5. References

	Name	Date	Type	Issue/Writer
1	2010-2011 Financial Statement Budget Document No.3	2010	Book	Ministry of Finance, Government of Malawi
2	Draft Estimates of Expenditure on Recurrent and Capital Budget for the Financial Year 2010/2011 Vol.2 Budget Document No.4	2010	Copy	Ministry of Finance, Government of Malawi
3	Approved Estimates of Expenditure on Recurrent and Capital Budget for the Financial Year 2009/10 Vol.3 Budget Document No.5	2009	Copy	Ministry of Finance, Government of Malawi
4	Approved Estimates of Expenditure on Recurrent and Capital Budget for the Financial Year 2008/09 Vol.VII Budget Document No.4	2009	Copy	Ministry of Finance, Government of Malawi
5	Approved Estimates of Expenditure on Recurrent and Capital Budget for the Financial Year 2007/08 Vol.VIII Budget Document No.4	2008	Copy	Ministry of Finance, Government of Malawi
6	Guidelines for Environmental Impact Assessment	1997.12	Book	Ministry of Forestry, Fisheries and Environmental Affairs Environment Affairs Department
7	CONSTRUCTION OF PHALOMBE TEACHER TRAINING COLLEGE BIDDING DOCUMENT 1 OF 4	2011	Copy	Ministry of Education Science and Technology
8	Senior Secondary School Teaching Syllabus (Biology)	2001.2	Copy	Ministry of Education, Science and Technology
9	Junior Secondary School Teaching Syllabus (Biology)	1998.12	Copy	Ministry of Education, Science and Technology
10	Senior Secondary School Teaching Syllabus (Physical Science Form 3 - 4)	2001.1	Copy	Ministry of Education, Science and Technology
11	Junior Secondary School Teaching Syllabus (Physical Science)	1998.12	Copy	Ministry of Education, Sports and Culture
12	Physics Lab. Manual (Year-1_3), Diploma of Education, Department of Physical Science	2004. 4	Copy	Domasi College of Education Malawi World University Service of Canada
13	Biology Lab. Manual (Year-1_3), Diploma of Education, Department of Physical Science	2005. 1	Copy	Domasi College of Education Malawi
14	Chemistry Lab. Manual (Year-1_3), Diploma of Education, Department of Physical Science	2005. 1	Copy	Domasi College of Education Malawi Japan International Cooperation Agency
15	University of Malawi Chancellor College Organization Structure	2010	Copy	University of Malawi Chancellor College

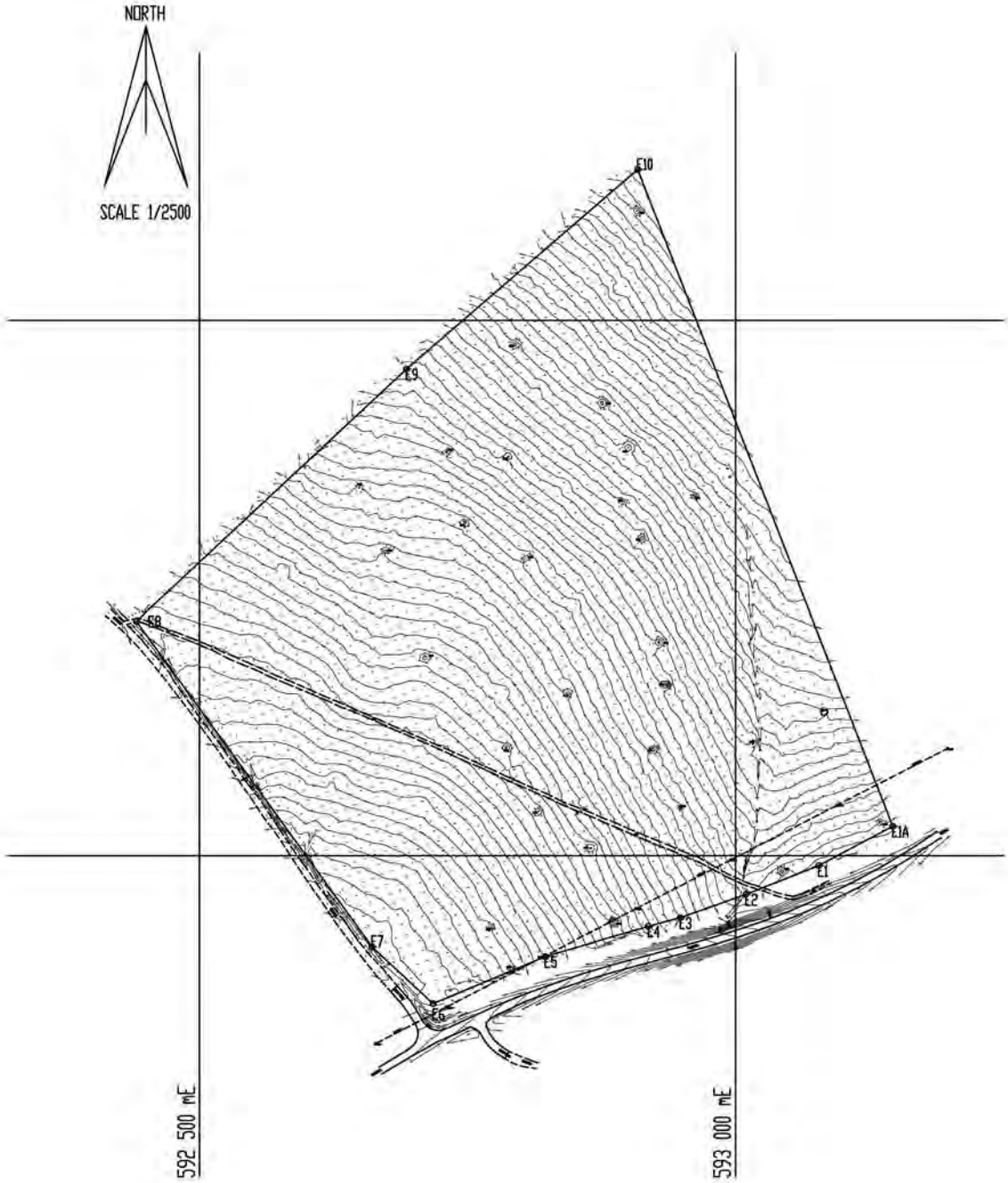
6. Other Relevant Data

6-1 Topographical Survey Reports

6-2 Geotechnical Investigation Reports(Extract)

6-3 Borehole Investigation Reports

6-1 Topographical Survey Reports



MALAWI POLYTECHNIC
CIVIL ENGINEERING DEPARTMENT

REPORT ON GEOTECHNICAL INVESTIGATIONS ON THE PROJECT FOR CONSTRUCTION OF A TEACHER TRAINING COLLEGE FOR SECONDARY SCHOOL TEACHERS IN LILONGWE

TO: MATSUDA INTERNATIONAL CONSULTANTS

PREPARED BY: TUTULE MSUKWA, MPhil, BSc Civil Eng, Reng.
Geotechnical Engineer

May 2011

INTRODUCTION

General

Matsuda International Consultant contacted Malawi Polytechnic, Civil Engineering Department to conduct geotechnical investigations and recommend appropriate bearing capacity of structures on various sites in Malawi, namely; Nalikule Forests in Lilongwe District.

Site reconnaissance, insitu testing and soil sampling for all the sites were carried out from 24th March 2011 to 31st March 2011. Laboratory testing proceeded immediately at the Malawi Polytechnic Laboratory in Blantyre.

Project Description

It is our understanding that the project involves the construction of a full Teachers Training college at Nalikule forests in Lilongwe. From our knowledge of schools structures in Malawi it is our understanding that the structures to be built will be ground level structures with no storeys and that the structures will be mainly load bearing walls resting on standard mass concrete strip footings.

Objectives of the Soil Investigation

The purpose of the geotechnical exploration exercise was to:

1. To determine the subsoil conditions under the proposed sites for the construction of tanks.
2. To determine the engineering properties of the subsoil.
3. To comment on the type of foundation to be adopted.
4. To assess the bearing capacity of the soil in line with standard strip footings of width 690mm.

Soil Sampling and Testing

In all there were eight sites. In all the sites, trial pits were dug in order to reveal the soil profile, carry out insitu tests and get samples for laboratory testing. Location for trial pits were agreed with Matsuda Consultants. The trial pits were approximately two metres deep.

Insitu tests carried out, were Water Penetration test (WPT) and Dynamic Cone Penetration Test (DCP). The soil samples recovered from the trial pits were taken to the Polytechnic laboratory, and examined to confirm the field descriptions. Representative samples were then selected for classification tests (plasticity and grading test) and compaction test. Where possible undisturbed samples for triaxial testing were collected.

Nalikule Forests

Eighteen trial pits for sample collection and testing evenly distributed were dug on Nalikule Forests. In addition six more pits were dug for Water penetration test. Furthermore 161 points were selected for DCP testing.

Observations on trial pits at 2m depth and classification tests indicated that the soils were alternating between light red lateritic firm sandy clays to decomposed light grey rock dominated by gravelly sand.

From the triaxial test, the worst case scenario was observed on Pit no. 17 which gave an angle of friction of 6 degrees and cohesion intercept of 45kN/m^2. Using Terzaghis Ultimate bearing capacity equation and assuming a 1m deep foundation and 690mm wide strip footing, the ultimate bearing capacity of the soil is 307kN/m^2. Applying a Factor of safety of two the safe bearing capacity is 154kN/m^2

From the DCP test it was observed that very few areas had a Penetration Index (PI) of more than 20mm/blow (approx CBR of 10). This indicates that averagely Nalikule forest has a quite strong and stable ground condition which can ably accommodate normal foundation loads from buildings. In areas where the PI is greater than 20mm/blow, the areas can be recompacted to improve their bearing capacity or otherwise they can be avoided.

The water penetration results gave an average percolation value of 0.8mm/min.

RECOMMENDATIONS

The soil conditions at the proposed CDSS are adequate for Nalikule Forest (safe bearing capacity for a strip footing of 690mm greater than 150kN/m^2)..

References

1. Soil mechanics by R.F. Graig
2. Elements of Soil mechanics by G.N. Smith

Appendices

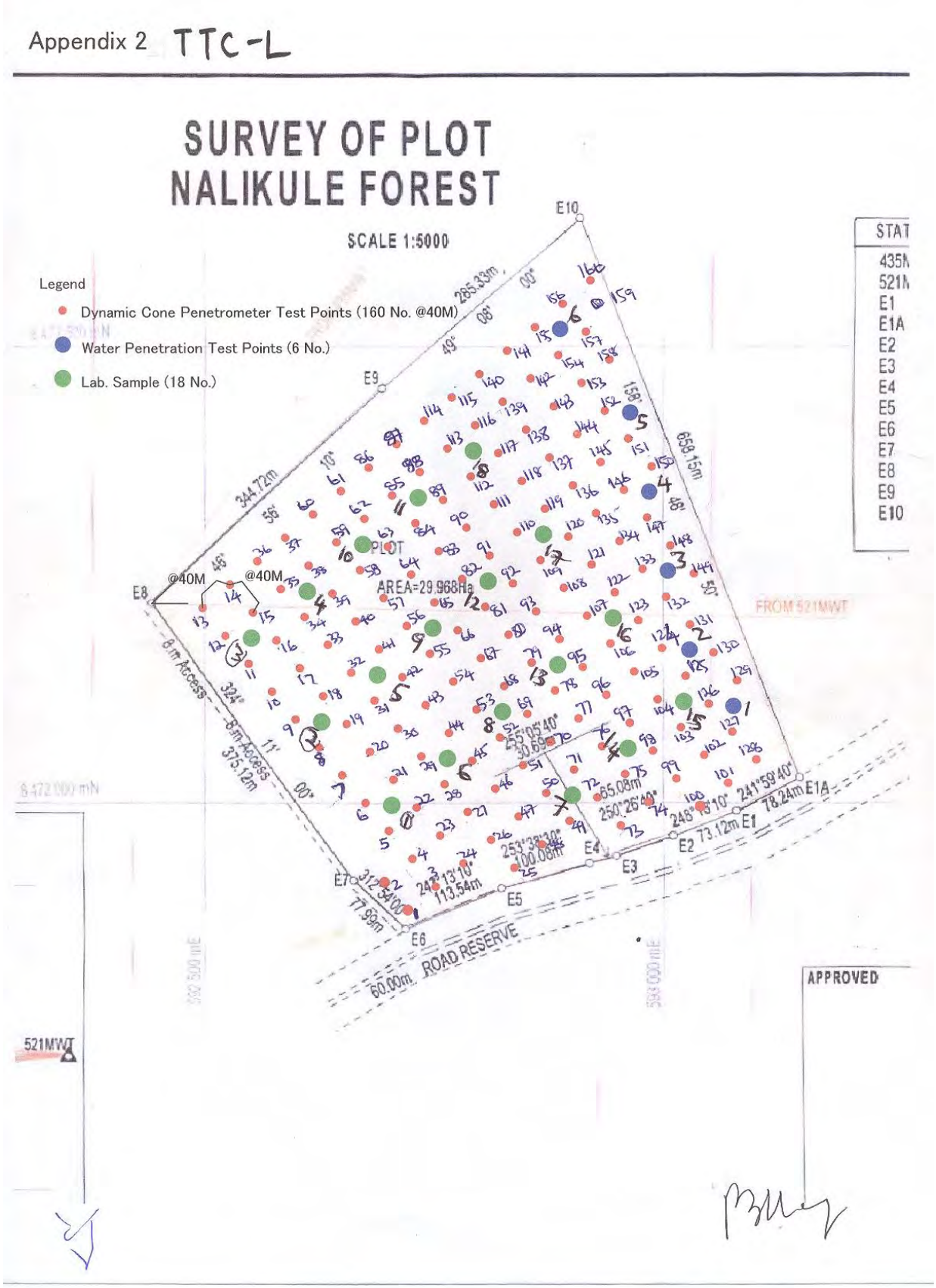
1. Site Location
2. Summary Report on Geotechnical Investigations
3. Triaxial Test Results
4. DCP Test results

Appendices

1. Site Location
2. Summary Report on Geotechnical Investigations
3. Triaxial Test Results
4. DCP Test results

1. Site Location

Appendix 2 TTC-L



2. Summary Report on Geotechnical Investigations

UNIVERSITY OF MALAWI

PRINCIPAL
Grant Kululanga, PhD. Eng., MSc. Eng., BSc. Eng., MASCE

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Our Ref.:

Your Ref:

Date: **15th June, 2011**

ATT: Matsuda International Consultants

SUMMARY REPORT ON GEOTECHNICAL INVESTIGATIONS

SITE	SOIL TYPE	PENETRATION RATE OF WATER (mm/min)	DCP PENETRATION INDEX	APPROXIMATE COMPARATIVE CBR	DEGREE OF COMPACTION	COMMENTS & RECOMMENDATIONS
NALIKULE FOREST	Light red lateritic firm sandy clay to decomposed light grey rock & gravelly sand	0.8 (Low Permeability)	<20 mm/blow	10	STIFF Strong and stable ground	Can ably accommodate normal foundation loads from buildings & >20mm/blow points to be recompacted to improve bearing capacity or be avoided.

3. Triaxial Test Results

UNIVERSITY OF MALAWI – THE POLYTECHNIC
DEPARTMENT OF CIVIL ENGINEERING

DATE : 03rd May.2011

SUMMARY OF RESULTS FOR SOIL INVESTIGATIONS – **MATSUDA INTERNATIONAL CONSULTANTS**

SITE	PIT NO	GRADING	ATTERBERG LIMITS			TRIAXIAL TEST	
			LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	COHENSION INTERCEPT (C')	ANGLE OF SHEARING (Ø)
NALIKULE FOREST (LILONGWE)	1	DONE	38.0	24.0	**14.0**	70 kN/m^2	26.6°
	2	DONE	48.0	21.0	**27.0**	57 kN/m^2	18.3°
	3	DONE	NP	NP	**NP**	Decomposed Rock	
	4	DONE	NP	NP	**NP**	Decomposed Rock	
	5	DONE	NP	NP	**NP**	Decomposed Rock	
	6	DONE	39.0	23.8	**15.2**	58 kN/m^2	10.2°
	7	DONE	NP	NP	**NP**	Decomposed Rock	
	8	DONE	NP	NP	**NP**	Decomposed Rock	
	9	DONE	NP	NP	**NP**	Decomposed Rock	
	10	DONE	36.8	20.8	**16.0**	66 kN/m^2	21.8°
	11	DONE	25.8	12.8	**13.0**	73 kN/m^2	20.3°
	12	DONE	NP	NP	**NP**	Decomposed Rock	
	13	DONE	NP	NP	**NP**	Decomposed Rock	
	14	DONE	NP	NP	**NP**	Decomposed Rock	
	15	DONE	40.9	19.9	**21.0**	55 kN/m^2	14.6°
	16	DONE	NP	NP	**NP**	Decomposed Rock	
	17	DONE	43.3	20.3	**23.0**	45 kN/m^2	5.7°
	18	DONE	32.0	16.8	**15.2**	70 kN/m^2	6.0°

4. DCP Test results

UNIVERSITY OF MALAWI

PRINCIPAL

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Our Ref.:

Your Ref:

Date: **07th July, 2011**

ATT: Matsuda Consultants International

DCP TEST RESULTS FOR NALIKULE FOREST IN LILONGWE

POINT	TOTAL NO OF BLOWS	PENETRATION (mm)	DCP NUMBER (mm/blow)	IN SITU CBR
1	106	2000	19	10
2	104	2000	19	10
3	94	2000	21	9
4	96	2000	21	9
5	110	2000	18	11
6	89	2000	22	8
7	78	2000	26	7
8	84	2000	24	7
9	96	2000	21	9
10	84	2000	24	7
11	77	2000	26	7
12	82	2000	24	7
13	110	2000	18	11
14	230	2000	9	25
15	220	2000	9	25
16	225	2000	9	25
17	180	2000	11	20
18	184	2000	11	20
19	200	2000	10	22
20	235	2000	9	25
21	335	2000	6	45
22	330	2000	6	45
23	280	2000	7	35
24	295	2000	7	35
25	300	2000	7	35
26	300	2000	7	35
27	335	2000	6	45

28	315	2000	6	45
29	300	2000	7	35
30	315	2000	6	45
31	115	2000	17	12
32	120	2000	17	12
33	130	2000	15	14
34	130	2000	15	14
35	130	2000	15	14
36	120	2000	17	12
37	125	2000	16	13
38	130	2000	15	14
39	145	2000	14	15
40	150	2000	13	16
41	180	2000	11	20
42	235	2000	9	25
43	230	2000	9	25
44	230	2000	9	25
45	235	2000	9	25
46	280	2000	7	35
47	300	2000	7	35
48	335	2000	6	45
49	320	2000	6	45
50	330	2000	6	45
51	250	2000	8	30
52	155	2000	13	16
53	160	2000	13	16
54	145	2000	14	15
55	160	2000	13	16
56	127	2000	16	13
57	135	2000	15	14
58	140	2000	14	15
59	165	2000	12	18
60	170	2000	12	18
61	150	1000	7	35
62	120	1000	8	30
63	215	1000	5	55
64	230	1000	4	75
65	220	1000	5	55
66	155	1000	7	35
67	125	1000	8	30
68	175	1000	6	45
69	180	1000	6	45
70	200	1000	5	55
71	255	1000	4	75
72	190	1000	5	55
73	190	1000	5	55
74	255	1000	4	75
75	195	1000	5	55
76	185	1000	5	55
77	185	1000	5	55
78	195	1000	5	55
79	175	1000	6	45
80	165	1000	6	45
81	155	1000	7	35
82	200	1000	5	55
83	225	1000	4	75
84	220	1000	5	55

85	225	1000	4	75
86	180	1000	6	45
87	190	1000	5	55
88	205	1000	5	55
89	210	1000	5	55
90	160	1000	6	45
91	160	1000	6	45
92	195	1000	5	55
93	200	1000	5	55
94	235	1000	4	75
95	200	1000	5	55
96	185	1000	5	55
97	205	1000	5	55
98	180	1000	6	45
99	165	1000	6	45
100	230	1000	4	75
101	230	1000	4	75
102	232	1000	4	75
103	166	1000	6	45
104	180	1000	6	45
105	198	1000	5	55
106	208	1000	5	55
107	210	1000	5	55
108	185	1000	5	55
109	165	1000	6	45
110	200	1000	5	55
111	210	1000	5	55
112	205	1000	5	55
113	210	1000	5	55
114	215	1000	5	55
115	225	1000	4	75
116	235	1000	4	75
117	190	1000	5	55
118	190	1000	5	55
119	200	1000	5	55
120	205	1000	5	55
121	175	1000	6	45
122	235	1000	4	75
123	230	1000	4	75
124	235	1000	4	75
125	230	1000	4	75
126	240	1000	4	75
127	235	1000	4	75
128	185	1000	6	45
129	190	1000	5	55
130	185	1000	6	45
131	165	1000	6	45
132	155	2000	13	16
133	120	2000	17	12
134	155	2000	13	16
135	145	2000	14	15
136	145	2000	14	15
137	150	2000	13	16
138	165	2000	12	18
139	170	2000	12	18
140	165	2000	12	18
141	165	2000	12	18

142	155	2000	13	16
143	175	2000	11	20
144	180	2000	11	20
145	165	2000	12	18
146	165	2000	12	18
147	167	2000	12	18
148	155	2000	13	16
149	150	2000	13	16
150	180	2000	11	20
151	155	2000	13	16
152	180	2000	11	20
153	190	2000	11	20
154	200	2000	10	22
155	235	2000	9	25
156	230	2000	9	25
157	245	2000	8	30
158	250	2000	8	30
159	155	2000	13	16
160	165	2000	12	18

LEGEND:

***DCP NUMBER (mm/blow) :** Is found by dividing **total penetration (2000mm)** by **total number of blows.**

*** BLOW(S) :** Counting the freely falling force applied to the DCP to attain penetration.

*** IN SITU CBR :** Comparative values with the DCP NUMBER found on the chart provided by the suppliers of the DCP machine.

Hoping this is in order.

Thanks for doing good business with us.

Yours truly,

D.B.Kasimpha

For Civil Engineering Laboratory

6-3 Borehole Investigation Reports

6-3 BOREHOLE INVESTGATION REPORT AT TTCL (Nalikure Site)

1. Results of the Test Drilling and Pumping Survey

1-1. Purpose and Methods of the Survey

A test drilling and pumping survey was implemented for the purpose of confirming whether or not there was a groundwater source required for the construction of a water supply facility at the Nalikure Teacher Training College (TTCL) Site of the Project for Construction of a Teacher Training College for Secondary School Teachers in Lilongwe (hereafter the Project). A local (Malawian) drilling company which had been selected as the subcontractor for the test drilling implemented the test drilling. The quality of the water from the boreholes constructed in the test drilling was analysed for its suitability for drinking at the Water Quality Laboratory of the Ministry of Agriculture, Irrigation and Water Development of the Republic of Malawi.

1-2. Survey Period

The test drilling and pumping, including drilling at the four sites of the Project for Re-Construction and Expansion of Selected Community Day Secondary Schools (Phase II) (CDSS-II) was scheduled for a two-month period between early September and late October 2011. The test drilling and pumping at the TTCL Site began in early October and was completed within an approximately one-month period. However, the schedule for the test drilling and pumping at the CDSS sites had to be postponed for a significant length of time because of the nationwide shortage of motor fuel.

1-3. Summary of the Survey Results

(1) Evaluation of Yields and Water Quality at the TTCL (Nalikure) Survey Site

The results of the test drilling and pumping survey are summarised in Table-2 below. The availability of groundwater as a source of water supply was confirmed as a borehole, TTC No. 2, yielded a small quantity of water and TTC Nos. 3 and 4 yielded fair quantities of water, though TTC No. 1 yielded no water. However, it is difficult to meet the anticipated water demand of 75 m^3/day with the yields of those wells. The results of the hydrogeological evaluation of the results of the test drilling and pumping survey will be used for the preparation of a technical recommendation required for satisfying the water demand. An officer in charge of the Water Quality Laboratory of the Ministry of Agriculture, Irrigation and Water Development of Malawi collected samples for the water quality analysis at the test drilling sites at the completion of the pumping test and analysed the samples using the drinking water specifications of Malawi and the Guidelines for Drinking-Water Quality of WHO as criteria. The analysis proved that the quality of the groundwater obtained from all the three test boreholes was ideal for drinking.

Figure-1 shows the locations of the test drilling sites in the TTCL Survey Site. The approximate locations of the drilling sites were marked on a Google Earth map using the latitudes and longitudes of

the sites observed with a GPS device.

Table-1: Results of the test drilling and pumping survey in the TTCL Site

Test drilling site	Test borehole	Location of the drilling site		Well depth (Drilling depth)	Evaluation of the yield and water quality
		Latitude (south)	Longitude (east)		
1.TTCL Nalikure	TTC No. 1	13°49′17.5″S	33°51′38.6″E	― (53 m)	×
	TTC No. 2	13°49′10.2″S	33°51′38.3″E	54 m (54 m)	△
	TTC No. 3	13°49′7.0″S	33°51′37.3″E	61 m (61 m)	◎
	TTC No. 4	13°49′00.7″S	33°51′38.3″E	70 m (70 m)	○

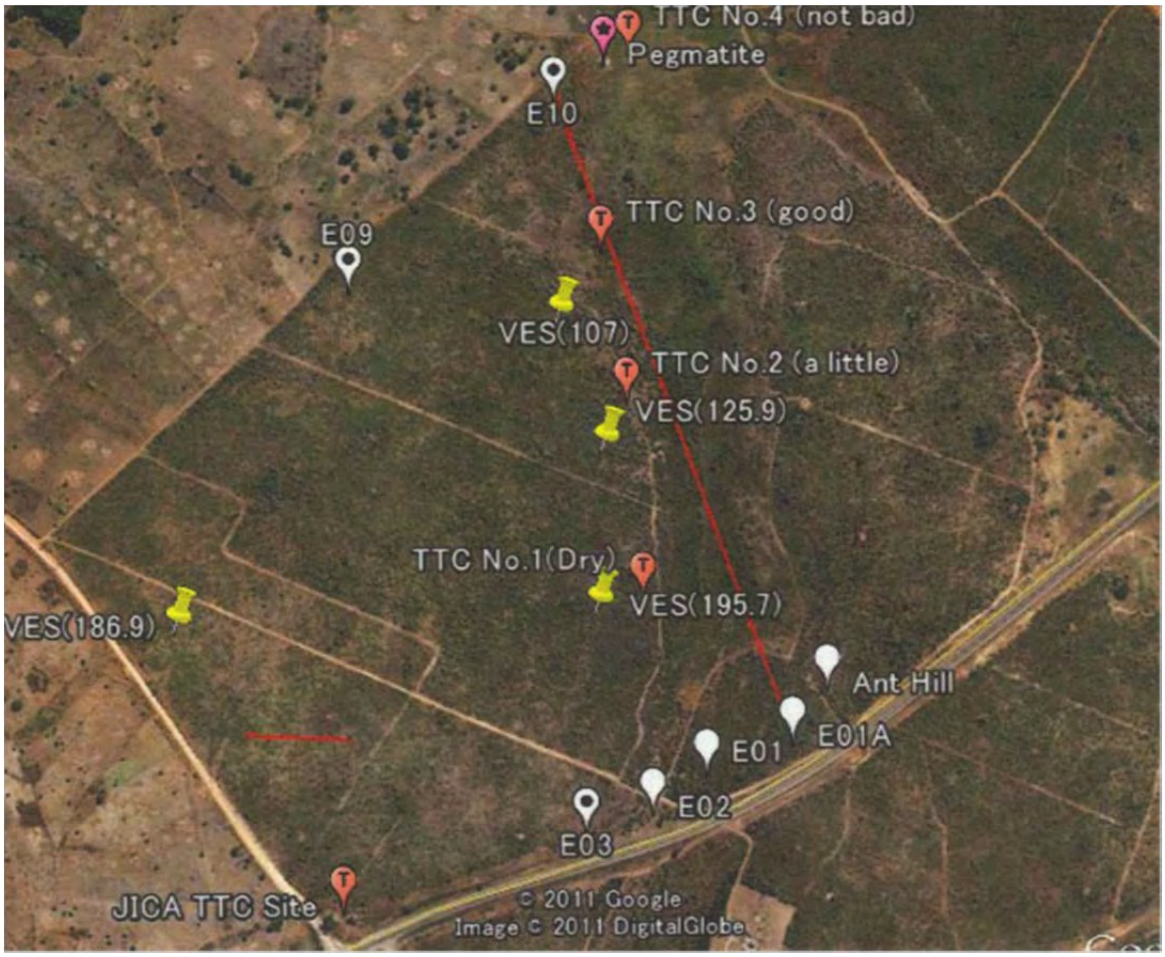


Figure-1: Locations of the test drilling and pumping sites at the TTCL (Nalikure) Site

Legend:
1) The red circles (TTC Nos. 1-4) indicate the locations of the four test drilling and pumping sites.
2) The four yellow 'VES' indicate the locations where the electrical prospecting (vertical electric sounding) was conducted.
3) The white circles (E01A - E10) indicate the locations of the boundary markers of the TTC premises.
4) The red line at the bottom of the figure is a scale bar representing 100 m.
5) The imagery data was created by marking the locations of the drilling sites obtained with the GPS observation on a Google Earth map.

(2) Specifications for the Test Drilling and Pumping Survey

The test drilling and pumping survey was implemented by the subcontracted local drilling company (WATEC) in accordance with the standard specifications for water wells of Malawi described in Table-3 below.

Table-2: Specifications for the survey using test drilling wells

① Borehole finishing diameter: φ 6 inches, Average drilling depth: 60 m
② Screen and casing diameter: φ 6 inches (external diameter: 160 mm), PVC
③ Screens installed in the aquifer
④ Void between the borehole wall and screens packed with gravel
⑤ Borehole development
⑥ Pumping test (Step drawdown pumping test: pumping for 2 hours/step x 4 steps, a total of 8 hours, Constant rate pumping test: continuous for 24 hours, Recovery test: for 6 hours or until the water head recovery of 90 % or more)
⑦ Water quality analysis (in accordance with the guidelines for drinking-water quality of Malawi and WHO) for the suitability for drinking
⑧ Analysis of water samples on the 21 parameters including coliform bacteria count and standard plate count at a public institution in Malawi engaged in water quality analysis

(3) Specifications for the Water Quality Analysis of the Water Sampled at the Survey Site

The water quality analysis of the samples taken at the Survey Site was carried out at a public institution for water quality analysis, the Water Quality Laboratory (in the capital Lilongwe) of the Ministry of Agriculture, Irrigation and Water Development, in accordance with the "Guidelines for Drinking-Water Quality" of WHO and "Malawi Standard: Drinking Water - Specification" (2005) of Malawi. The samples were tested for the standard 21 parameters of Malawi shown in the table below (Table-4) and proven to have no problem to be used for drinking. (See Table-15 for reference.)

Table-3: Guidelines for drinking-water quality of WHO and Malawi (unit: mg/L)

	Water quality parameter	WHO	Malawi		Water quality parameter	WHO	Malawi
1	TDS	1,000	2,000	12	Alkalinity	-	-
2	Turbidity	-	25	13	Chloride	250	750
3	pH Value	6.5-8.5	6.0-9.5	14	Sulphate	250	800
4	Silicate	-	-	15	Nitrate	50	100
5	Sodium (Na)	200	500	16	Carbonate	-	-
6	Potassium (K)	-	-	17	Fluorine	1.5	3.0
7	Magnesium (Mg)	0	200	18	Electric	-	3,500

					conductivity		
8	Calcium (Ca)	-	250	19	Coliform bacteria count	0/100mL	50/100mL
9	Iron (Fe)	0.3	3.0	20	Bicarbonate	-	-
10	Total hardness	200	800	21	Standard plate count	-	0
11	Suspended solids (SS)	-	-				

(4) Hydrogeological Evaluation of the Four Drilling Sites in the Survey Site

In terms of hydrogeology, the Survey Site is in a small water system located in the uppermost reaches of a small water catchment area where intermittent streams (wetland) appear only at the time of rainfall during the rainy season. These streams are devoid of water during the dry season. When they have water, it flows from south to north. The test drilling was carried out at four locations, TTC Nos. 1 to 4, located in the order of the upper reaches to the lower reaches, in the area where the results of the analysis of the electric prospecting (horizontal and vertical electric sounding) data had suggested a high probability of the existence of groundwater, for the evaluation of groundwater potential and the hydrogeological evaluation of the Survey Site.

While the borehole, TTC No. 1, in the uppermost reaches was non-productive, the others were productive. A natural tendency of boreholes in the lower reaches having higher yields was observed. Existence of groundwater in granite pegmatite was expected on the basis of the geological observation that highly-weathered granitic gneiss outcrops were found on the ground surface. However, groundwater was not found either in a weathered zone or on a surface of unconformity of the pegmatite. Instead, pressurized groundwater was found in a fissure zone of the fresh and dark-grey biotite gneisses further below the ground.

In order to meet the anticipated water demand at the survey site of 75 m^3/day on the assumption that an engine pump was to be operated for eight to ten hours per day, pump discharge of 7.5 - 9.4 m^3/hour or 2.1 - 2.6 L/second is required. If the demand is to be satisfied with yields from three wells, each of them will have to have groundwater potential of 25 m^3/day allowing pump discharge of 2.5 - 3.1 m^3/day or 0.7 - 0.9 L/second. The results of the evaluation of groundwater potentials and discharges of the four test boreholes are summarised in Tables-5 to -8.

Table-6 shows the results of the constant flow rate (continuous) pumping test. Among the four test boreholes, TTC No. 3 (43.2 m^3/day) and TTC No. 4 (20.7 m^3/day) have good yields and water quality and, thus, can be equipped with engine pumps and used as the deep-well sources of a water supply system. Meanwhile, TTC No. 1 is a completely dry hole and it seems very difficult to use TTC No. 2 as a water source because the pumping test has revealed a very small yield (2.3 m^3/day) of groundwater from it. In the recovery test, while good recovery rates of 98.3 % and 99.0 % in 4.5 hours were observed in TTCs No. 3 and 4, respectively, large drawdowns of 34.67 m and 48.04 m

were observed in TTC Nos. 3 and 4, respectively.

Table-7 shows the results of the estimation of the available discharges based on the results of the hydrogeological evaluation of the pumping test data and using the drawdown of 20 m as a standard in the estimation of groundwater potential from specific capacity. The available discharges of TTC Nos. 3 and 4 were estimated at 24.96 m^3/day and 14.4 m^3/day, respectively, in this table. Meanwhile, Table-5 shows the results of the estimation of the available discharges on the condition that engine pumps are installed at depths determined on the basis of the actual structural drawings of the test boreholes (Figures-7 and -11) and operated at the maximum drawdowns. On this condition, TTC No. 3 is estimated at 21.8 m^3/day and TTC No. 4 at 15.1 m^3/day. As an engine pump is not usually installed at a depth where a screen for collecting groundwater is installed because of the interaction between structure of borehole and an aquifer, the depths of pump installation of 56 m and 65 m were used in the estimation of the available discharges of TTC Nos. 3 and 4, respectively.

The results of the analyses mentioned above show that the total available discharge estimated from the groundwater potential of the three productive wells in the site at present is *ca.* 50 m^3/day, which is significantly smaller than the anticipated water demand of 75 m^3/day. The analysis of the current situation suggests the need for the construction of additional boreholes. The results of the test drilling and pumping survey have narrowed down the area with a high probability of the existence of groundwater to the area close to TTC Nos. 3 and 4 and revealed that the water from them has the quality ideal for drinking. In the test drilling and pumping survey, the area for the groundwater prospecting was limited within the premises of the TTCL Site, in principle. It is considered possible to construct two additional deep wells with yields larger than those of TTC Nos. 3 and 4 by drilling boreholes to an average depth of 65 m in the area north of the boundary area where there is some extra reserve of groundwater for the supply of groundwater in the actual project.

Table-4: Depths of pump installation and available discharges deduced from the borehole structures

Test drilling site	Static water level (m)	Pump set level (m)	Pumping water level (maximum) (m)	Drawdown (maximum) (m)	Specific capacity (m^3/hr/m)	Discharge (maximum) (m^3/hr)	Available discharge (m^3/day) with 8 hrs/day of pumping	Evaluation of the yield
Symbol	E	M	O	P=O-E	H=D/G	Q=HxP	R8=Qx8hr	S
1.TTC No. 1	-	-	-	-	-	-	-	×
2.TTC No. 2	9.5	37 m	37 m	27.5	0.022	0.61	4.9	×
		47 m	47 m	37.5	0.022	0.83	**6.4**	▲
3.TTC No. 3	3.49	38 m	38 m	34.5	0.052	1.79	14.3	○
		56 m	56 m	52.5	0.052	2.73	**21.8**	◎
4.TTC No. 4	1.96	32 m	32 m	30.0	0.03	0.9	7.2	△
		41 m	41 m	39.0	0.03	1.17	9.4	△
		65 m	65 m	63.0	0.03	1.89	**15.1**	○

Note 1) An available discharge (R8) estimated on the condition that a pump was operated for eight hours per day at the discharge (maximum) (Q) was evaluated. Q was estimated from the specific capacity (H) obtained in the hydrogeological evaluation shown in Table-8 and the drawdown (maximum) calculated using the pump installation depth determined on the basis of the borehole structure.

Note 2) Evaluation of the yield ◎: The estimated available discharge of TTC No. 3 (21.8 m^3/day)
○: The estimated available discharge of TTC No. 4 (15.1 m^3/day)
∆: The estimated available discharge of TTC No. 2 (6.4 m^3/day)

Table-5: Results of the constant flow rate (continuous) pumping test (for 24 hours) and the recovery test

Drilling site	Constant flow rate of (continuous) discharge (m^3/hr)	Duration of the pumping test (hr)	Discharge (m^3)	Drawdown (m)	Recovery test (% recovery)	Recovery time (hr)	Specific capacity (m^3/hr/m)	Evaluation of the yield
Symbol	D	T	S=DxT	G=F-E	U	V	H=D/G	W
1.TTC No. 1	Dry	-	-	-	-	-	-	×
2.TTC No. 2	0.90	2.3	2.1	40.5	100%	4.0	0.022	∆
3.TTC No. 3	1.8	24	43.2	34.67	98.3%	4.5	0.052	◎
4.TTC No. 4	1.48	14	20.7	48.04	99.0%	4.5	0.03	○

Note 1) The test boreholes were evaluated on the bases of the results of the (constant flow rate continuous) pumping test

Note 2) Evaluation of the yield ◎: The discharge of TTC No. 3 estimated from the results of the pumping test (43.2 m^3/day)
○: The estimated discharge of TTC No. 4 (20.7 m^3/day)
∆: The estimated discharge of TTC No. 2 (2.1 m^3/day)

Table-6: Evaluation of groundwater potentials and discharges

Survey site Borehole No.	Drilling depth (m)	Borehole depth (m)	Discharge (m^3/hr)	Static water level (m)	Pumping water level (maximum) (m)	Drawdown (maximum) (m)	Specific capacity (m^3/hr/m)	Groundwater potential (m^3/h)	Available discharge (m^3/day)	Pump installation depth (m)	Evaluation
Symbol	B	C	D	E	F	G=F-E	H=D/G	K=Hx20m	L=Kx24hr	M	N
1.TTC No. 1	53	-	-	-	-	-	-	-	-	-	×
2.TTC No. 2	54	54	0.9	9.5	50	40.5	0.022	0.44	10.56	47m	∆
3.TTC No. 3	61	61	1.8	3.49	38.16	34.67	0.052	1.04	24.96	56m	◎
4.TTC No. 4	70	70	1.44	1.96	50.0	48.04	0.03	0.60	14.4	65m	○

Note 1) The available discharge of each borehole estimated from the groundwater potential obtained from the results of the pumping test and the standard drawdown of 20 m was within a range between 10 and 25 m^3 per day.

Note 2) Evaluation

◎: TTC No. 3 can be satisfactorily used as a water source of a water supply system because it has the available discharge of *ca.* 25 m^3/day.

○: TTC No. 4 may be satisfactorily used as a water source of a water supply system because it has the available discharge of 14.4 m^3/day.

∆: Although the available discharge of 10.56 m^3/day estimated from the groundwater potential seems to suggest that TTC No. 2 may be used as a water source of a water supply system, it is quite difficult to do so because the actual discharge obtained from the results of the pumping test is only 2.1 m^3/day as shown in the column under the symbol 'S' in Table-6.

Table-7: Hydrogeological evaluation of the test boreholes in the TTC Site

Survey Site Borehole No.	Borehole diameter (mm)	Drilling depth (m)	Borehole depth (m)	Discharge (m^3/hr)	Static water level (m)	Pumping water level (m)	Drawdown (m)	Specific capacity (m^3/hr/m)	Aquifer	Screen installation depths (m)
Symbol	A	B	C	D	E	F	G=F-E	H=D/G	I	J
1. TTC No. 1	160	53	-	-	-	-	-	-	-	Dry hole
2. TTC No. 2	160	54	54	0.9	9.5	50	40.5	0.022	Biotite-Gneiss	24 - 36, 42 - 45
3. TTC No. 3	160	61	61	1.8	3.49	38.16	34.67	0.052	Biotite-Gneiss	40 - 55
4. TTC No. 4	160	70	70	1.44	1.96	50.0	48.04	0.03	Biotite-Gneiss	19 - 31, 34 - 40, 61 - 64

2. BOREHOLE INVESTIGATION DATA AT TTCL (Nalikure)

2-1. BOREHOLE TTC No.1

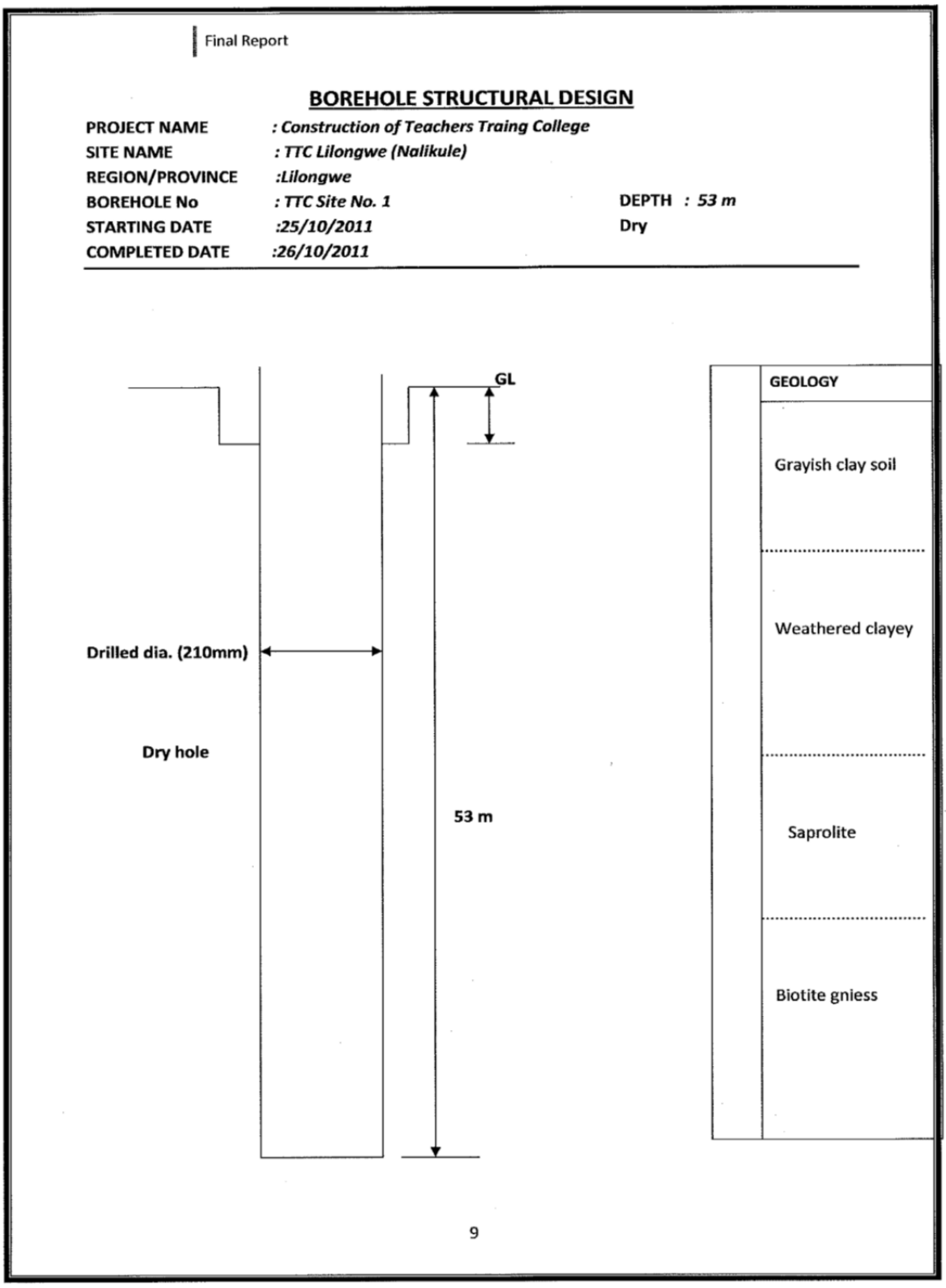


Figure-2 TTC No.1 VERTICAL PROFILE (Dry)

2-2. BOREHOLE TTC No.2

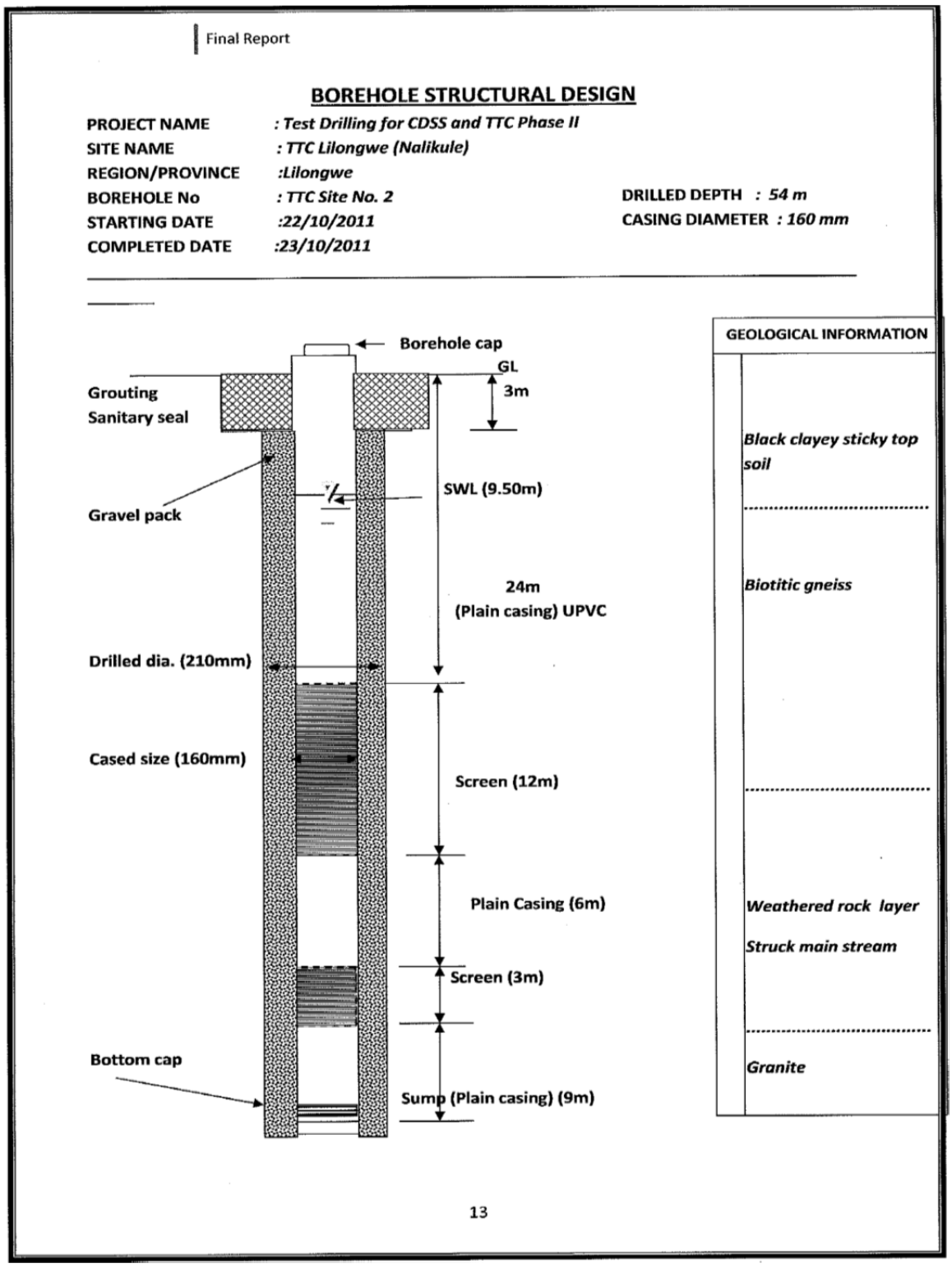
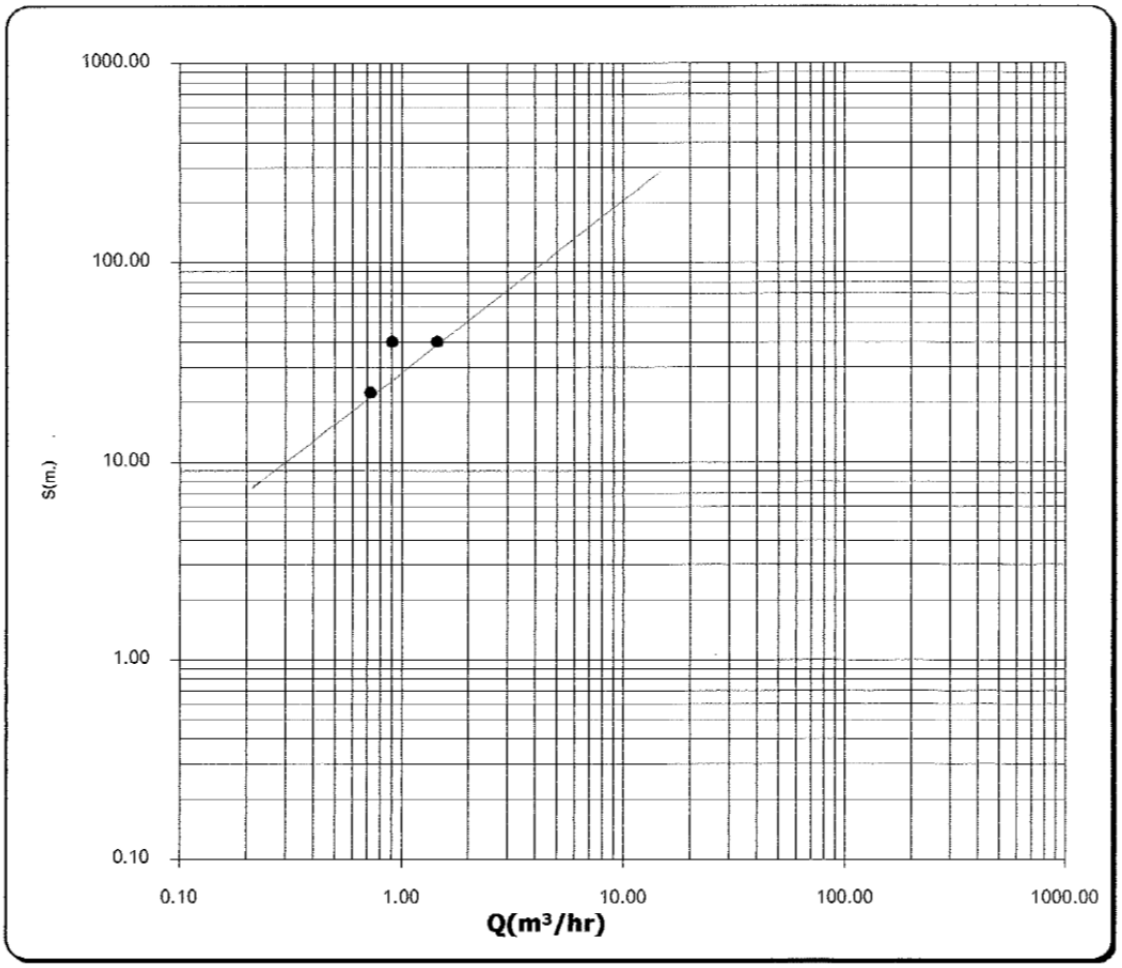


Figure-3 TTC No.2 VERTICAL PROFILE

STEP DRAWDOWN TEST

PROYECT NAME	Malawi CDSS & TTC Phase 2		
BOREHOLE No.	TTC No.2	STATIC WATER LEVEL	9.50 m.
SITE	TTC Nalikule	DATE	25/10/11

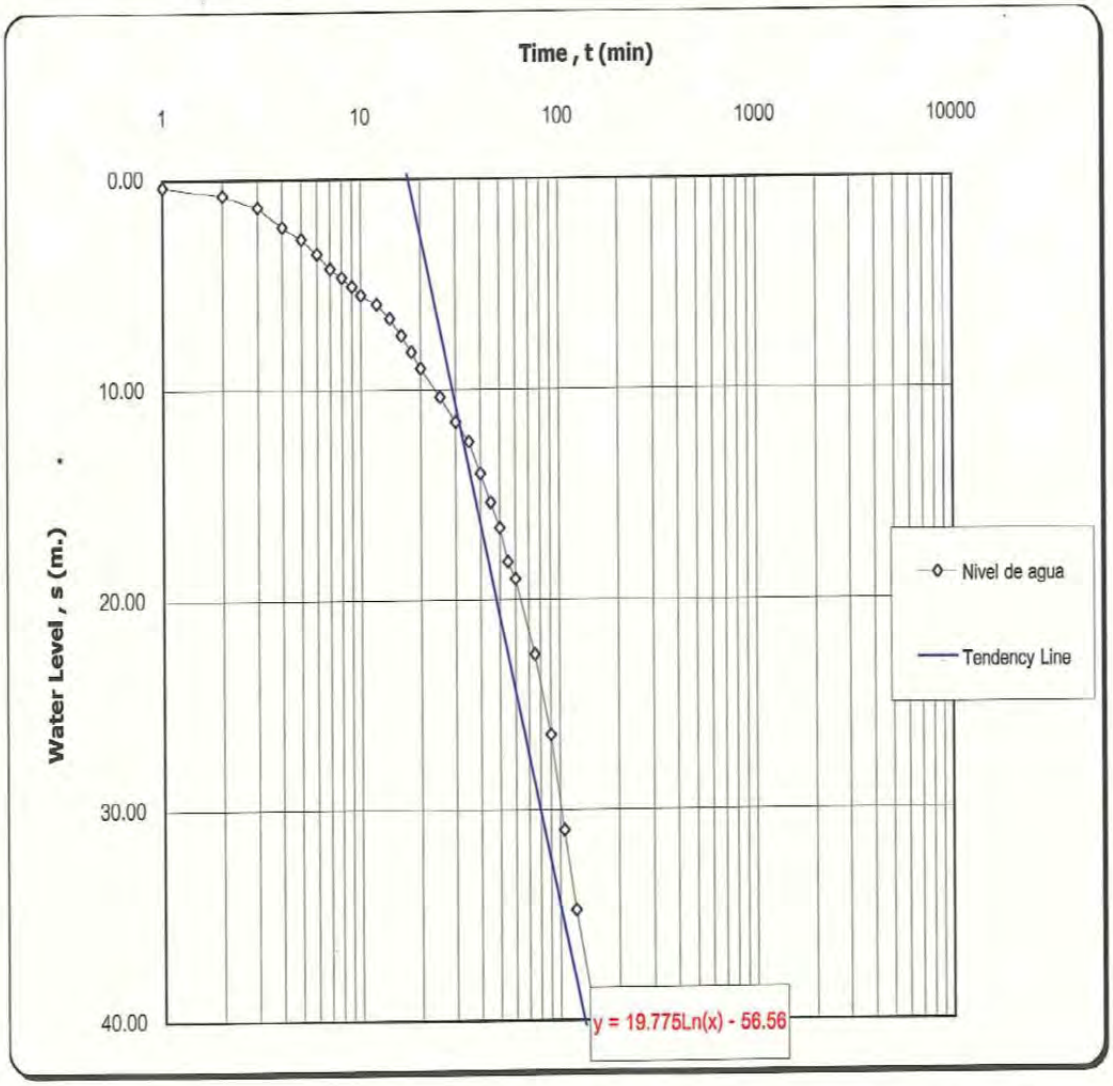


STEP	DISCHARGE Q (m^3/hr.)	DYNAMIC LEVEL N.D. (m.)	DRAWDOWN S (m.)	SPECIFIC CAPACITY Q/S (m^3/hr/m.)
FIRST(1st)	0.72	32.05	22.55	0.0319
SECOND(2nd)	1.44	50.00	40.50	0.0356
THIRD(3rd)				
FORTH(4th)				
FIFTH(5th Constant)	0.90	50.00	40.50	0.0222

Figure-4 TTC No.2 STEP DRAWDOWN TEST

CONSTANT DISCHARGE TEST

PROYECT NAME	Malawi CDSS & TTC Phase 2		
BOREHOLE No.	TTC No.2	STATIC WATER LEVEL	9.50 m.
SITE	TTC Nalikule	DATE	26/10/11



DESCRIPTION	
Discharge, Q (m^3/hr.)	0.90 m^3/hr.
water Level ,ΔS (m.)	40.50 m.
Transmissivity , T (m^2/hr.) T = (2.30 Q)/(4πΔS)	0.004 m^2/hr.
Screen Length , b (m.)	15.00 m.
Hydraulic Gradient , K (m./hr.) K = T/b	2.712E-04 m./hr.

Figure-5 TTC No.2 CONSTANT DISCHARGE TEST

Table-9 TTC No.2 RECORD OF CONSTANT DISCHARGE TEST

CONSTANT DISCHARGE TEST

NAME OF PROJECT	Malawi CDSS and TTC PHASE 2		
No.	TTC – No. 2	BOREHOLE DEPTH	54 m
NAME OF LOCATION	NALIKULE T.T.C	YIELD(L/sec)	0.25 L/S
DISTRICT	LILONGWE	STATIC WATER LEVEL	9.50 m
	T.A. CHIMUTU	DYNAMIC WATER LEVEL	50 m
DATA	26th /10/2011	PUMP SET	50 m

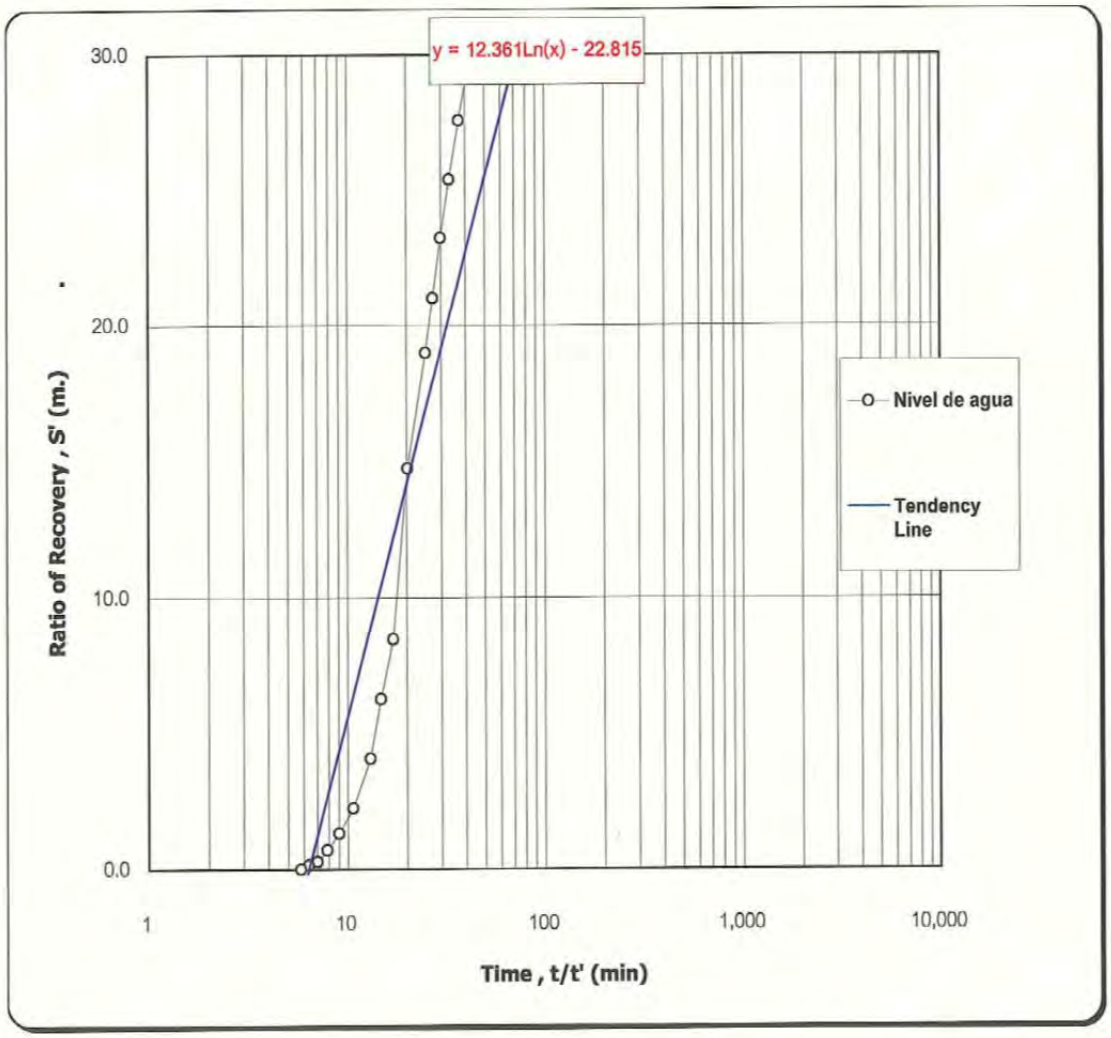
ACTUAL (Hour: Minute)		TIME t(min)	DISCHARGE (Lit/min)	DYNAMIC (m)	DRAW DOWN (m)	REMARKS
07 00	0	0	0.25L/sec	9.50	0.00	
: 01	1	1	0.25L/sec	9.85	0.35	
: 02	1	2	0.25L/sec	10.25	0.75	
: 03	1	3	0.25L/sec	10.82	1.32	
: 04	1	4	0.25L/sec	11.75	2.25	
: 05	1	5	0.25L/sec	12.33	2.83	
: 07	2	7	0.25L/sec	13.74	4.24	
: 10	3	10	0.25L/sec	15.00	5.50	
: 13	3	13	0.25L/sec	15.68	6.18	
: 15	2	15	0.25L/sec	16.54	7.04	
: 20	5	20	0.25L/sec	18.50	9.00	
: 25	5	25	0.25L/sec	19.85	10.35	
: 30	5	30	0.25L/sec	21.05	11.55	
: 35	5	35	0.25L/sec	21.98	12.48	
; 40	5	40	0.25L/sec	23.50	14.00	
: 45	5	45	0.25L/sec	24.87	15.37	
: 50	5	50	0.25L/sec	26.08	16.58	
: 55	5	55	0.25L/sec	27.70	18.20	
08 : 00	5	60	0.25L/sec	31.10	21.60	
: 10	10	70	0.25L/sec	33.16	23.66	
; 20	10	80	0.25L/sec	35.93	26.43	
: 30	10	90	0.25L/sec	39.30	29.80	
: 40	10	100	0.25L/sec	41.67	32.17	
: 50	10	110	0.25L/sec	44.26	34.76	
09 : 00	10	120	0.25L/sec	49.02	39.53	
: 20	20	140	0.25L/sec	50.00	40.50	

Temperature : PH:

Conductivity :

WATER LEVEL RECOVERY TEST

PROYECT NAME	Malawi CDSS Phase II		
BOREHOLE No.	Ezondweni No.2	STATIC WATER LEVEL	9.50 m.
SITE	Ezondweni CDSS	DATE	27/09/11



DESCRIPTION	
Discharge, Q (m^3/hr.)	0.90 m^3/hr.
Water Level ,ΔS (m.)	40.50 m.
Transmissivity , T (m^2/hr.) T = (2.30 Q)/(4πΔS)	0.00 m^2/hr.
Screen Length , b (m.)	15.00 m.
Hydraulic Gradient , K (m./hr.) K = T/b	2.712E-04 m./hr.

Figure-6 TTC No.2 WATER LEVEL RECOVERY TEST

Table-10 TTC No.2 RECORD OF DISCHARGE TEST(RECOVERY)

DISCHARGE TEST (RECOVERY)

NAME OF PROJECT	Malawi CDSS and TTC PHASE 2		
No.	TTC – No. 2	BOREHOLE DEPTH	54m
NAME OF LOCATION	NALIKULE TTC	YIELD (L/sec)	0.25 l/s
DISTRICT	LILONGWE	STATIC WATER LEVEL	9.50m
	T.A. CHIMUTU	DYNAMIC WATER LEVEL	
DATA	26/10/2011	PUMP SET	50 m

TIME (Hour: Minute)		Elapsed Time t(min)	Accumulated time (Lit/min)	Water Level (m)	Recovery (m)	Remarks
10 : 20	0	0	1440	50.00	40.50	Clean water
: 21	1	1	1441	49.20	39.70	
: 22	1	2	1442	48.65	39.15	
; 23	1	3	1443	47.25	37,75	
: 24	1	4	1444	46.28	36.78	
: 25	1	5	1445	45.84	36.34	
: 29	2	7	1447	44.94	35.44	
: 30	3	10	1450	44.04	34.54	
: 33	3	13	1453	43.20	33.70	
: 25	2	15	1455	42.30	32.80	
: 40	5	20	1460	41.85	32:35	
; 45	5	25	1465	41.30	31.80	
: 50	5	30	1470	39.40	29.90	
: 55	5	35	1475	37.08	27.58	
11 : 00	5	40	1480	34.90	25.40	
: 05	5	45	1485	32.76	23.26	
: 10	5	50	1490	30.54	21.04	
: 15	5	55	1495	28.50	19.00	
: 20	5	60	1500	26.00	16.50	
: 30	10	70	1510	17.94	8.44	
; 40	10	80	1520	16.57	7.07	
: 50	10	90	1530	14.93	5.43	
12 : 00	10	100	1540	13.56	4.06	
: 10	10	110	1550	12.68	3.18	
: 20	10	120	1560	11.74	2.24	
: 35	15	135	1575	11.27	1.77	
: 50	15	150	1590	10.82	1.32	
13 : 05	15	165	1605	10.50	1.00	
: 20	15	180	1620	10.21	0.71	
: 35	15	195	1635	9.78	0.28	
: 50	15	210	1650	9.74	0.24	
14 : 05	15	225	1665	9.65	0.15	
: 20	15	240	1680	9.55	0.05	
: 35	15	255	1695	9.50	0.	100%

2-3. BOREHOLE TTC No.3

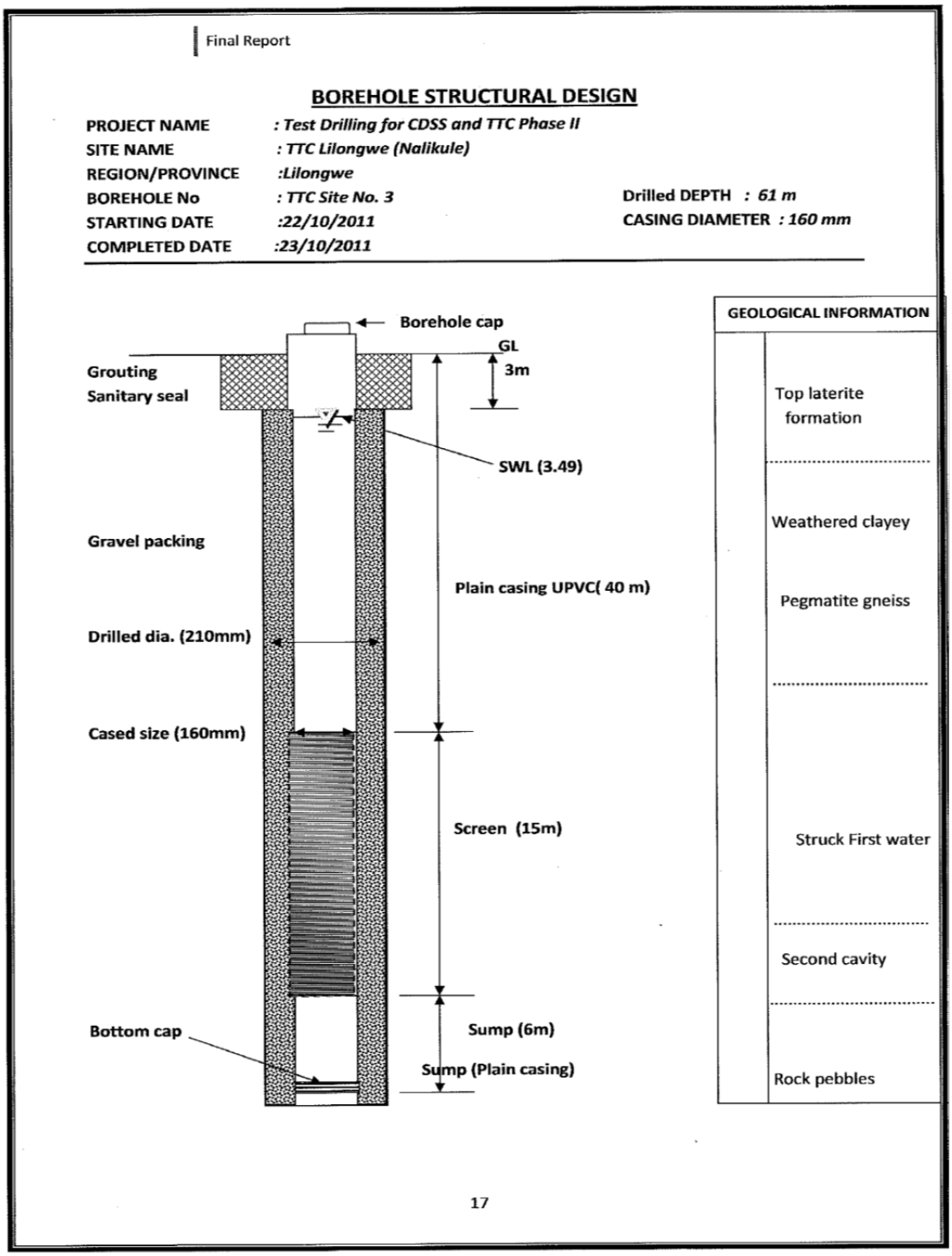
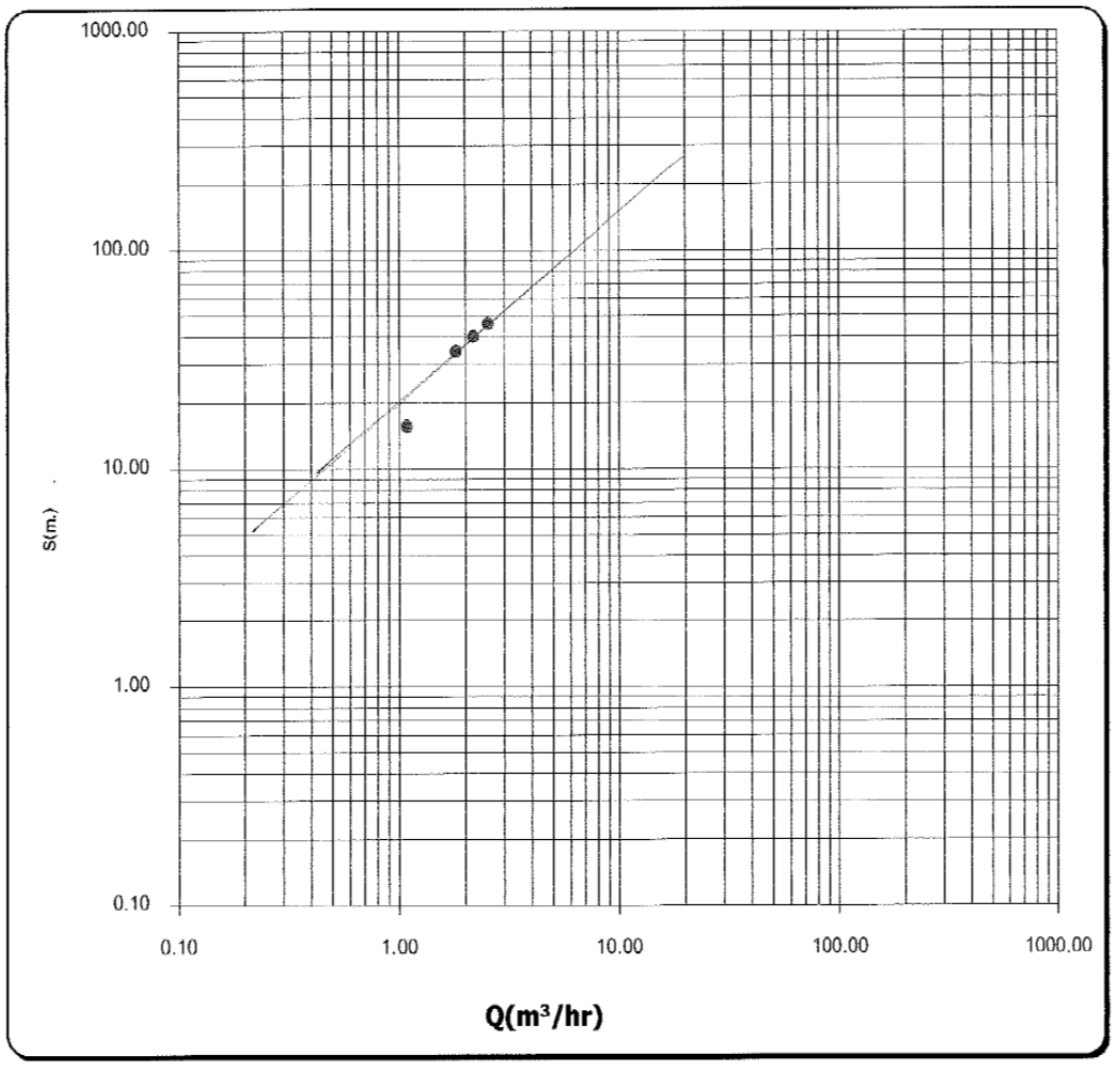


Figure-7 TTC No.3 VERTICAL PROFILE

STEP DRAWDOWN TEST

PROYECT NAME	Malawi CDSS and TTC Phase II		
BOREHOLE No.	TTC No.3	STATIC WATER LEVEL	3.49 m.
SITE	TTC No.3	DATE	2011/110/23

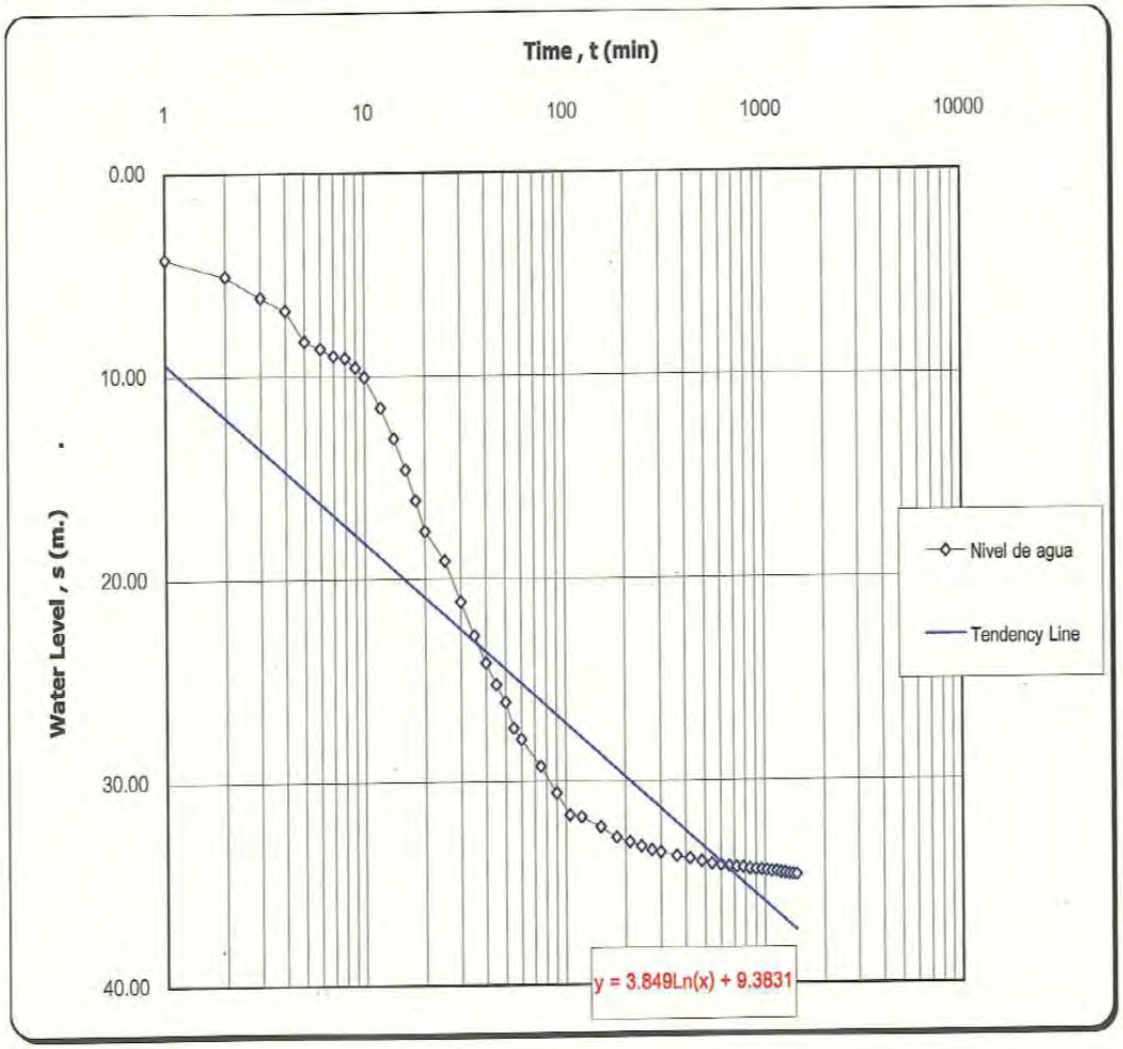


STEP	DISCHARGE Q (m^3/hr.)	DYNAMIC LEVEL N.D. (m.)	DRAWDOWN S (m.)	SPECIFIC CAPACITY Q/S (m^3/hr/m.)
FIRST(1st)	1.08	19.30	15.81	0.0683
SECOND(2nd)	2.16	44.14	40.65	0.0531
THIRD(3rd)	2.52	50.00	46.51	0.0542
FORTH(4th)				
FIFTH(5th: Constant)	1.80	38.16	34.67	0.0519

Figure-8 TTC No.3 STEP DRAWDOWN TEST

CONSTANT DISCHARGE TEST

PROYECT NAME	Malawi CDSS Phase II Malawi DSS Phase II		
BOREHOLE No.	TTC No.3	STATIC WATER LEVEL	3.49 m.
SITE	TTC Nalikule	DATE	23/10/11



DESCRIPTION	
Discharge, Q (m^3/hr.)	1.80 m^3/hr.
water Level ,ΔS (m.)	34.67 m.
Transmissivity , T (m^2/hr.) T = (2.30 Q)/(4πΔS)	0.010 m^2/hr.
Screen Length , b (m.)	15.00 m.
Hydraulic Gradient , K (m./hr.) K = T/b	6.335E-04 m./hr.

Figure-9 TTC No.3 CONSTANTDISCHARGE TEST

Table-11 TTC No.3 RECORD OF CONSTANTDISCHARGE TEST

CONSTANT DISCHARGE TEST

NAME OF PROJECT	Malawi CDSS and TTC PHASE 2		
No.	TTC – No. 3	BOREHOLE DEPTH	61m
NAME OF LOCATION	NALIKULE T.T.C	YIELD (L/sec)	0.5L/S
DISTRICT	LILONGWE	STATIC WATER LEVEL	3.49m
	T.A. CHIMUTU	DYNAMIC WATER LEVEL	38.16 m
DATE	23 /10/2011	PUMP SET	54 m

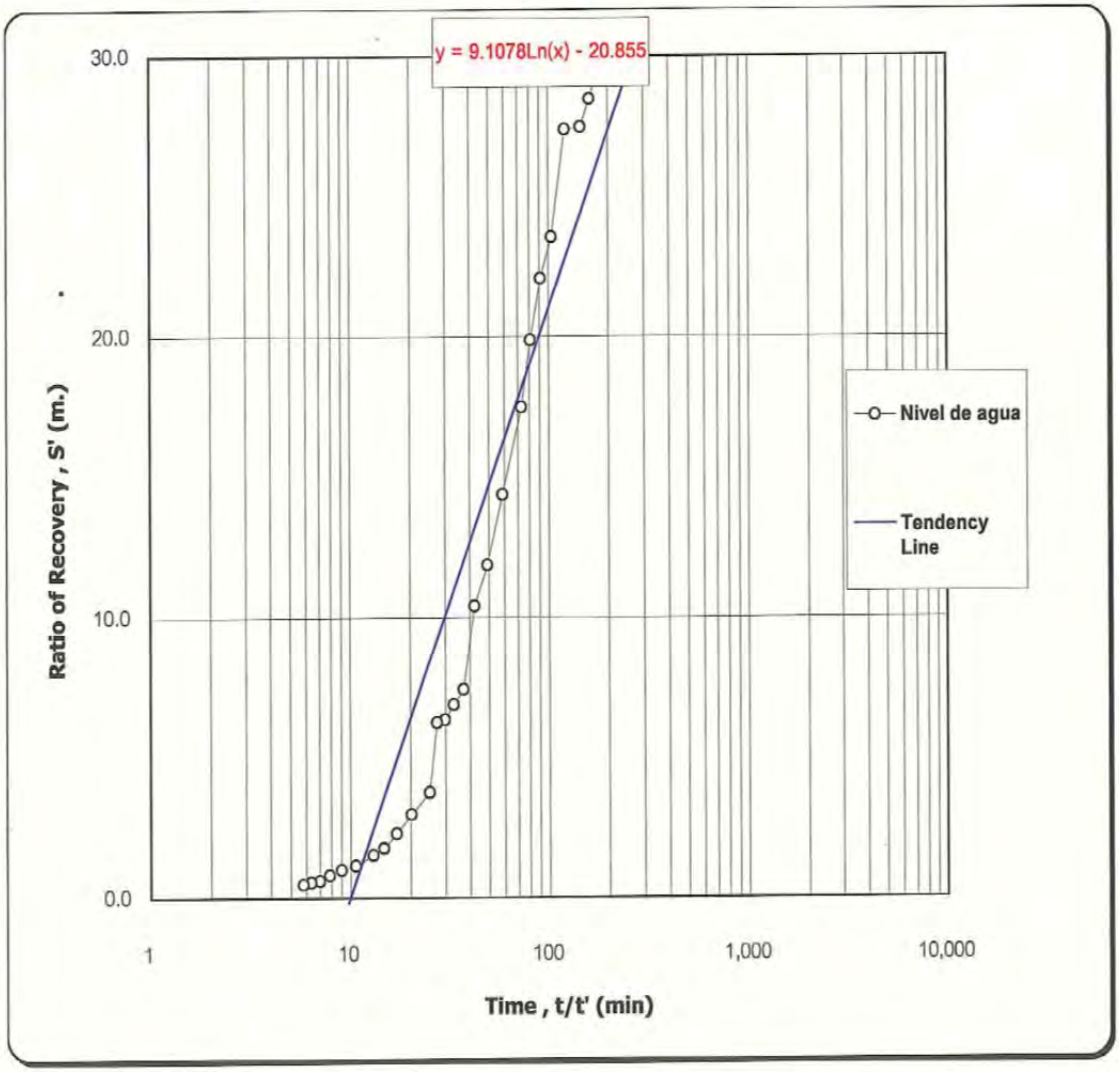
ACTUAL TIME (Hour: Minute)		TIME t(min)	YIELD (Lit/min)	DYNAMIC (m)	DEPTH (m)	REMARKS
8 : 10	0	0	5L/10sec	3,49	0	
: 11	1	1		7,73	4.24	
: 12	1	2		8.56	5.07	
: 13	1	3		9.60	6.11	
: 14	1	4		10.25	6.76	
: 15	1	5		11.78	8.29	
: 17	2	7		12.50	9.01	
: 20	3	10		13.55	10.06	
: 23	3	13		16.58	13.09	
: 25	2	15		18.49	15.00	
: 30	5	20		21.15	17.66	
: 35	5	25		22.60	19.11	
: 40	5	30		24.62	21.13	
: 45	5	35		26.30	22.81	
: 50	5	40		27.04	23.55	
: 55	5	45		28.71	25.22	
9 : 00	5	50		29.58	26.09	
: 05	5	55		30.86	26.93	
: 10	5	60		31.42	27.93	
: 20	10	70		32.58	29.09	
: 30	10	80		33.32	29.83	
: 40	10	90		34.05	30.56	
: 50	10	100		35.24	31.75	
10 : 00	10	110		35.74	32.25	
: 10	10	120		36.02	32.53	
: 30	20	140		36.26	32.77	
: 50	20	160		36.49	33.00	
11 : 10	20	180		36.68	33.19	
: 30	20	200		36.72	33.23	
: 50	20	220		36.90	33.41	
12 : 10	20	240		37.02	33.53	
:40	30	270		37.14	33.65	
13 : 10	30	300		37.20	33.71	
: 40	30	330		37.25	33.76	
14 : 10	30	360		37.32	33.83	
: 40	30	390		37.47	33.98	
15 : 10	30	420		37.60	34.11	
16 : 10	60	480		37.65	34.16	
17 :10	60	540		37.72	34.23	
18 : 10	60	600		37.76	34.27	
19 : 10	60	660		37.78	34.29	
20 : 10	60	720		37.85	34.36	
21: 10	60	780		37.89	34.40	
22: 10	60	840		37,92	34.43	
23: 00	60	900		37.94	34.45	
00: 10	60	960		37.96	34.47	
01: 10	60	1020		37.99	34.50	
02: 10	60	1080		38.04	34.55	
03: 10	60	1140		38.08	34.59	
04: 10	60	1200		38.12	34.63	
05 :10	60	1260		38.14	34.65	
06 :10	60	1320		38.16	34.67	

Temperature : PH:

Conductivity :

WATER LEVEL RECOVERY TEST

PROYECT NAME	Malawi CDSS Phase II		
BOREHOLE No.	TTC No.3	STATIC WATER LEVEL	3.49 m.
SITE	TTC Nalikule	DATE	24/10/11



DESCRIPTION	
Discharge, Q (m^3/hr.)	1.80 m^3/hr.
Water Level ,ΔS (m.)	34.67 m.
Transmissivity , T (m^2/hr.) T = (2.30 Q)/(4πΔS)	0.01 m^2/hr.
Screen Length , b (m.)	15.00 m.
Hydraulic Gradient , K (m./hr.) K = T/b	6.335E-04 m./hr.

Figure-10 TTC No.3 WATER LEVEL RECOVERY TEST

Table-12 TTC No.3 RECORD OF WATER LEVEL RECOVERY TEST

DISCHARGE TEST (RECOVERY)

NAME OF PROJECT	Malawi CDSS and TTC PHASE 2		
No.	TTC – No. 3	BOREHOLE DEPTH	61.0 m
NAME OF LOCATION	NALIKULE TTC	YIELD (L/sec)	0.5 l/s
DISTRICT	LILONGWE	STATIC WATER LEVEL	3.49 m
	T.A. CHIMUTU	DYNAMIC WATER LEVEL	38.16
DATE	24/10/2011	PUMP SET	54.0m

Time (Hour: Minute)		Elapsed Time t(min)	Accumulated time (Lit/min)	Water Level (m)	Recovery (m)	Remarks
8 : 14	0	0	1440	38.16	34.67	Clean water
: 15	1	1	1441	36.33	32.84	
: 16	1	2	1442	35.55	32.06	
: 17	1	3	1443	34.42	30.93	
: 18	1	4	1444	33.14	29.65	
: 19	1	5	1445	31.96	28.47	
: 21	2	7	1447	29.92	26.43	
: 24	3	10	1450	27.04	23.55	
: 27	3	13	1453	24.08	20.59	
: 33	2	15	1455	22.67	19.18	
: 37	5	20	1460	19.30	15.81	
: 44	5	25	1465	16.48	12.99	
: 49	5	30	1470	14.24	10.75	
: 54	5	35	1475	12.55	9.06	
: 59	5	40	1480	11.18	7.69	
09 : 04	5	45	1485	10.03	6.54	
: 09	5	50	1490	9.01	5.52	
: 14	5	55	1495	7.54	4.05	
: 24	5	60	1500	7.00	3.51	
: 34	10	70	1510	6.55	3.06	
: 44	10	80	1520	5.98	2.49	
: 54	10	90	1530	5.58	2.09	
10 : 04	10	100	1540	5.30	1.81	
: 14	10	110	1550	5.12	1.63	
: 29	10	120	1560	4.90	1.41	
: 44	15	135	1575	4.73	1.24	
: 59	15	150	1590	4.60	1.11	
11 : 14	15	165	1605	4.52	1.03	
: 29	15	180	1620	4.48	0.99	
: 44	15	195	1635	4.37	0.88	
: 59	15	210	1650	4.30	0.81	
12 : 14	15	225	1665	4.23	0.74	
: 29	15	240	1680	4.20	0.71	
: 44	15	255	1695	4.12	0.63	
: 59	15	270	1710	4.08	0.59	

2-4. BOREHOLE TTC No.4

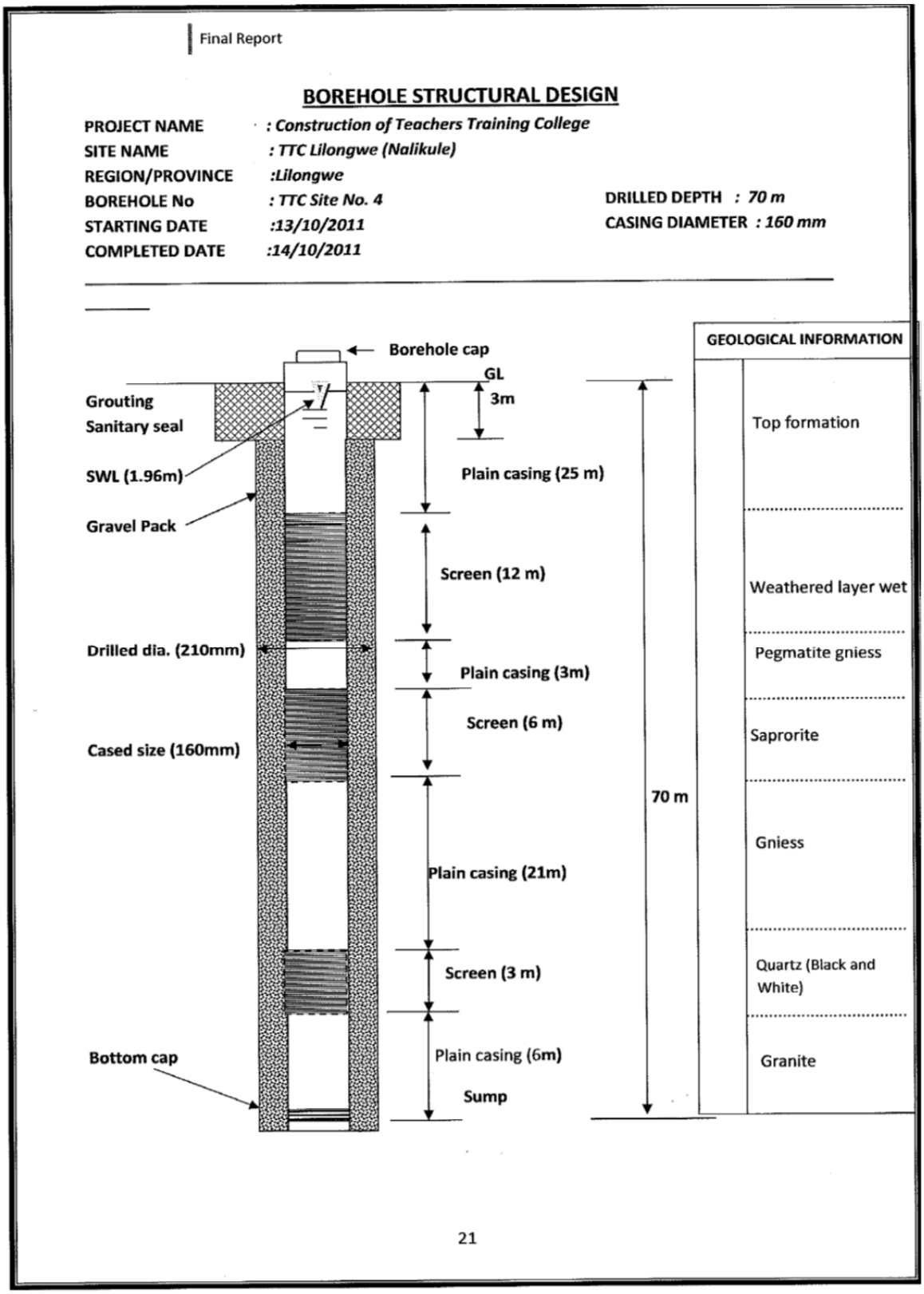
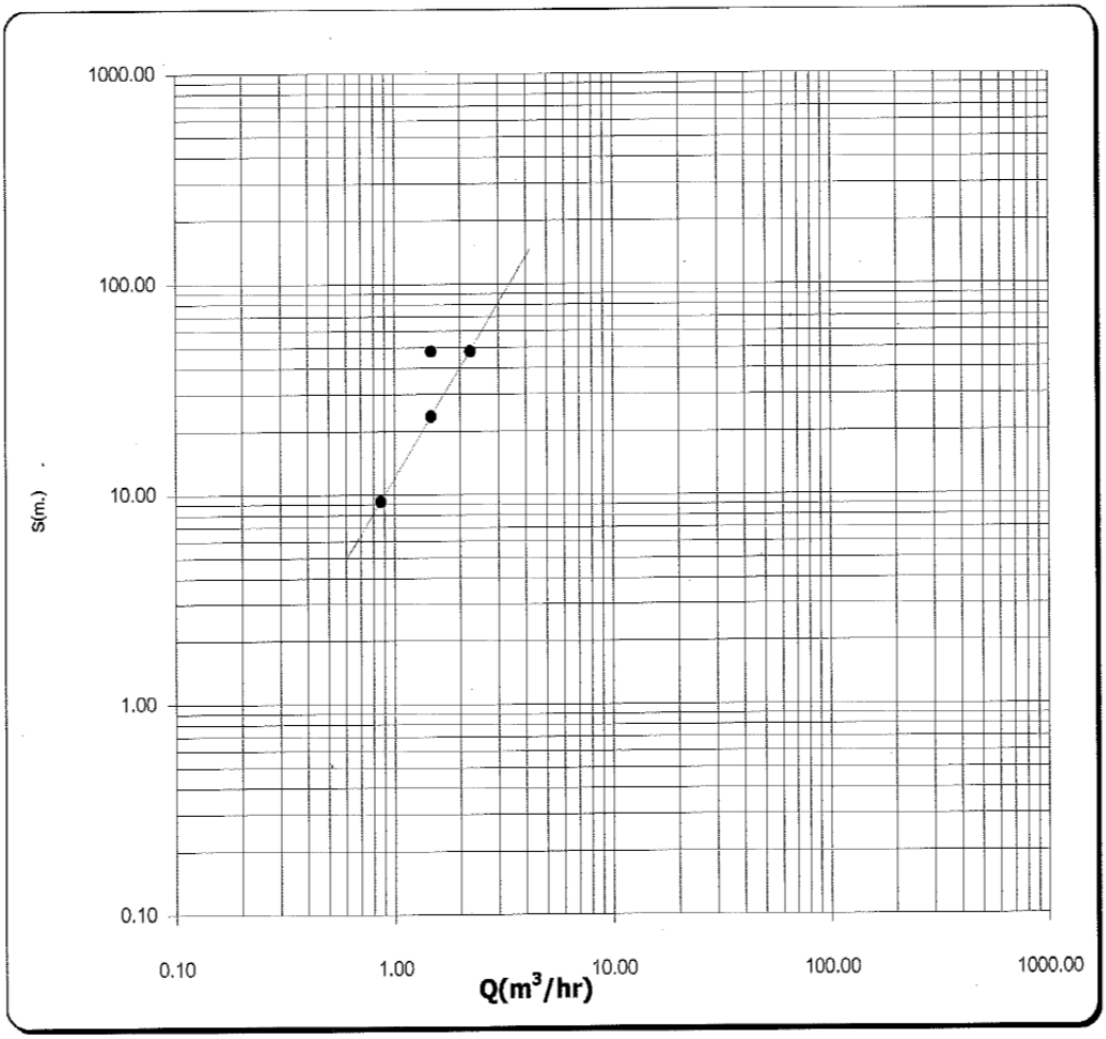


Figure-11 TTC No.4 VERTICAL PROFILE

STEP DRAWDOWN TEST

PROYECT NAME	Malawi CDSS & TTC Phase 2		
BOREHOLE No.	TTC No. 4	STATIC WATER LEVEL	1.96 m.
SITE	TTC Nalikule	DATE	27/10/11

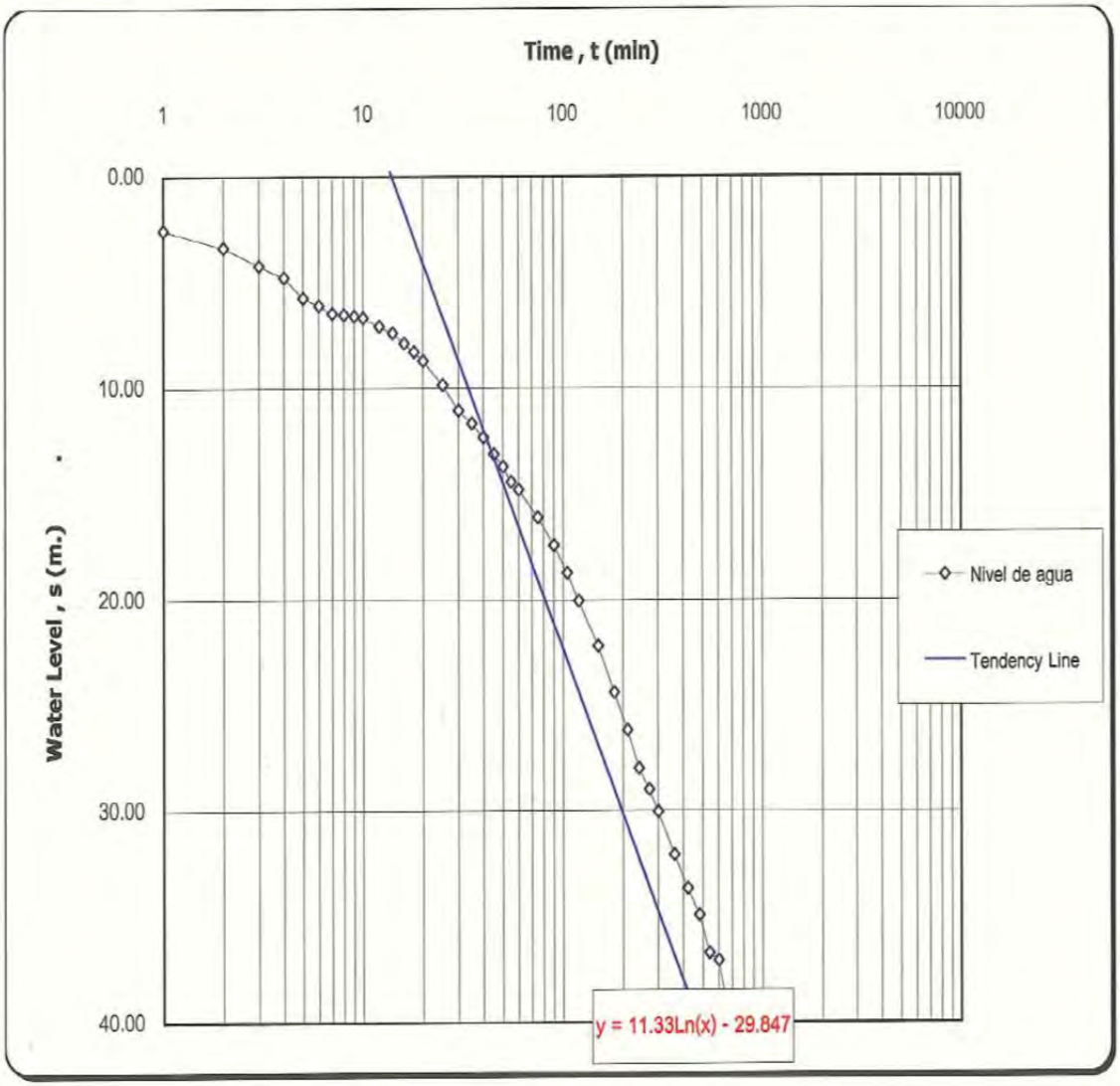


STEP	DISCHARGE Q (m^3/hr.)	DYNAMIC LEVEL N.D. (m.)	DRAWDOWN S (m.)	SPECIFIC CAPACITY Q/S (m^3/hr/m.)
FIRST(1st)	0.86	11.24	9.28	0.0931
SECOND(2nd)	1.48	25.50	23.54	0.0627
THIRD(3rd)	2.23	50.00	48.04	0.0465
FORTH(4th)				
FIFTH(5th Constant)	1.48	50.00	48.04	0.0307

Figure-12 TTC No.4 STEP DRAWDOWN TEST

CONSTANT DISCHARGE TEST

PROYECT NAME	Malawi CDSS & TTC Phase 2		
BOREHOLE No.	TTC No.4	STATIC WATER LEVEL	1.96 m.
SITE	TTC Nalikule	DATE	29/10/11



DESCRIPTION	
Discharge, Q (m^3/hr.)	1.48 m^3/hr.
water Level ,ΔS (m.)	48.04 m.
Transmissivity , T (m^2/hr.) T = (2.30 Q)/(4πΔS)	0.006 m^2/hr.
Screen Length , b (m.)	21.00 m.
Hydraulic Gradient , K (m./hr.) K = T/b	2.678E-04 m./hr.

Figure-13 TTC No.4 CONSTANT DISCHARGE TEST

Table-13 TTC No.4 RECORD OF CONSTANT DISCHARGE TEST

CONSTANT DISCHARGE TEST

NAME OF PROJECT	Malawi CDSS and TTC PHASE 2		
No.	[redacted]	BOREHOLE DEPTH	70M
NAME OF LOCATION	NALIKULE T.T.C	YIELD (Lit/sec)	0.41L/S
DISTRICT	LILONGWE	STATIC WATER LEVL	1.96m
	T.A. CHIMUTU	DYNAMIC WATER LEVEL	50M
DATE	28 /11/2011	PUMP SET	50M

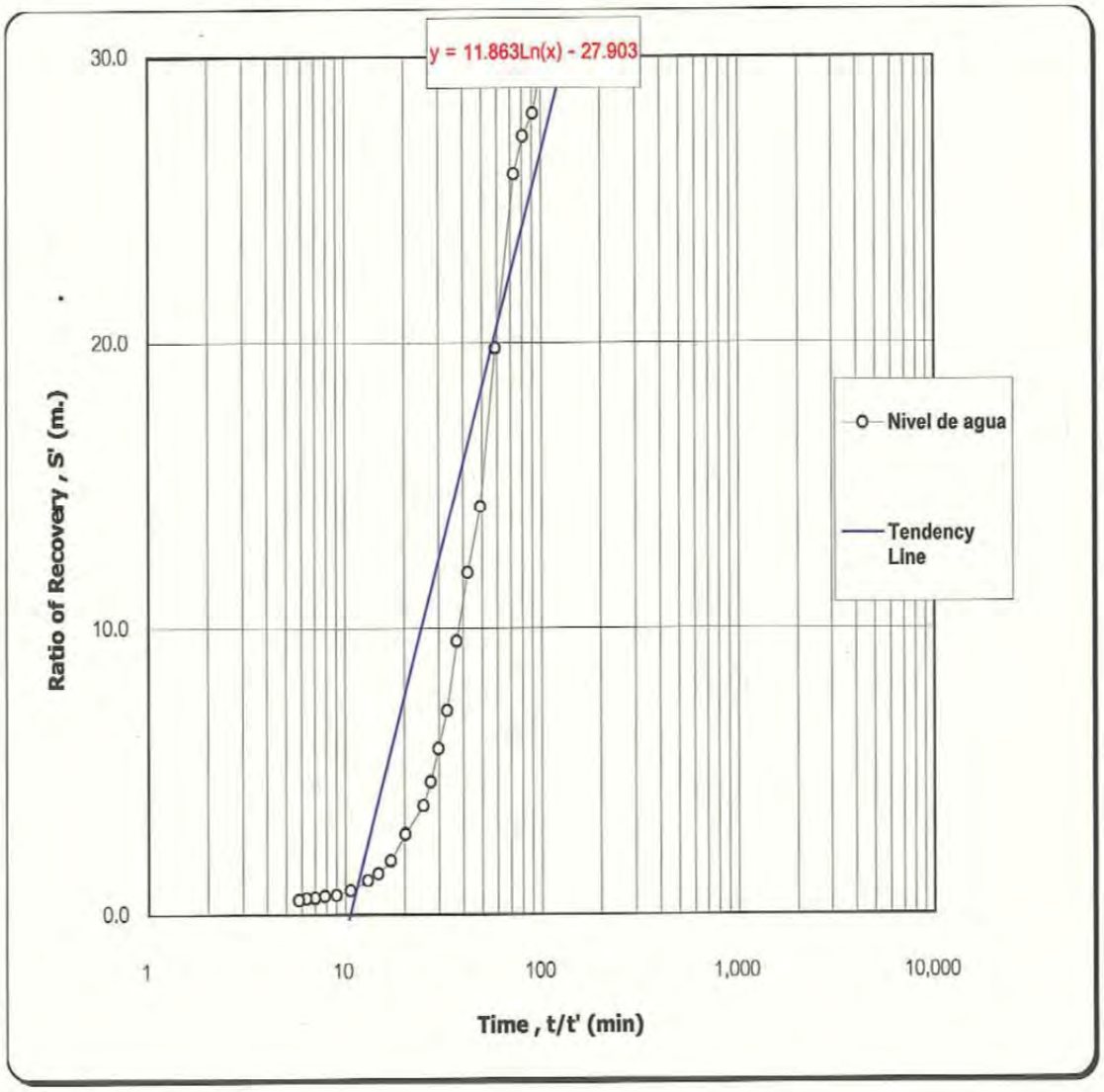
ACTUAL TIME (Hour: Minute)		TIME t(min)	YIELD (Lit/min)	DYNAMIC (m)	DRAWDOWN (m)	REMARKS
08: 55	0	0	5L/12sec	1.96	0	
: 56	1	1		4.50	2.54	
: 57	1	2		5.30	3.34	
: 58	1	3		6.17	4.21	
: 59	1	4		6.72	4.76	
09: 00	1	5		7.68	5.72	
: 02	2	7		8.42	6.46	
: 05	3	10		8.62	6.66	
: 08	3	13		9.01	7.05	
: 10	2	15		9.49	7.53	
: 15	5	20		10.66	8.70	
: 20	5	25		11.80	9.84	
: 25	5	30		13.62	11.66	
: 30	5	35		14.27	12.31	
; 35	5	40		15.07	13.11	
: 40	5	45		15.67	13.71	
: 45	5	50		16.75	14.79	
: 50	5	55		17.60	15.64	
: 55	5	60		18.38	16.42	
10 : 05	10	70		19.37	17.41	
; 15	10	80		20.24	18.28	
: 25	10	90		21.20	19.24	
: 35	10	100		22.00	20.04	
: 45	10	110		23.57	21.61	
; 55	10	120		24.92	22.96	
11 : 15	20	140		26.37	24.41	
: 35	20	160		27.34	25.38	
: 55	20	180		28.52	26.56	
12 : 15	20	200		29.54	27.58	
: 35	20	220		30.95	28.99	
; 55	20	240		31.99	30.03	
13 :25	30	270		32.94	30.98	
; 55	30	300		34.03	32.07	
14 : 25	30	330		35.01	33.05	
; 55	30	360		35.63	33.67	
15: 25	30	390		36.87	34.91	
: 55	30	420		38.67	36.71	
16 : 55	60	480		39.02	37.06	
17 :55	60	540		41.27	39.31	
18 : 55	60	600		43.08	41.12	
19 ; 55	60	660		46.52	44.56	
20 ; 55	60	720		48.04	46.08	
21: 55	60	780		49.18	47.22	
22: 55	60	840		50.00	48.04	

Temperature : PH:

Conductivity :

WATER LEVEL RECOVERY TEST

PROYECT NAME	Malawi CDSS & TTC Phase II		
BOREHOLE No.	TTC No.4	STATIC WATER LEVEL	1.96 m.
SITE	TTC Nalikule	DATE	29/10/11



DESCRIPTION	
Discharge, Q (m^3/hr.)	1.48 m^3/hr.
Water Level ,ΔS (m.)	48.04 m.
Transmissivity , T (m^2/hr.) T = (2.30 Q)/(4πΔS)	0.01 m^2/hr.
Screen Length , b (m.)	21.00 m.
Hydraulic Gradient , K (m./hr.) K = T/b	2.685E-04 m./hr.

Figure-14 TTC No.4 WATER LEVEL RECOVERY TEST

Table-14 TTC No.4 RECORD OF WATER LEVEL RECOVERY TEST

DISCHARGE TEST (RECOVERY)

NAME OF PROJECT	Malawi CDSS and TTC PHASE 2		
No.	[redacted]	BOREHOLE DEPTH	70m
NAME OF LOCATION	NALIKULE TTC	YIELD (Lit/sec)	0.41 l/s
DISTRICT	LILONGWE	STATIC WATER LEVL	1.96m
	T.A. CHIMUTU	DYNAMIC WATER LEVEL	50M
DATE	29/10/2011	PUMP SET	50M

Time (Hour: Minute)		Elapsed Time t(min)	Accumulated time (Lit/min)	Water Level (m)	Recovery (m)	Remarks
00 : 06	0	0	1440	50.00	48.04	Clean water
: 07	1	1	1441	48.50	46.54	
: 08	1	2	1442	47.28	45.32	
; 09	1	3	1443	46.50	44,54	
: 10	1	4	1444	45.72	43.76	
: 11	1	5	1445	44.18	42.22	
: 13	2	7	1447	40.52	38.56	
: 15	3	10	1450	37.00	35.04	
: 20	3	13	1453	33.74	31.78	
: 21	2	15	1455	30.52	28.56	
: 26	5	20	1460	27.86	25.90	
; 30	5	25	1465	21.77	19.81	
: 35	5	30	1470	16.80	14.54	
: 40	5	35	1475	13.91	11.95	
: 50	5	40	1480	11.50	9.54	
: 55	5	45	1485	9.07	7.11	
: 01	5	50	1490	7.75	5.79	
: 05	5	55	1495	6.59	4.63	
: 16	5	60	1500	5.75	3.79	
: 23	10	70	1510	3.09	3.13	
; 30	10	80	1520	4.46	2.50	
: 46	10	90	1530	3.83	1.87	
: 36	10	100	1540	3.44	1.48	
02 : 06	10	110	1550	3.32	1.36	
: 21	10	120	1560	3.15	1.19	
: 36	15	135	1575	2.92	0.96	
: 51	15	150	1590	2.80	0.84	
: 36	15	165	1605	2.72	0.76	
: 51	15	180	1620	2.64	0.68	
03 : 06	15	195	1635	2.60	0.64	
: 21	15	210	1650	2.58	0.62	
: 36	15	225	1665	2.54	0.58	
: 51	15	240	1680	2.53	0.57	
04 : 06	15	255	1695	2.52	0.56	
: 21	15	270	1710	2.50	0..54	
: 36	15	285	1725	2.46	0.50	99%

Table-15 WATER QUALITY TEST RESULT OF B BOREHOLES TTC No.2～TTC No.4

FORM No. WQPC 12/1

MINISTRY OF AGRICULTURE, IRRIGATION & WATER DEVELOPMENT

WATER QUALITY TEST RESULTS

LAB No.	814	821	822	
DATE SAMPLED	28/10/2011	28/10/2011	28/10/2011	
WATER RESOURCE UNIT				
MAP SHEET/GRID REF.				
SOURCE IDENTITY/LOCATION	NALIKULE TTC BOREHOLE (BH No.3) T/A CHIMUTU, LILONGWE DISTRICT	NALIKULE TTC BOREHOLE (BH No.4) T/A CHIMUTU, LILONGWE DISTRICT	NALIKULE TTC BOREHOLE (BH No.2) T/A CHIMUTU, LILONGWE DISTRICT	MALAWI DRINKING WATER STANDARDS FOR BOREHOLE WATER (MS733:2005)
pH Value	6.89	7.84	7.64	6.0-9.5
CONDUCTIVITY (µS/cm at 25°C)	311	390	460	3, 500
TOTAL DISSOLVED SOLIDS, mg/l	160	175	182	2, 000
CARBONATE (as CO_3^{2-}), mg/l	0.00	30	42	-
BICARBONATE (as HCO_3^{2-}), mg/l	132	90	119	-
CHLORIDE (as Cl^-), mg/l	26.2	28	21	750
SULPHATE (as SO_4^{2-}), mg/l	5.18	4.49	6.96	800
NITRATE (as NO_3^-), mg/l	0.003	0.199	0.013	100
FLUORIDE (as F^-), mg/l	-	-	-	3.0
SODIUM (as Na^+), mg/l	11	19	15	500
POTASSIUM (as K^+), mg/l	3.7	4.4	5.5	-
CALCIUM (as Ca^{++}), mg/l	29	35	41.6	250
MAGNESIUM (as Mg^{++}), mg/l	12.3	9.2	13.4	200
IRON (Fe^{++}), mg/l	0.153	0.309	0.140	3.0
TOTAL HARDNESS (as $CaCO_3$), mg/l	123	125	159	800
TOTAL ALKALINITY (as $CaCO_3$), mg/l	108	123	167	-
SILICA (as SiO_2), mg/l	19	20	17	-
TURBIDITY, NTU	<0.01	<0.01	2.0	25
SUSPENDED SOLIDS, mg/l	<0.10	<0.10	<0.10	25
Faecal coliform (FC), Count ml/100 ml	3	0	0	50
Faecal streptococci (FS), Count/100 ml	0	0	0	0

Analysis conducted by Central Water Laboratory

1. Drilling at TTC No.1

2. Setting of casing (D160mm) at TTC No.3

3. Sampling by the technical officer of MAIWD at TTC No.3

4. Soil sample (GL-3m～61m) at TTC No.3

5. Clean development at TTC No.4

6. Constant discharge test at TTC No.3

Figure-15 TTC No.1～No.4 Photograph (Oct.2011)