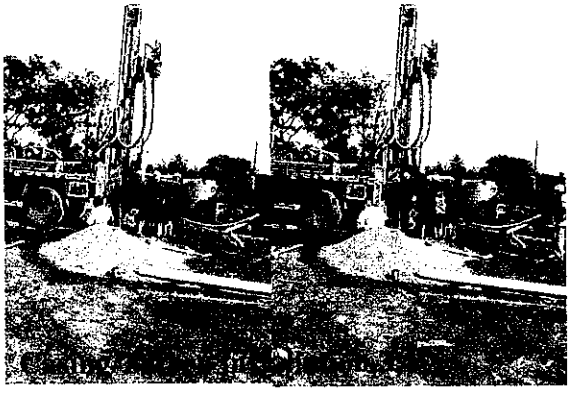
Insertion of casing/ Screen



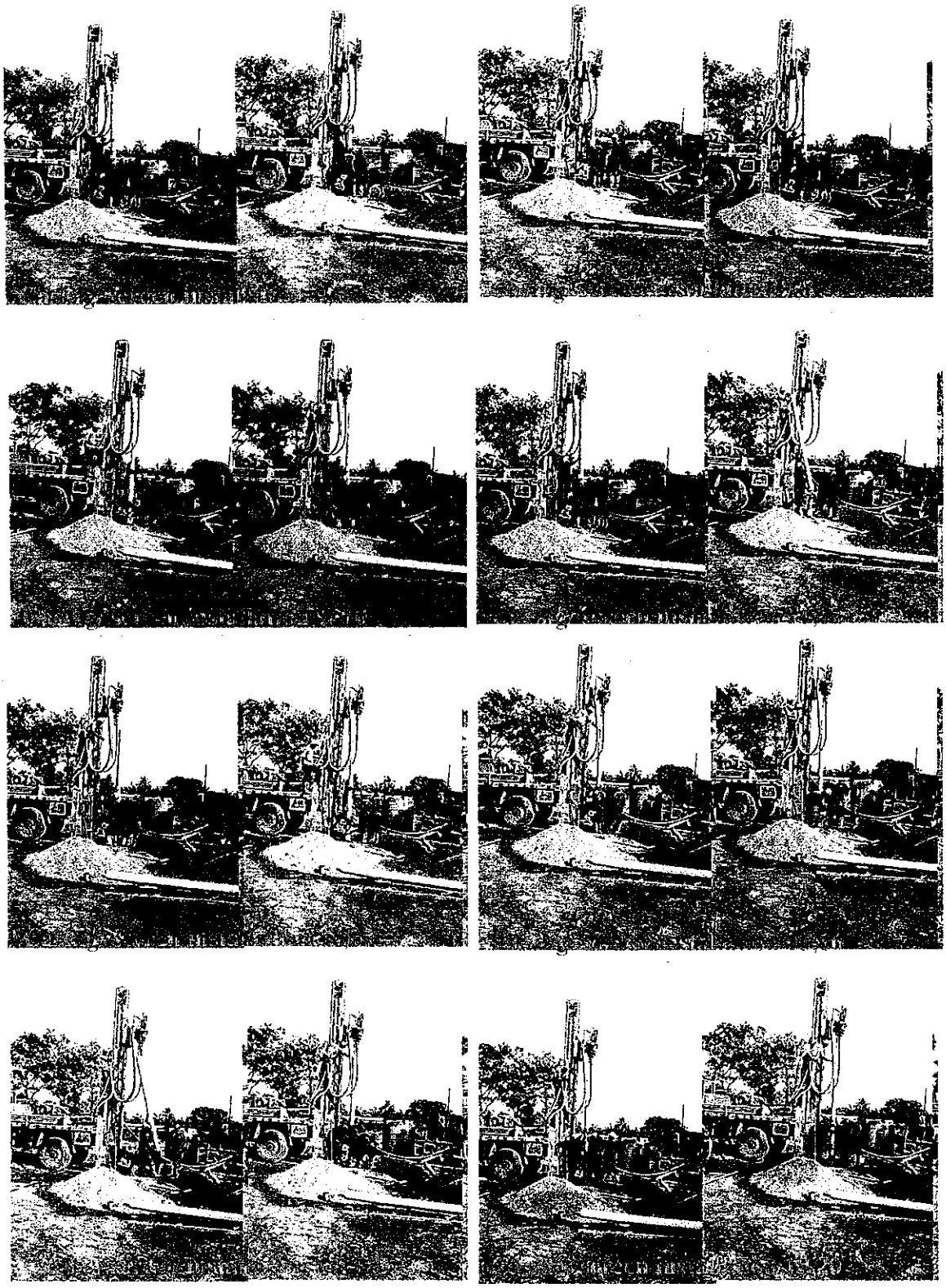
Well cleaning

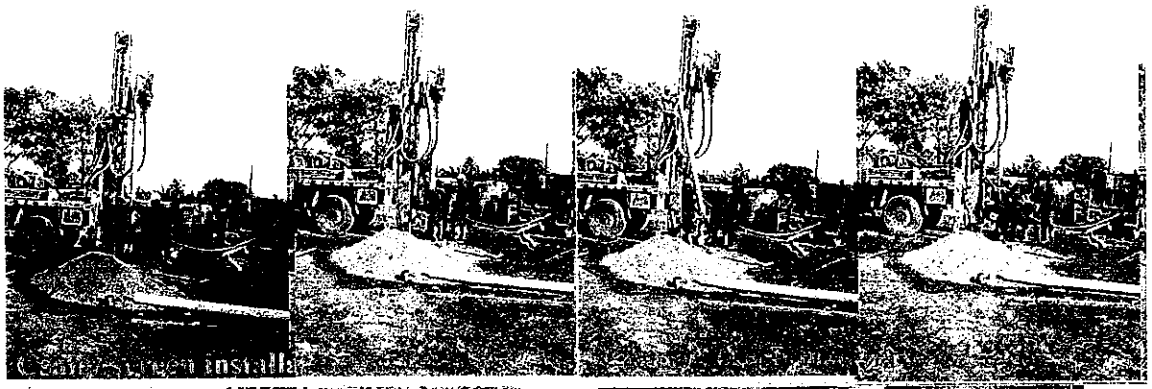


Casing/ Screen installation



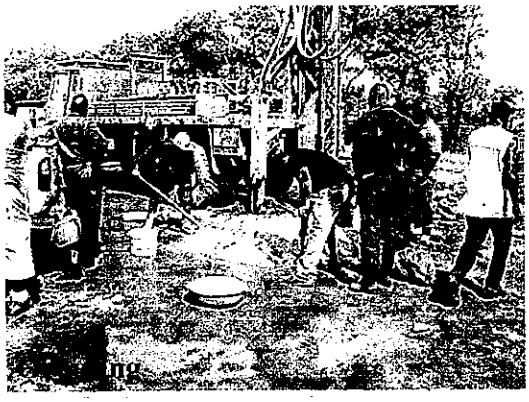
Gravel

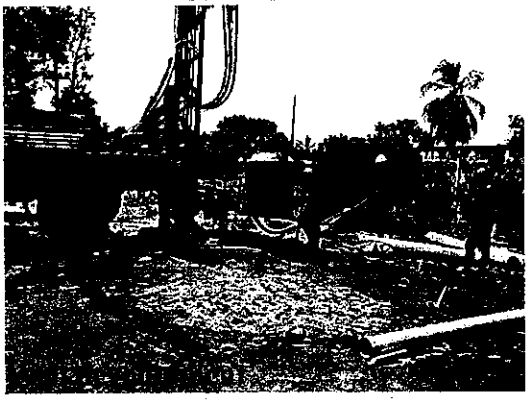


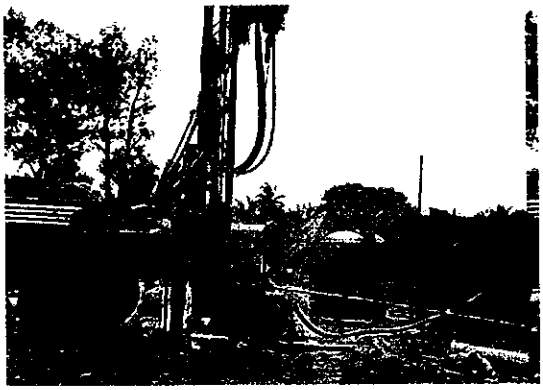


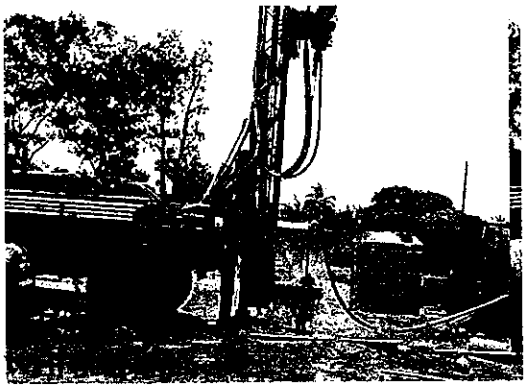
Gravel packing

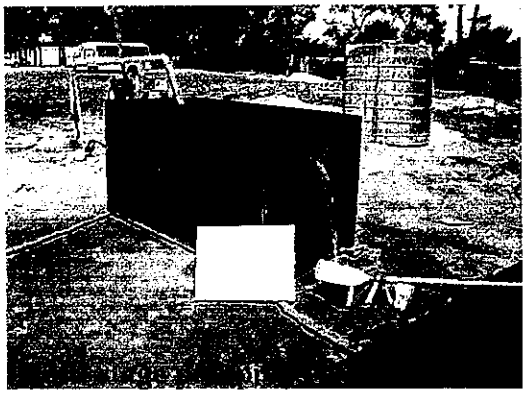
Gravel packing

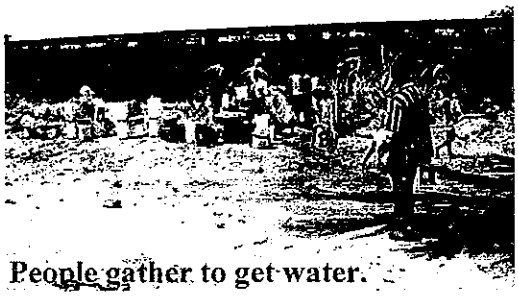




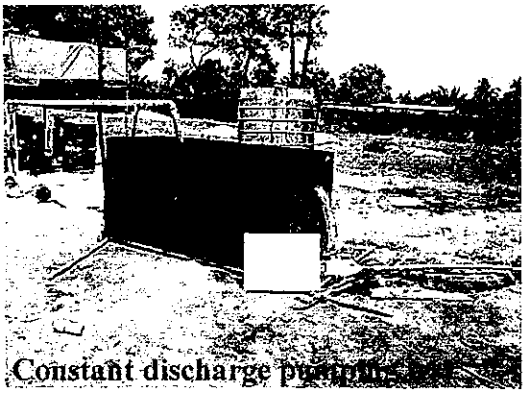




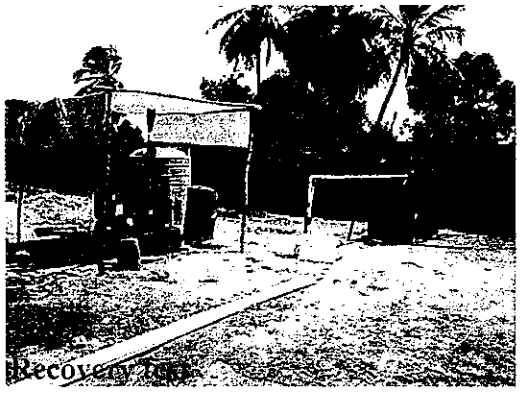




People gather to get water.



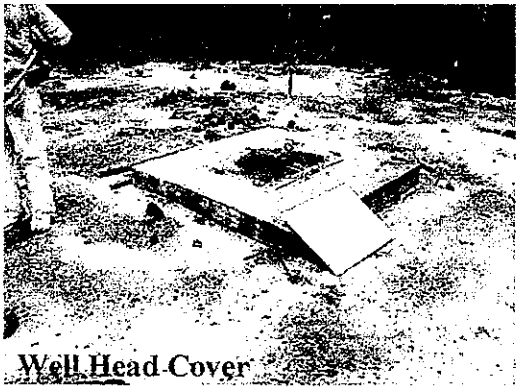
Constant discharge pumping



Recovery test

Installation of well head cover

Installation of well head cover



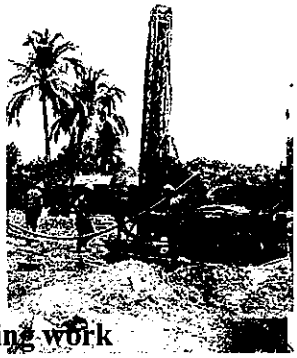
Well Head Cover

J-2

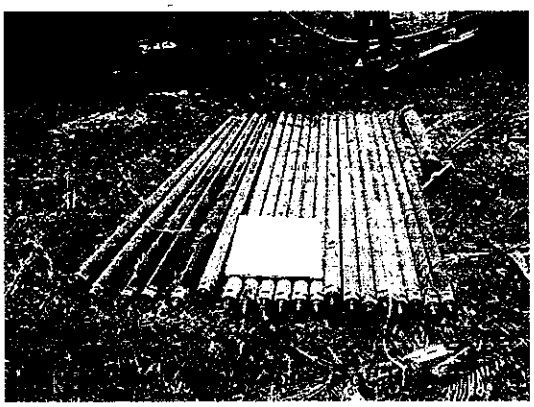
Drilling point

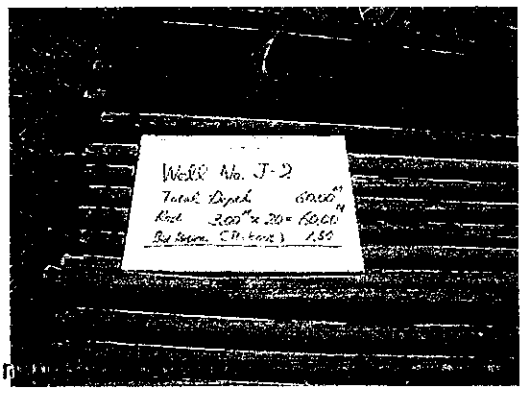
Drilling point

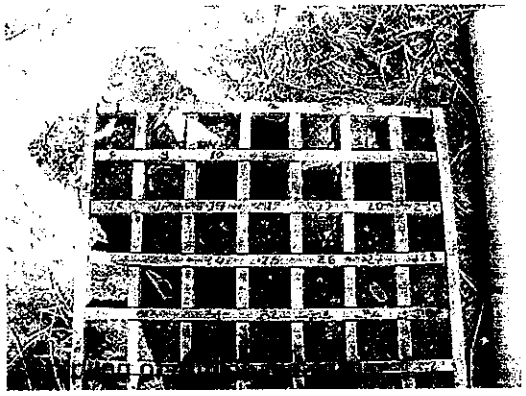
Drilling work

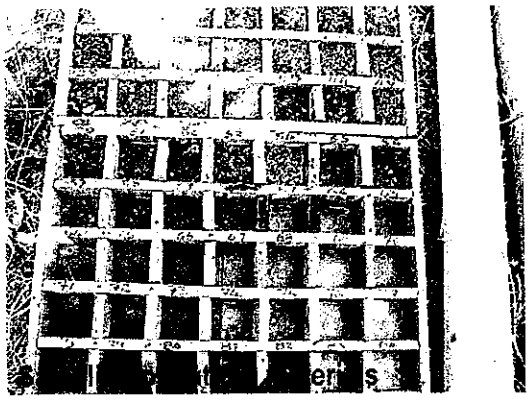


Drilling work



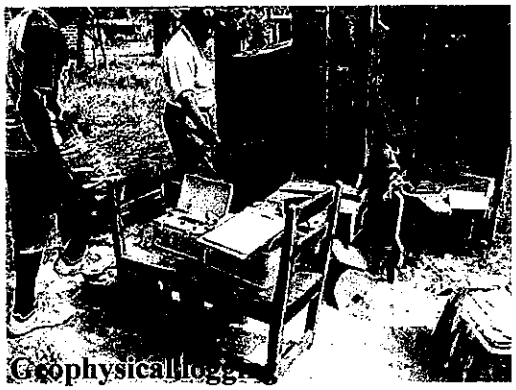


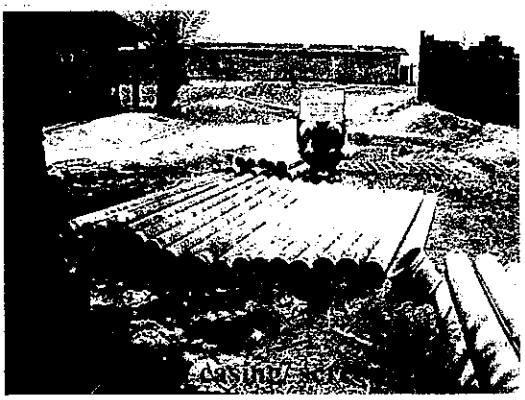




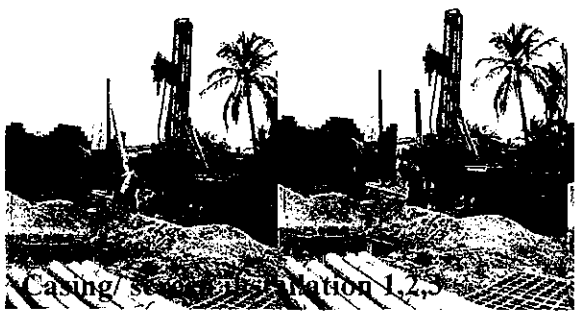

Well cleaning

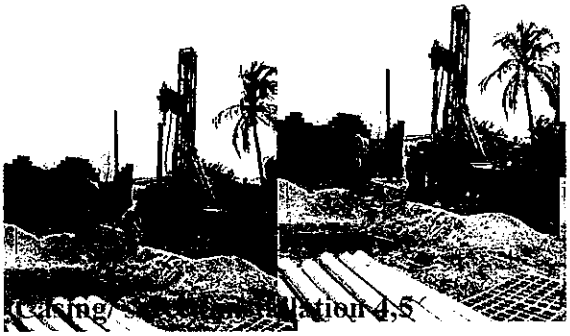

Geophysical logging


Geophysical logging


Casing/ screen installation

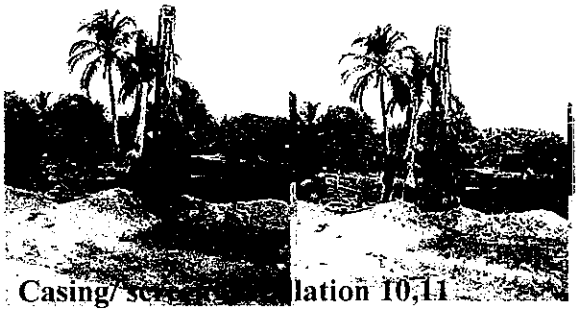

Installation


Casing/ screen installation 1,2,3


Casing/ screen installation 4,5

Casing/ screen installation 6,7

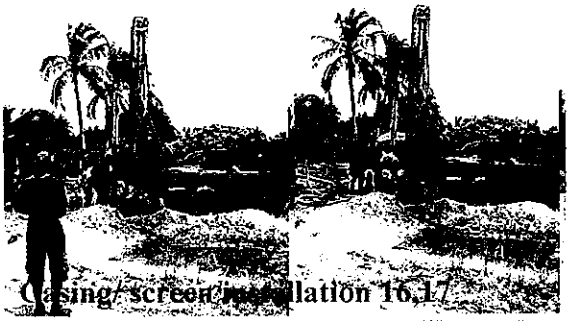
Casing/ screen installation 8,9



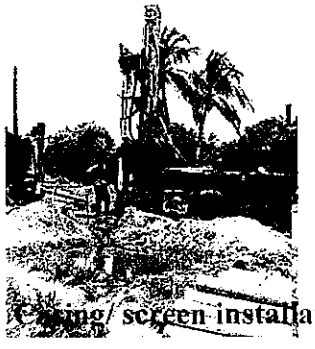
Casing/ screen installation 10,11

Casing/ screen installation 12,13

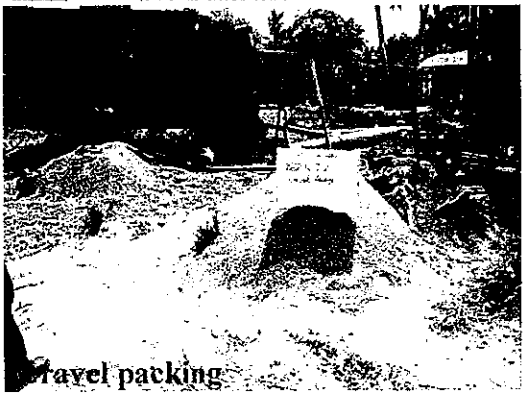
Casing/ screen installation 14,



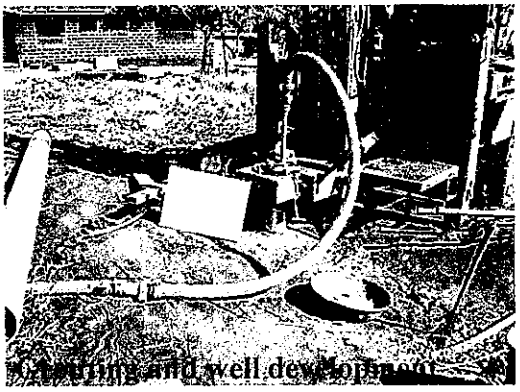
Casing/ screen installation 16,17



Casing/ screen installation 18,

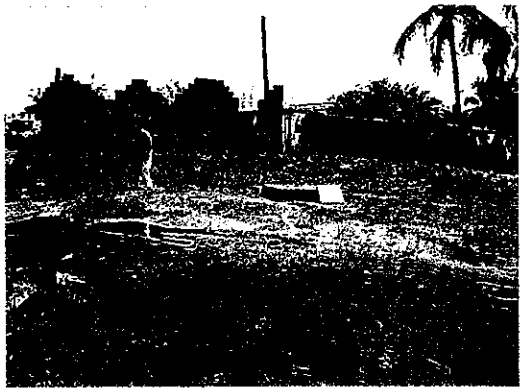


Travel packing

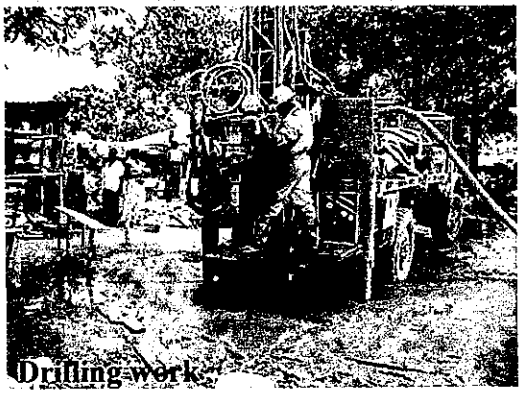


Recovery [illegible]

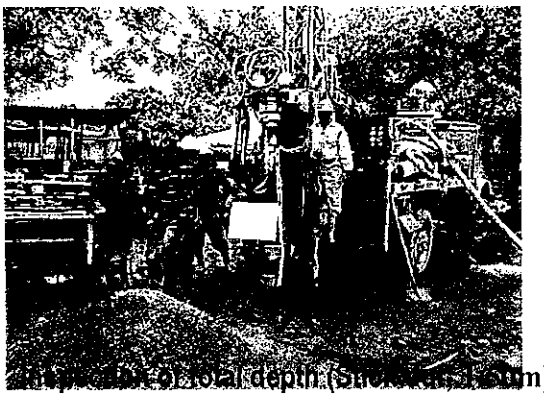
Well head cover

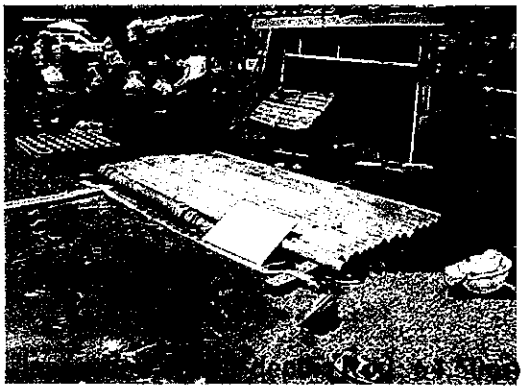


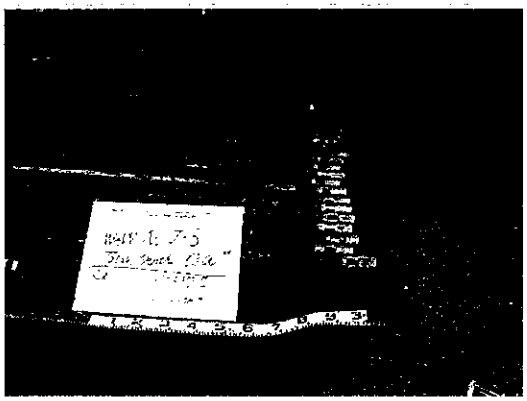
J-3

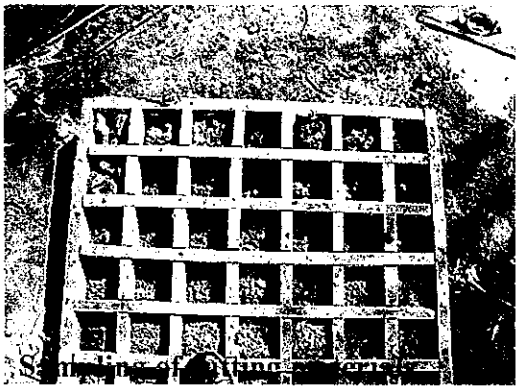


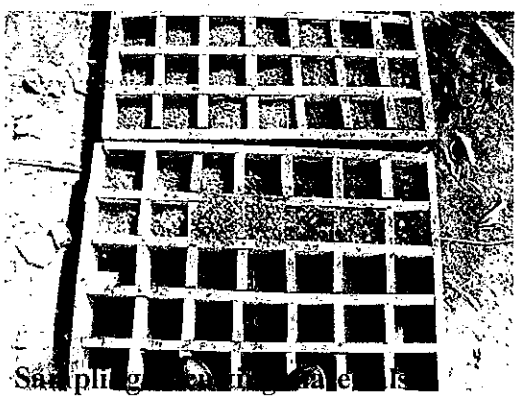
Drilling work

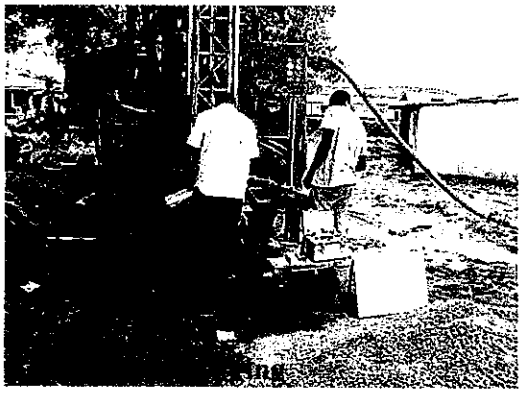




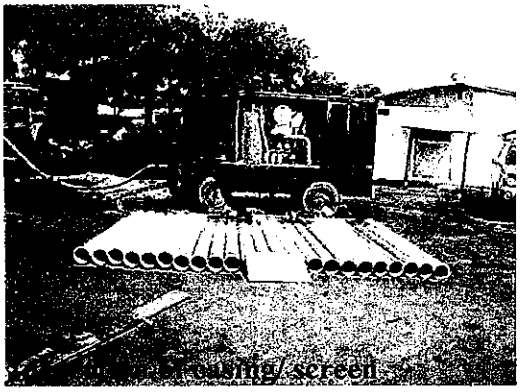


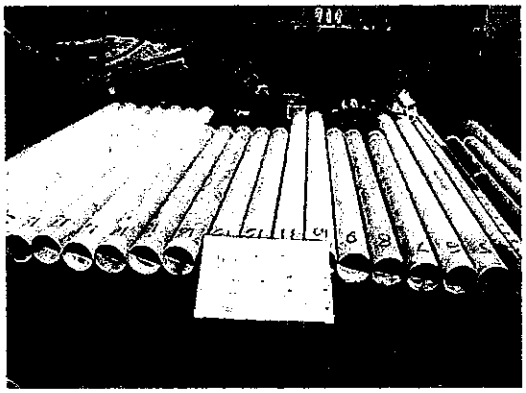


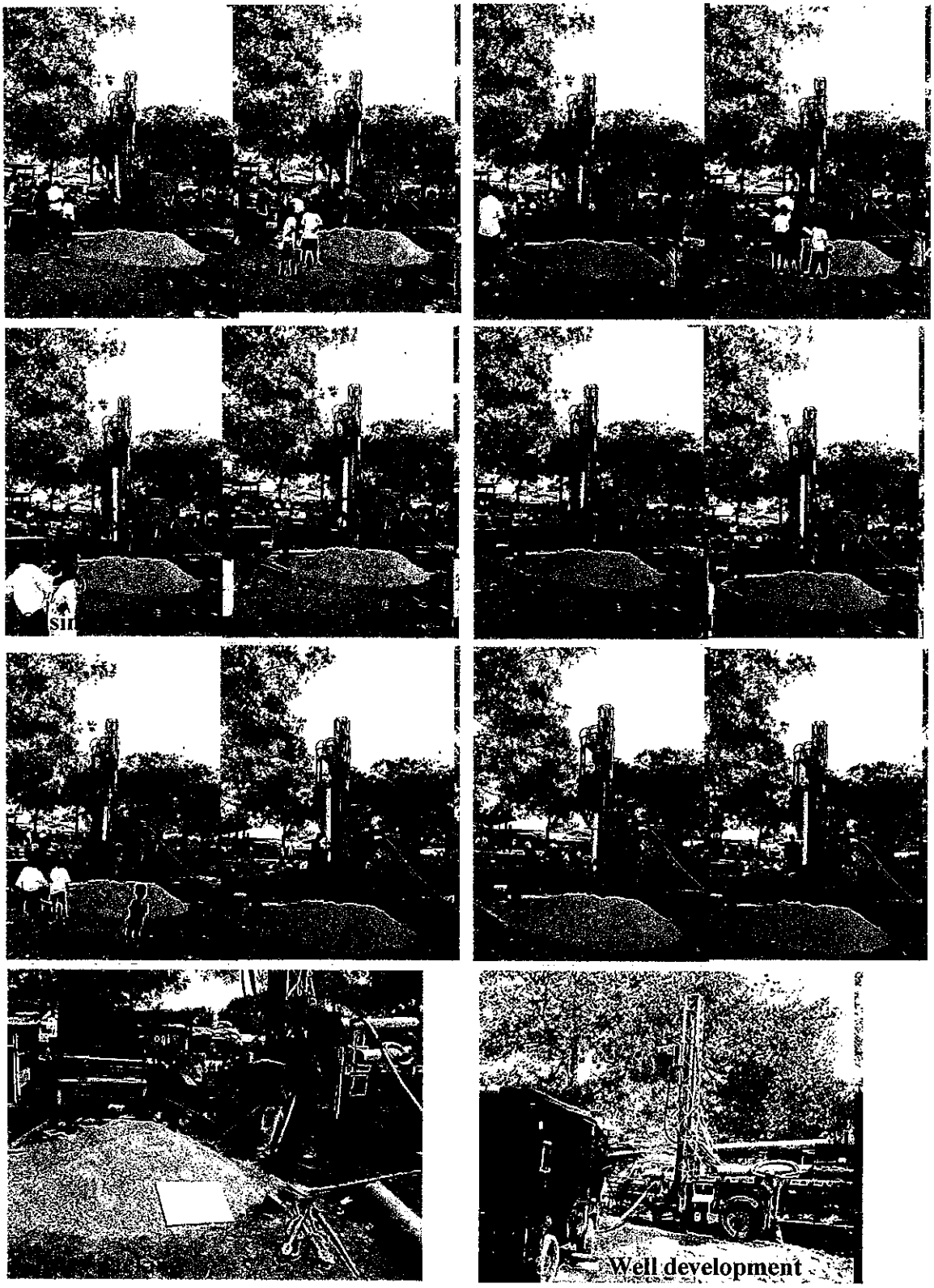




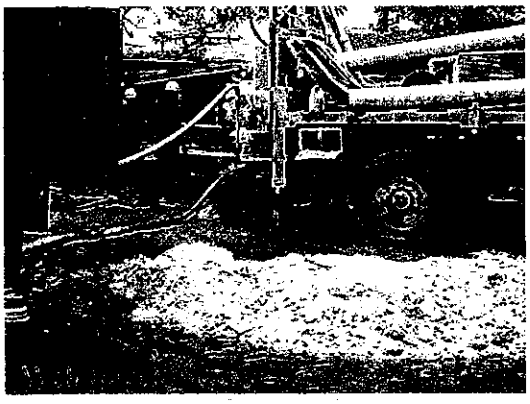

Well cleaning

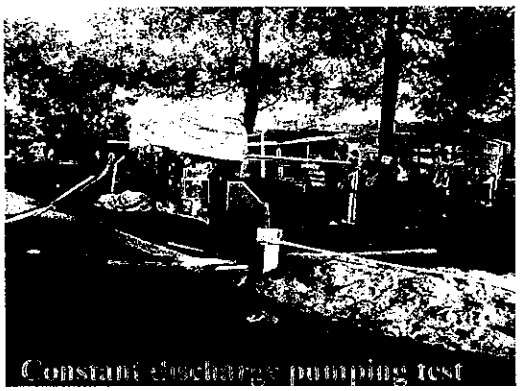

Casing/ screen

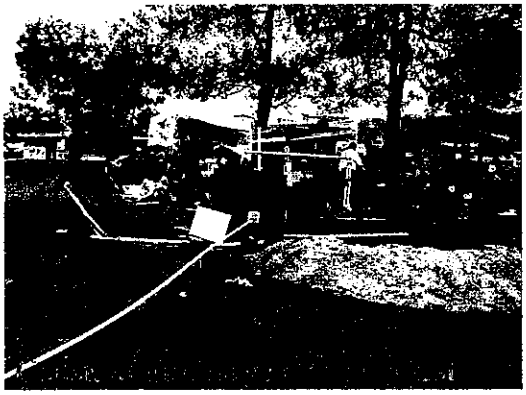


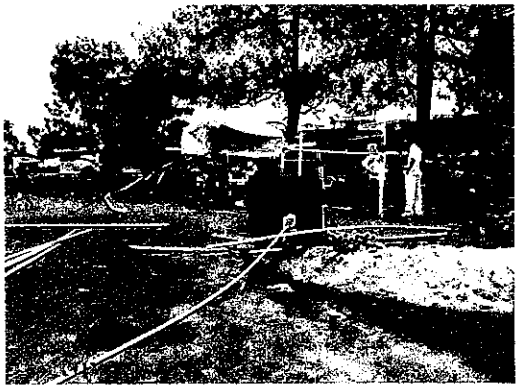


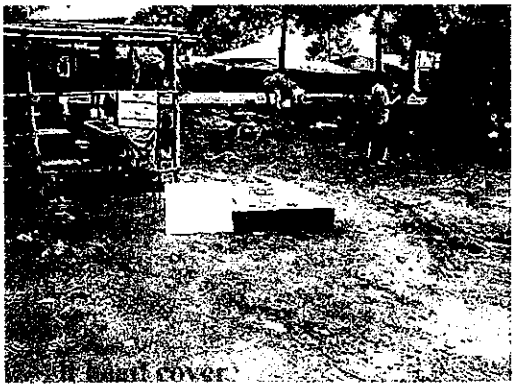
Well development











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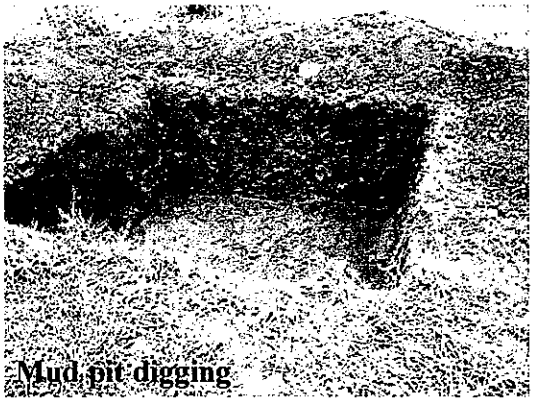
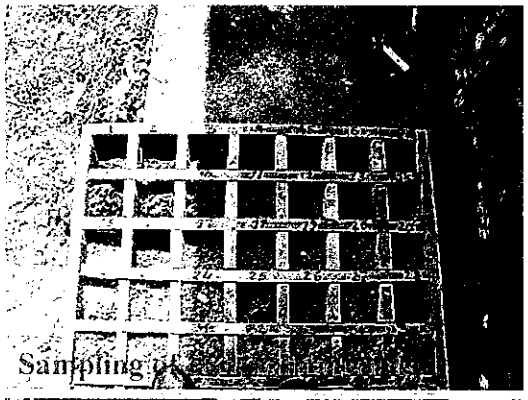
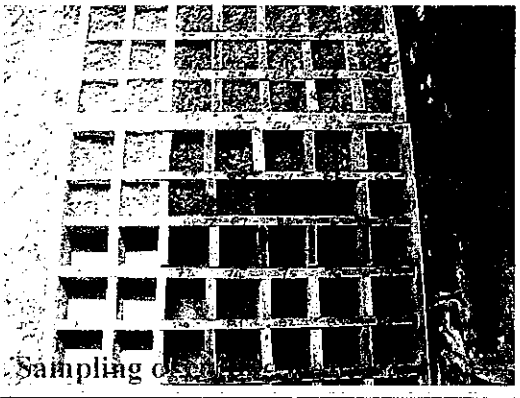
J-4

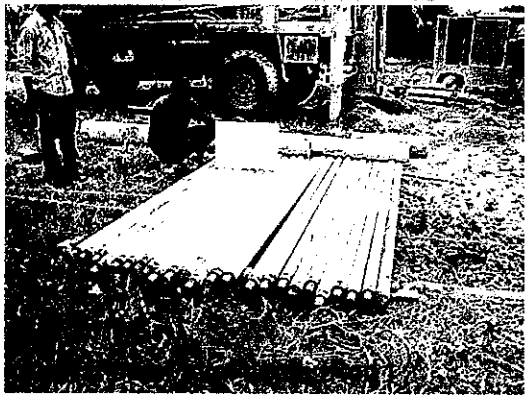

Mud pit digging

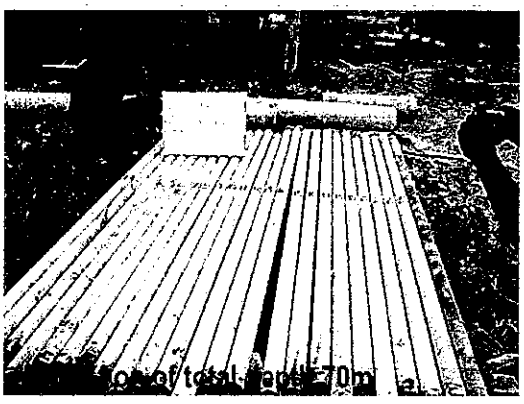

Drilling work

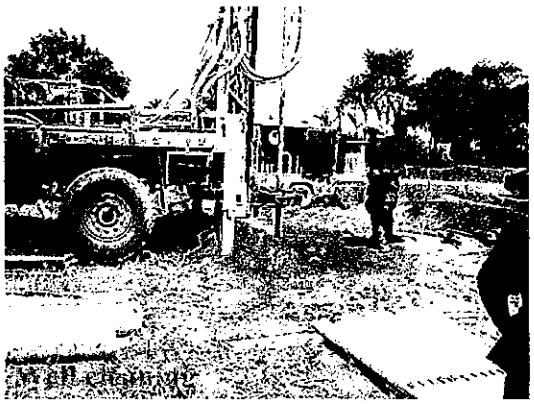

Drilling work

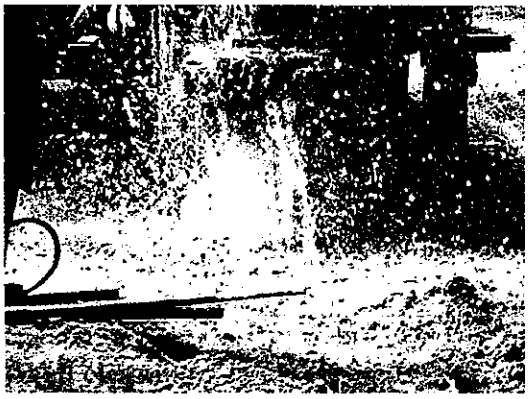

Sampling

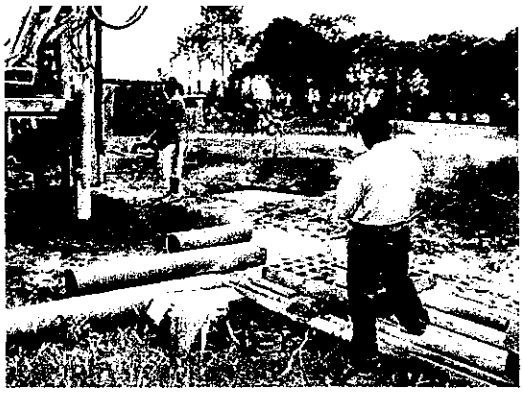

Sampling

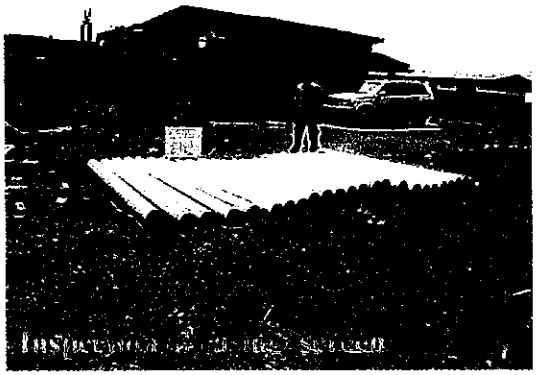


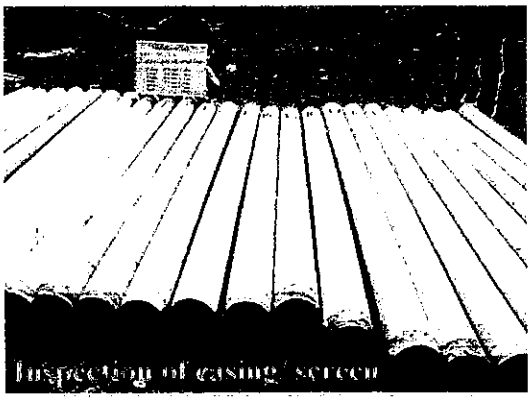

Top of total depth 70m

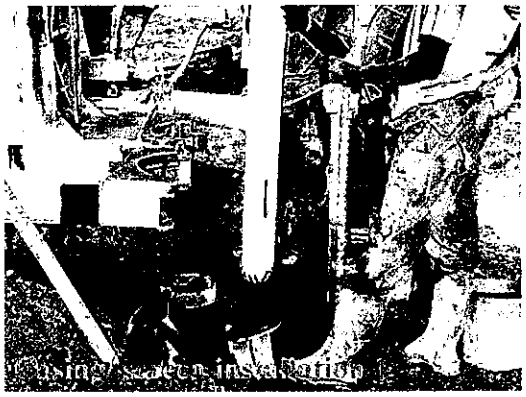


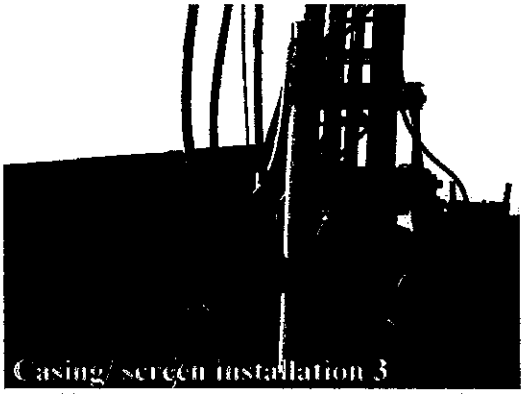


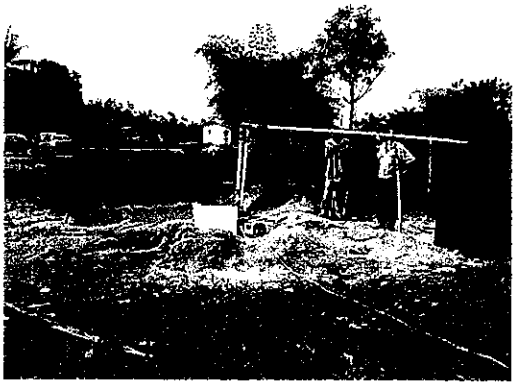


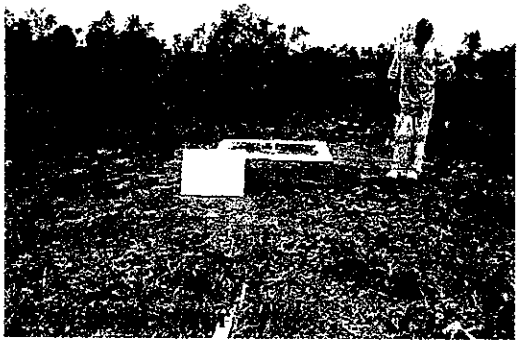







Casing/ screen installation 3





APPENDIX-13

FORECASE OF SEWAGE PRODUCTION VOLUME

Sewage Producion Volume in 2014

No.	Zone Name	Pop. in 2014	Coverage rate in 2014(%)									Service Population in 2014 (%)									Rate of Water useage(Gal/c/d)				Water Usage volume (Gal/d)							
			Off-site (For fiamah)			Off-site (For each community)			On-site				Off-site (For fiamah)			Off-site (For each community)			On-site				Off-site		On-site		Off-site			Off-site (For each community)			On-site			
			Private House	Public toilet	Total	Private House	Public toilet	Total	Private House	Public toilet	Total	Total	Private House	Public toilet	Total	Private House	Public toilet	Total	Private House	Public toilet	Total	Total	Private House	Public toilet	Private House	Public toilet	Private House	Public toilet	Total	Private House	Public toilet	Total	Private House	Public toilet	Total	Total
1	New Kru Town	75,670	10	0	10	5	0	5	5	35	40	55	7,567	0	7,567	3,784	0	3,784	3,784	26,485	30,268	41,619	16	2	16	2	121,072	0	121,072	60,536	0	60,536	60,536	52,969	113,505	295,113
2	Logan Town	63,201	25	0	25	0	0	0	5	35	40	65	15,800	0	15,800	0	0	0	3,160	22,120	25,280	41,081	16	2	16	2	252,804	0	252,804	0	0	0	50,561	44,241	94,802	347,606
3	Clara Town	57,815	20	0	20	5	0	5	5	40	45	70	11,563	0	11,563	2,891	0	2,891	2,891	23,126	26,017	40,471	16	2	16	2	185,008	0	185,008	46,252	0	46,252	46,252	46,252	92,504	323,764
4	West Point	29,175	0	0	0	0	30	30	5	30	35	65	0	0	0	0	8,753	8,753	1,459	8,753	10,211	18,964	16	2	16	2	0	0	0	0	17,505	17,505	23,340	17,505	40,845	58,350
5	Central Monrovia A	55,580	35	35	70	0	0	0	0	0	0	70	19,453	19,453	38,906	0	0	0	0	0	0	38,906	16	2	16	2	311,248	38,906	350,154	0	0	0	0	0	0	350,154
6	Central Monrovia B	46,216	35	35	70	0	0	0	0	0	0	70	16,176	16,176	32,351	0	0	0	0	0	0	32,351	16	2	16	2	258,810	32,351	291,161	0	0	0	0	0	0	291,161
7	Sinkor	47,210	50	0	50	0	0	0	15	5	20	70	23,605	0	23,605	0	0	0	7,082	2,361	9,442	33,047	16	2	16	2	377,680	0	377,680	0	0	0	113,304	4,721	118,025	495,705
8	Lakpazee	44,595	20	0	20	20	0	20	20	5	25	65	8,919	0	8,919	8,919	0	8,919	8,919	2,230	11,149	28,987	16	2	16	2	142,704	0	142,704	142,704	0	142,704	142,704	4,460	147,164	432,572
9	Old Road	51,328	35	0	35	5	0	5	10	5	15	55	17,965	0	17,965	2,566	0	2,566	5,133	2,566	7,699	28,230	16	2	16	2	287,437	0	287,437	41,062	0	41,062	82,125	5,133	87,258	415,757
10	Congo Town	29,065	0	0	0	30	0	30	15	5	20	50	0	0	0	8,720	0	8,720	4,360	1,453	5,813	14,533	16	2	16	2	0	0	0	139,512	0	139,512	69,756	2,907	72,663	212,175
11	Paynesville	509,871	0	0	0	15	0	15	25	5	30	45	0	0	0	76,481	0	76,481	127,468	25,494	152,961	229,442	16	2	16	2	0	0	0	1,223,690	0	1,223,690	2,039,484	50,987	2,090,471	3,314,162
12	Gardnersville	90,327	0	0	0	40	0	40	5	0	5	45	0	0	0	36,131	0	36,131	4,516	0	4,516	40,647	16	2	16	2	0	0	0	578,093	0	578,093	72,262	0	72,262	650,354
13	New Georgia	59,041	0	0	0	40	0	40	5	0	5	45	0	0	0	23,616	0	23,616	2,952	0	2,952	26,568	16	2	16	2	0	0	0	377,862	0	377,862	47,233	0	47,233	425,095
14	Barnersville	40,195	0	0	0	40	0	40	5	0	5	45	0	0	0	16,078	0	16,078	2,010	0	2,010	18,088	16	2	16	2	0	0	0	257,248	0	257,248	32,156	0	32,156	289,404
15	Johnsonville	16,437	0	0	0	20	0	20	20	5	25	45	0	0	0	3,287	0	3,287	3,287	822	4,109	7,397	16	2	16	2	0	0	0	52,598	0	52,598	52,598	1,644	54,242	106,841
16	Caldwell	34,272	0	0	0	20	0	20	20	5	25	45	0	0	0	6,854	0	6,854	6,854	1,714	8,568	15,422	16	2	16	2	0	0	0	109,670	0	109,670	109,670	3,427	113,098	222,768
	Total	1,250,000											121,048	35,629	156,676	189,327	8,753	198,079	183,874	117,122	300,996	655,752					1,936,762	71,257	2,008,020	3,029,229	17,505	3,046,734	2,941,981	234,245	3,176,225	8,230,979
																							52						2,008,020							

Cover rate for sanitary facility in Monrovia	52	%

Planned Conditon for Fiamah Sewage Tratement Plant

Item			
Average Daily Flow rate	2.01 (MGal/day) (=	7,600	m^3/day)
Maximum Daily Flow Rate※1	4.02 (MGal/day) (=	15,201	m^3/day)

※1 Maximum Daily Flow Rate = Average Dailly Flow Rate X 2.0

Capacity of Pump Station

Location	Flow Rate (m^3/min)	Total Head (m)	
New Kru Town P.S	0.64	10	Gravity
Bushrod Island P.S	2.94	20	Pressured
Mesurado River P.S	3.86	30	Pressured
BTC P.S	6.31	30	Pressured

Inlet Daily Flow Rate for Pipe(G/day) ※		
363,216	+New Kru Town	
1,676,652	+Logan Town+Clara Town	
2,201,883	+Clara Town+1/2MonroviaA	
3,600,596	+1/2MonroviaA+MonroviaB	

※Inlet Daily Flow Rate = Average Daily Flow Rate × 3.0

Inlet Daily Flow Rate for Pump(G/day) ※		
242,144	+New Kru Town	
1,117,768	+Logan Town+Clara Town	
1,467,922	+Clara Town+1/2MonroviaA	
2,400,398	+1/2MonroviaA+MonroviaB	

※Inlet Daily Flow Rate = Average Daily Flow Rate × 2.0

Sewage Producion Volume in 2008

No.	Zone Name	Pop. in 2008	Coverage rate in 2008 (%)									Service Population in 2008 (%)									Rate of Water useage(Gal/c/d)				Water Usage volume (Gal/d)							
			Off-site						On-site				Off-site						On-site				Off-site		On-site		Off-site						On-site			
			Private House	Public toilet	Total				Private House	Public toilet	Total	Total	Private House	Public toilet	Total				Private House	Public toilet	Total	Total	Private House	Public toilet	Private House	Public toilet	Private House	Public toilet	Total				Private House	Public toilet	Total	Total
1	New Kru Town	73,379	0	0	0				5	35	40	40	0	0	0				3,669	25,683	29,352	29,352	13	2	13	2	0	0	0				47,696	51,365	99,062	99,062
2	Logan Town	58,168	0	0	0				5	35	40	40	0	0	0				2,908	20,359	23,267	23,267	13	2	13	2	0	0	0				37,809	40,718	78,527	78,527
3	Clara Town	55,462	0	0	0				5	40	45	45	0	0	0				2,773	22,185	24,958	24,958	13	2	13	2	0	0	0				36,050	44,370	80,420	80,420
4	West Point	29,516	0	0	0				5	30	35	35	0	0	0				1,476	8,855	10,331	10,331	13	2	13	2	0	0	0				19,185	17,710	36,895	36,895
5	Central Monrovia A	42,139	5	35	40				0	0	0	40	2,107	14,749	16,856				0	0	0	16,856	13	2	13	2	27,390	29,497	56,888				0	0	0	56,888
6	Central Monrovia B	40,688	5	35	40				0	0	0	40	2,034	14,241	16,275				0	0	0	16,275	13	2	13	2	26,447	28,482	54,929				0	0	0	54,929
7	Sinkor	43,780	20	0	20				15	5	20	40	8,756	0	8,756				6,567	2,189	8,756	17,512	13	2	13	2	113,828	0	113,828				85,371	4,378	89,749	203,577
8	Lakpazee	42,045	10	0	10				20	5	25	35	4,205	0	4,205				8,409	2,102	10,511	14,716	13	2	13	2	54,659	0	54,659				109,317	4,205	113,522	168,180
9	Old Road	48,274	10	0	10				10	5	15	25	4,827	0	4,827				4,827	2,414	7,241	12,069	13	2	13	2	62,756	0	62,756				62,756	4,827	67,584	130,340
10	Congo Town	25,217	0	0	0				15	5	20	20	0	0	0				3,783	1,261	5,043	5,043	13	2	13	2	0	0	0				49,173	2,522	51,695	51,695
11	Paynesville	350,335	0	0	0				15	5	20	20	0	0	0				52,550	17,517	70,067	70,067	13	2	13	2	0	0	0				683,153	35,034	718,187	718,187
12	Gardnersville	80,397	10	0	10				5	0	5	15	8,040	0	8,040				4,020	0	4,020	12,060	13	2	13	2	104,516	0	104,516				52,258	0	52,258	156,774
13	New Georgia	54,188	10	0	10				5	0	5	15	5,419	0	5,419				2,709	0	2,709	8,128	13	2	13	2	70,444	0	70,444				35,222	0	35,222	105,667
14	Barnersville	35,224	10	0	10				5	0	5	15	3,522	0	3,522				1,761	0	1,761	5,284	13	2	13	2	45,791	0	45,791				22,896	0	22,896	68,687
15	Johnsonville	4,514	0	0	0				15	0	15	15	0	0	0				677	0	677	677	13	2	13	2	0	0	0				8,802	0	8,802	8,802
16	Caldwell	26,586	0	0	0				15	0	15	15	0	0	0				3,988	0	3,988	3,988	13	2	13	2	0	0	0				51,843	0	51,843	51,843
	Total	1,009,912											38,910	28,989	67,900				100,118	102,564	202,682	270,581					505,832	57,979	563,811				1,301,533	205,127	1,506,660	2,070,471
																							27						343,059							

Sewage Producion Volume in 2019

No.	Zone Name	Pop. in 2019	Coverage rate in 2019(%)										Service Population in 2019 (%)										Rate of Water useage(Gal/c/d)				Water Usage volume (Gal/d)									
			Off-site (For fiamah)			Off-site (For each community)			On-site				Off-site (For fiamah)			Off-site (For each community)			On-site				Off-site		On-site		Off-site (For fiamah)			Off-site (For each community)			On-site			
			Private House	Public toilet	Total	Private House	Public toilet	Total	Private House	Public toilet	Total	Total	Private House	Public toilet	Total	Private House	Public toilet	Total	Private House	Public toilet	Total	Total	Private House	Public toilet	Private House	Public toilet	Private House	Public toilet	Total	Private House	Public toilet	Total	Private House	Public toilet	Total	Total
1	New Kru Town	78,818	20	0	20	15	0	15	5	35	40	75	15,764	0	15,764	11,823	0	11,823	3,941	27,586	31,527	59,114	16	2	16	2	252,218	0	252,218	189,164	0	189,164	63,055	55,173	118,227	559,609
2	Logan Town	68,431	50	0	50	5	0	5	5	35	40	95	34,215	0	34,215	3,422	0	3,422	3,422	23,951	27,372	65,009	16	2	16	2	547,447	0	547,447	54,745	0	54,745	54,745	47,902	102,646	704,838
3	Clara Town	60,724	40	0	40	10	0	10	5	40	45	95	24,290	0	24,290	6,072	0	6,072	3,036	24,290	27,326	57,688	16	2	16	2	388,635	0	388,635	97,159	0	97,159	48,579	48,579	97,159	582,952
4	West Point	29,370	0	0	0	0	65	65	5	30	35	100	0	0	0	0	19,090	19,090	1,468	8,811	10,279	29,370	16	2	16	2	0	0	0	0	38,180	38,180	23,496	17,622	41,117	79,298
5	Central Monrovia A	67,692	65	35	100	0	0	0	0	0	0	100	44,000	23,692	67,692	0	0	0	0	0	0	67,692	16	2	16	2	703,992	47,384	751,376	0	0	0	0	0	0	751,376
6	Central Monrovia B	51,579	65	35	100	0	0	0	0	0	0	100	33,527	18,053	51,579	0	0	0	0	0	0	51,579	16	2	16	2	536,425	36,106	572,531	0	0	0	0	0	0	572,531
7	Sinkor	50,842	80	0	80	0	0	0	15	5	20	100	40,673	0	40,673	0	0	0	7,626	2,542	10,168	50,842	16	2	16	2	650,776	0	650,776	0	0	0	122,020	5,084	127,105	777,880
8	Lakpazee	47,451	30	0	30	45	0	45	20	5	25	100	14,235	0	14,235	21,353	0	21,353	9,490	2,373	11,863	47,451	16	2	16	2	227,764	0	227,764	341,646	0	341,646	151,843	4,745	156,588	725,998
9	Old Road	54,715	60	0	60	10	0	10	10	5	15	85	32,829	0	32,829	5,471	0	5,471	5,471	2,736	8,207	46,508	16	2	16	2	525,262	0	525,262	87,544	0	87,544	87,544	5,471	93,015	705,821
10	Congo Town	32,748	0	0	0	55	5	60	15	5	20	80	0	0	0	18,011	1,637	19,649	4,912	1,637	6,550	26,198	16	2	16	2	0	0	0	288,182	3,275	291,457	78,595	3,275	81,870	373,327
11	Paynesville	650,620	0	0	0	35	0	35	35	5	40	75	0	0	0	227,717	0	227,717	227,717	32,531	260,248	487,965	16	2	16	2	0	0	0	3,643,472	0	3,643,472	3,643,472	65,062	3,708,534	7,352,007
12	Gardnersville	100,081	0	0	0	65	0	65	5	5	10	75	0	0	0	65,053	0	65,053	5,004	5,004	10,008	75,061	16	2	16	2	0	0	0	1,040,843	0	1,040,843	80,065	10,008	90,073	1,130,916
13	New Georgia	64,053	0	0	0	65	0	65	5	5	10	75	0	0	0	41,634	0	41,634	3,203	3,203	6,405	48,040	16	2	16	2	0	0	0	666,151	0	666,151	51,242	6,405	57,648	723,799
14	Barnersville	44,995	0	0	0	65	0	65	5	5	10	75	0	0	0	29,247	0	29,247	2,250	2,250	4,500	33,746	16	2	16	2	0	0	0	467,949	0	467,949	35,996	4,500	40,496	508,445
15	Johnsonville	26,643	0	0	0	35	0	35	35	5	40	75	0	0	0	9,325	0	9,325	9,325	1,332	10,657	19,982	16	2	16	2	0	0	0	149,201	0	149,201	149,201	2,664	151,866	301,067
16	Caldwell	41,239	0	0	0	35	0	35	35	5	40	75	0	0	0	14,433	0	14,433	14,433	2,062	16,495	30,929	16	2	16	2	0	0	0	230,936	0	230,936	230,936	4,124	235,060	465,996
Total		1,470,000											239,532	41,745	281,277	453,562	20,728	474,290	301,299	140,307	441,606	1,197,173					3,832,519	83,490	3,916,009	7,256,992	41,455	7,298,447	4,820,789	280,614	5,101,403	16,315,859
																							81						3,916,009							

Cover rate for sanitary facility in Monrovia	81	%

Planned Conditon for Fiamah Sewage Tratement Plant

Item		
Average Daily Flow rate	3.92 (MGal/day) (=	14,822 m^3/day)
Maximum Daily Flow Rate※1	5.87 (MGal/day) (=	22,233 m^3/day)

※1 Maximum Daily Flow Rate = Average Dailly Flow Rate X 1.5

Capacity of Pump Station

Location	Flow Rate (m^3/min)	Total Head (m)	
New Kru Town P.S	0.99	10	Gravity
Bushrod Island P.S	4.69	20	Pressured
Mesurado River P.S	6.17	30	Pressured
BTC P.S	9.90	30	Pressured

Inlet Daily Flow Rate for Pipe(G/day) ※	
756,654	+New Kru Town
3,564,900	+Logan Town+Clara Town
4,691,964	+Clara Town+1/2MonroviaA
7,536,620	+1/2MonroviaA+MonroviaB

※Inlet Daily Flow Rate = Average Daily Flow Rate × 3.0

Inlet Daily Flow Rate for Pump(G/day) ※	
378,327	+New Kru Town
1,782,450	+Logan Town+Clara Town
2,345,982	+Clara Town+1/2MonroviaA
3,768,310	+1/2MonroviaA+MonroviaB

※Inlet Daily Flow Rate = Average Daily Flow Rate × 1.5

Sewage Producion Volume in 2008

No.	Zone Name	Pop. in 2008	Coverage rate in 2008 (%)										Service Population in 2008 (%)										Rate of Water useage(Gal/c/d)				Water Usage volume (Gal/d)									
			Off-site						On-site				Off-site						On-site				Off-site		On-site		Off-site						On-site			
			Private House	Public toilet	Total				Private House	Public toilet	Total	Total	Private House	Public toilet	Total				Private House	Public toilet	Total	Total	Private House	Public toilet	Private House	Public toilet	Private House	Public toilet	Total				Private House	Public toilet	Total	Total
1	New Kru Town	73,379	0	0	0				5	35	40	40	0	0	0				3,669	25,683	29,352	29,352	13	2	13	2	0	0	0				47,696	51,365	99,062	99,062
2	Logan Town	58,168	0	0	0				5	35	40	40	0	0	0				2,908	20,359	23,267	23,267	13	2	13	2	0	0	0				37,809	40,718	78,527	78,527
3	Clara Town	55,462	0	0	0				5	40	45	45	0	0	0				2,773	22,185	24,958	24,958	13	2	13	2	0	0	0				36,050	44,370	80,420	80,420
4	West Point	29,516	0	0	0				5	30	35	35	0	0	0				1,476	8,855	10,331	10,331	13	2	13	2	0	0	0				19,185	17,710	36,895	36,895
5	Central Monrovia A	42,139	5	35	40				0	0	0	40	2,107	14,749	16,856				0	0	0	16,856	13	2	13	2	27,390	29,497	56,888				0	0	0	56,888
6	Central Monrovia B	40,688	5	35	40				0	0	0	40	2,034	14,241	16,275				0	0	0	16,275	13	2	13	2	26,447	28,482	54,929				0	0	0	54,929
7	Sinkor	43,780	20	0	20				15	5	20	40	8,756	0	8,756				6,567	2,189	8,756	17,512	13	2	13	2	113,828	0	113,828				85,371	4,378	89,749	203,577
8	Lakpazee	42,045	10	0	10				20	5	25	35	4,205	0	4,205				8,409	2,102	10,511	14,716	13	2	13	2	54,659	0	54,659				109,317	4,205	113,522	168,180
9	Old Road	48,274	10	0	10				10	5	15	25	4,827	0	4,827				4,827	2,414	7,241	12,069	13	2	13	2	62,756	0	62,756				62,756	4,827	67,584	130,340
10	Congo Town	25,217	0	0	0				15	5	20	20	0	0	0				3,783	1,261	5,043	5,043	13	2	13	2	0	0	0				49,173	2,522	51,695	51,695
11	Paynesville	350,335	0	0	0				15	5	20	20	0	0	0				52,550	17,517	70,067	70,067	13	2	13	2	0	0	0				683,153	35,034	718,187	718,187
12	Gardnersville	80,397	10	0	10				5	0	5	15	8,040	0	8,040				4,020	0	4,020	12,060	13	2	13	2	104,516	0	104,516				52,258	0	52,258	156,774
13	New Georgia	54,188	10	0	10				5	0	5	15	5,419	0	5,419				2,709	0	2,709	8,128	13	2	13	2	70,444	0	70,444				35,222	0	35,222	105,667
14	Barnersville	35,224	10	0	10				5	0	5	15	3,522	0	3,522				1,761	0	1,761	5,284	13	2	13	2	45,791	0	45,791				22,896	0	22,896	68,687
15	Johnsonville	4,514	0	0	0				15	0	15	15	0	0	0				677	0	677	677	13	2	13	2	0	0	0				8,802	0	8,802	8,802
16	Caldwell	26,586	0	0	0				15	0	15	15	0	0	0				3,988	0	3,988	3,988	13	2	13	2	0	0	0				51,843	0	51,843	51,843
Total		1,009,912											38,910	28,989	67,900				100,118	102,564	202,682	270,581					505,832	57,979	563,811				1,301,533	205,127	1,506,660	2,070,471
																							27						343,059							

APPENDIX-14

ROAD USER COST

APPENDIX-14 ROAD USER COSTS

1.1 Road User Cost (RUC) Components

RUC consists of the following two (2) major components:

- Vehicle operating costs (VOC), that is, the physical costs of operating a vehicle such as fuel, lubricants, spare parts, deprecation, crew costs, etc;
- Travel time costs (TTC), that is the value of time spent in traveling that could be used in the other activities

In RUC component, accident cost (ACC), that is the physical costs of an accident and the value of injuries and fatalities, is sometimes taken into accounts. However, ACC is not taken into accounts in this study. This is reasons why saving in ACC is comparatively small in amount compared with the saving in VOC and TTC.

2 Inputs for Vehicle Operating Costs (VOC)

2.1 Vehicle Prices

The vehicle prices have been estimated on the basis of average prices from vehicle dealers. Most of vehicles are imported to Liberia as second hand reconditioned vehicles. However, the selling vehicle prices are used in this study.

For the purpose of calculating the economic price of each vehicle these taxes and import duties have been subtracted from retail price. The resulting economic price incorporates elements of CIF price, retailer's margin, and covering transport cost. **Table 2.1** shows the economic cost of the vehicle price.

Table 2.1 Vehicle Prices

(US $)

Type	Typical Model	CIF	Import /Goods Sales Tax	Retail Margin	Financial Cost	Economic Cost
Motor Cycle	TATA/Chinese Brand	350	43	307	700	350
Passenger Car	Nissan Florida	2,800	862	1,338	5,000	2,800
Taxi	Nissan Sunny	2,800	862	1,338	5,000	2,800
Mini Bus	Nissan Pathfinder	5,000	1,540	5,460	12,000	5,000
Large Bus	TATA	7,000	1,246	6,754	15,000	7,000
Truck	KIA	15,000	3,450	4,550	23,000	15,000

Source: JICA Study Team

Import tax 10.8%, Luxury tax 20%, Goods sales tax (GST)7%, basically

Retail margin may be including some license charged or others.

2.2 Tire Costs

The economic costs of tires have been assessed in the same way as vehicle prices. For the purpose of calculating the economic price of each vehicle tires, GST has been subtracted from retail price. The resulting economic price incorporates elements of CIF price, retailer's margin, and covering transport cost. **Table 2.2** shows the economic cost of the vehicle tire price.

Table 2.2 Tire Cost

(US $)

Type	No. of Tire	CIF	GST	Retail Margin	Financial Cost	Economic Cost
Motor Cycle	2	14.00	0.80	0.20	15	14.00
Passenger Car	4	27.90	1.90	0.20	30	27.90
Taxi	4	46.50	3.25	0.25	50	46.50
Mini Bus	4	37.20	2.60	0.20	40	27.90
Large Bus	6	46.50	3.25	0.25	50	46.50
Truck	4	93.00	6.50	0.50	100	93.00

Source: JICA Study Team

2.3 Fuel and Lubricants Costs

Fuel and lubricants prices have been estimated based on a survey of prices in Monrovia. There are a number of suppliers in here operating competitively.

Fuels are subject to import duty and GST.

For the purpose of calculating the economic price of fuel and lubricants, these taxes and import duty have been subtracted from retail price. The resulting economic price incorporates elements of CIF price, retailer's margin, and covering transport cost. **Table 2.3** shows the economic cost of the Fuel and Lubricants Costs.

Table 2.3 Fuel and Lubricants Costs

(US $)

Type	CIF	Import Duty / GST	Selling Price	Economic Cost
Gasoline	2.80	0.30	3.10	2.80
Diesel	2.60	0.20	2.80	2.60
Lubricant	1.86	0.14	2.00	1.86

Source: JICA Study Team

2.4 Vehicle Maintenance Costs

(1) Maintenance Labor Cost

The maintenance labor costs have been estimated based on a survey of average monthly cost of semi-skilled mechanics in Monrovia. Applied to average working hours of 176 hours per month, proportion of working time and Wage Rate, it is calculated and is shown in **Table 2.5**.

Table 2.5 Maintenance Labor Cost

(US $)

	Motor Cycle	Passenger Car	Taxi	Mini Bus	Large Bus	Truck
Wages per month						
Mechanic	288	288	400	288	288	496
Maintained by (%)						
Mechanic	40	50	50	50	50	50
Average hourly rate for services	1.80	1.80	2.50	1.80	1.80	2.60
Shadow wage rate factor	1	1	1	1	1	1
Economic rate	2	1.80	2.50	1.80	1.80	2.60

Source: JICA Study Team

2.5 Crew Cost

The crew costs have been estimated based on a survey of that of unit costs per drivers and conductor, number of staff per vehicle, and number of hours per vehicle. In Monrovia, unit costs for drivers are estimated at around US$ 150 to $ 180 per worker depend on the type of vehicle, while conductors are estimated to be one half of the average monthly cost of semi-skilled worker in Monrovia. Applied to average working hours of 176 hours per month, proportion of working time and the Shadow Wage Rate Factor (SWRF), it is calculated and is shown in **Table 2.6**.

Table 2.6 Crew Cost

(US $)

	Motor Cycle	Passenger Car	Taxi	Mini Bus	Large Bus	Truck
Number of drivers & Conductor	0	0	0.5	1	1	1
Average monthly wage rate	150	180	180	180	180	180
Working Hour	176	176	176	176	176	176
Average hourly rate for driver	0	0	0.21	0.41	0.41	0.41
Number of conductors	0	0	0	0	1	1
Conductor cost	0	0	0	0	0.41	0.41

Source: JICA Study Team

2.6 Vehicle Utilization and Depreciation

The depreciation cost can be expressed as a percent of vehicle cost and is given by following formula:

Car per 1,000 veh-km = DEP/ vehicle prices

A vehicle is a medium-term asset. Its purchase costs represent an investment which yields services over several years. The market value of the asset declines with both the passenger of time and with amount and type of usage.

It is this loss of market value that represents vehicle depreciation. The vehicle depreciation per km is a function of the average annual depreciation and annual utilization.

DEP = ADEP/AKM

Where: ADEP: Average annual depreciation, expressed as % of average new vehicle cost

ADEP: (1 / LIFE)*100

LIFE is average vehicle service life

AKM: Average number of kilometers driven per vehicle per year

The annual kilometers and hours driven are used as shown in **Table 2.7**.

The interest rate is applied at 14% per year taking into account of the opportunity capital of Liberia.

Table 2.7 Vehicle Characteristics

Type	Fuel Type	Number of Axles	Number of heels	Operating Weight	Annual Utilization	Service Life	Hour Worked	Occupancy
Motor Cycle	G	2	2	0.075	5,475	6	1,235	1.6
Passenger Car	G	2	4	1.2	10,950	6	1,235	2.2
Taxi	G	2	4	1.2	21,930	3	1,235	5.1
Mini Bus	D	2	4	4.2	5,475	5	1,460	13.5
Large Bus	D	2	6	7.1	3,650	5	1,460	21.6
Truck	D	2	4	2.8	21,930	6	1,460	4.7

Source: JICA Study Team
Note: G-Gasoline, D-Diesel

2.7 Summary of Basic VOC

Based on the above mentioned discussions and estimations, the basic vehicle operating costs (BVOC) are calculated and shown in **Table 2.8**.

Table 2.8 Basic Vehicle Operating Cost by Vehicle Types

(US $/1000 km)

Type	Item	Motor Cycle	Passenger Car	Taxi	Mini Bus	Large Bus	Truck
Distance related VOC	Fuel cost	24	86	86	156	117	156
	Lubricant cost	1	2	2	4	7	7
	Tire maintenance cost	2	16	34	92	380	103
	Depreciation cost	2	4	8	39	23	110
	Total	29	108	130	291	527	376
Time related VOC	Crew cost	0	0	210	410	820	820
	Opportunity cost of Capital	10	50	90	80	50	80
	Depreciation cost	30	270	540	470	320	620
	Total	40	320	840	960	1,190	1,520

Source: JICA Study Team

2.8 VOC by Surface Type and IRI

Condition of the surface type and road roughness is very important factor to calculate the VOC. The empirical studies carried out has already found out the relationship between International Roughness Index (IRI) and VOC or between travel speed and VOC. Based on these relationships, VOC by road conditions are computed by Roads Economic Decision Model (RED)-HDM 4VOC workbook and shown in **Table 2.9** and **Table 2.10.**

Table 2.9 Vehicle Operating Cost by Road Conditions, primary road

(US$/1000 km)

Road Condition	Motor Cycle	Passenger Car	Taxi	Mini Bus	Large Bus	Truck
Good	29	108	130	291	527	376
Fair	30	110	132	302	546	391
Bad	35	117	139	383	709	461
Very Bad	40	126	150	450	842	531

Source: JICA Study Team, WB RED-HDM 4 VOC workbook

Table 2.10 Vehicle Operating Cost by Travel Speed, primary road

(US$/1000 km)

Travel Speed	Motor Cycle	Passenger Car	Taxi	Mini Bus	Large Bus	Truck
5-10 km	90	220	260	620	1,160	920
10-15 km	80	200	240	600	1,130	840
15-20 km	70	180	220	580	1,100	780
20-25 km	60	160	200	560	1,060	720
25-30 km	40	140	180	520	1,030	640
30-35 km	40	130	160	490	950	580
35-40 km	40	120	150	440	870	520
40-45 km	40	110	130	290	530	370

Source: JICA Study Team, WB RED-HDM 4 VOC workbook

3 TRAVEL TIME COST (TTC)

3.1 General

Travel time costs (TTC) also referred to as Value of Time (VOT) is an important component of road user costs (RUC). The concept of travel time costs is based on a premise that the time spent in traveling has an ‘opportunity cost” and could be used in an alternative activity which also produce or may produce some significant utility (benefit). If the alternative activity can have monetary value assigned to it, this can be used as a part of RUC in the economic appraisal of the projects, particularly road improvement project.

3.2 Methodology

To estimate the travel time costs, the Average Wage Approach method is taken into consideration. The wage rates of vehicle occupants are assessed and then their average rates are estimated to reflect the value of time of occupants in different vehicles. An assessment of umber of travelers in working time and non-working time is made for each vehicle type.

The TTC for working time is then as the estimated wage rate and that for non-working time is not taken into accounts in this study.

3.3 Forecast of Time Value

Table 3.1 shows the household monthly income. For this analysis it is chosen different measure of the time value for motor-cycle, passenger car, taxi, mini bus, and large bus. For passenger car, it is chosen average income of top two (2) of monthly income. For motor cycle and taxi, it is chosen average income of next two (2) deciles (6,000- 19,999 Liberia dollars) of monthly income. And for buses, it is chosen average income of bottom two (2) deciles of monthly income.

Table 3.1 Household Monthly Income

Monthly Income (L$)	Percent (%)
2,999 or less	24
3,000 – 5,999	25
6,000-9,999	27
10,000-19,999	16
20,000-39,999	6
40,000 and above	2
Total	100

Source: JICA Study Team, Traffic Survey

Table 3.2 shows the composition of trip purpose by vehicle type.

Table 3.2 Composition of Trip Purpose

Trip Purpose	Motorcycle	Passenger car	Taxi	Mini bus	Large bus
To Work	11.1	35.4	15.0	17.1	41.0
To School	15.5	7.5	10.2	4.1	0.8
Business	13.2	10.0	7.9	7.3	6.7
Private	19.2	10.5	20.1	23.9	6.6
To Home	41.0	36.6	46.8	47.6	44.9
Total	100.0	100.0	100.0	100.0	100.0

Source: JICA Study Team, Traffic Survey

Table 3.3 shows the estimation of time value composition by vehicle type.

Table 3.3 Estimation of Time Value Computation by Vehicle Type

	Motorcycle	Passenger car	Taxi	Mini bus	Large bus
Hourly Income in US $	0.86	2.44	0.37	0.37	0.37
Time Value in US $	0.16	0.72	0.06	0.06	0.10
Occupancy	1.6	2.2	5.1	13.5	21.6
Time Value per Vehicle in US$	0.26	1.58	0.31	0.81	2.16

Source: JICA Study Team

APPENDIX-15

IEE ON REQUESTED PROJECTS

Appendix-15　IEE on the Requested Projects

（Water Supply Sector）

①　The Project for Emergency Development of Water Supply at Paynesville in Greater Monrovia

Potential Impacts and Mitigation/Enhancement Measures

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
Pre-Construction and Construction Phases PHYSICAL ENVIRONMENT				
Geomorphology	Project facilities will be provided on a flat plane which locates in the south-east of Monrovia, and some hills are found here and there. Steep slope is not found around the site and geomorphology features is stable	Long-term, Almost negative	C	◇ Special attention is not necessary.
Geology	The foundation rock consists of Precambrian Melanocratic gneiss and Project bore-holes will take water from Devonian Paynesville sandstone layer, shallow wells which take water from Ediana sandstone layers are working at present	Long-term, Almost negative	C	◇ Special attention is not necessary.
Land	Possibility on loss of land due to Project facilities such as wells, elevated tanks and pipelines	Long-term, Almost negative	C	◇ Special attention is not necessary.
Ground water	Possible decrease in ground water level caused by provided new water pumps.	Long-term, Further study is necessary to assess the impacts	B	◇Alternative sites for wells must be provided when the considerable negative impacts are serious.
Water Quality	Possible increase in pH level of waterways due to mortar spillage during concrete pouring.	Short-term, Almost negative	C	◇Concrete pouring will be closely supervised to prevent spillage. ◇ All formworks will be secured prior to pouring to ensure failure will not occur; and ◇Washing of transit concrete mixers along the waterways or anywhere near the waterways will be strictly prohibited
	Possible increase in the bacteriological content of waterways, particularly fecal coli form due to domestic wastes	Short-term, Almost negative, however must be	C	◇ Temporary sanitation facilities such as portable

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
	generated by construction personnel	confirmed in Engineering stage		toilets and garbage bins will be provided by the Contractors to ensure that domestic wastes to be generated by the construction personnel are properly handled and are not thrown into the rivers and creeks to prevent further pollution of the waterways
	Increase in total suspended solids and artificial decrease in water flow in rivers and/or creeks.	Short-term, Almost negative	C	◇ Impact to the receiving waterways is insignificant if mitigating measures are strictly implemented. During construction period only.
Air Quality	Excavation and installation activities during the pre-construction and construction of facilities, and road may possibly increase the present level of suspended particulate matters within the construction sites and adjacent areas	Short-term, Almost negative	C	◇ Exposed and cleared construction areas will be regularly sprayed with water, particularly those near residential and environmentally sensitive areas; ◇Excavated materials will be regularly hauled and disposed to the approved disposal sites; and ◇ Temporary stockpiles of excavated and filling materials will be covered with tarpaulin, canvass or sack materials to prevent re-suspension of particulate matters
	Possible increase in exhaust gas emission levels such as SOx, NOx, CO, and other hydrocarbons generated by the various pre-construction and construction equipment	Short-term, Almost negative	C	◇Contractors will be required to conduct daily routine equipment and machinery check-ups to ensure that these are in the optimum working conditions; and ◇Regular maintenance of the construction equipment and machineries will be strictly complied with
Noise Level	Possible increase in noise level due to operations of various pre-construction and construction equipment and machineries	Short-term, Almost negative	C	◇Noise suppressors, such as mufflers will be installed whenever deemed necessary to maintain the noise generated by the various heavy equipment and other construction machinery within permissible limits; ◇ Temporary noise barriers such as corrugated metal sheets will be installed around the construction sites to maintain noise level within permissible limits; and ◇ High noise generating pre-construction and construction activities will be scheduled during daytime to

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
				minimize noise disturbance to adjacent residential and commercial areas, and other noise-sensitive areas
Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
Pre-Construction and Construction Phases BIOLOGICAL Environment				
Flora	Loss of natural and cultivated vegetative cover in areas traversed by the facilities	Long-term, Almost negative	C	◇ Special attention is not necessary.
Fauna	Loss of the natural habitat of wildlife in the area	Long-term, Almost negative	C	◇ Special attention is not necessary
Pre-Construction and Construction Phases SOCIO-ECONOMIC Environment				
Permanent displacement of affected families within the ROW	Facilities will be provided within the ROW or public land. No displacement will be required	—	N/A	—
Demolition of affected commercial establishments and industrial structures due to the Project facilities	Facilities will be provided within the ROW or public land. No demolition will be required.	—	N/A	—
Possible displacement of public structures along alignment	Facilities will be provided within the ROW or public land. No possible displacement of public structure will be required.	—	N/A	—
Interruption of service utilities	Possible interruption of the social service utilities such water and power due to foundation works and other related construction works	Short-term, Almost negative however must be confirmed	C	◇ Special attention is not necessary.
Safety of pedestrians in the areas near the construction sites	Safety of pedestrians along heavily populated areas, schools, commercial, office, and industrial areas	Short-term, Almost negative however must be confirmed in Engineering stage	C	◇ Traffic enforcers will be designated at busy areas such as schools, heavily populated areas, major pedestrian crossings, commercial and industrial areas to guide pedestrians along these areas; ◇ Adequate reflectorized warning signs will be installed within the construction area to ensure safety of pedestrians; ◇ Construction areas, particularly excavation areas will be enclosed with corrugated metal sheet barriers to avoid accidents; and ◇ Adequate lighting will be installed within the construction area to provide illumination during nighttime
Pre-Construction and Construction Phases SICIO-ECONOMIC Environment				
Occupational health hazards	Construction personnel, particularly operators of heavy equipment and	Short-term, Almost negative	C	◇ Construction personnel, especially operators of heavy

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
and safety rules and regulations	machinery may experience temporary hearing problems due to long-term exposure to high noise generated by said equipment. Similarly, long-term exposure to the exhaust gas emissions from the equipment and machineries may cause upper respiratory ailments			equipment and machineries will be provided with earmuffs to prevent drastic effects of noise; ◇Construction personnel will be provided with the necessary safety material such as protective masks to; First aid stations supervised by the Environment and Safety Health Officer of the Contractor will be located within the construction site; and ◇Emergency vehicles will be on stand-by within the construction area
Temporary Employment	Generation of temporary employment within the project area.	Short-term, Almost negative	C	◇ Priority in hiring of qualified workers and laborers will be given to the residents within the direct impact area.
OPERATIONAL PHASE PHYSICAL ENVIRONMENT				
Air Quality	Possible increase in gaseous emissions and other air pollutants due to the power generators.	Long-term, Almost negative	C	◇ Proper and regular maintenance of power generators.
Noise Level	Possible increase in the level of noise due to the power generators	Long-term, Almost negative	C	◇ Proper and regular maintenance of power generators.
Hydrology and Water Quality	Reduction of oil and grease loads in the rivers and/or creeks.	Long-term, Positive	B	◇ Proper and regular maintenance of power generators.

（Road Sector）

① Project for Improvement of Johnson Street Bridge

Potential Impacts and Mitigation/Enhancement Measures

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
PRE-CONSTRUCTION AND CONSTRUCTION PHASES PHYSICAL ENVIRONMENT				
Geomorphology	Project facility is located in the west edge of Mesurado wetland where southern terrain is hilly and northern is flat. A change of terrain due to the Project is almost nil	Long-term, Almost negative	C	◇ Special attention is not necessary.
Geology	The foundation consists of Precambrian Melanocratic gneiss, and thick layered Devonian Paynesville sand stone or thin layered Edina sandstone lays above the foundation. Deposited soft soil layer caused by the river flow activity is found. Possibility of soil consolidation needs to be considered	Long-term, Possible of the negative impact to the structure or embankment caused by the consolidation needs to be considered in Engineering stage	B	◇ Possibility of consideration is carried out by the boring work and geotechnical test. ◇ Countermeasures will be taken when the soft layer shows the tendency of consolidation.
Slope Erosion	Slope instability, increase in rate of erosion and siltation	Short-term, Almost negative however must be confirmed before Project will commence	C	To ensure slope stability the following measures are recommended: ◇ re-vegetation of cleared and/or cut slopes; ◇ re-grading of steep slopes; ◇ construction of concrete lined drainage channels; ◇ construction of concrete cribs;

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
				◇ construction of retaining walls; Construction spoils and materials will be properly stockpiled prior to hauling and disposal to designated disposal sites.
Land	**Loss of accommodation/commercial lands along the ROW**	**Long Term, Widening of bridge work will be carried out in the wetland which is designated as Ramsar site. And approach roads may be widened within ROW, however, the possibility of negative impacts shall be clarified through Engineering stage**	**A**	**◇ Select the alignment that enable to minimize the affected lands** **◇ Compensation will be accorded to affected landowners prior to construction of the requested project**
Hydrology	Temporary facility required for the new pier may possibly hamper the water flow section and cause the flood	Short-Term, Almost negative, however, must be confirmed in Engineering stage	C	◇Select the working method that enable to minimize the affected water flow section
Water Quality	Possible increase in pH level of waterways due to mortar spillage during concrete pouring	Short-term, Almost negative	C	◇Concrete pouring will be closely supervised to prevent spillage. ◇ All formworks will be secured prior to pouring to ensure failure will not occur; and ◇Washing of transit concrete mixers along the waterways or anywhere near the waterways will be strictly prohibited
	Possible increase in the bacteriological content of waterways, particularly fecal coli form due to domestic wastes generated by construction personnel	Short-term, Almost negative however must be confirmed in Engineering stage	C	Temporary sanitation facilities such as portable toilets and garbage bins will be provided by the Contractors to ensure that domestic wastes to be generated by the construction personnel are properly handled and are not thrown into the rivers and creeks to prevent further pollution of the waterways
	Increase in total suspended solids and artificial decrease in water flow in rivers and/or creeks.	Short-term, Almost negative	C	Impact to the receiving waterways is insignificant if mitigating measures are strictly implemented. During construction period.

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
Air Quality	Excavation, bore holes and other related activities involved during the pre-construction and construction of interchanges, bridges, and road may possibly increase the present level of suspended particulate matters within the construction sites and adjacent areas	Short-term, Almost negative	C	◇ Exposed and cleared construction areas will be regularly sprayed with water, particularly those near residential and environmentally sensitive areas; ◇Excavated materials will be regularly hauled and disposed to the approved disposal site/s; and ◇ Temporary stockpiles of excavated and filling materials will be covered with tarpaulin, canvass or sack materials to prevent re-suspension of particulate matters
	Possible increase in exhaust gas emission levels such as SO_X, NO_X, CO, and other hydrocarbons generated by the various pre-construction and construction equipment	Short-term, Almost negative	C	◇Contractors will be required to conduct daily routine equipment and machinery check-ups to ensure that these are in the optimum working conditions; and ◇Regular maintenance of the construction equipment and machineries will be strictly complied with
Noise Level	Possible increase in noise level due to operations of various pre-construction and construction equipment and machineries	Short-term, Almost negative	C	◇Noise suppressors, such as mufflers will be installed whenever deemed necessary to maintain the noise generated by the various heavy equipment and other construction machinery within permissible limits; ◇ Temporary noise barriers such as corrugated metal sheets will be installed around the construction sites to maintain noise level within permissible limits; and ◇ High noise generating pre-construction and construction activities will be scheduled during daytime to minimize noise disturbance to adjacent residential and commercial areas, and other noise-sensitive areas
PRE-CONSTRUCTION AND CONSTRUCTION PHASES BIOLOGICAL ENVIRONMENT				
Flora	**Facilities will be provided within the Mesurado Wetland which designated as Ramsar Site. Possible to cause negative impacts to precious species such as mangroves.**	**Long-term, magnitude of impacts can not be specified, therefore, it shall be identified**	**A**	**◇ Specify the distribution of plants around project site is necessary**

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
		through EIA survey		
Fauna	**Possible to cause negative impacts to roosting place/breeding/nest building for wildlife those habituating in wetland**	**Long-term, magnitude of impacts can not be specified, therefore shall be identified through EIA survey**	**A**	**◇Specify the distribution of precious wildlife species, particularly birds, fishes and crocodiles around project site**
PRE-CONSTRUCTION AND CONSTRUCTION PHASES SICIO-ECONOMIC ENVIRONMENT				
Permanent displacement of affected families along the ROW of the proposed alignment	**Possible displacement due to the Project**	**Long-Term, must be specified in Engineering stage**	**A**	**◇ Choose the alignment/working method which enable to mitigate the number of displacement**
Demolition of affected commercial establishments and industrial structures along the ROW of the proposed alignment	**Possible demolition due to the Project**	**Long-Term, must be specified in Engineering stage**	**A**	**◇ Choose the alignment/working method which enable to mitigate the number of affected structures**
Possible displacement of public structures due to the alignment	**Possible displacement of police box**	**Long-Term, must be specified in Engineering stage**	**A**	**◇ Choose the alignment/working method which will not cause the displacement**
Interruption of service utilities	Possible interruption of the social service utilities such water and power due to foundation works and other related construction works	Short-term, Almost negative however must be confirmed	C	◇ illumination, especially during ◇ A the nighttime to avoid ◇ untoward accident sound traffic management plan duly approved by the concerned government agency will be implemented to ensure safety of motorists plying the major routes and intersections to be traversed by the Project alignment; ◇ Traffic enforcers and flagmen will be designated along major thoroughfares and intersections affected by the Project alignment; ◇ Reflectorized warning and traffic signs will be installed at least 100 meters from the construction sites to caution

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
				motorist of the on-going construction works; and ◇ Adequate lighting will be installed within the construction sites to provide ◇ ◇ s
Safety of pedestrians in the areas near the construction sites	Safety of pedestrians along heavily populated areas, schools, commercial, office, and industrial areas	Short-term, Almost negative however must be confirmed in Engineering stage	C	◇ Traffic enforcers will be designated at busy areas such as schools, heavily populated areas, major pedestrian crossings, commercial and industrial areas to guide pedestrians along these areas; ◇ Adequate reflectorized warning signs will be installed within the construction area to ensure safety of pedestrians; ◇ Construction areas, particularly excavation areas will be enclosed with corrugated metal sheet barriers to avoid accidents; and ◇Adequate lighting will be installed within the construction area to provide illumination during nighttime
Safety of motorist plying the routes to be traversed by the Project alignment	Safety of motorists along the routes to be traversed by the Project alignment, particularly major roads and intersections	Short-term, Almost negative, however must be confirmed in Engineering stage	C	◇ A sound traffic management plan duly approved by the concerned government agency will be implemented to ensure safety of motorists plying the major routes and intersections; ◇ Traffic enforcers and flagmen will be designated along major thoroughfares and intersections affected by the alignment; ◇ Reflectorized warning and traffic signs will be installed at least 100 meters from the construction sites to caution motorist of the on-going construction works; and ◇ Adequate lighting will be installed within the construction sites to provide illumination, especially during the nighttime to avoid untoward accidents
PRE-CONSTRUCTION AND CONSTRUCTION PHASES SICIO-ECONOMIC ENVIRONMENT				
Safety of vessels	Safety of vessels navigating in Mesurado River	Short-term,	C	◇Reflectorized warning signs and adequate lighting will be

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
along the waterways		Almost negative, however must be confirmed before Project will commence		installed at the construction areas along these major waterways
Traffic	Possible increase in traffic congestion along major roads and intersections traversed by the alignment	Short-term, Almost negative, however must be confirmed before Project will commence	C	◇A sound traffic management and re-routing plans duly approved by the concerned government agency will be strictly implemented to minimize traffic congestion along affected major roads and intersections; ◇ Traffic enforcers and flagmen will be designated along these areas to assist in directing traffic flow; and ◇Parking time of construction equipment such as dump trucks and concrete mixers along the major thoroughfares will be limited, especially during rush hours to minimize traffic congestions
Occupational health hazards and safety rules and regulations	Construction personnel, particularly operators of heavy equipment and machinery may experience temporary hearing problems due to long-term exposure to high noise generated by said equipment. Similarly, long-term exposure to the exhaust gas emissions from the equipment and machineries may cause upper respiratory ailments	Short-term, Almost negative however must be confirmed before Project will commence	C	◇ Construction personnel, especially operators of heavy equipment and machineries will be provided with earmuffs to prevent drastic effects of noise; ◇Construction personnel will be provided with the necessary safety material such as protective masks to; First aid stations supervised by the Environment and Safety Health Officer of the Contractor will be located within the construction site; and ◇Emergency vehicles will be on stand-by within the construction area
Temporary Employment	Generation of temporary employment within the project area.	Short-term, Almost negative	C	Priority in hiring of qualified workers and laborers will be given to the residents within the direct impact area.
OPERATIONAL PHASE PHYSICAL ENVIRONMENT				
Air Quality	Possible increase in gaseous emissions and other air pollutants due to increased volume of traffic.	Long-term, Almost negative	C	◇ Proper and regular maintenance of vehicles. ◇ Planting of fast-growing trees along the shoulders of the newly approaches that will serve as settling areas of gaseous vehicular emissions and other air pollutants.
Noise Level	Possible increase in the level of noise	Long-term,	C	◇Strict implementation of

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
	due to the increased volume of traffic.	Almost negative		proper and regular maintenance of vehicles through installation of mufflers and other vehicular noise reduction gadgets. ◇ Monitoring of vehicle maintenance. ◇Planting of fast-growing trees along the shoulders of the newly constructed way that will serve as noise barriers.
Hydrology and Water Quality	Reduction of oil and grease loads in the rivers and/or creeks.	Long-term, Positive	B	◇ Posting of signs on bridges that prohibit washing of vehicles in rivers and/or creeks.
OPERATIONAL PHASE BIOLOGICAL ENVIRONMENT				
Flora	**Enhance the house construction activity will cause the possible threat by intense charcoal burning and fuel wood collection in wetland**	**Long-term, Positive & negative**	**A**	**◇MCC should monitor and supervise the illegal activities within the wetland**
Fauna	**Possible to cause negative impacts to roosting place/breeding/nest building for wildlife those habituating in wetland**	**Long-term, magnitude of impacts can not be specified, therefore shall be identified through Environmental Impact Assessment**	**A**	**◇Specify the distribution of precious wildlife species, particularly birds, fishes and crocodiles living around the alignment**

② Project for Reconstruction of Somalia Drive in Monrovia

Potential Impacts and Mitigation/Enhancement Measures

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
PRE-CONSTRUCTION AND CONSTRUCTION PHASES PHYSICAL ENVIRONMENT				
Geomorphology	Project road is located in the northern part of flat area from Mesurado wetland where crosses two rivers flow into the wetland A change of terrain due to the Project is almost nil	Long-term, Almost negative	C	◇ Special attention is not necessary.
Geology	The foundation rock consists of Precambrian Melanocratic gneiss, and thin layered Devonian Paynesville sand stone is locating above the foundation. Deposited soft soil layer is found caused by the river flow activity. Possibility of soil consolidation needs to be considered	Long-term, Almost negative, however the consolidation of soil needs to be considered in Engineering stage	C	◇Possibility of consideration is carried out by the boring work and geotechnical test. ◇ Countermeasures will be taken when the soft layer shows the tendency of consolidation
Slope Erosion	Slope instability, increase in rate of erosion and siltation.	Short-term, Possible, must be confirmed before Project will commence	B	To ensure slope stability the following measures are recommended: ◇ re-vegetation of cleared and/or cut slopes; ◇ re-grading of steep slopes; ◇ construction of concrete lined drainage channels; ◇ construction of concrete cribs; ◇ construction of retaining walls; Construction spoils and materials will be properly stockpiled prior to hauling and disposal to designated

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
				disposal sites.
Land	**Loss of accommodation/commercial lands along the ROW**	**Long Term, Widening of road work will be carried out within ROW however illegal occupancy ignoring the ROW is on-going. Negative impacts shall be clarified through Engineering stage**	**A**	**◇MPW and MCC should take countermeasures to the illegal occupancy** **◇Based on this Master Plan Study, MCC is advised to set up Regional Development Plan and solve the issues such as small kiosks and taxies which constitute majority of illegal occupancy by providing permanent market area**
Hydrology	Pier for the bridge may possibly hamper the water flow section and cause the flood	Short-term, Almost negative, however must be confirmed before Project will commence	C	◇Select the type and working method that enable to minimize the affected water flow section
Water Quality	Possible increase in pH level of waterways due to mortar spillage during concrete pouring	Short-term, Almost negative	C	◇ Concrete pouring will be closely supervised to prevent spillage. ◇ All formworks will be secured prior to pouring to ensure failure will not occur; and ◇Washing of transit concrete mixers along the waterways or anywhere near the waterways will be strictly prohibited
	Possible increase in the bacteriological content of waterways, particularly fecal coli form due to domestic wastes generated by construction personnel	Short-term, Almost negative	C	◇ Temporary sanitation facilities such as portable toilets and garbage bins will be provided by the Contractors to ensure that domestic wastes to be generated by the construction personnel are properly handled and are not thrown into the rivers and creeks to prevent further pollution of the waterways
	Increase in total suspended solids and artificial decrease in water flow in rivers and/or creeks.	Short-term, Almost negative	C	◇ Impact to the receiving waterways is insignificant if mitigating measures are strictly implemented. During construction period only.
Air Quality	Dozing, stripping, earthmoving, and other related activities involved during the pre-construction and construction of interchanges, bridges, and road may possibly increase the present level of suspended particulate matters within the construction sites and adjacent areas	Short-term, Almost negative	C	◇ Temporary stockpiles of excavated and filling materials will be covered with tarpaulin, canvass or sack materials to prevent re-suspension of particulate matters and; ◇Cleared construction areas

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
				will be regularly sprayed with water, particularly those near residential and environmentally sensitive areas; ◇Excavated materials will be regularly hauled and disposed to the approved disposal site/s;
	Possible increase in exhaust gas emission levels such as SO_X, NO_X, CO, and other hydrocarbons generated by the various pre-construction and construction equipment	Short-term, Almost negative	C	◇Contractors will be required to conduct daily routine equipment and machinery check-ups to ensure that these are in the optimum working conditions; and ◇Regular maintenance of the construction equipment and machineries will be strictly complied with
Noise Level	Possible increase in noise level due to operations of various pre-construction and construction equipment and machineries	Short-term, Almost negative	C	◇Noise suppressors, such as mufflers will be installed whenever deemed necessary to maintain the noise generated by the various heavy equipment and other construction machinery within permissible limits; ◇ Temporary noise barriers such as corrugated metal sheets will be installed around the construction sites to maintain noise level within permissible limits; and ◇ High noise generating pre-construction and construction activities will be scheduled during daytime to minimize noise disturbance to adjacent residential and commercial areas, and other noise-sensitive areas
PRE-CONSTRUCTION AND CONSTRUCTION PHASES BIOLOGICAL ENVIRONMENT				
Flora	Facilities will be provided within the ROW or public land. Negative effect is almost nil, however there is a possibility that the huge amount of embankment will affect flora in/around the soil borrow pits	Long Term, Negative impacts shall be clarified through Engineering stage	B	◇ Study come candidates and choose the borrow pits which enable to minimize the negative affect
Fauna	Facilities will be provided within the ROW or public land. Negative effect is almost nil, however there is a possibility that the huge amount of embankment will affect flora in/around the soil borrow pits	Long Term, Negative impacts shall be clarified through Engineering stage	B	◇ Study some candidates and choose the borrow pits which enable to minimize the negative impact
PRE-CONSTRUCTION AND CONSTRUCTION PHASES				

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
SOCIO-ECINOMIC ENVIRONMENT				
Permanent displacement of affected families along the ROW of the proposed alignment	**Possible displacement of illegal houses within ROW**	**Long-term, Must be Specified in Engineering stage**	**A**	**◇ Study and confirm the Resettlement Policy and Land Acquisition Policy which applied in Liberia ◇Choose the alignment and working method which enable to minimize the negative impact**
Demolition of affected commercial establishments along the ROW of the proposed alignment	**Possible demolition of illegal street stores/kiosks carrying on business within ROW**	**Short-term, Must be Specified in Engineering stage**	**A**	**◇ Study and confirm the Resettlement Policy and Land Acquisition Policy which applied in Liberia**
Possible displacement of public structures along alignment	Facilities will be provided within the ROW or public land. No displacement of public structure will be required.	―	N/A	―
Interruption of service utilities	Possible interruption of the social service utilities such water and power due to foundation works and other related construction works	Short-term, Almost negative however must be specified in Engineering stage	C	◇ illumination, especially during ◇ A the nighttime to avoid ◇ untoward accident sound traffic management plan duly approved by the concerned government agency will be implemented to ensure safety of motorists plying the major routes and intersections to be traversed by the Project alignment; ◇ Traffic enforcers and flagmen will be designated along major thoroughfares and intersections affected by the Project alignment; ◇ Reflectorized warning and traffic signs will be installed at least 100 meters from the construction sites to caution motorist of the on-going construction works; and Adequate lighting will be installed within the construction sites to provide
Safety of pedestrians in the areas near the construction sites	Safety of pedestrians along heavily populated areas, schools, commercial, office, and industrial areas	Short-term, Almost negative however must be confirmed in Engineering stage	C	◇ Traffic enforcers will be designated at busy areas such as schools, heavily populated areas, major pedestrian crossings, commercial and industrial areas to guide pedestrians along these areas;

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
				◇ Adequate reflectorized warning signs will be installed within the construction area to ensure safety of pedestrians; ◇ Construction areas, particularly excavation areas will be enclosed with corrugated metal sheet barriers to avoid accidents; and ◇ Adequate lighting will be installed within the construction area to provide illumination during nighttime
Safety of motorist plying the routes to be traversed by the alignment	Safety of motorists along the routes to be traversed by the Project alignment, particularly major roads and intersections	Short-term, Almost negative however must be confirmed in Engineering stage	C	◇ A sound traffic management plan duly approved by the concerned government agency will be implemented to ensure safety of motorists plying the major routes and intersections to be traversed by the alignment; ◇ Traffic enforcers and flagmen will be designated along major thoroughfares and intersections affected by the alignment; ◇ Reflectorized warning and traffic signs will be installed at least 100 meters from the construction sites to caution motorist of the on-going construction works; and ◇ Adequate lighting will be installed within the construction sites to provide illumination, especially during the nighttime to avoid untoward accidents
OPERATIONAL PHASE PHYSICAL ENVIRONMENT				
Air Quality	Possible increase in gaseous emissions and other air pollutants due to increased volume of traffic.	Long-term, Almost negative	C	◇ Proper and regular maintenance of vehicles. ◇ Planting of fast-growing trees along the shoulders of the newly constructed highway that will serve as settling areas of gaseous vehicular emissions and other air pollutants.
Noise Level	Possible increase in the level of noise due to the increased volume of traffic.	Long-term, Almost negative	C	◇ Strict implementation of proper and regular maintenance of vehicles through installation of mufflers and other vehicular noise reduction gadgets.

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
				◇ Monitoring of vehicle maintenance. ◇ Planting of fast-growing trees along the shoulders of the newly constructed way that will serve as noise barriers.
Hydrology and Water Quality	Reduction of oil and grease loads in the rivers and/or creeks.	Long-term, Positive	C	◇ Posting of signs on bridges that prohibit washing of vehicles in rivers and/or creeks.
OPERATIONAL PHASE BIOLOGICAL ENVIRONMENT				
Flora	Enhance the house construction activity will cause the possible threat by intense charcoal burning and fuel wood collection in wetland	Long-term, Positive & negative	B	◇MCC should monitor and supervise the illegal activities within the wetland
Fauna	Possible to cause negative impacts to roosting place/breeding/nest building for wildlife those habituating in wetland	Long-term, magnitude of impacts can not be specified, therefore shall be identified through Engineering stage	B	◇Specify the distribution of precious wildlife species, particularly birds, fishes and crocodiles living around alignment
OPERATIONAL PHASE Socio-economic Environment				
	The newly rehabilitated road will; ◇ provide better accessibility to basic social services; and ◇ ensure undisrupted flow of commodity.	Long-term, Positive	B	◇ MPW must continuously keep its regular road maintenance activities to ensure optimal benefits to road users.
	Possible increase in population due to migration.	Long-term, Almost negative	C	◇This is unavoidable, cannot be mitigated, and MCC should manage and control the illegal occupancy such as illegal land occupation or construction of illegal structures.
	Increase in demand for basic social services.	Long-term, Almost negative	C	MCC traversed by the alignment is expected to have a significant increase in tax revenues due to possible commercial development in the said areas. Such increase will enable the MCC to provide; ◇ more health and educational facilities; ◇ better water and electric supply; and ◇ more transportation and communication facilities.

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
	Possible urbanization and commercial development of the area.	Long-term, Positive	B	◇ MCC should formulate sound Comprehensive Master Plan, and Land Use and Site Development Plans to prepare for the urbanization and commercial growth in their areas.

③ Project for Reconstruction of Bridges on Missing Link

Potential Impacts and Mitigation/Enhancement Measures

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
PRE-CONSTRUCTION AND CONSTRUCTION PHASES PHYSICAL ENVIRONMENT				
Geomorphology	Project bridges are located in the northern and eastern part of Mesurado wetland A change of terrain due to the Project is almost nil	Long-term, Almost negative	C	◇ Special attention is not necessary.
Geology	The foundation consists of Precambrian Melanocratic gneiss, and thin layered Devonian Paynesville sand stone is locating above the foundation. Deposited soft soil layer is found caused by the river flow activity. Possibility of soil consolidation needs to be considered	Long-term, Almost negative, however, the impact caused by the consolidation needs to be considered in Engineering stage	C	◇Possibility of consideration is carried out by the boring work and geotechnical test. ◇ Countermeasures will be taken when the soft layer shows the tendency of consolidation.
Slope Erosion	Slope instability, increase in rate of erosion and siltation.	Short-term, Almost negative however must be confirmed before Project will commence	C	To ensure slope stability the following measures are recommended: ◇ re-vegetation of cleared and/or cut slopes; ◇ re-grading of steep slopes; ◇ construction of concrete lined drainage channels; ◇ construction of concrete cribs; ◇ construction of retaining

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
				walls; Construction spoils and materials will be properly stockpiled prior to hauling and disposal to designated disposal sites.
Land	Loss of accommodation along the ROW	Long Term, Facility will be provided in the wetland, possibility of negative impacts shall be clarified through Engineering stage	B	◇ Select the alignment that enable to minimize the affected lands ◇ Compensation will be accorded to affected landowners prior to construction of the requested project
Hydrology	Pier for the bridge will hamper the water flow section and cause the flood	Short-term, Almost negative however must be confirmed before Project will commence	C	◇Select the type and working method that enable to minimize the affected water flow section
Water Quality	Possible increase in pH level of waterways due to mortar spillage during concrete pouring	Short-term, Almost negative	C	◇Concrete pouring will be closely supervised to prevent spillage. ◇ All formworks will be secured prior to pouring to ensure failure will not occur; and ◇Washing of transit concrete mixers along the waterways or anywhere near the waterways will be strictly prohibited
	Possible increase in the bacteriological content of waterways, particularly fecal coli form due to domestic wastes generated by construction personnel	Short-term, Almost negative however must be confirmed in Engineering stage	C	◇ Temporary sanitation facilities such as portable toilets and garbage bins will be provided by the Contractors to ensure that domestic wastes to be generated by the construction personnel are properly handled and are not thrown into the rivers and creeks to prevent further pollution of the waterways
	Increase in total suspended solids and artificial decrease in water flow in rivers and/or creeks.	Short-term, Almost negative	C	◇ Impact to the receiving waterways is insignificant if mitigating measures are strictly implemented. During construction period only.
Air Quality	Excavation, piling and other related activities involved during the pre-construction and construction of interchanges, bridges, and road may possibly increase the present level of suspended particulate matters within the	Short-term, Almost negative	C	◇Temporary stockpiles of excavated and filling materials will be covered with tarpaulin, canvass or sack materials to prevent re-suspension of particulate matters and;

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
	construction sites and adjacent areas			◇ Cleared construction areas will be regularly sprayed with water, particularly those near residential and environmentally sensitive areas; ◇Excavated materials will be regularly hauled and disposed to the approved disposal site/s;
	Possible increase in exhaust gas emission levels such as SO_X, NO_X, CO, and other hydrocarbons generated by the various pre-construction and construction equipment	Short-term, Almost negative	C	◇Contractors will be required to conduct daily routine equipment and machinery check-ups to ensure that these are in the optimum working conditions; and ◇Regular maintenance of the construction equipment and machineries will be strictly complied with
Noise Level	Possible increase in noise level due to operations of various pre-construction and construction equipment and machineries	Short-term, Almost negative	C	◇Noise suppressors, such as mufflers will be installed whenever deemed necessary to maintain the noise generated by the various heavy equipment and other construction machinery within permissible limits; ◇ Temporary noise barriers such as corrugated metal sheets will be installed around the construction sites to maintain noise level within permissible limits; and ◇ High noise generating pre-construction and construction activities will be scheduled during daytime to minimize noise disturbance to adjacent residential and commercial areas, and other noise-sensitive areas
PRE-CONSTRUCTION AND CONSTRUCTION PHASES BIOLOGICAL ENVIRONMENT				
Flora	Loss of natural and cultivated vegetative cover in areas traversed by the facilities.	Long-term, Almost negative	C	◇ Special attention is not necessary
Fauna	Loss of the natural habitat of wildlife in the area.	Long-term, Almost negative	C	◇ Special attention is not necessary
PRE-CONSTRUCTION AND CONSTRUCTION PHASES SOCIO-ECONOMIC ENVIRONMENT				
Permanent displacement of affected families along the ROW of	Possible displacement due to the approach roads to the bridge。	Long-term, Specified in Engineering stage	B	◇ Choose the alignment which enable to mitigate negative impact

Parameters	Impacts	Duration and Degree of Impacts	Category	Mitigation/Enhancement Measures
the proposed alignment				
Safety of pedestrians in the areas near the construction sites	Safety of pedestrians along heavily populated areas, schools, commercial, office, and industrial areas	Short-term, Almost negative however must be confirmed in Engineering stage	C	◇ Construction areas, particularly excavation areas will be enclosed with corrugated metal sheet barriers to avoid accidents; and ◇Adequate lighting will be installed within the construction area to provide illumination during nighttime
OPERATIONAL PHASE PHYSICAL ENVIRONMENT				
Air Quality	Possible increase in gaseous emissions and other air pollutants due to increased volume of traffic.	Long-term, Almost negative	C	◇ Proper and regular maintenance of vehicles.
Noise Level	Possible increase in the level of noise due to the increased volume of traffic.	Long-term, Almost negative	C	◇Strict implementation of proper and regular maintenance of vehicles through installation of mufflers and other vehicular noise reduction gadgets.
Hydrology and Water Quality	Reduction of oil and grease loads in the rivers and/or creeks.	Long-term, Almost negative	C	◇ Posting of signs on bridges that prohibit washing of vehicles in rivers and/or creeks.
OPERATIONAL PHASE BIOLOGICAL ENVIRONMENT				
Flora	Enhance the house construction activity will cause the possible threat by intense charcoal burning and fuel wood collection in wetland	Long-term, Almost negative	C	◇MCC should monitor and supervise the illegal activities within the wetland
Fauna	Possible to cause negative impacts to roosting place/breeding/nest building for wildlife those habituating in wetland	Long-term, Almost negative	C	◇MCC should monitor and supervise the illegal activities within the wetland
OPERATIONAL PHASE Socio-economic Environment				
	The newly rehabilitated bridge will provide better accessibility to basic social services	Long-term, Almost negative	C	◇MPW must continuously keep its maintenance activities to ensure optimal benefits to users.
	Possible increase in population due to migration.	Long-term, Almost negative	C	◇This is unavoidable, cannot be mitigated, and MCC should manage and control the illegal occupancy such as illegal land occupation or construction of illegal structures.