EVALUATION OF GROUND WATER SUPPLY AT THE TEMPORARY SITE (BOSSO CAMPUS) OF THE FEDERAL UNIVERSITY OF TECHNOLOGY MINNA.

BY

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A PROJECT REPORT

SUBMITTED

TO

THE SCHOOL OF POSTGRADUATE STUDIES
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CHAPTER ONE

1.0 INTRODUCTION

Water is essential to people, and the largest available source of fresh water lies underground. Increased demands for water have stimulated development of underground water resources. As a result, techniques for investigating the occurrence and movement of groundwater have improved, better equipments for extracting groundwater have been established, and research has contributed to a better understanding of the subject.

However, the need to harness and perfect our ground water supply system can not be over emphasized. Water wells are structures dug, drilled, driven or bore into the ground bringing groundwater to the surface depending on geological formations of the acquifer (water bearing rock or formations). Dug and driven wells are usually for soft ground, gravels and sand at shallow depths of about 30 metres or more, while bored and drilled wells are usually used in hard ground and rocks and sunk to depth of hundreds to thousands of metres. (NWRI, 1997).

1.1 DESCRIPTION OF PROJECT AREA.

The project area is the temporary site of Federal University of Technology Minna, it is situated in Bosso L.G.A. of Niger State. The site area cover about One hundred hectares of land in Bosso and almost all the total surface area of land was underlain by rocks of Precambrian basement complex.

1.1.1 GEOLOGY OF THE AREA

The area of study is underlain by rocks of Precambrian basement complex, comprising mainly the intermediate rocks of medium granites with pegmatitic intrusions.

The granites exposures are physically seen around the northern fence (i.e. at facing the quarters). The out crops, through not

massive, they did not show any sign of fracturing or surface weathering. They are almost fresh rock out crops.

1.1.2 HYDROGEOLOGY AND GROUND WATER

In crystalline terrain (like the area studied) water is stored throughout the saturated part of the weathered zone and transmitted mainly via joints in almost fresh rocks.

This shows that the study area is general highly resistive. However there are up to five hand dug wells present within the area. All these wells are hand pump bore holes.

Two out of them were found to be out of service, but through my effort and series of consultation to works department of F.U.T. an arrangement was made to call on the expert on bore holes from bore hole installation and maintenance department of Niger State Water Board to carry out the repairs, now the two broken bore holes are now back on operation.

Therefore presently all the five hand pumps bore holes are now functional.

1.1.3 POPULATION OF FEDERAL UNIVERSITY OF TECHNOLOGY MINNA (BOSSO CAMPUS).

The population record for Federal University of Technology Minna (Bosso Campus) at two years interval are given Below. The population record was obtained from the Students affair of the University for the year 1992- 2002

TABLE 1.

POPULATION OF THE PROJECT AREA.

YEAR	1992	1994	1996	1998	2000	2002
POPULATION	3,720	3,832	3,948	4,066	4,188	4,900

Source: Students Affair office- 2001

In view of the above table an attempt will be made to forecast the water requirement of Federal University of Technology Minna from 2000 to 2015 (i.e. 15 years).

DEDICATION

This project is dedicated to my Late father Alh. Musa Aliyu Kontagora who sponsored my education right from kindergaton.

CERTIFICATION

This is to certify that ABDULKARIM MUSA a post graduate student in the Department of Agricultural Engineering with Reg. No:PGD/AGRIC ENG/2000/2001/114 has satisfactorily completed the requirements for the award of postgraduate Diploma (PDG) in soil and water Engineering.

.....	.....
PROJECT SUPERVISOR	**HEAD OF DEPARTMENT**
ENGR. MOHAMMED BASHIR	*DR. D. ADGIDZI*

holes of hand pumping type scattered within the University Campus.

1.1.5 SCOPE OF STUDY

This work is restricted to groundwater resources in the Bosso Campus of the Federal University of Technology, Minna.

CHAPTER TWO

2.0 LITERATURE REVIEW

Groundwater is subsurface water that fills voids and permeable geological formations. It occurs many different geological formations. Nearly all rocks in the upper part of the earth's crust, whatever, their types, origin or age, possess openings called pores or voids.

Groundwater therefore is relatively cheaper than surface water. Water wells are structures dug, drilled driven or bore into the ground bringing groundwater to the surface depending on geological formations of the aquifer (water bearing rocks or formations). Dug and driven wells are usually for soft ground, gravel and sand at shallow depths of about 30 meters or more, while bored and drilled wells are usually used in hard ground and rocks and sunk to depths of hundreds to thousand of meter, therefore, the design of any water bore hole should ensure that the installation will provide clean portable water for the whole of the planned design life. The secret of a long life borehole is not in the drilling but in the development of the bore and the design of the permanent installation (Bill, 1999). Ground water is the largest source of fresh water in storage on our planet. In arid and semi-arid regions, construction of efficient water wells is fundamental to any program of social and economic progress. Fractures or solution openings in consolidated aquifers provide pathways for ground water flow, whereas water flows through the interstitial opening (pores) of unconsolidated aquifer such as sand and gravel. Recognizing that a basis is a large natural underground reservoir, it fellow that utilization of ground water by one landowner affects the water supply of all other landowners, management objectives must be selected in order to develop and operate the basis. These involve not only geologic and hydrologic considerations but also

economic legal, political, and financial aspects. After evaluation of total water resources and preparation of alternative management made by appropriate public bodies or agencies.

In general, taking Niger State as an example there are many bore holes that have failed or not yielding water this might be due to lack of proper management of our boreholes or wells and other factors highlighted below:-

2.1 CAUSES OF BOREHOLE FAILURE

A proper drilled borehole, serves it entire useful life with little or no attention. Many bore hole's yield, decreases in water quantity with time, sometimes it is the pump that is faulty rather than the boreholes. Therefore in Niger State, for example the site selection was done primarily by trial and error (wild cat). Although satisfactory result were obtained on the sedimentary environments numerous sites were unsuccessful particularly in the crystalline rock terrain.

It is apparent that the potential for expansion of shallow bore holes in the crystalline rock was enormous, however, there was no reliable estimate of the area with potential for exploration of the shallow groundwater, nor guideline establishing the quantity that could be safety extracted by suitable spaced boreholes.

Another cause of failure is the depletion of the ground water supply. Not a fault of the well, this trouble can sometimes by remedied by decreasing pumping drafts, resetting the pump or deepening the well. The cause of well trouble may results from faulty well construction, such items as poor casing connections, unproper perforations or screens, incomplete placement of gravel packs and poorly seated wells are typical of difficulties encountered. Depending upon the particular situation, the well can be repaired, but sudden failures involving entrance of sand or collapse of a casing often required replacement of the entire well.

Lastly and most prevalent cause of well failure results from corrosion or incrustation of perforated sections of casing. Corrosion may result from direct chemical action caused by the presence of two different metals in the well. The effects of corrosion resistant metal (such as nickel, copper or stainless steel) and by providing cathodic protection. Incrustation is caused by precipitation on or near perforated well casings of materials carried in solution by ground water.

Therefore, the knowledge of the cause of borehole failure here gives one the insight to carryout a comprehensive study to delineate appropriate areas and to determine the quality of water that is potentially available.

Niger State in particular is virtually a basement area. An indirect preliminary assessment of the underground potential of the basement complex showed that aquifers are narrow and discontinuous hence more difficult to find than had been anticipated. In view of the nature of this state, basic knowledge of the environment or the region is very necessary hence baseline data is very important such as Geological map and report on the area, Topographical map, surface reconnaissance study, logs of previous boreholes or hand dug wells, Hydrological data all this need to be studied. (Project Planning, Research and Statistic Department of Niger State Water Board).

2.2 POPULATION FORECASTING

Any water supply scheme must be planned to serve the present as well as the feature needs. In order to achieve this objectives in this project work Geometrical method is employed for the estimation.

The Federal University of Technology Minna as of 1998 has the students population of 4,066 and a staff strength of 300 making the total population of 4,366 people, while in 2002 the total

population of students and staff in the campus is 4,900. (Students Affairs Office Federal University of Technology Minna, 2001).

2.2.1 WATER DEMAND

There are various methods water demand can be estimated namely:-

(i) Mathematical or logistic method.

(ii) Geometric growth method

(iii) Graphical rate of progression method

(iv) Decreasing rate of growth (increase)

(v) Employment forecasting.

All these methods utilize different assumption and therefore give different results. Selection of any method depend on the amount and type of data available and whether projections are made for the short or long-term.

However in this project only one method is used i.e. Geometric Growth method. i.e.:-

$P_n = P_o (1 + r)^n$

P_o = Present Population

r = Annual Growth rate

n = Design period.

CHAPTER THREE

MATERIALS AND METHODS:-

3.0 SOURCES OF WATER SUPPLY TO F.U.T (BOSSO CAMPUS) MINNA.

The source of water supply to the University apart from the five Boreholes, is the Bosso package treatment plant which is about 350 metres away from the University reservoir tanks.

3.1 BOSSO DAM AND BOSSO PACKAGE TREATMENT PLANT

Bosso dam was one of the oldest sources of water supply that supplied Minna town since the creation of Niger State in 1976. The Dam was constructed in 1956 purposely for water supply, and the dam has a storage capacity of $0.68 \times 10^6 m^3$. The Dam was initially connected to pressure filter at the centre of Bosso Area. In 1979 a stockvis company constructed a package treatment plant that is capable of treating 1.25lit/day to argument the water supply from Chanchaga Water Works. The package treatment plant is still in existence but not producing to its design capacity and that is where the University was connected through 250 x 150mm pipe line providing portable water to F.U.T Campus.

3.1.1 EXAMINATION OF EXISTING GROUND WATER SUPPLY IN BOSSO CAMPUS

After almost three years of the Educational Trust Fund (ETF) intervention in water supply in F.U.T. Water Supply in the Campus is still inadequate. Despite the huge financial resources already invested but the result is still below average. Presently these boreholes that were drilled within the premises of the University to serve the current population is still inadequate and the failure or depreciation of the yield is due to the following reasons stated below:-

1. Reduction in well yield:- This might be due to general drop in water table as a result of climatic changes or plugging of the well screen.

2. Sand pumping:- This might occur at the beginning of the well's life or after some month or years of operation. This can be attributed to poor design, development or completion. An improper setting of casing and screens, breaking and corrosion of well screen and casing result in sand pumping.

3. Plugging of the well screen by fine particles of formation materials usually in consolidated aquifer where particles are agitated during pumping cycle.

4. Collapse of boreholes screens and casings as a result of corrosive action of water with low PH and high concentration of carbondioxide the presence of oxygen can also effect ferrous iron casings and screens.

5. State of pumps can indirectly affect the performance of a well, as errors in design construction can affect the pump performance. Sand pumping and corrosion of pump parts can result in its failure.

6. The depreciation in water quality as a result of contamination of the aquifer. This information was quoted from the (Okoye, 1996).

Finally with this reasons stated above, this project report has sought to examine the water supply situation in Bosso Campus of the University. It was fully examined that the major problems affecting the performance of the existing boreholes drilled in the University premises was as a result of appropriate techniques or construction methods and the right equipments to be used.

3.1.2 GEOPHYSICAL INVESTIGATION REPORTS.

The Survey was carried out only in the morning before sunshine. All the profiling were carried out and completed each day before 10.00 a.m. This was done because the equipments used responds very well at low temperatures. An area of (20 x 5 x 6) + (17 x5) + (12 x 5 x3) = 865 square metres. A total of ten profiles was run covering more than 60% of the whole area. In fact, the survey was conducted in such a way that, it was only the built up areas that was not intervened.

The first two profiles were even run outside the fenced quarters, right in front of the quarters. All these precautions were taken because of the high resistive nature of the terrain. The whole area was thoroughly combed and the least resistive area was selected and recommended for drilling. Only one point was picked being the only reliable point in the area-based on its lowest apparent resistively in the whole area. The role of geolophyics in water exploration is optimally in combination. The type of aquifer which is amenable to geophysical investigation in the area of study is a weathered jointed rocks. Locative of joints and associated narrow zones of deep weathering in crystalline terrain intervened is achieved by resistively techniques. Electromagnetic technique could have been better preferred here being a completely basement terrain, but for one of its shortcomings. There are magnetic substances that could have serious effect on the readings.

The Electrical Survey method used entails the already proved assumptions that on a higher ground of crystalline outcrop, deeply weathered zones (to about and more than 30 metres depth) and near vertical fractures containing abstractable water are electrically conductive by contrast with the fresh rock. This principle can be located by the combination of vertical electrical sounding (VES) and electric

resistively profiling (ERP) measurements base on local well data, from geological logging of boreholes in adjacent areas surrounding the staff quarters, soil and out crop information. This are all combined and made use of before picking the only site- by Geo explore Nigeria Limited of 1999.

CALCULATION OF WATER DEMAND

Considering the design period of 15 years and a growth rate of 1.5%.

Projected Population (2015)

$P_n = P_0(1 + r)^n$

$= 4900\ (1 + 0.015)^{15}$

$= 6,126.14$

6,200

PER CAPITA DEMAND

(a) Considering the population of students in the campus to be 4,600.

Taking 120 lit/Student/day

:. 4,600 x 120 = 552,000Lit/day

= **552 m³/day**

(b) Taking the population of staff in campus to be 300 assuming the family of five for each staff

taking 150 lit/head/day

= 300 x 5 x 150 = 225000 lit/day

= **225m³/day**

(c) Considering all others off campus to be 500 people.

Taking 50 lit/head/day

500 x 50 = 2500 lit/day

, = **25m³/day**

:. Total water per capita demand of the total population of F.U.T. Minna.

= 552 + 225 + 25 = **802 m³/day**

FIRE DEMAND

This can be estimated using the following expressions:-

$$Q_f = 3860\sqrt{p}\ (1-0.01\sqrt{p})$$

Where: Q_f = Fire Demand Lit/min

P = Population in thousand.

$$\therefore = 3860\sqrt{6,200}\ (1-0.01\sqrt{6200})$$

$$= 303936.7039\ (0.213)$$

$$= 64738.51 \text{ lit/day}$$

$$= \mathbf{64.74m^3/day}$$

WASTES

According to (UNICEF Report, 1980) 10% of domestic Demand is fixed for waste

$$\therefore\ Q_w = 552\ X0.1 = \mathbf{55m^3/day}$$

TOTAL WATER DEMAND

$$Q_T = Q + Q_f + Q_w$$

$$= 552 + 64.74 + 55$$

$$= 671.74$$

Use: = **700m³/day**

Maximum hourly demand $= \frac{700}{24} = 29.17$

$$= \frac{29.17 \times 1000}{60 \times 60}$$

$$= 8.10 \text{ lit/s}$$

Use 9lit/s

TOTAL YIELD OF FIVE EXISTING HAND PUMP BOREHOLE IN THE CAMPUS

$$= 0.5 + 0.4 + 0.5 + 0.6 + 0.48 \text{ lit/s}$$

$$= 2.48 \text{ lit/s.}$$

$$\therefore \frac{2.48 \times 60 \times 60 \times 24}{1000} = 214m^3/day$$

The above total yield of the five boreholes were obtain from Geo explore Nigeria Limited. 1999.

Total water supplied to F. U. T. Bosso Campus Minna

= 200,000 lit/day

Quantity use = 100,000 lit/day

Consumption rate = 100 m^3/day

2.2.2 AVAILABILITY OF WATER SUPPLY IN F.U.T. MINNA – BOSSO CAMPUS.

Water Supplied from Bosso Package treatment plant to F.U.T. Minna Bosso Campus = 200m^3/day

Total yield of five hand pump bore holes in the campus =214 m^3/day

:. Total Available Water = 200 + 214 = 414m^3 /day

Total water demand = 700 m^3/day

Total available water = 414 m^3 /day

Amount of water required to balance the water demand in the Campus = 286 m^3/day.

HYDRAULIC CALCULATIONS:-

BOREHOLE.

Max. hourly demand = $\frac{700}{24}$ = 29.17

= $\frac{29.17 \times 1000}{60 \times 60}$

= 8.10 lit/s

Use 9 lit/s

Total Discharge Q = 9lit/s

From geophysical report, yield of well = 0.6 lit/s

No. of borehole required by the 2015 = $\frac{9}{0.6}$ = **15 Nos.**

However, if three bore holes of better yield of 5.0 lit/sec can be provided by now, then additional bore holes should be drilled by the year 2015.

3.1.3 ASSESSMENT AND RESULT OF WATER QUALITY ANALYSIS.

The examination of water supply property embodies four lines of investigations- Topographical, Chemical, Bacteriological, each having its uses and indications and each yielding information not obtainable. Bacteriology offers the most delicate test for the detection of recent, and therefore potentially dangerous fecal pollution, this is the chief function of the bacteriological examination.

Chemical analysis though lacking the sensitivity of Bacteriology in this respect may nevertheless assist in the hygienic assessment. The information derived from bacteriological test must be assessed in the light of thorough knowledge of the conditions at the sources of supply throughout the stages of treatment to which the raw water may be subjected, in the distribution system.

It should be borne in mind the possible contingencies, which can result in the sudden pollution of a supply which has previously passed all laboratory test clearly failure of neatness processes could be very serious but gap there are various other hazards.

Most of the information contained herein were obtained as per investigative drilling form (Geo explore Nigeria Limited 1999). For example the draw down water levels and yields. All the five boreholes gives very low yield ranging from 0.4 litres per second (24 litres per minutes) to 0.6 litres per second (36 litres per minutes). The bore hole that have a yield of 0.6litres per second could carry a one house power submersible pump if required, this borehole is located around the staff quarters area. Depth to fresh basement varies from 20.30m to 24.24m and this shows that there is a possibility of going further deep depending on the equipment used. Referred to appendix for a daily and descriptive logging reports for each borehole.

3.1.4 EXISTING RESERVOIRS AND OVER HEAD TANKS AT FEDERAL UNIVERSITY OF TECHNOLOGY MINNA.

There was a total of four surface reservoir steel tanks constructed very close to senate office. The total volume of each tank is 100,000 litres. These tanks are the reservoir tanks, where the water supplied to Federal University of Technology was pumped directly to the tanks and this gives a total of 400,000 litres. The University also has two overhead tanks of 100,000 litres each measuring a total volume of 200,000 litres of water was lifted from the surface reservoir to the overhead tank and these serve the entire campus with water by gravity. Apart from all these tanks and reservoirs there are some departments like Chemical Engineering and Micro Biology Department that installed smaller tanks of about 1000 litres capacity in their departments as a reserve storage for their daily activities in the laboratory.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

From the result of the drilling obtained from Geoexplore Nigeria Limited which was concluded that the geophysical report is fairly good one. The yield is also fair to some extent, because the water did not cut off during the development and pump testing, however, from the geophysical investigation report which was also concluded that something unusual is happening in the point picked for drilling, i.e. water in the fresh rock and another important point of discussion is the maintenance of such boreholes more especially the India Mark-II handpumps which were provided in the whole five boreholes drilled in the campus.

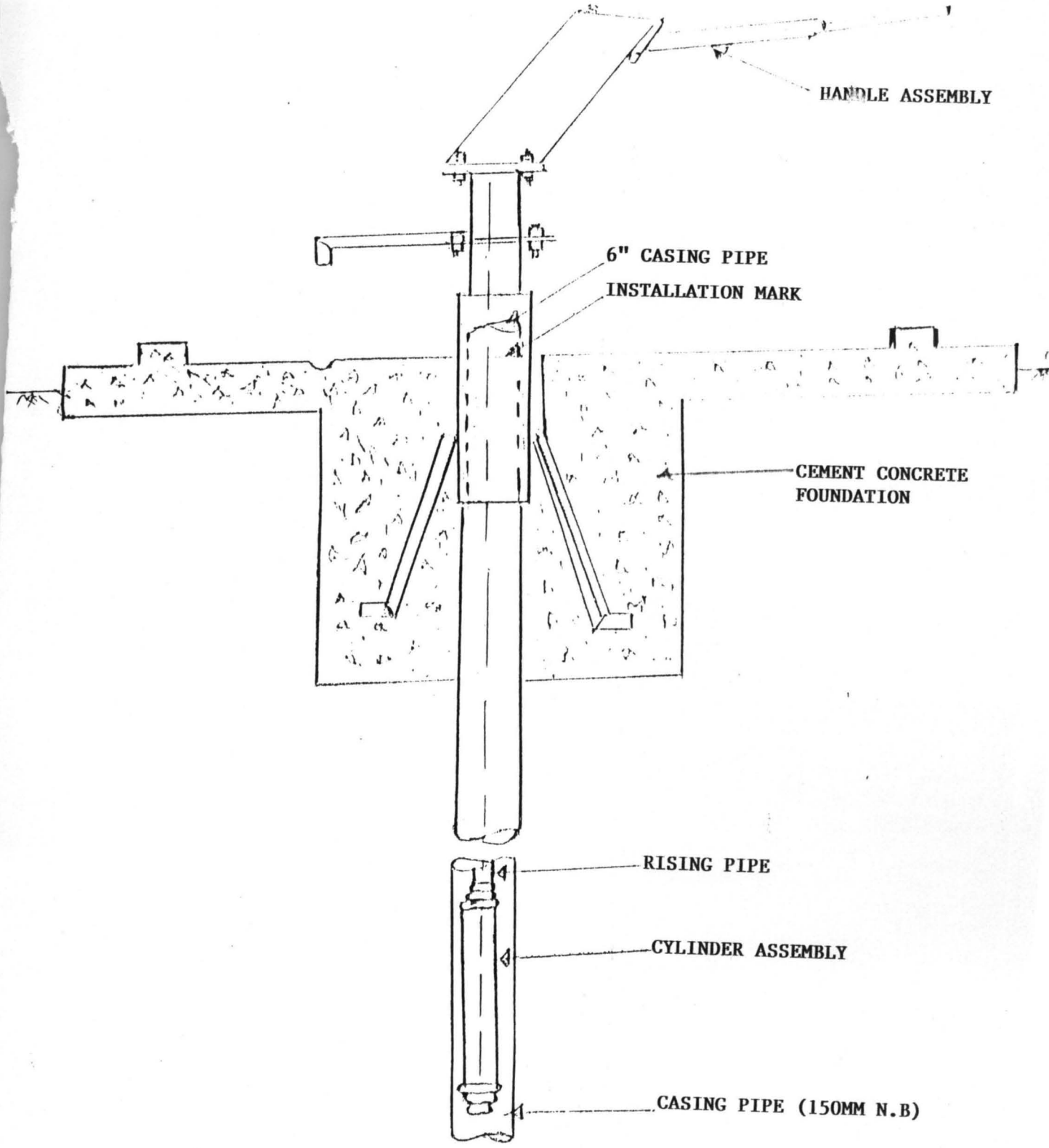
The India Mark-II deep well handpump are to be properly monitored and maintained to ensure safe portable drinking water to the design population without break. Proper and regular maintenance will prevent break down and ensure continuity.

India Mark-II hand pump is like any other mechanical machine. All machine are to be kept clean. If for no other reason than that in cleaning all parts are inspected for formation of rust, insufficient lubrication, loose bolts, nuts etc. and also for missing part in time to prevent major failures. The moving parts in the India Mark-II handpump above and below the ground level are the important parts which required attention, therefore, maintenance schedule has to be drawn at fixed interval. (Table 1) below refers.

4.1 TROUBLE SHOOTING, CAUSES, REMEDIES.

Table 1.

TROUBLE	CAUSE	REMEDY
Pump handle works easily but no flow of water	(a) Damaging rising main or rising main disconnected. (b) Water level gone down much below the cylinder assembly (c) Worn cylinder leather bucket. (d) Connecting rod joint disconnected. (e) Value seats worn out (f) Pump cylinder creaked.	(a) Replace the damaged pipe or connect the affected rising main. (b) Add more pipes and rods (c) Over hauls the cylinder and replace the leather bucket. (d) Pull out the pump and join the connecting rod. (e) Replace value seats (f) Replace cylinder assembly.
2. Delayed flow or small flow.	(a) Leakage in cylinder bottom check value or upper value. (b) Leakage in pipe assembly.	(a) Overhaul cylinder replace rubber seat. (b) Replace rising main.
3. Folding of chain during return stroke.	(a) Improper erection. (b) Leather cup washers getting jammed inside the cylinder.	(a) Adjust the length of last connecting rod suitably. (b) Overhaul the cylinder and replace leather buckets.
4. Noise during operation	(a) Stand assembly flange not levelled properly. (b) Bent connecting rod Hexagonal coupler welded off-set.	(a) Level the flange (b) Change the defective rod. (c) Change the defective rod
5. Shaky Handle	(a) Loose handle axle nut (b) Worn out ball bearings (c) Spacer damaged	(a) Tighten handle axle nut. (b) Replace ball bearings (c) Replace spacer



TYPICAL HAND PUMP BOREHOLE PROFILE

4.1.1 DEVELOPMENT OF GROUND WATER SUPPLY SYSTEM FOR FEDERAL UNIVERSITY OF TECHNOLOGY MINNA.

Since the desired goal is to obtain the maximum quantity of water to meet predetermined quantity requirement for the University Campus. Therefore the development of water supplies from ground water which begin typically with a few hand pump bore holes scattered in the University Campus would not solve the problem of water supply in the Campus, since the University is bond of expansion with years ahead. In this case a careful consideration has to be made in providing at least five additional bore holes that will use motorized pump and if possible, to convert one out of the five existing bore holes more especially the bore hole located around staff quarters which has a better yield of 0.6 litres per second since it was already suggested that the bore hole is capable of carrying one horse power submersible pump.

4.1.2 THE RESULT OF WATER QUALITY ANALYSIS

SAMPLE 1: BOREHOLE

LOCATION: GEOGRAPHY GARDEN F.U.T. BOSSO CAMPUS

PARAMETERS:

A PHYSICAL PROPERTIES

i.	Taste	Insipid
ii.	Colour	Turbid (15mg/lit)
iii.	Odour	None
iv.	Total dissolve solid	110 mg/lit
v.	Suspended solid	118 mg/lit
vi.	Temperature	32^0C

B INSTRUMENTAL ANALYSIS

i.	PH	6.49
ii.	Conductivity	$4.50 X10^2$

C CHEMICAL ANALYSIS (ANIONS)

i.	Chloride CL^-	14.00
ii.	Sulphate SO_4^-	42.11
iii.	Nitrate NO_3^-	9.47
iv.	Carbonate CO_3^-	11.23
v.	Phosphate $P_2 O_5^-$	5.84

D CHEMICAL ANALYSIS (CATION)

i.	Iron Fe^{2+}	0.61
ii.	Copper Cu^{2+}	0.29
iii.	Lead, Pb^{2+}	0.34
iv.	Silica, $S_1 0_2^-$	3.07
v.	Sodium, Na^{2+}	7.85
vi.	Potassium K^+	10.36
vii.	Hardness (Ca + mg)	46.16
viii.	Alkalinity	29.10
ix.	Acidity	15.62

Source: Department of chemistry, F.U.T. Minna 9TH December, (1999.)

SAMPLE 2: BOREHOLE

LOCATION: UNIVERSITY CAFETERIA F.U.T. BOSSO CAMPUS.

PARAMETERS:

A PARAMETERS:

i.	Taste	Insipid
ii.	Colour	Clear (clean)
iii.	Odour	None
iv.	Total Dissolve Solid	16
v.	Suspended Solid	22
vi.	Temperature	29.5^0C

B INSTRUMENTAL ANALYSIS

i.	PH	8.45
ii.	Conductivity	$2.50 X10^2$

C CHEMICAL ANALYSIS (ANIONS)

i.	Chloride CL^-	24.51
ii.	Sulphate SO_4^-	16.34
iii.	Nitrate NO_3^-	8.27
iv.	Carbonate CO_3^-	16.91
v.	Phosphate $P_2 O_5$	10.32

D CHEMICAL ANALYSIS (CATIONS)

i.	Iron Fe^{2+}	0.37
ii.	Copper Cu^{2+}	0.29
iii.	Lead P_b^{2+}	0.13
iv.	Silica $S_1 0_2^-$	0.98
v.	Sodium Na^{2+}	8.04
vi.	Potassium K^+	3.99
vii.	Hardness (Ca + Mg)	48.00
viii.	Alkalinity	29.90
ix.	Acidity	9.14

Source: Department of Chemistry, F.U.T. Minna 9TH December, (1999.)

SAMPLE 3: BOREHOLE

LOCATION: STAFF QUARTERS F.U.T. BOSSO CAMPUS.

PARAMETERS:

A PHYSICAL PROPERTIES

i.	Taste	Insipid
ii.	Colour	Clear (10)
iii.	Odour	None
iv.	Total Dissolve Solid	80
v.	Suspended Solid	45
vi.	Temperature	$27^{0}C$

B INSTRUMENTAL ANALYSIS

i.	PH	8.60
ii.	Conductivity	$3.81X10^{2}$

C CHEMICAL ANALYSIS (ANIONS)

i.	Chloride CL^{-}	33.60
ii.	Sulphate SO_4^{-}	50.87
iii.	Nitrate NO_3^{-}	8.28
iv.	Carbonate CO_3^{-}	13.57
v.	Phosphate $P_2\ O_5$	2.75

D CHEMICAL ANALYSIS (CATIONS)

i.	Iron Fe^{2+}	0.59
ii.	Copper Cu^{2+}	0.11
iii.	Lead P_b^{2+}	0.71
iv.	Silica $S_1 0_2^-$	0.63
v.	Sodium Na^{2+}	9.44
vi.	Potassium K^+	6.80
vii.	Hardness (ca + mg)	18.00
viii.	Alkalinity	44.43
ix.	Acidity	12.18

Source: Department of Chemistry, F.U.T. Minna 9TH December, (1999.)

SAMPLE 4: BORE HOLE

LOCATION: UNIVERSITY MOSQUE F.U.T. BOSSO CAMPUS.

PARAMETERS:

A PHYSICAL PROPERTIES

i.	Taste	Insipid
ii.	Colour	Clear (clean)
iii.	Odour	None
iv.	Total Dissolve Solid	88
v.	Suspended Solid	34
vi.	Temperature	21^0C

B INSTRUMENTAL ANALYSIS

i.	PH	6.9
ii.	Conductivity	$4.8 X10^2$

C CHEMICAL ANALYSIS (ANIONS)

i.	Chloride CL^-	22.10
ii.	Sulphate SO_4^-	71.09
iii.	Nitrate NO_3^-	9.66
iv.	Carbonate CO_3^-	18.12
v.	Phosphate $P_2 O_5$	4.17

D CHEMICAL ANALYSIS (CATIONS)

i.	Iron Fe 2+	0.16
ii.	Copper Cu $^{2+}$	0.15
iii.	Lead P_b $^{2+}$	0.18
iv.	Silica S_1 0_2^-	1.11
v.	Sodium Na $^{2+}$	8.93
vi.	Potassium K^+	13.87
vii.	Hardness (ca + mg)	42.00
viii.	Alkalinity	16.30
ix.	Acidity	9.17

Source: Department of Chemistry, F.U.T. Minna 9TH December, (1999.)

4.1.3 COMPARISON OF PHYSICAL ANALYSIS RESULT OF 1999 AND 2002

SAMPLE 1: BORE HOLE

LOCATION: GEOGRAPHY GARDEN F.U.T. CAMPUS.

PARAMETERS

A. PHYSICAL PROPERTIES 1999 PHYSICAL PROPERTIES – 2002

i.	Taste	Insipid	Taste	NIL
ii.	Colour	Turbid (15mg/lit	Colour	Clear
iii.	Odour	None	Odour	None
iv.	Total dissolve solid	110 mg/lit	Total dissolved solid	124.9 mg/lit
v.	Suspended solid	118 mg/lit	Suspended	119 mg/lit
vi.	Temperature	32^{0}C	Temperature	28.9^{0}C

B.INSTRUMENTAL ANALYSIS – 1999 * INSTRUMENTAL ANALYSIS - 2002

i.	PH	6.49	PH	8.3
ii.	Conductivity	4.50 X 10^2	Conductivity	0.2ms/cm

C. CHEMICAL ANALYSIS (Amions) – 1999 * CHEMICAL ANALYSIS (Amions) 2002

i.	Chloride Cl^-	14.00	Chloride Cl^-	13.00
ii.	Sulphate S_{04}^-	42.11	Sulphate S_{04}^-	40.10
iii.	Nitrate NO_3^-	9.47	Nitrate NO_3^-	9.50
iv.	Carbonate CO_3^-	11.23	Carbonate CO_3^-	11.20
v.	Phsophate P_2 0_5	5.84	Phosphate P_2 0_5	6.00

D. CHEMICAL ANALYSIS (Cation) 1999 * CHEMICAL ANALYSIS (cation) 2002

i.	Iron Fe^{2+}	0.61	Iron Fe^{2+}	0.60
ii.	Copper Cu^{2+}	0.29	Copper Cu^{2+}	0.31
iii.	Lead Pb^{2+}	0.34	Lead Pb^{2+}	0.34
iv.	Silica $S_1\ 0_2^-$	3.07	Silica $S_1 0_2$	3.09
v.	Sodium Na^{2+}	7.85	Sodium Na^{2+}	7.90
vi.	Potassium K^+	10.36	Potassium K^+	9.23
vii.	Hardness (Ca + mg)	46.16	Hardness (ca + mg)	45.12
viii	Alkalinity	29.10	Alkalinity	30.00
ix.	Acidity	15.62	Acidity	14.70

SAMPLE 2: BOREHOLE

LOCATION: UNIVRSITY CAFETERIA F.U.T. BOSSO CAMPUS

PARAMETERS

A PHYSICAL PROPERTIES-1999 * PHYSICAL PROPERTIES 2002

i	Taste	Insipid	Taste	NIL
ii	Colour	Clear	Colour	Clear
iii	Odour	None	Odour	None
iv	Total dissolve solid	16	Total dissolve solid	81.7mg/lit
v	Suspended solid	22	Suspended solid	22
vi	Temperature	29.5^{0}C	Temperature	28.^{0}C

B. INSTRVMENTAL ANALYSIS-1999 * INSTRVMENTAL ANALYSIS 2002

i	PH	8.45	PH		9.0
ii	Conductivity	2.50 x 10^2	Conductivity		0.15ms/cm

C. CHEMICAL ANALYSIS (ANION) 1999* CHEMICAL ANALYSIS (ANION)- 2002 RESULT

i	Chloride CL^-	24.51	Chloride CL^-	25.60
ii	Sulphate SO_4^-	16.34	Sulphate 50_4^-	17.40
iii	Nitrate No^-_3	8.27	Nitrate NO^-_3	8.33
iv	Carbonate CO_3^-	16.91	Carbonate	17.01
v	Phosphate p_2 0_5^-	10.32	Phosphate p_3 0_5-	11.45

D. CHEMICAL ANALYSIS (CATIONS) * CHMEICAL ANALYSIS (CATION) 2002

i	Iron Fe2+	0.37	Iron Fe2+	0.35
ii.	Copper Cu^{2+}	0.29	Copper Cu^{2+}	0.30
iii.	Lead Pb^{2+}	0.13	Lead Pb^{2+}	0.15
iv.	Silica $S_1O_2^-$	0.98	Silica $S_1O_2^-$	0.01
v.	Sodium Na^{2+}	8.04	Sodium Na^{2+}	9.11
vi.	Potassium K^+	3.99	Potassium K^+	4.00
vii.	Hardness (Ca +Mg)	48.00	Hardness (Ca + Mg)	49.00
viii.	Alkalinity	29.90	Alkalinity	30.01
ix.	Acidity	9.14	Acidity	9.12

SOURCE: Central Laboratory of Niger State Water Board Mlnna 2002

BACTERIOLOGICAL TEST

STANDARD QUALITATIVE ANALYSIS OF WATER

There are six basic test to detect pollution especially detecting of coliform bacteria in water i.e. presumptive confirmed and completed the test were performed sequentially on each sample under analysis.

They detect the presence of coliform bacteria (indicators of fecal contamination). Animals and birds may also harbont in their various organisms pathogenic to man, and the importance of these sources of pollution must not be over looked. The protocol for presumptive test was observed and the following result were obtained:-

4.1.4 MICROBIAL EXAMINATION OF WATER (WATER QUALITY ANALYSIS)

PRESUMPTIVE TEST

Sample	LB 1X(0.1ML)			LB 1X(0.1ML)			LB 2X(1.0ML)			Reading		MPN	% Pb.
A	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	0-0-0		NIL	NIL
B	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	0-0-0		NIL	NIL

Source: The department of Micro-Biology F.U.T. Minna

Year: May, 2002

KEY: A = Water Sample from bore hole near geography.

B = Water Sample from bore hole near Cafteria

LB = Lactose broth, 1X = Single Strength.

2X = Double Strength.

ML = Milliliter, MPN = Most probable No. Organisms

%Pb = Percentage Probability

Confirmatory Test:

Sample	EMB	MCA	BGA	SF	DCA	CA	BA	Gram's Morphology.
A	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
B	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL

KEY: EMB = Eiosine Methylene blue Agar — E.Coli Test

MCA = MacConkey Agar — Federal Coliforms.

BCA = Brillient green Agar — Salmonella Spp test

SF = Salente "F" broth

DCA = Deoxy Chocolate Agar — (Sheigella test)

CA = Chocolate Agar — Other pathogenic

BA = Blood Agar — bacteria test

Gram's morphology = Gram stain and microscopic examination.

Total Counts (Viable Counts)

Sample	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}
A	-ver	-ve	-ve	-ve	-ve	-ve
B	-ve	-ve	-ve	-ve	-ve	-ve

KEY: 10^{-1}---------- 10^{-6}

= Dilution factor that will used if there was bacteria multiplication.

The format is the no. of bacteria colouries X is the reciprocal of the dilution factor.

(No. of colonie X $\frac{1}{10^{-1}}$ = no of colonies 10^{1})

+ no of colonies X 102 ---------- 106 and find the average counts.

-ve = Negative.

Completed test:

This is a summary of the whole procedure, since from beginning everything was negative there was no need to do that.

Comments:

The two boreholes are very portable to drink. They are free of any microorganism.

This can be as result of the water level that has gone down so much to produce the pure portable water for human consumption.

This procedure was repeated three consecutive times so as to be sure of the result, all necessary precautions was taken so as to avoid external contaminations. All protocols were observed for completed test Gram staining were performed on nutrient Agar slant cultures and the slides were examined microscopically for the presence of bacteria.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

Since the result of all the test falls within the World Health Organization (WHO) permissible limit. It is therefore concluded that the water from all the borehole located within the University premises is safe for drinking. In spite of the effort made by the University Authority in conjunction with ETF, it appears that water sector management of F.U.T. is not able to achieve its goals in providing sufficient water to meet the demand of the present population need in terms of quantity. And also in terms of availability and durability of services. Several reasons explain this deficiency in this project work.

In order to face the over increasing demand from population, to have safe water in a sustainable way and sufficient quantity, the works department of the F.U.T. Minna must be aware and inspire themselve with progress achieved in the implementation of new technologies in water treatment plant that exist in most of the University in Nigeria.

In this regard therefore, I will like to recommend and introduce to the institution a portable package treatment plant which is capable of treating 5,000 cu.m daily which can be installed behind livestock department where an impounding reservoir can be constructed as a source of raw water collection point through the existing drainage. The major components of this package treatment plant are aeration, clarification, filtration, sedimentation and disinfection. (See fig b, show a layout sketch of the package treatment plant).

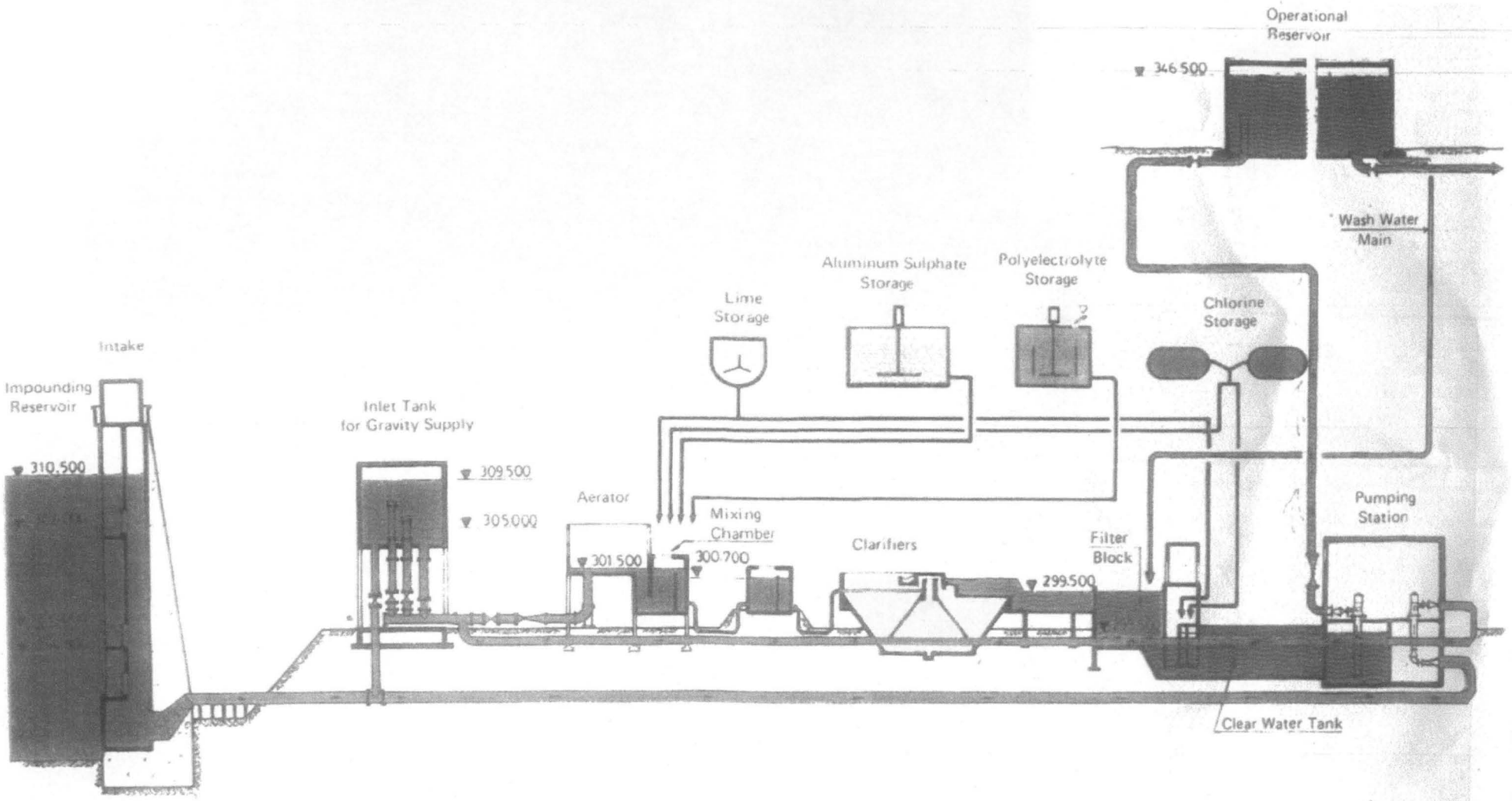


FIG: 8 A PACKAGE TREATMENT PLANT.

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APPENDIX

THE DAILY AND DESCRIPTIVE LOGGING REPORTS FOR THE BORE HOLE LOCATED AROUND THE FEMALE HOSTEL AREA (NEAR THE WEATEHR STATION)

The Bore hole located around the female Hostel area (near the Weather Station)

DATE STARTED:- Friday 29th October, 1999

DRILLING METHOD: - Air

ROCK TYPE: Basement

TYPE & SIZE OF BIT: 95/4 inches (245 mm) roller bit to open the top soil and over burning ; 61/2 inches (170mm)to the drilling to the bottom.

DEPTH RANGE	LITHOLOGY/OBSERVAION/DESCRIPTION	TIMEOFPENETRATION.
-4m	Dark brown topsoil	2.45.m-2.54p.m
-7m	Light brown clay soil. It contains some over burden water	3.01 p.m-3.33p.m
-10m	Highly weathered basement rich in pegmatite and mica more water is encountered here.	3.42 p.m-4.37 p.m.
10-13	Weathered and fractured basement, it is pegmatite the competent rock is reached. Drilling was stopped and the 9 5/8" (245mm) rollers bit was changed to 6 ½ (170mm) boltoried bit. Working (term porary) casings were placed to cover all the 13 metres drilled, to ease drilling and case off the over burden.	4.52p.m-5.49 p.m.
	SATURDAY 30/OCTOBER/1999	
13-16m	Highly fractured and weathered aquiferous zone	7.00am-9.00a.m
16-19m	Slightly weathered. As we area already in the fresh basement a good place to end drilling	3.15p.m-9.20p.m
7.08 a.m	**SUNDAY 31ST/OCTOBER 1999** First stage of development was done until the water is free particles.	

The working (term portray) casings were pulled out, they are being replaced with 6 ½" (170mm) VPVC casing (API standards), up to and slightly more than 13 metres is to make sure that the casing lapse very well the competent rock (hard basement). Crouting was also done around the bore hole to seal the annular of (245mm-170mm) after the depths of 1-13m metres have been gravel packed.

Gravel used are rounded silicean 10-15mm grain size.

The screen of 3mlength was placed between 10-13 metres down the bore hole.

12.00 noon development follows immediately. This was done for six hours to see that the water is clear, and free of particles.

GENERAL INFORMATION ON THE BOREHOLE LOCATION AROUND THE FEMALE HOSTEL

(A) LOCATION: Near the weather station

DATE STARTED: Friday 29th October 1999

DATE COMPLETED: Monday 1st November 1999

TOTAL DEPTH DRILLED: 20.30metres (67feet)

GEOLOGIC FORMATION: Basement

LITHOLOGIES INTERCEPTION: Laterites-Clay Sandy, clay basement.

(B) AQUIFERS: 10-13m (over burden water)

13-16m (basement water)

(C) DRILLING DIAMETERS:

(95/8") 245mm roller bit: 0-13m (based hole)

(61/2") 170mm bottomed bit: 13-20.3m (open hole)

(D) GRAVEL PACKING: 10-13 metres was gravel packed, and

0-10 Metres was grouted

(E) STATIC WATER LEVEL: 1.52 metres(5ft)

DYNAMIC WATER LEVEL: 11.68 metres (38ft)

(F) DATE HAND PUMP INSTALLED: 17 – November, 1999

PUMP TYPE: Indian Mark II Hand pump.

YIELD OF THE BORE HOLE: 0.4 litres per second (24 litresper

NO OF STROKES NEEDED RAISE WATER: 3 STROKES

DISCHARGE PER 5 STROKES: 7 litres.

Fig. 2 (a): THE BOREHOLE DESIGN FOR THE BOREHOLE LOCATED z AROUND THE FEMALE HOSTEL (NEAR THE WEATHER STATION) OF F.U.T. BOSSO CAMPUS MINNA.

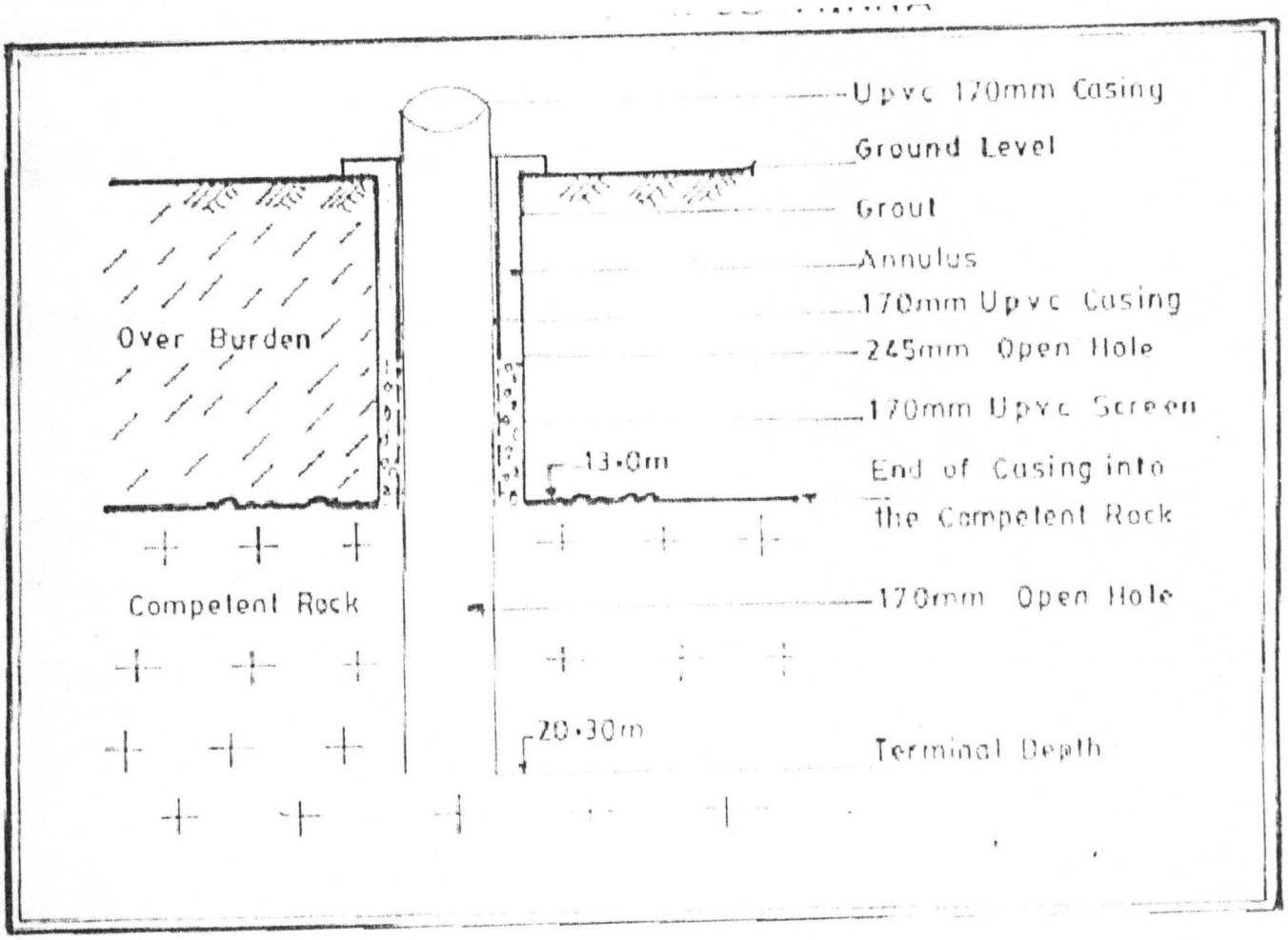
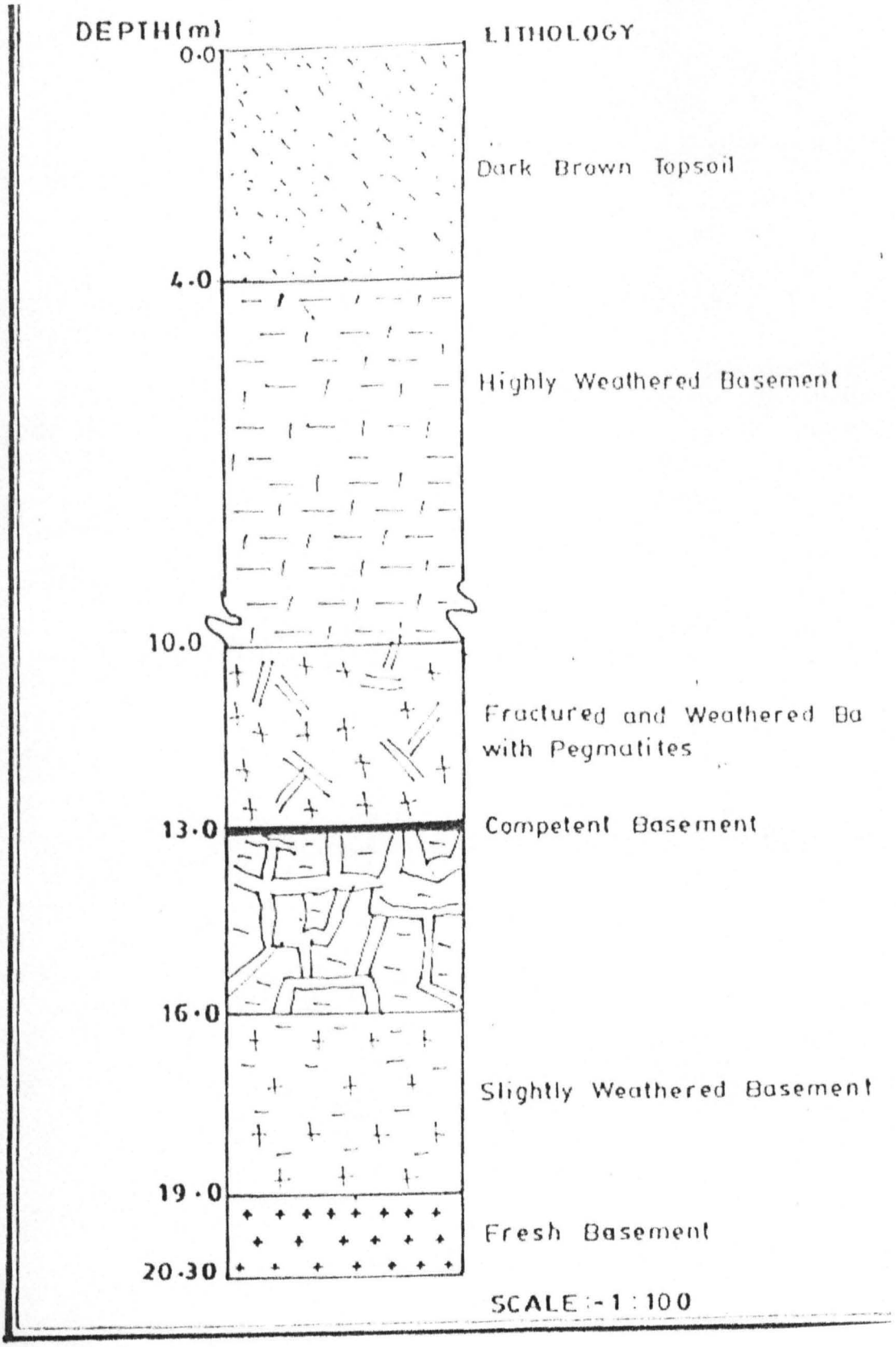


Fig 2 (b): SKETCH OF DOWN-HOLE DRILLING LOG FOR THE BOREHOLE LOCATED AROUND THE FEMALE HOSTEL (NEAR WEATHER STATION) OF F.U.T. BOSSO CAMPUS MINNA.



THE DAILY AND DESCRIPTION REPORT FOR THE BOREHOLE LOCATED AROUND THE MALE HOSTEL AREA

DATE STARTED: Wednesday, 03 November,1999

DRILLING METHOD: Air

ROCK TYPE: Basement

TYPE AND SIZE OF BIT: 9 5/8 (245mm) rollers bit to open the over burden.

6 ½" (170mm) to complete the drilling to the bottom of the bore hole

GEOLOGIST AT SITE: Alabi A. Adekola

SUPERVISOR : Jimoh M. O.

DEPTH RANGE	LITHOLGY/ OBSERVATION	TIME OF PENETATION
0-4m	Brown Lateritic top soil	12: 40pm-1:00p.m
4-7m	Sandy/clay soil with small amount of overburden water	1:31pm – 1:52p.m.
7-10m	Highly weathered pegmatitic basement, there is some water	3:00 pm-4:07pm
10-13m	Highly weathered pegmatite	4:12pm-5:50p.m.
13:16m	Highly weathered basement the competent basement has been reached; so, working casings were placed upto this depth that had been drilled. This will ease drilling. The overburden was eased off with place between 12-15m	6:02 p.m-7:15p.m.
	THURDAY, 04/NOVEMBER/1999 95/8" (245mm) rollers bit changed to 61/2" (170mm) bottomed bit	
16-19m	Fractured and weathered basement rich in pegmatite, it contains a lot of water	9:05 a.m-11:11 am
19-21.2m	Slightly weathered basement for upto 21m	11:20 am-4:30 pm

During drilling when the fresh basements is reached, there was the shearing of one of the drilling pipes. The third (3rd) pipe from the bottom of the bore hole got cut and that length of about 7m (23ft) dropping into the bore hole. It took us a month to be able to fish the cut part out.

7:21am WEDNESDAY, 05 DECEMBER, 1999

Development, first stage of it, was done for more than 4 hours. 2:02 pm. The working easings were removed and was replaced by 61/2" (170mm) UPVC casings up to the depth of 16m and forced so as to make sure it lapses well into the competent basement.

Gravel packing was done using 10-15mm grain size gravel. A depth of between 10-16m was gravel packed. Grouting follows. The top 10m was evaluately grounted.

Monday, 06 December, 1999.

Final development was done for up to 6 hours

GENERAL INFORMATION ON THE BOREHOLE LOCATED AROUND THE MALE HOSTEL AREA (NEAR THE CAFETERIA).

(A)	DATE STARTED:	Wednesday, 03 November, 1999
	DATE COMPLETED:	Monday, 6th December, 1999
	GEOLOGIC FORMATION:	21.21m (70ft)
	LITHOLOGIES INTERCEPTED:	Laterites-Sandy/Clay Basement
(B)	**AQUIFERS.**	
	7-12m	Overburden water
	16-20m	Basement water
(C)	**DRILLING DIAMETER:**	
	245mm rollers bit -	0-16m cased hole
	170mm bottoned bit -	16.21.2m Open hole

(D) **GRAVEL PACKING**

The depth between 10-16m was gravel packed

0-10m was grouted

16-21.2m was left open

(E) STATIC WATER LEVEL: 2.42m (8ft)

DYNAMIC WATER LEVEL: 12.42m (41ft)

(F) DATE HAND PUMP INSTALLED: 15 December, 1999

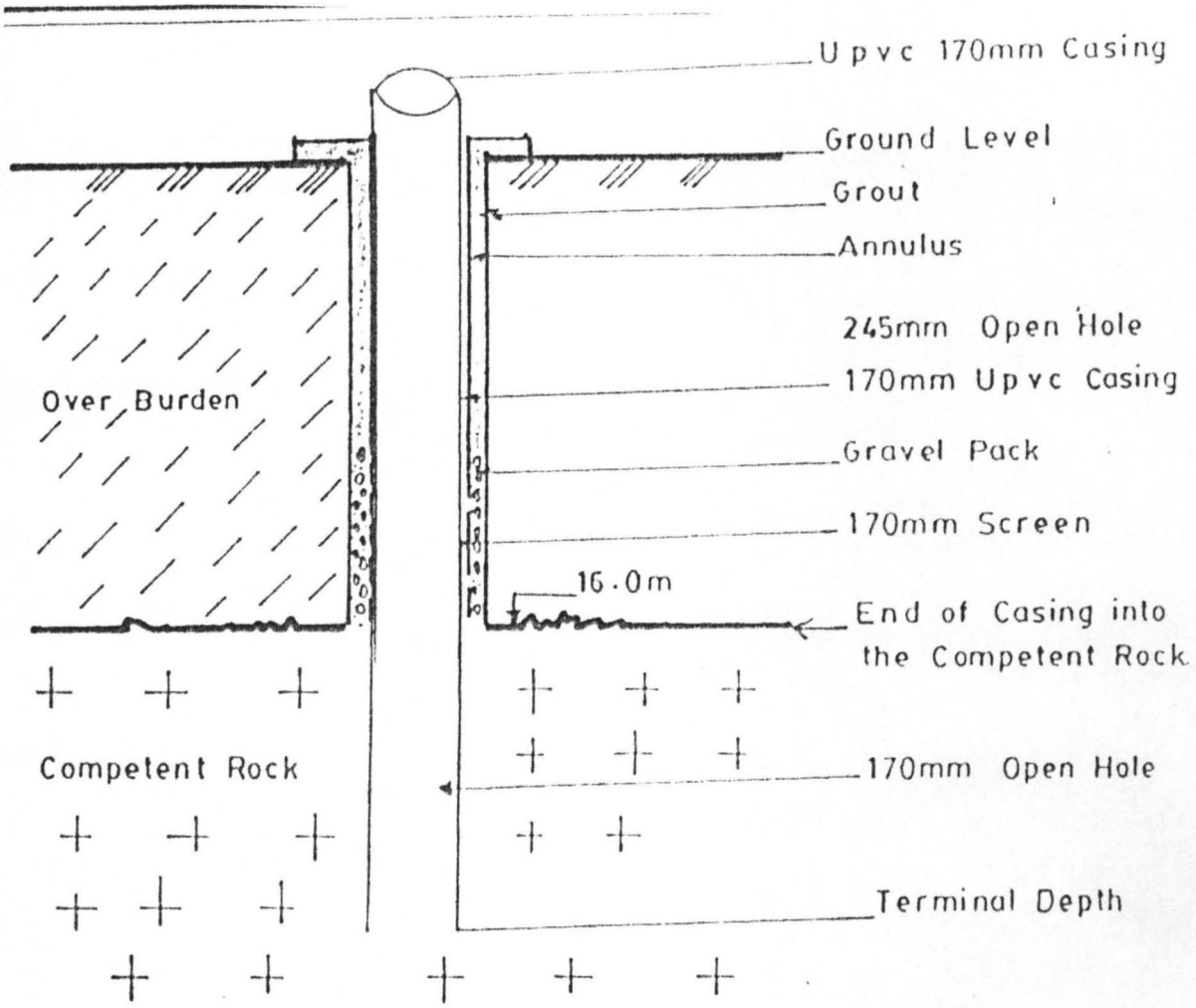
PUMP TYPE: Indian Mark-II Hand pump

YIELD OF THE BOREHOLE: 0.5 Litre per sec. (30 litres per minute)

NO OF STROKES TO RAISE WATER: 2 Strokes

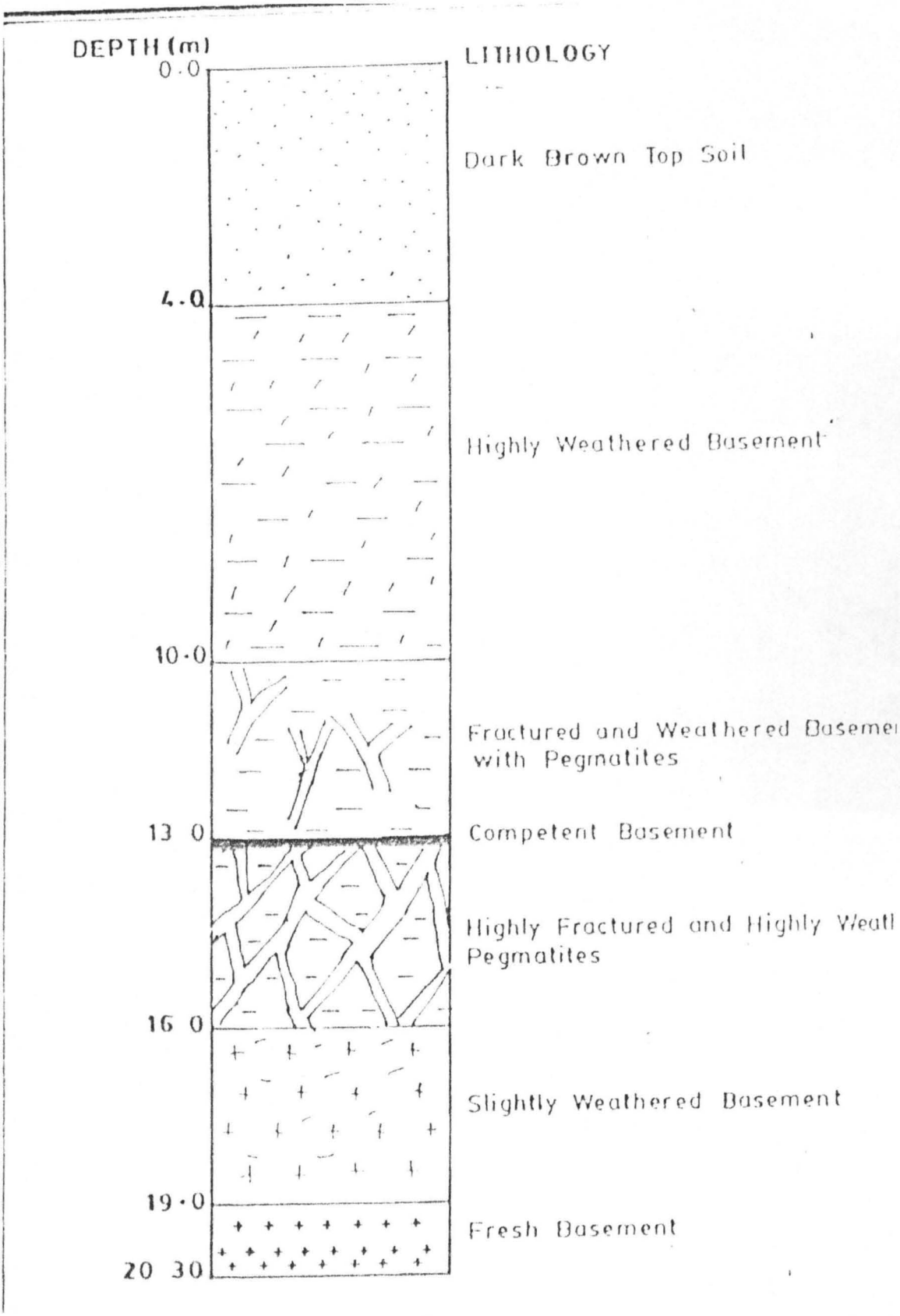
DISCHARGE PER 5 STROKES: 9 Litres.

Fig 3(a): THE BOREHOLE DESIGN FOR THE BOREHOLE LOCATED AROUND THE MALE HOSTEL AREA (NEAR THE CAFETERIA OF F.U.T. BOSSO CAMPUS MINNA.



NOTE Not Drawn to Scale

Fig. 3(b) SKETCH OF DOWN-HOLE DRILLING LOG FOR THE BOREHOLE LOCATED AROUND THE MALE HOSTEL AREA (NEAR THE CAFETRERIA) OF F.U.T. BOSSO CAMPUS MINNA.



THE DAILY AND DESCRIPTIVE LOGGING REPORT FOR THE BOREHOLE LOCATED AROUND THE STAFF QUARTERS AREA.

DATE STARTED: Wednesday, 08 December, 1999.
DRILLING MEHTOD: Air
ROCK TYPE: Basement
TYPE AND SIZE OF BIT USED: 95/8" (245mm) rollers bit to open the over burden. 61/2" (170mm) bottoned bit to completed the drilling to the bottom of the hole.
GEOLOGIST AT SITES: Alabi A. Adekola

SUPERVISOR: Jimoh M. O.

DEPTH RANGE	LITHOLOGY/OBSERVATION/DESCRIPTIONS	TIME OF PENETRATION
0-4m	Brown lateritic top soil	12:10 pm-12.30 pm
4.7m	Sand-clay soil with a lot of over burden water. It could be because it is a fadama area.	12.38pm-1:47pm
7-10m	High weathered basement with little pegmatite	1:57pm-2.40pm
10-13m	Highly weathered basement with high fractured pegmatite. The competent basement rock has been reached. Working casings were placed against the wall of the depth drilled, to avoid/reduce carving of the hole. 95/8" (245mm) rollers bit was changed to 61/2" (170mm) bottoned bit at this depth.	
13-16m	Fractured pegmatite and fractured basement. There is a lot of water here.	3.57pm-4.30pm
16-19m	Fractured and weathered basement	4.40pm-5.55pm
19-22m	Slightly weathered basement	6.00-8.10pm

Source ?? Also others.

THURSDAY, 09 DECEMBER, 1999

7.59am. Flushing was done for about 3 hours.

22-24.42m Fresh basement 11.15-4.48pm

This is a good to stop the drilling, since it is not possible to penetrate. Flushing was then done to remove cuttings and particles.

Working temporary casings were removed, and were being replaced with 61/2" (170mm) permanent casings and screen.

A depth of slightly more than 13m were cased as the 170mm casing was forced into to make sure that it lapses with the competent rock. 9 metres of blind casings and 3 metres of screen were inserted to overlap with the competent rock. The screen placed between 9-12 metres, will tap the water from over burden.

Gravel-parking was done immediately from 12m-6m; metres was properly grouted.

FRIDAY, 10 DECEMBER, 1999

Development, the final one was done for up to 6 hours to make sure that there is no particle in the borehole and the water is clear (colourless)

4.3 GENERAL INFORMATION ON THE BOREHOLE LOCATED AROUND THE STAFF QUARTERS

A.	DATE STARTED:	Wednesday, 08 December, 1999
	DATE COMPLETED:	Saturday 11 December, 19999
	DEPTH DRILLED:	24.24 metres
	GEOLOGICAL FORMATION	Basement
	LITHOLOGIES INTERCEPTION:	Laterites-sandy-clay Basement

B. AQUIFERS 7-12m Over burden water

12-16m Basement water

C DRILLING DIAMETERS: 245mm rollers bit = 0.16m cased hole.

D GRAVEL PACKING: the depth between 7 and 16 metres was gravel-packed

The depth of 0 to 7m was grouted

The depth of 16-24.24m was left open.

E STATIC WATER LEVEL: 1.82M (6FT)

DYNAMIC WATER LEVEL: 9.35M (30.86FT)

F DATE HANDPUMP INSTALLED: 18 DECEBER, 1999

PUMP TYPE: Indian mark II hand pump

YIELD OF THE BOREHOLE: 0.6 litres per sec (36 litres per minute)

NO. OF STROKES TO RAISE WATER: 2 strokes

DISCHARGE PER 5 STROKES: 11 5litres

FIG.4(a): THE BOREHOLE DESIGN FOR THE BOREHOLE LOCATED AROUND THE STAFF QUARTERS AREA OF F.U.T BOSSO CAMPUS MINNA

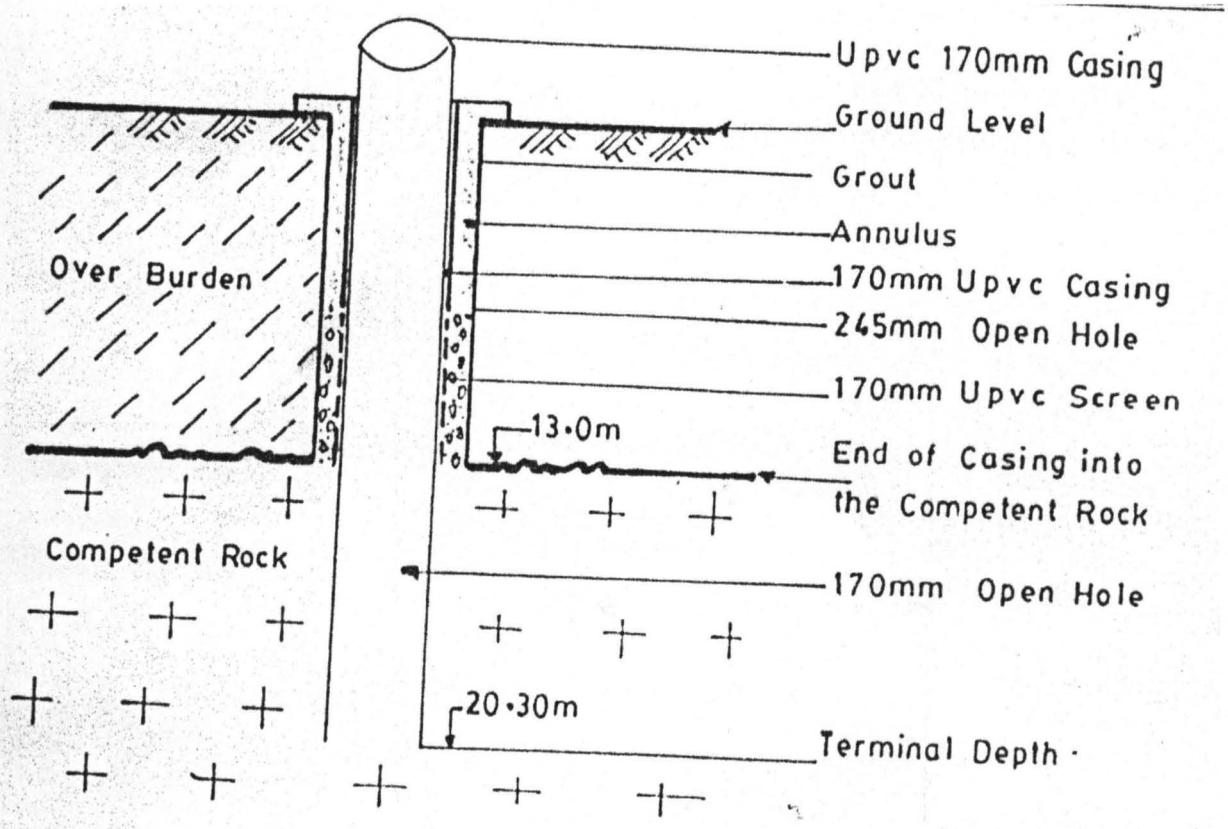
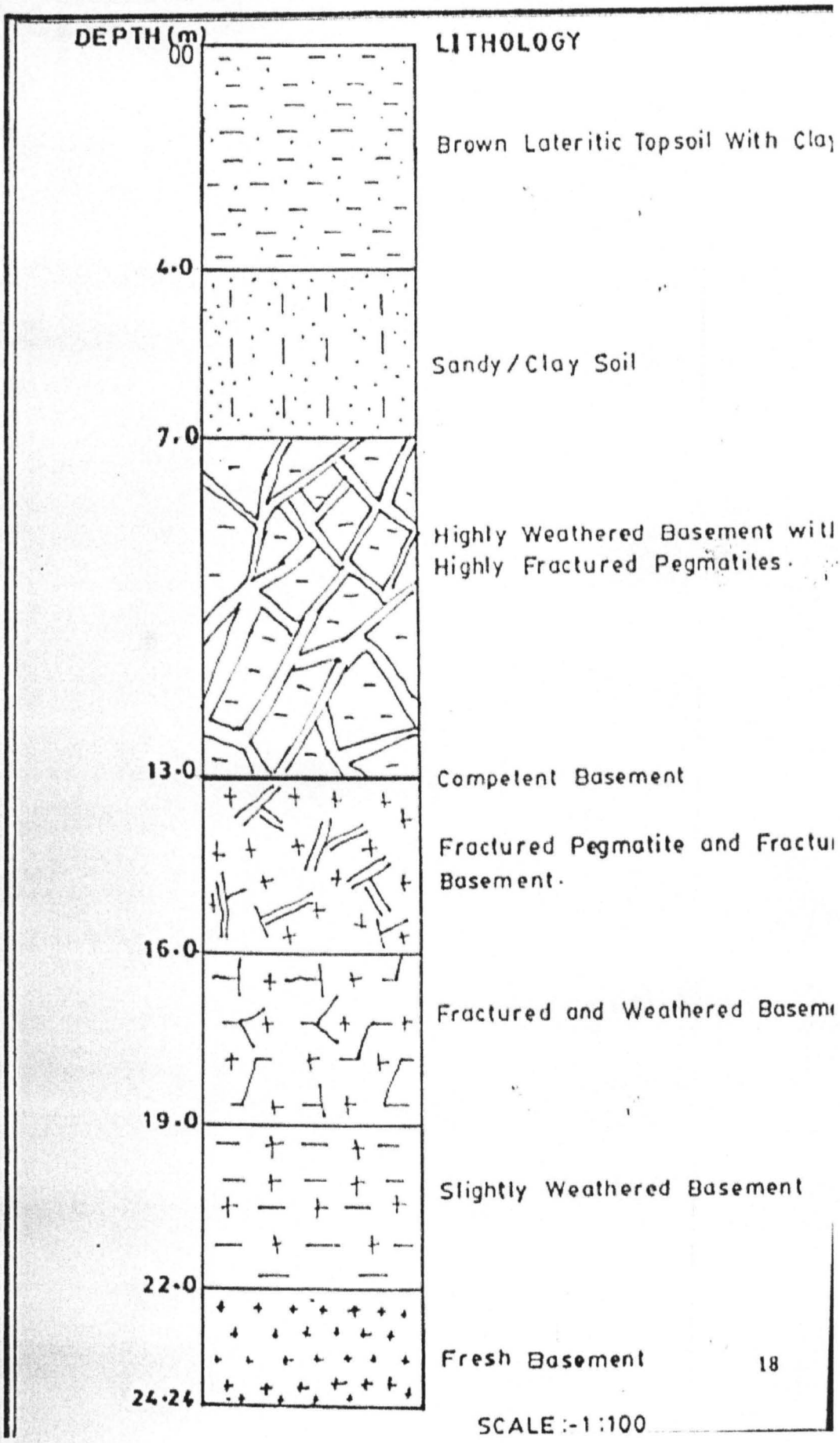


Fig. 4(b): **SKECH OF DOWN-HOLE DRILLING LOG FOR THE BOREHOLE LOCATED AROUND THE STAFF QUARTERS AREA OF F.U.T. MINNA**



THE DAILY AND DESCRIPTIVE REPORT FOR THE BOREHOLE LOCATED AROUND THE CONVOCATION SQUARE.

DATE STARTED: Thursday, 16 December, 1999

DRILLING METHOD: Air

ROCK TYPE: Basement

TYPE AND SIZE OFBIT:95/8" (245mm) rollers bit to open the Over burden 61/2" (170mm) to complete the drilling to the bottom of the borehole.

GEOLOGIST AT SITE: Alabi A. Adekola

SUPERVISOR: Jimoh M.O.

DEPTH RANGE	LITHOLOGY/OBSERVATION/DESCRPTION	TIME OF PENETRATION
0-4m	Brownish sandy/clay soil	11:50-12.05pm
4-7m	Light brown clay soil, highly weathered basement.	12.12pm-12:43pm
4-710m	Highly weathered basement. Working (temporary) casings were placed against the wall up to the depth drilled, this will prevent casing of the borehole. The 207mm rollers bit was then changed into 170mm bottoned bits. Then drilled continues.	12.59pm-1.56am
10-13m	Fractured basement with some pegmatites, these is some water.	3.01pm –4.14pm
13-16m	Highly fractured pegnatite this is the main aquiferous zone.	4:12pm-5.59pm
16-19m	Weathered pegmatites and weathered basement.	10-25am-2.32pm
19-22m	Slightly weathered basement	2.41pm-6.15pm

	SATURDAY, 18 DECEMBER, 1999	
22-23.33m	Fresh basement. A very hard zone, the bammer is just bouncing on this fresh rock. A very good place to stop drilling.	7.30am-2.05pm
3.13pm 7:15 am	Flushing was again done for one hour Casings were run down the bore hole to make sure that it overlaps with the competent basement. One length of screen was placed between the length of 7-10m This will tap the overburden water and the blind casings were placed between the depth of 0-7m, to seal off are water from clay. Grouting was done from the depth of 0-5m. The depth of 5m to slightly more than 10m was gravel-packed. End of today's work 6:56pm **SUNDAY, 19 DECEMBER, 1999** Development was done for about 6 hours, until the water was clear and free of particles.	

GENERAL INFORMATION ON THE BORE HOLE LOCATED AROUND CONVOCATION SQUARE AREA.

(A) DATE STARTED: 16 December, 1999

DATE COMPLETED: 19 December, 1999

TOTAL DEPTH DRILLED: 23-33meters (77ft)

GEOLOGICAL INFORMATION: Basement

LITHOLOGIES INTERCEPTED: Sand/clay-clay soil Basement

(B) AQUIFERS: 7-10m = Over burden water

10-16m = Basement water

(C) DRILLING DIAMETER: 245mm rollers bit = 0-10m cased hole

170mm bottoned bit = 16-23.33 open hole

(D) GRAVEL PACKING: The depth between 0-5m was grouted.
The depth of 5-10m was gravel-packed.
The depth of 10-23.33m was left open.

(E) STATIC WATER LEVEL: 2.12m (7ft)

DYNAMIC WATER LEVEL: 14.85m (49ft)

(F) DATE PUMP INSTALLED: 20 December, 1999

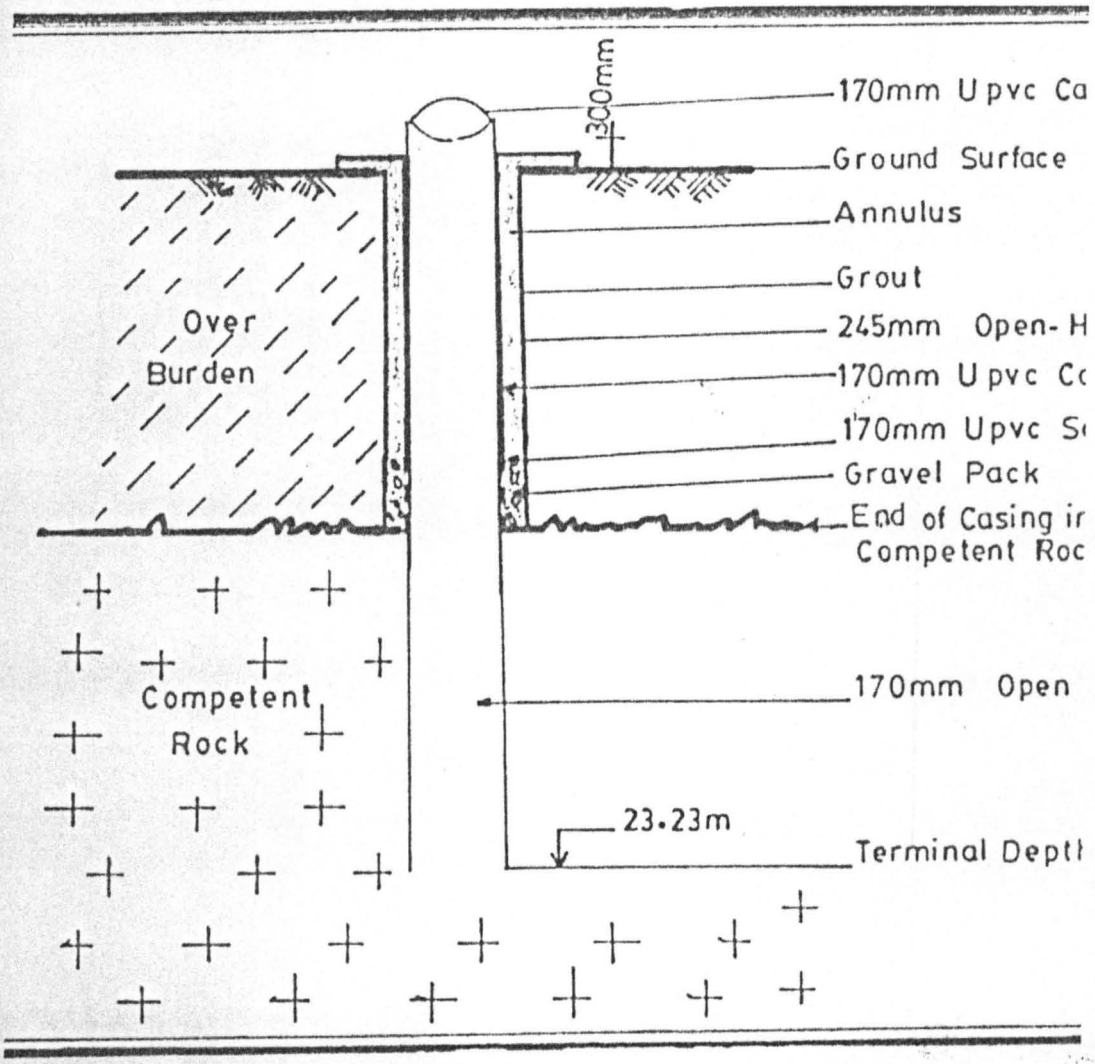
PUMP TYPE: India Mark II Hand Pump

YIELD OF THE BORE HOLE: 0.48 Litres per sec. (29L/min)

NO. OF STROKES TO RAISE WATER: 4 Strokes

DISCHARGE PER 5 STROKES: 7 Litres.

Fig. 5(a): THE BOREHOLE DESIGN FOR THE BOREHOLE LOCATED AROUND THE CONVOCATION SQUARE AREA OF F.U.T. BOSSO CAMPUS MINNA.



NOTE : Not Drawn to Scale.

Fig. 5(b) **SKETCH OF DOWN-HOLE DRILLING LOG FOR THE BOREHOLE LOCATED AROUND THE CONVOCATION SQUARE AREA OF F.U.T. BOSSOCAMPUS MINNA.**