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QUANTITATIVE AND QUALITATIVE ASSESSMENT OF BIWATER BORE HOLES AT BARO, ETSUGAIE, AND KUTIRIKO IN AGAIE LOCAL GOVERNMENT: NIGER STATE.

BY

KASSIM N. YAWA
REG.No. PGD/AGRIC/17/97-98

DEPARTMENT OF AGRICULTURAL ENGINEERING FEDERAL UNIVERSITY OF TECHNOLOGY MINNA.

DECEMBER, 1999.

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DEPARTMENT OF AGRICULTURAL ENGINEERING.

SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY,

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA.

PROJECT SUBMITTED TO

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CERTIFICATION

This project has been read and approved to have met the requirements governing the award of post-Graduate Diploma in Agricultural Engineering of the Federal University of Technology, Minna by the under signed.

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Engr. Ayodeji Olufemi Samson Date
Project Supervisor

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Dr. M.G Yisa Date
H.O.D Agric Engineering

ABSTRACT

Assessment of the Biwater bore hole schemes in Baro, Etsugaie and kutikiri was carried out to determine the success of the schemes and their present conditions.

Preliminary study was carried out through visits to various sites, desk study of geological and hydrogeological maps and structured questionnaires. Laboratory tests were then carried out. Results obtained were analysed and discussed .

Baro has four bore-holes, two drilled at Etsugaie and two at Kutiriko. The yields obtained from the bore-holes were adequate and efficient. The total daily water abstractions from these bore-holes exceeded the daily water demand of the communities initially. However, the situation changed after as a result of inadequate funding, vandalisation and low community participation. Thus, the supply could not meet the demand again.

The results obtained from the water quality tests carried out conformed with world Health organisation, international standard for drinking water. Hence the bore-holes could be described as portable.

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DEDICATION

This work is dedicated to my late father, Alh. Mohammed Yewa, my mother Madam Khadijat Yewa (Nna), wives Rakiya and Aisha, children, Mohammed, Abubakar, Abdulrahman, Yewa jnr. and Ahmed Shehu.

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CHAPTER ONE

1.0 INTRODUCTION

As the population of man increases on earth, the availability of portable water supply will no doubt, continue to occupy a place on the top of the agenda for ensuring high standards of living. Partly because fresh water is only 0.01% of all water available on earth and also because this amount is not equatable distributed across space even over small areas, meeting human needs is sometimes a very dauting task. This often necessitates huge investments in water supply schemes to meet needs in centre of human concentration - a long -term policy of all governments.

In Nigeria, like in many developing countries, over 80 percentage of her population live in rural areas with farming as their main pre-occupation. Main water supply sources in rural areas are the springs, streams, rivers and hand dug wells. These water sources are most often contaminated as a result of the application of pesticides and chemical fertilizer on the farms, faecal contamination as a result of indecent excretion habits, washing of farm produce such as melon in the body of rivers and streams. For the above stated reasons, provision of portable water supply in rural areas has been a mirage.

1.1 GOVERNMENTAL EFFORTS

Over the years, collective efforts have been made at both the Federal and state levels and of recent, the local Government levels nation-wide to provide portable water for rural communities who constitute the majority of the population. These collective efforts have involved different bodies and agencies at various times of our national development. Such bodies or agencies include.

(a) The Directorate of Food, Roads and rural infrastructures (DFRRI).

(b) State water Boards/Agencies.

(c) The Petroleum (special) Trust Fund- National water supply project. (PTF)

In 1987, a decree was promulgated by the Federal Military Government establishing the Directorate of Food, Roads and Rural infrustructures (DFRRI) at both Federal and state levels. It was charged among other things.

(a) To mobilise the rural communities for the development of rural areas in Nigeria. It was charged with diverse functions directed towards the improvements and development of quality of life in rural areas. The functions include the provision of roads, basic infrastructures and increased food and industrial raw materials output, the stimulation of agricultural activity and any other activities that will facilitate an improved quality of life in the rural areas.

(b) To formulate and support a national rural water supply programme with emphasis on full initial involvement of local communities and local government personnel to ensure sustained maintenance of built infrustructures.

In line with the above objectives, the DFFRI in Niger state was in the first phase of its bore hole construction, mandated to provide 200 bore holes for the various communities all over state, and the same number in the second phase. In the third phase, it was mandated to construct 500 bore holes, however, this could not be realized because of its disbandment. A new body in its place is now referred to as Niger state Directorate for Rural Development.

Biwater working in conjunction with Niger state water and sanitation board (N.S.W.& S.B) was in 1989 awarded a water supply contract by the Niger state government to cover the construction of 49 schemes, each consisting of either a river intake or bore holes with rising mains, treatment plant and reticulation to provide clean drinking water to 146 separate towns and villages including the three (3) major towns of Bida, Minna and Kontagora. The contract which was targeted for completion by October 1991, also included about 200 bore holes and over 122 km of rising main and aimed at proving portable water to an estimated 1.2 million people.

In Biwater project, not only the volume of water a bore hole is capable of supplying was of primary concern, but also the chemical quality of the water. Hence these tests were carried out by the company on each bore hole and some of the results (data) made available by Niger State water and sanitation Board.

The Petroleum (special) Trust Fund (PTF) National Rural water supply project is intended to make portable water available to as many rural communities as possible through utilization of ground water resources in the country. The project which is envisaged to entail drilling and rehabilitation of new and existing bore holes respectively, and the construction of open wells, is to cover thirty six states of the Federation. The project is intended to among other things, achieve the following objectives.

(a) To make portable water available to as many rural settlement as possible through utilization of ground water resources.

(b) To acquire relevant hydrological information with a view to creating a national ground water data bank in order to guide future national water development policies and or programmes.

In Niger state like in all other states of the Federation, the project is expected to cover only rural local Government Areas where hydro- geological conditions are favorable for ground water utilization to meet portable water requirements of selected rural communities. Hence for each of the beneficiary local Governments (Appendix I), the project shall involve the following:

(a) Construction of ten (10) new open wells.

(b) Drilling of five (5) new bore holes fitted with land pumps or two (2) bore holes fitted with submergible pumps depending on local geological conditions.

(c) Rehabilitation of five (5) bore holes with hand pumps or two (2) motorised bore holes.

Generally, fourteen to twenty (14-20) rural communities in each of the beneficiary local Government areas are expected to benefit from the project, and in Niger state, of the twenty five (25) local Government areas, only twenty three (23) being considered rural are expected to be covered by the project as shown in appendix I.

Finally, the Federal Government recently (January 1998) through the Federal Ministry of water Resources, announced its intention to increase the scope of national rural water supply schemes from 30 to 50 percent coverage.

1.2 DESCRIPTION OF THE STUDY AREAS.

1.2.1 LOCATION AND GEOLOGY

Etsuagaie and Kutiriko are situated 95km and 85km respectively by road to the South of Minna. It is reached Via 20km and 10km unsealed track from Takuti on the Paikoro - Lapai road.

The areas are both under lain by the cretaceous Nupe sand stone series, which is made up of finely laminated sands stones and silt stones with isolated rounded quartz pebbles. The lithic particles are bounded in a metric of clay. Occasional pockets of lensoidal and ribbon like gravel unit occurs which are thought to represent paleo river beds and levee deposits. There are no well defined regional aquifers and the sand stone is highly variable both laterally and vertically.

Baro also has the same geological formations like the other two villages under study. Only that the village is situated 82km by road to the south east of Bida. And it is reached Via 45km of unsealed track from Badeggi on the Bida - Lapai road. And the village is adjacent to the flood plain of the River Niger and the recent alluvium which is more pronounced in the vanity of wadata village which also represents a potential aquifer.

1.3 OBJECTIVE OF THE STUDY

The main objective is to make the quantitative and qualitative assessment of the bore holes drilled by the Biwater-shellabear in the study areas for the Niger state water and sanitation Board, with the followings.

(a) To determine the yields of the bore in relation to the targeted populations of the village areas.

(b) Assess the performances of the bore holes.

(c) Find out reasons why some have failed (if any)

(d) Assess the chemical analysis carried out the company and establish, if the various data provided fall within the specified international limits for portable water set up by the World Health Organizations (WHO).

(e) Make recommendation's where necessary in order to meet the said objectives.

1.4 JUSTIFICATION OF THE STUDY

Etsu Agaie, Kutiriko and Baro are fast growing villages in Agaie local Government Area, in both population and size, and as such there is invariably, increase (greater) need for the available water sources to meet up with wholesome water supply quality need for both domestic and municipal uses.

Etsu Agaie and Kutiriko villages have no identified source of surface water supply. They depends solely on ground - water sources such as wells and bore holes, of which 70% of the water needs of the inhabitants is from the raw Biwater bore holes water supply scheme of the Niger State water and sanitation Board.

In natural waters, the inorganic pollutants level continue to rise due mainly to increasing discharge of Agro-chemicals in Agriculture. The ultimate results of this pollution include harm to human and animals lives. Presence of pathogenic bacteria and viruses in water sources have given rise to such water borne diseases as cholera, dysentery, typhoid etc, which have claimed thousands of human lives in different parts of the world and leading to huge expenses in health sector for their cure and possible eradication.

Hence, water is one of the man's precious and indispensable resources on which virtually all human activities depend. Thus, environmental pollution of water is serious. It is therefore, one of the main objectives of the water industry to ensure that ample supply of water in appropriate quantity and quality is met to the growing demand of the people at all time.

CHAPTER TWO

2.0 LITERATURE REVIEW.

2.1 GENERAL REVIEW.

Not quite long ago, some researchers made some attempts to investigate the hydro- geological setting of the Bida Basin and to ascertain the causes of bore hole failures in the Bida sand stone formation within which the study area falls. Shekwolo (1983), using methods of electro-resistivity measurement, screen analysis and slot size analysis of wells and the gravel materials used in the completion of wells, described the Bida sand stone formation as consisting essentially of weakly cemented Siltshones. It covers three quaters of the entire middle Niger Basin.

The Bore hole strata logs, electro-resistivity measurement and transmissivity values have shown that two main types of aquifers exist in the region. These have been named TYPE1 and TYPE2 aquifers on the basis of their productivity. (P.D shekwol, water resouces journal vol.1,No.1, December 1990). The one that is more prolific and which is termed TYPE1 consists of medium to coarse grained sand and the second called TYPE2 is composed of medium to fine grained sand and often intercalated with clay and or silt clay admixture. Both are usually found semi- confirmed between the thick layers of clay and or silt clay admixture and occur at varying depths.

Previous studies were mainly on the general stratigraphy, geomorphology, petrology and economic geology of the southern extremes of the basin. Adeleye (1971,1973) worked on the sedimentology and stratigraphy of the basin with emphasis on the areas around Bida. It was said that the precambrian basement complex is directly overlain by basal sediments of alluvial fan origin, sand stone, subsidiary clay stone, fine conglomerates and silt stones. Both these beds and underlying ones are about 3.5 km thick (Ademiyi,19840). They are known by various local names; Bida sand stone around Bida and Lokoja basal sand stone around the Niger /Benue confluence.

Reyment (1965) speculated final evidence on the possibility of connection between the tethys and the south Atlantic via the Bida Basin during the maestrichian time. He however admitted that the marine sediments in both seas were separated by a wide area about which little was known (Reyment, Adeleye, and Dessarragie.1972).

Adeleye (1973, 1975), Adegoke (1969) and Kogbe (1976) have all argued in favour of the maestrichian connection of two seas via Bida Basin.

Some workers have also written brief reports on the ground water geology of Bida sand stone. They include Jone (1953) and maxlock ground Nigeria Ltd (1979). Jones (1953) also made some brief notes on the water supply for Bida town.

2.2 AQUIFERS

Ground water occurs in many types of geological formations. Those known as AQUIFERS are of most importance. An aquifer may be defined as a formation that contains sufficient suturated permeable material to yield significant quantities of water to wells and springs. (D.K todd,1980). And this implies that it has an ability to store water and transmit it. Unconsolidated sands and gravel are a typical example.

2.1.1 TYPES OF AQUIFERS

(a) CONFINE AQUIFER :

A confined aquifer is one in which the water rises to a higher level in the bore hole than in the surrounding rock as shown in (bore n°1 in fig.1). This occurs where the aquifer is confined at the top by an overlying unpermeable layer and the level to which the water rises in the bore hole is known as the PIEZOMETRIC LEVEL. In such an aquifer the water pressure is higher than atmospheric pressure. Water pressure can be so great that water flows out of the bore hole opening and this phenomenon is called an ARTESIAL well (shown in bore n°2 in fig.1).

Replenishment or recharge of the water in a confined aquifer can be far away from the location of the well by infiltration in a recharge area.

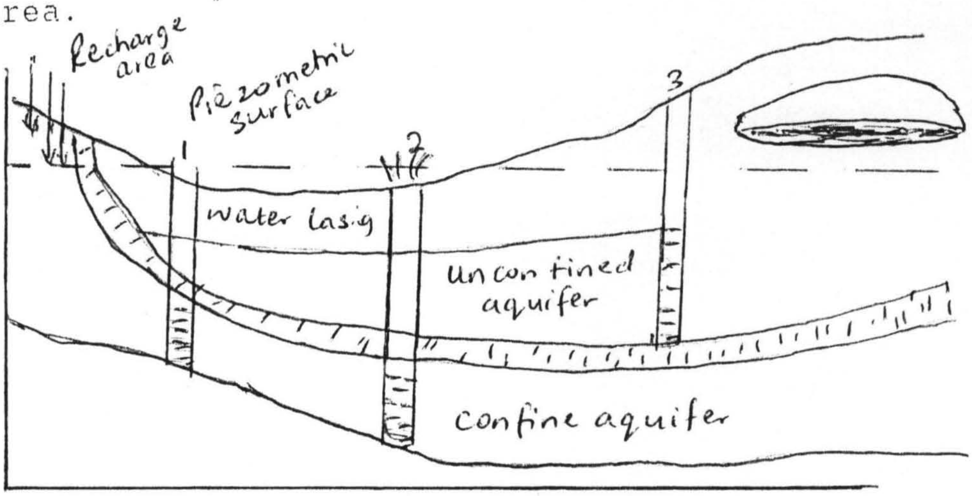


Fig.1 Different types of aquifer

(b) **Unconfined aquifer:**

If a bore hole is drilled in an unconfined aquifer, the water does not rise above the level where it struck (bore n^{0}3 in fig.1). The water in which an aquifer is at atmospheric pressure, just like an open reservoir. The upper limit of the aquifer is formed by the water table, the shape and slope of which depend on local recharge/ discharge area and permeability.

Perched water tables can occur when infiltrating water is stored on the top of impermeable layers of relatively smaller area such as clay lenses (fig.1). They can be easily mistaken for the water table of main aquifer which lies deeper. The chances are that the well in such a perched water body will quickly run dry since the storage capacity is only small and recharge can only place in the rainy season by local infiltration.

2.2.2 CHARACTERISTICS OF AQUIFERS

The aquifer material must contain interconnected space or pores; filled with water, and the openings between these pores must be large enough to permit water to move towards wells at a sufficiently high rate. The water yield characteristics of aquifers which largely determined by the grain size of the soil are described below and some representative values are listed in (Table 1.1).

2.2.3 POROSITY AND SPECIFIC YIELD

If a rock or soil contains many pores, it is described as a formation of high posity. This means that per unit of volume, a large amount of water can be stored in such an aquifer. Porosity is defined as the percentage of the total volume which is occupied by the pores. Example: Total volume of soil= 1 litre; volume of pores= 0.3 litre; Porosity= 30%.

The water in the pores, however, is not always easy to remove by pumping. Some of it is very tightly connected to the soil particles by molecular forces. For example, clay has a very high porosity, but if saturated clay is placed on a sieve, hardly any water will drain out. Sand gravel, on the other hand, easily release the stored water. They have a high ``Specific yield'' and are therefore of more interest for the construction of wells. The specific yield of a soil is defined as the ratio of the volume of water that, after saturation, can be drained by gravity to the original volume of the saturated soil and is usually expressed as a percentage. Fig.2 shows that with increasing size of the soil particles, the value of the specific yield approaches that of the porosity because the influence of the molecular forces is reduced.

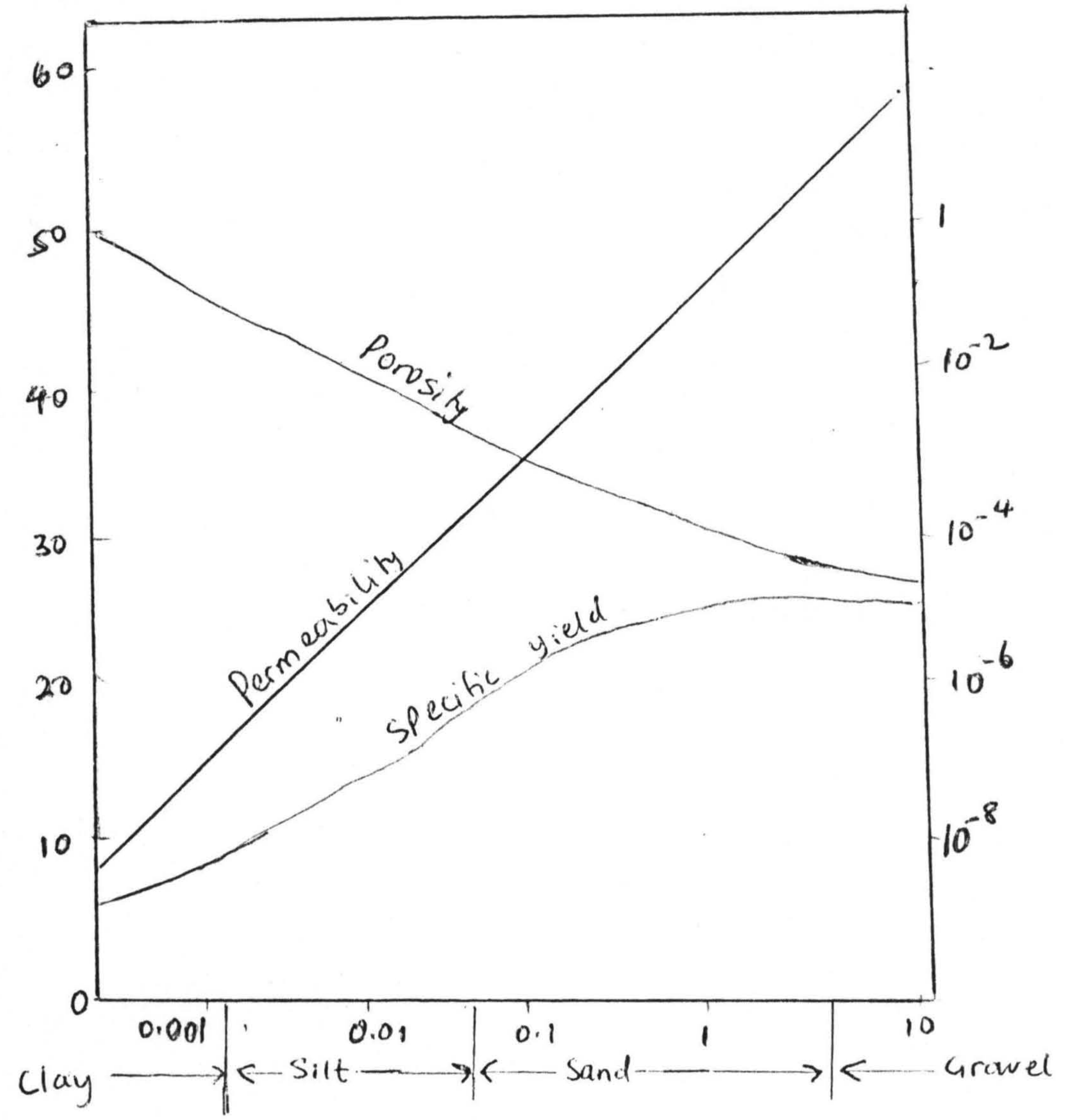


Fig.2 Showing porosity, permeability and specific yield as a function of grain size

Table 2.1 Characteristics of some unconsolidated sediment

Type of sediment	Gradat.	Grain size	Porosity (%)	Specific yield (%)	Permeability cm/sec.
Clay		(µm) <2	45-55	3.5	10^{-8}-10^{-6} (very low)
Silt		2-50	40-50	5-10	10^{-6}-10^{3} (low)
Sand			30-40	10-30	10^{-3}-1 moderate
	Fine	50-250			
	Medium	250-500			
	Coarse	500-2000			
Gravel		> 2000	25-35	20-30	1-100 very high

Source: Blankwaardt B: (1984) Hand drilled wells.

2.4.4 Storage Coefficient

The storage coefficient is defined as the volume of water released from or taken into storage, per unit surface areas of the aquifer per unit change in the water level. In unconfined aquifers, the storage coefficient is equal to the specific yield.

2.2.5 Permeability

Permeability is a measure of the capability of an aquifer to conduct water. If the convection between the pores are larged, the water can flow easily and the permeability is high. It has a dimension of a velocity and is usually expressed in M/day or cm/sec. When the pores are not interconnected, water can not pass through and the rock or soil is described as "impermeable".

Some hard rocks can have a high permeability, despite the impermeability of the rock materials itself. This is caused by faults and fractures in the rock through which the water can flow and is called "secondary permeability". However, such aquifers are of no interest for the construction of hand drilled wells.

2.3 WELL DESIGN IN GENERAL

Designing a well involves selecting the proper dimension factors for the for the structure, and choosing the materials to be used in its constructions. Forth with a good design aim to ensure an optimum combination of performance, long service life and reasonable cost.

Basically, there are principles that are however being applied to both wells in unconsolidated and consolidated rock formation.

Generally, the principal factors in both consolidated and unconsolidated rock formation well design, is that the cost and technical factors must be property analysed, if this factor is not taken in to consideration, it may saddles the owner with higher pumping and maintenance costs as well as reduced the usefulness of the well.

For the design of municipal, industrial and Irrigation wells, they must be designed in such a way as to obtained the highest yield available from the aquifer, and the highest efficiency in term of specific capacity. Another important cost factor in these types of installations is the economic loss that may result from interruption of service in large water supply development. Good design minimises this danger by building in to the well the factors that will assure long and trouble free life.

A good borehole design depends to a greater extend on accurate formation identification. The techniques used for formation identification are basically of three different kinds.

(a) Observation of the drilling process, rotary air or mud flush and Down - the - hole- Hammer (DHH).

(b) Collection, inspection and analysis of formation samples.

(c) Geophysical logging.

2.3.1 BOREHOLE DESIGN CRITERIA

(1) Aquifer types:-	Hard rock, Soft rock
(2) Purpose :-	Yield limits for the well.
(3) Pump chamber casing	- Depth
	- Diameter
	- Material to be used
(4) Screen Section	- Diameter of the screen
	- Length
	- Blank sections
	- Filter materials
	- Corrosion
	- Encrustation
	- Material

(5) Pump choice

(6) Economics . - Aimed at producing at the lowest possible cost.

2.3.2 CAUSES OF DECREASE IN BORE-HOLE CAPACITY

In most cases, the cause of decrease in well capacity is a dogging of the opening in the well screen. This phenomenon is called INCRUSTATION. It results from deposits or accumulation of extraneous materials in the openings of pores water-bearing sand and screen. The three main types:- Chemical, Physical Biological and combination of all the three.

(a) Chemical Incrustation:- is the deposition of carbonates, oxides, hydroxide and sulphate on or within the intake structure of the well. This causes declines in well capacity exponentially with increase in velocity.

(b) Physical:- refers to particles phyging of the well. This occurs when fine sand, silt and clay slowly migrate toward well.

(c) Biological:- When there is bacteria growths, in aquifer adjacent to well in screen opening or in well bore. The rate of bacteria growth is exponential with abundance of nutrients. So also contamination during drilling. This involves introduction of bacteria from the surface into the bore hole.

Other causes might include, pump wear, poor construction technique, general drop in the water table, interference from the new bore holes drilled within the vicinity etc.

2.4 IMPURITIES IN WATER

Drinkable or portable water (water certified fit for human consumption) has since time immemorial stood out clearly as a definition of water quality. Many natural waters are portable with out the necessity of purification by men. However, the fact of portability does not make this water suitable for the requirement of science, medicine and industry. Impurities in water (raw water) may be classified in to the following groups.

2.4.1 DISSOLVED SUBSTANCES.

The could be inorganic salts or organic matter. The inorganic salts could result from leaching of minerals, fertilizer run-off (mostly phosphates, nitrates and sulphates), domestic wastes and industrial matter, decay products and residual discharges of all kinds. The dissolved organic matter could result from decay of vegetable and animal matter, domestic wastes, general biological debris, decay products and residuals of pesticides and herbicides etc.

2.4.2 LIVING MATTER

These are micro-organisms such a Algae, viruses, bacterial etc. They occur in all natural waters. While large life forms include fish, worms, insect larva, water lie etc.

2.4.3 DISSOLVED GASES

Dissolved gases such as O_2, CO_2, oxides of nitrogen etc can occur in all natural waters. Some underground water sources contain high CO_2, a few contain H_2S, NH_3, from biological decay or from industrial discharges.

2.4.4 SUSPENDED PARTICLES

These could be colloids of organic and in organic origin, e.g natural organic macro molecules, clay and oxides of iron and manganese. Suspended in'organic includes sand, mining wastes etc. while suspend organic could be plants and animals particles.

Also application of pesticides, herbicides and fertilizers are key agricultural activities that affect the quality of ground water and surface water. e.g. Nitrogen in the form of nitrate is a contaminant found in ground water supply underlying agricultural areas.

Likewise, the presence of livestock on water sheds and over aquifers has an obvious and direct effect on bacterial contamination. Feed lots have been found to contribute nitrates to wells and faecal coliform bacteria to surface water supplies and hence, the ground water supply, depending on the infiltration rate in the saturated zone.

Other typical sources includes industrial waste water in pounded, sanitary land fills, storage piles, absorption fields following house hold septic tanks etc.

CHAPTER THREE

3.0 MATERIALS AND METHODOLOGY

In order to obtain fair assessment of water quantitatively and qualitatively from the three selected locations, three methods were designed and adopted to facilitate easy collection and collation of the data for analysis.

3.1 FIELD VISIT

Intermittent visits were paid to each of the locations - Baro, Etsugaie and Kutiriko with the aim of having physical assessment of both the bore-holes and pump. The current status of the sites were also determined. At the same time maps and drawing were obtained during the visits.

Frequent interactions between the researcher and officials of the Niger state water Board was established with the sole aim of retrieving vital information and on both the quantity and quality of the water from there locations. Some of these data were obtained from the library and field operation offices.

3.2 QUESTIONNAIRE TECHNIQUE

Two different types of questionaires were designed to obtain information and data from the managers and operators of the bore holes sites. Likewise local inhabitants were interviewed to collect more information to compliment the earlier data obtained from various sources. (see appendix II)

3.3 LABORATORY TECHNIQUE

Samples of bore- hole water from the three locations were collected and sent to the quality control laboratory of the Niger State water Board for analysis. The chemist was mandated to conduct analysis on the samples to determine the chemical constituents of the followings.

(a) Electrical conductivity

(b) PH

(c) Turbidity

(d) Colour

(e) Total Iron (Fe)

(f) Total alkalinity $CaCO_3$ mg/l.

(g) Total hardness

(h) Magnesium hardness

(i) Nitrate Nitrogen

(j) Total manganese

(k) Chloride

(l) Sulphate

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

The information and data obtained from fields, offices and through interactions are hereby presented for analysis. For the purpose of this project each of the locations would be treated under its own heading.

4.1 RESULTS

4.1.1 BARO

Baro is about 48km away south of Agaie town with an estimated population of about 1945. Geophysical survey was carried out by the Biwater shellabear company at Baro, principally to determine the depth to any shallow aquifer and its lateral variation.

Design and constructions were carried out by the company. Four production wells were constructed at Baro namely 11A,13A,17A and 18B. The exercise started in september 1990 and finished in March 1991.

The production wells were developed by swabbing, jetting and back-washing for a periods of up to fourty-eight hours during the exercise.

With reference to the well log and lithological tables in Appendix III, the drilling at Baro penetrated a sequence of clay and fine to medium grained, weakly cemented sandstone. This comprised mainly clay and clayed sand above 20m. Below 20m, clayed sand grading to sand stone were encountered. The major water ingress occured above 20m in all the bore-holes.

The depths of the drilled wells were shown in the Table 4.1.1.1.

Table 4.1.1.1. The Depth of the Boreholes.

Bore-hole No.	Depth (m)
11A	32
13A	36
17A	21
18B	14.5

The total daily water abstraction at the beginning of the project operation in 1991 was 380.16 cubic waters.

Table 4.1.1.2 is showing the total daily water abstraction 1990).

Table 4.1.1.2 Total daily water abstractions (1990)

Bore-hole No.	Pump Rate L/S	Daily Pumping Period (hrs)	Total daily Abstraction (cubic meters)
11A	1.5	24	129.60
13A	0.5	24	43.20
17A	0.6	24	51.84
18B	1.8	24	155.52

Grund fos sp8a-25 pump model of 5HP were selected to meet the bore hole yield at the calculated maximum pumping head.

As at the time of compiling the data at the field, all the bore holes were functioning. However the operation period had been reduced to six hours instead of 24 twenty four (24) hours. The contributory running cost from the local government to the state water board was not forth coming. The villagers decided to take charge of the running cost of the scheme. Hence the daily water abstraction has greatly reduced as shown in Table 4.1.1.3

Table 4.1.1.3, daily water abstraction as october'99

Bore hole No	pump rate L/s	daily pumping period (hr)	Total daily abstraction m^3/day
11A	1.3	6hr	28.08
13A	0.3	6hr	6.48
17A	0.4	6hr	8.64
18B	1.5	6hr	32.40

Total daily abstraction was 75.6 cubic meters.

The results of water samples as analysed by the Biwater laboratory in 1991 is summerised in the Table 4.1.1.4.

Table 4.1.1.4 Results of water quality analysis. Biwater (1991)

parameters				
	11A	13A	17A	18B
Electrical conductivity (micro (ohm).	32	33	40	32
PH	6.6	6.6	5.6	.6
Turbidity	15	18	-	12.5
Colour (Hazen unit)	0	0	0	0
Total Iron (fe) mg/l	.12	.65	.05	.13
Total alkalinity ($caco_3$) mg/l	.30	.82	-	20
Total hardness ($caco_3$) mg/l	83	26	-	53
Calcium hardness ($caco_3$) mg/l	15	15	-	34
Magnesium hardness mg/l	68	11	-	19
Nitrate nitrogen	.75	1.5	-	1.3
Total magnisium mg/l	-	-	-	-
Chloride mg/l	-	-	-	-
sulphide	-	2	-	4.5

In October, 1999, raw water samples were taken from the bore-holes to the quality control laboratory of the Niger state water board for analysis, using the same parameters being used by Biwater company. The result of the analysis is summerised in table 4.1.1.5

Table 4.1.1.5 result of the analysed bore hole water at baro (October 1999).

Parameters	11A	13A	17A	18B	MEAN VALUE
Electrical conductivity micro-ohms	30	31	36	28	30.75
PH	6.21	6.4	6.3	6.2	6.27
Total alkalanity ($caco_3$) mg/l	0.4	0.6	1.2	1.8	5.05
Total hardness ($caco_3$) mg/l	78	24	36	55	48.25
Total Iron (fe) mg/l	.11	.53	0.3	.12	0.19
calcium hardness	13	13	15	32	18.25
Magnisium hardness mg/l	65	9	9	17	25
Nitrate nitrogen mg/l	0.75	1.2	1.11	1.2	1.06
Total magnisium mg/l	-	-	-	-	-
Chloride mg/l	-	-	-	-	-
Sulphate mg/l	-	0.3	1.5	3.6	2.02

4.12 ETSU GAIE

The village is about 20km away from Agaie town with an estimated population of about 1789 according to 1991. Currently the projected estimate of the populace is about 1976.

The geophysical surveys were undertaken by Biwater company principally to determine the thickness of the sand stone , depth of the water table and any aquifer in the vicinity of the village.

According to the report gotten from the Niger state water board, two schlumberger vertical electrical soundings ABEM SAS 300 Terra-meter were used. And the results were interpreted by computer modelling.

Two bore holes were drilled at etsu gaie using a Dando 250 top- head drive hydraulic rotary rig standered air and air foam flush was used through out . Bore hole 1 and 2 were completed as production wells.

Lithological logs, construction and drilling details of the production well are shown in appendix III.

The drilling at etsugaie penetrated a sequence of weakly cemented fine to medium grained sand stone and clayey sand. It contained larger percentages of clay above 30m and was capped by approximately 5m of laterite.

The major water ingress occured below 100 meters in both bore - holes.

TABLE 4.1.2.1 the depth of the bore holes.

Bore hole No	Depth (m)
1	119
2	120

The daily water demand of the village was 268.05 cubic metres per days as at 1991 and daily water abstraction from the two bore-holes was 285.12 cubic metres as shown in the Table 4.1.2.2.

TABLE 4.1.2.2. Total daily abstraction at estsugaie (1991)

Bore-hole	Pumping Rate L/S	Daily pumping (hrs)	Total daily Abstraction (cubic metres)
1	1.85	24	159.84
2	1.45	24	125.28

Total = 285.12 cubic metres per day.

As at time of compiling the reports, the scheme had stop functioning due to the fact that pumps had been vandalised. And repairs has not been effected on the pumps.

The water quality analysis was carried by the construction firm - Biwater in 1991. Find in Table 4.1.2.3 the summary of the result of the analysis.

Table 4.1.2.3. The result of the water sample analysis at etsugaie (1991).

Parameters	Bore-hole No.		
	1	2	Mean Value
Electrical conductivity	195	220	207.5
PH micro ohms	6.6	6.7	6.65
Turbidity (NTU)	5.6	4	4.8
COLOUR (Hazen unit)	35	0	17.5
Total iron (fe)mg/L	0.2	0.2	0.2

Continuation

Parameters	Bore-hole No.		
	1	2	Mean Value
Total alkalinity (cao3)mg/L	165	168	166.5
Total Hardness (caco3)mg/L	25	59	42
Calcium Hardness(caco3)mg/L	15	30	22.5
Magnes.Hardness(caco3)mg/L	10	29	19.5
Nitrate Nitrogen mg/L	1.3	-	0.65
Chloride mg/L	1.5	-	0.75
Sulphate So4 mg/L	13	13	13

4.1.3 KUTIRIKO

Kutiriko village is about 18km from Agaie town. It has an estimated population of about 2500 people.

The geophysical surveys carried out by Biwater firm was to determine the thickness of the sand stone; depth to water table and any aquifer in the vicinity of the village.

One offset wenner vertical electrical sounding was made using an ABEM SAS 300 Terrameters.

The result was interpreted by computer modelling.

Two bore-holes were drilled at Kutiriko.

Bore-hole No. A and No.1 were completed in 1982 and 1989 respectivelly.

The lithological logs, construction and drilling details of the production wells are shown by the composite well logs in Appendix III.

The drilling at Kutiriko penetrated a sequence of clay, sand clay and poorly sorted clayed sand and gravels. The upper 30m in both bore-holes comprised mainly clay, hopped by a 5m thick surface layer of laterite. The major water strikes were made below 30m.

TABLE 4.1.3.1 the depth of the bore-holes

Bore-hole No.	Depth (m)
A	60
1	45

The daily water demand of the Kutiriko was 375 cubic meters per day and the total daily water abstraction from wells was 382.32 cubic metres. This was achieved at the beginning of the project in 1989.

Table 4.1.3.2 the total daily abstraction from the bore holes 1989.

Bore-Hole No.	Pumping rate L/s	Daily pumping (hrs)	Total daily Abstraction cubic metres
1	1.9	24	164.16
A	1.9	24	164.16

At the time of compiling the data, the two bore-holes were functioning but the operating period had since been reduced to 12hours per day. This is shown in the Table 4.1.3.3.

Table 4.1.3.3 the total daily water abstraction (1999)

Bore-Hole No.	Pumping rate L/s	Daily pumping (hrs)	Total daily Abstraction cubic metres
1	1.6	12	69.12
A	1.6	12	69.12

The total daily water abstraction was 138.24 cubic meters.

The water quality analysis was carried out immediately after the completion of the bore-holes and the result of the analysis is summarised in table 4.1.3.4.

TABLE 4.1.3.4. The result of the water quality analysis (1991).

Parameters	Bore-hole No.	
	A	I
Electrical Conductivity unhos	N/A	180
PH	N/A	7.3
Turbidity (NTU)	N/A	.5
Colour (hazen unit)	N/A	0
Total iron (fe) mg/L	N/A	0.04
Total alkalinity(caco3)mg/L	N/A	.18
Total Hardness (caco3)mg/L	N/A	45
Calcium Hardness (caco3)mg/L	N/A	27
Magnesium Hardness (caco3)mg/L	N/A	18
Nitrate Nitron mg/L	N/A	0.5
Total manganese mg/L	N/A	0.2
Cloride mg/L	N/A	0.2
Sulphate mg/L	N/A	Nil

Table 4.1.3.5 the result of the water quality analysis (1999)

Parameters	Bore-Hole No.		
	A	I	Mean Value
Electrical Conductivity umhos	176	180	178
PH	7.0	7.2	7.1
Total iron (fe) mg/L	0.04	0.03	0.23
Total alkalinity(caco3)mg/L	17.2	17	17.1
Total Hardness mg/L	42	43	42.5
Calcium Hardness mg/L	27.5	27	27.25
Magnesium Hardness mg/L	16.7	16	16.35
Nitrate Nitron mg/L	0.6	0.4	0.5
Total manganese mg/L	0.3	0.2	0.25
Chloride mg/L	0.25	0.2	0.25
Sulphate mg/L	Nil	Nil	Nill

4.2 DISCUSSION

4.2.1 BORE HOLE YIELDS AND WATER DEMAND OF THE THREE LOCALITIES

The estimated population of Baro was 1945 as 1991 and the projected water demand was 201.75 cubic meters per day, while the total daily water abstraction from the four bore holes was 380.16 cubic meters per day. Thus the average quantity of water available per head was 195.45 litres per day. This meant that the supply met the demand.

However, as from 1995 to date, the total daily water abstraction dropped to 75.6 cubic meters. Hence only 38.8 litres per head per day was available. This has not conformed with the world health organisation recommendation of between 150- 200 litres per head per day.

Etsugaie had an estimated population of about 1787 in 1991 and with a projected water demand of about 270 cubic meters per day. However, the total daily abstraction from the two bore holes drilled was 285.12 cubic meters per day . The average quantity available per head of 159.5 litres. However it was quite adequate as per the WHO standard.

Kutiroko had an estimated population of 2,500 with total water demand of about 375 cubic meters per day. However, the total daily water abstraction was 382.32 cubic meters per day.

4.2.2 YIELD CONSTRAINS

At Baro, the daily pumping period has reduced to six hours as at the time of study. Thus, the daily water abstraction fell to 75.6

cubic meters per day. This was attributable to the operational problems being encountered by the Niger State water board with the Local Government council..

The agreement was that the council would be contributing to the operational fund, being administered by the State water Board. However, the Local council had been failing in honoring her obligation. Hence the residents resolved to making contributions for the operation and maintenance of the bore holes.

The same problem was experience at Kutiriko. This could be observed from table 4.1.3.3 where the daily water abstraction dropped to 138.24 cubic meters per day, due to the fact that the pumping period fell to 12 hours in a day.

4.2.3 WATER QUALITY

Table 4.1.1.4 shows the result of the water analysis carried out in 1991 immediately after the completion of the bore holes at Baro. Manganese was not detected and iron was appreciably low. The turbidity was slightly high at the initial stage and became lower as the pumping operation continued.

Fresh water analysis was recently out and the result is shown in table 4.1.1.5.

Manganese and Chlorides were nil and total iron dissolved in water was low. Hence the quality of water sample could be classified as portable.

At Etsugaie the result of the water quality test carried out in 1991 is summarized in table 4.1.2.3 the level of the relevant parameters conformed with WHO standard for drinking water as shown in Appendix IV.

Water sample for fresh analysis could not be gotten as a result of non functioning of the scheme.

At Kutiriko the table 4.1.3.4 shows the summary of result of the quality analysis carried out in 1991. The water was portable in line with WHO standard shown in Appendix IV.

However, table 4.1.3.5 is the result of the fresh test carried out recently. The total iron dissolved was low and sulphate was not available in the sample. Thus, the bore hole water was portable.

CHAPTER FIVE

5.1 CONCLUSIONS

Four bore holes were drilled at Baro. The total yield obtained was adequate to meet the water demand of the community as at 1991. The operation period later changed due to poor funding from the State and local governments. And this resulted in low quantity of water available for consumption.

The quality of water from the bore holes conformed with the international standard. Thus the water was portable for drinking.

At Etsugaie, the two bore holes drilled were good both quantitatively and qualitatively. The yield obtained was adequate for the population. However, there was no adequate security around the scheme; because of low monitoring by the State water Agency and low community participation in the project right from the beginning. Thus, the generating set was vandalised by the unscrupulous people. And the scheme had ceased functioning.

Kutiriko has two bore holes drilled. They were good and adequate in satisfying the Local water demand of the community. The yield was high and water portable. The operating period subsequently changed due to non availability of the fund from the State and Local Government to maintain the designed status quo. This however culminated in short fall in water available for consumption. The quality test recently carried out showed that the bore hole water was portable.

5.2 RECOMMENDATIONS

A) Baro is just by the side of River Niger with a lot agricultural potentialities. Hence, there is a need for the State Government to harness the surface water resources for the agricultural purposes especially irrigation, since the community has large parcel of lands around.

B) From the study, it could be observed that total daily water abstractions had greatly reduced both at Baro and Kutiriko. Thus, the supply could not meet the demand of those communities. The State and Local Governments were not living to their expectations as regard to their funding for the operation of these schemes.

Hence, it is strongly recommended that tri- partite management committee comprising the representatives of the State, Local Governments and Local community to see that each of the partners observe its obligation as to the operation and maintenance of the schemes.

C) Vandals were getting access to some of these schemes. This could be attributable to low- key participation or involvement of the communities in the project right from the on- set. Secondly, there was no serious monitoring by the State and local Governments. Hence, Government, should ensure that communities are involved at the beginning of the projects to avoid non chalant attitude and promote the safety or security of the schemes in their domain.

D) Quality tests were being carried out by the contracting firm about eight or nine years ago. None has been done since then. Thus, it is pertinent to strongly recommend to the two tiers of the

D) Quality tests were being carried out by the contracting firm about eight or nine years ago. None has been done since then. Thus, it is pertinent to strongly recommend to the two tiers of the Governments to map out a continuous programme of analysis. With this any changes in the physical and chemical characteristics of raw bore hole water can be monitored and possibly controlled to ensure effective and safe water supply to the communities.

REFERENCES

1) Supplement to the Gazzatte Extraordinary (DFRRI Decree No4) No 19-vol.74, 10-4-98

2) National policy on integrated Rural Development (DRAFT) By the DFRRI 1991

3) Niger state and Biwater
3rd - Joint Domestic Trade fair
"NIGER "90"

4) Petroleum Trust Fund - National Rural Water supply Niger state 1997

5) Usman, M.T, Abubakar A.J, Okhimamhe A.A (1997)
The challenge of managing our Environment Human Issues - Paper presented at the Environmental management semina- organised by NISEPA in conjunction with UNDP. 30-9-97 at Minna.

6) Blankwaardt B. (1984) Hand - drilled - wells

7) Shekwolo, P.D - (1983) Hydro geology of Gboko River Basin Unpublish Msc. Dissertation Ahmadu Bello University Zaria)

8) Mohammed, A.S (1993) Hydro geology of Bida sandstone unpublished (B.sc) Geology project to Federal University of Technology Minna.

9) A Hand book of community Water supplies
Water quality and Treatment
4th Edition 1990
published by American water works
Association.

10) Water Lorch (1981) Hand book of the water purification

11) Marks J. H. (1986)
Water and waste water technology

12) Hydro geological Investigations and Final well
Biwater shellabear Nig Ltd (19991).

APPENDIX I.

LIST OF BENEFICIARY LOCAL GOVERNMENT AREAS

S/NO.	LOCAL GOVT. AREAS	L.G. HEAD QUATERS
1	MARIGA	BANGI
2	GBAKO	LEMU
3	KONTAGORA	KONTAGORA
4	LAPAI	LAPAI
5	RIJAU	RIJAU
6	BOSSO	MAIKUNKELE
7	PAIKORO	PAIKO
8	AGWARA	AGWARA
9	SHIRORO	KUTA
10	EDATI	ENAGI
11	BORGU	NEW BUSSA
12	LAVUN	KUTIGI
13	AGAIE	AGAIE
14	WUSHISHI	WUSHISHI
15	RAFI	KAGARA
16	MASHEGU	MASHEGU
17	MAGAMA	NASKO
18	KATCHA	KATCHA
19	MOKWA	MOKWA
20	GURARA	GAWU BABANGIDA
21	SULEJA	SULEJA
22	TAFA	NEW WUSE
23	MUNYA	SARKIN PAWA

APPENDIX IIA

QUESTIONAIRES 'A' ON THE QUANTITATIVE AND QUALITATIVE ASSESSMENT OF BORE HOLES AT BARO, ETSU AGAIE AND KUTIRIKO.

(1) Name of respondent......................................

(2) Name of location...

(3) Local Government Area.................................

(4) State..

(5) Current status of the bore holes, are they working at present, Tick Yes or No

(6) If no, what are the problems(s)

(7) Who design and construct the bore holes ?

(8) Who operate the bore holes ?

(9) Who is responsible for the mainteinance ?

(a) state Govt. (b) Local Govt. (c) Local inhabitants.

(10) when were they constructed ?

(11) what problems were encountered during the construction ?

(12) What is\are the depth of the bore holes

(13) What is the Goelogical log of the bore holes ?

(14) Were they test run after the construction, Yes or No .

(15) If "Yes"; for how hours.........

(16) What yield was obtained ?.......

(17) What type of pump is in use ?

(18) what is the capacity ?.......

(19) What is the pumping head ?........

(20) What is the capacity of the tank ....

(21) What is the commonest problem encountered from the pump.....

(22) How many hour is pumping carried out in a day ?.......

(23) Is the operator skillful ? Yes or No

if yes, what his/her qualification ?....... and if no, what was the basis of his/her employment......................

(24) What was the status of water quality in terms of the following elements at the end of the construction.

(a) Electrical conductivity..............

(b) P.H ....

(c) Colour..........................

(d) Total iron..........................

(e) Total alkalinity....................

(f) Total hardness $CoCo_3$.................

(g) Magnesium hardness..................

(h) Nitrate Nitrogen.....................

(i) Chloride.............. .....

(j) Sulphate.....................

(25) When was the carried out ?

(26) How frequent is the quality test carried out ?............

(27) What has been the assessment of the local inhabitants ?

(28) Is there any source of water in the village ?...........

(29) What is the distance from the bore hole ?..............

(30) Is farming activities taking place around the bore hole site?

(31) How many month of rain fall is averagely experienced in the village ?...

APPENDIX II_B

QUETIONAIRE "B"

(1) Name of the respondent..........................

(2) Name of the village/location......................

(3) L.G.A......................................

(4) state ....

(5) How many are you in your house hold ?...........

(6) How do you get water ? Tick any

(a)Stream (b) Bore hole (c) Hand dug well

(7) How often do you get water from the bore hole?........

(8) How many buckets of water do you fetch from the bore hole daily ?........................

(9) What is the colour of the water from the bore hole ?......

(10) What is the test ?......................

(11) Have you ever experienced any disease as a result of your

drinking from the bore hole ? yes or no, If yes , what did you experience.......................................

(12) Are you people farming around the bore hole site ?......

(13) What agro - chemicals are they using ?

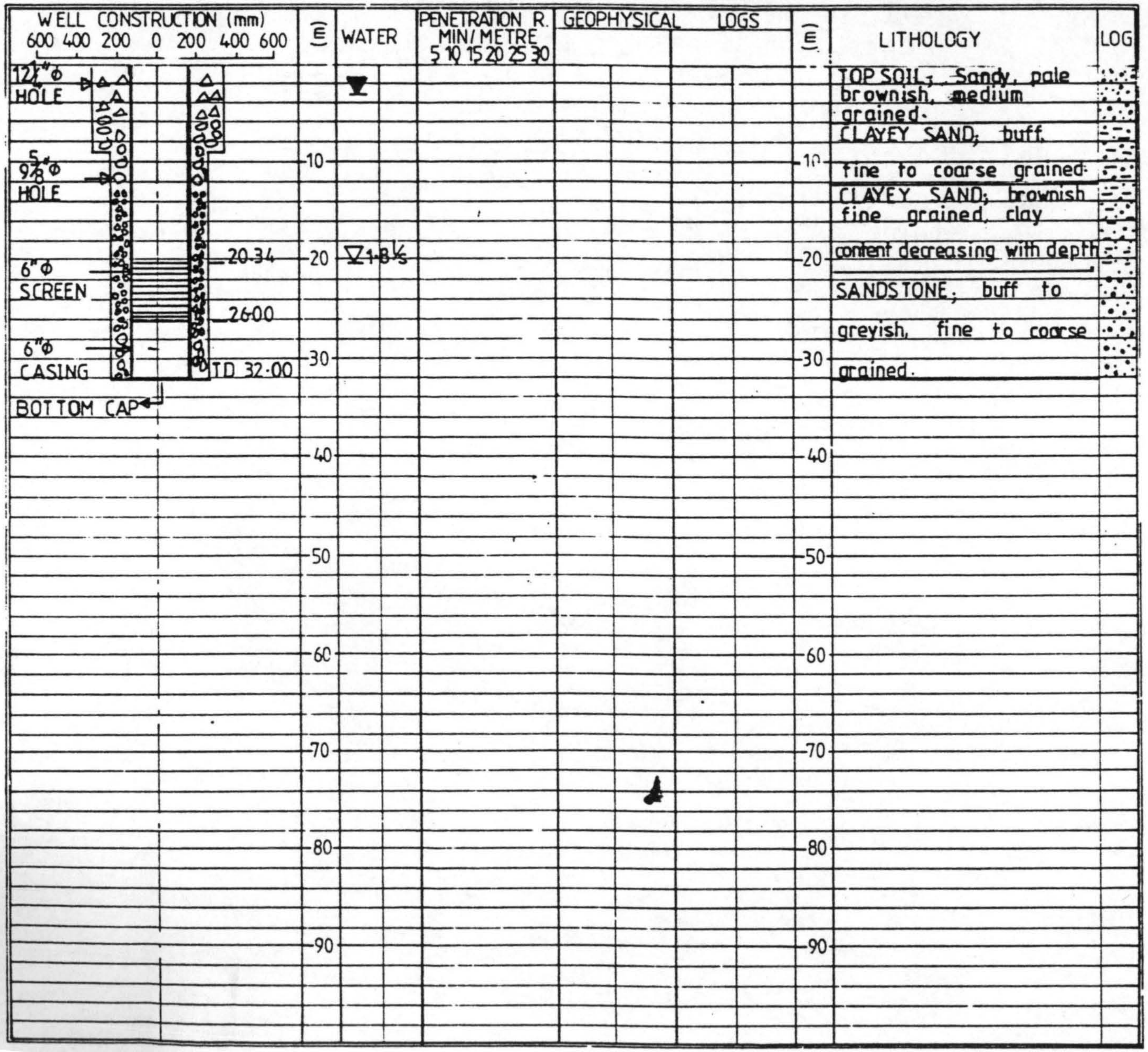
(a) Fertilizer (b) Herbicide (c)Insecticide. Any other.

(14) What is your general assessment of the bore hole in the village ?

APPENDIX IV

WORLD HEALTH ORGANISATION INTERNATIONAL STANDARDS FOR DRINKING WATER.

Parameter	Permissible Limit (ppm)	Excessive Limit (ppm)	Maximum Limit (ppm)	Recommended Limit (ppm)	Tolerable Limit (ppm)
Ammonia (NH_3)	-	-	-	0.5	-
Arsenic			0.05	0.01	0.05
Cadmium	-	-	-	-	0.01
Chromium (Hexavalent)			0.05	-	0.05
Copper					
Cyanide	1.0	1.5	-	3.0	-
Fluoride	-	-	0.05	-	0.01
Iron	-	-	-	1.5	-
Lead	0.3	1.0	-	0.1	-
Magnesium	-	-	0.1	-	0.1
	50	150	-	125	-
Manganese + Sodium Sulp.	500	1000	-	-	-
Nitr. as No3	-	4.5	-	4.5	-
Dissolved oxyge(min.)	-	-	-		
					-
					-
					-
					-
					-
					-
					-
					-



49 BARO BOREHOLE No 11A
RIG 0022

COMPLETED ON 8 : 3 : 91
DRILLING MEDIUM: AIR/ FOAM

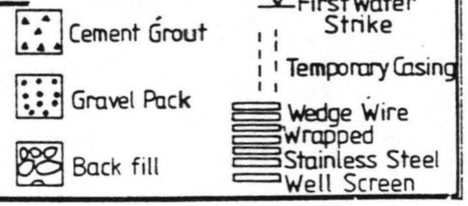
PUMPING TEST DATA

STEP DRAWDOWN TEST ON: 12 3 91

Step	Discharge (l/s)	Duration (mm)	Sw (m)
1	0·3	100	1·70
2	0·6	100	3·30
3	0·9	100	4·97
4	1·2	100	6·54
5	1·5	100	8·40
6	1·8	100	10·91

CONSTANT DISCHARGE TEST ON: 13 : 3 : 91
Discharge 1·5 L/S For 6000 Minutes SW=13·80
REFERENCE POINT: TOP OF CASING
DATUM LEVEL 0·4

KEY



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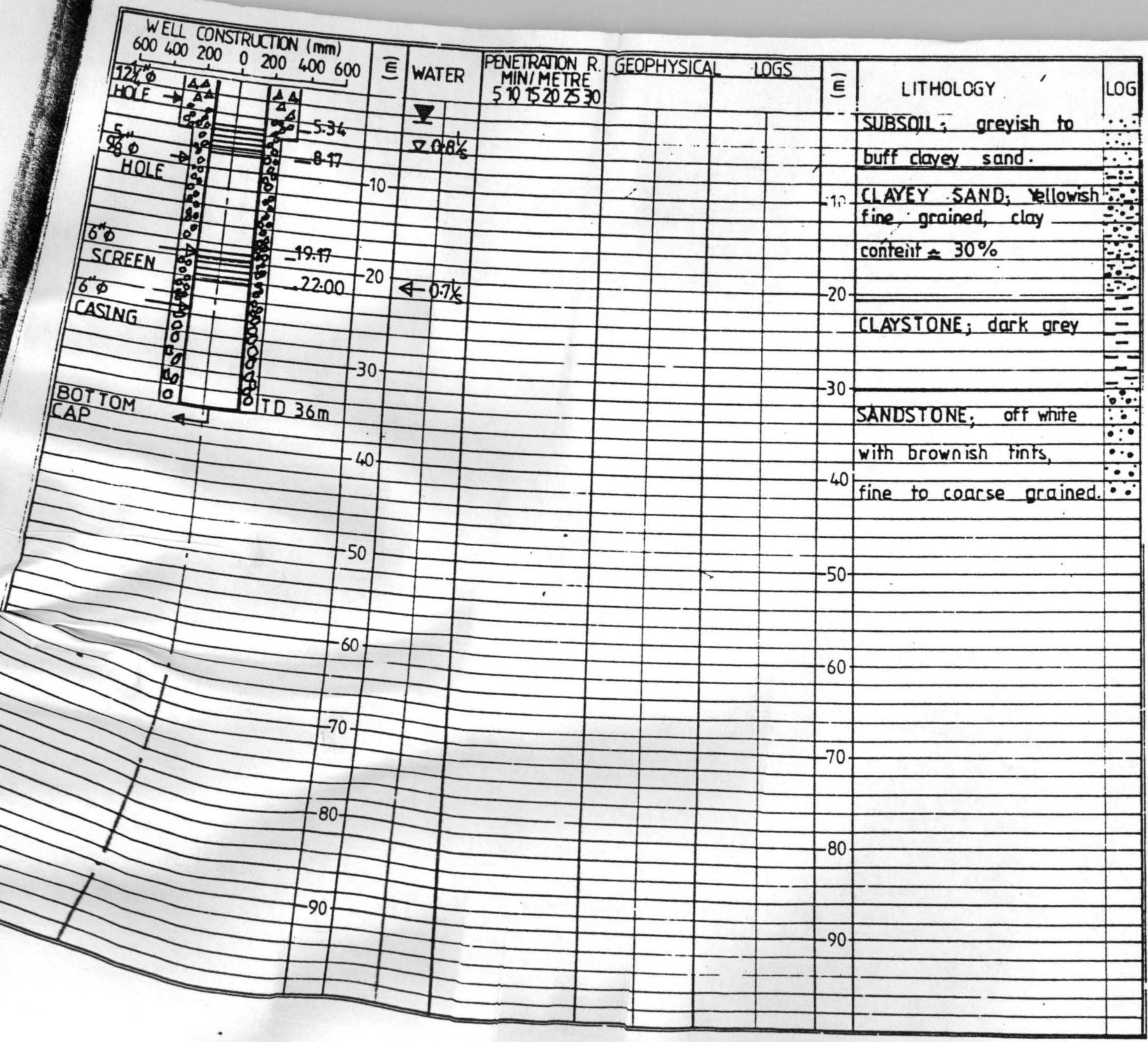
49 BARO BOREHOLE No 11A
COMPOSITE WELL LOG

DATE	SCALE	DRAWING No
25:3:91	AS SHOWN	9003/49/B11A/R
DRAWN ABRAM	CHECKED SAO	



49 BARO BOREHOLE No 13A

RIG 0022

COMPLETED ON 12 : 3 : 91

DRILLING MEDIUM: AIR / FOAM

PUMPING TEST DATA

STEP DRAWDOWN TEST ON: 16 : 3 : 91

Step	Discharge (l/s)	Duration (min)	Sw (m)
1	0·2	100	0·2
2	0·3	100	0·75
3	0·5	100	1·35
4	0·6	100	2·05
5	0·8	100	2 90
6	0·9	100	4·00

CONSTANT DISCHARGE TEST ON: 17 : 3 : 91

Discharge 0·8 L/S For 6000 Minutes SW=16·03

REFERENCE POINT: TOP OF CASING

DATUM LEVEL 1·16

KEY

- Standing water level
- First Water Strike
- Cement Grout
- Temporary Casing
- Gravel Pack
- Wedge Wire Wrapped Stainless Steel Well Screen
- Back fill

B... (Nig...a)

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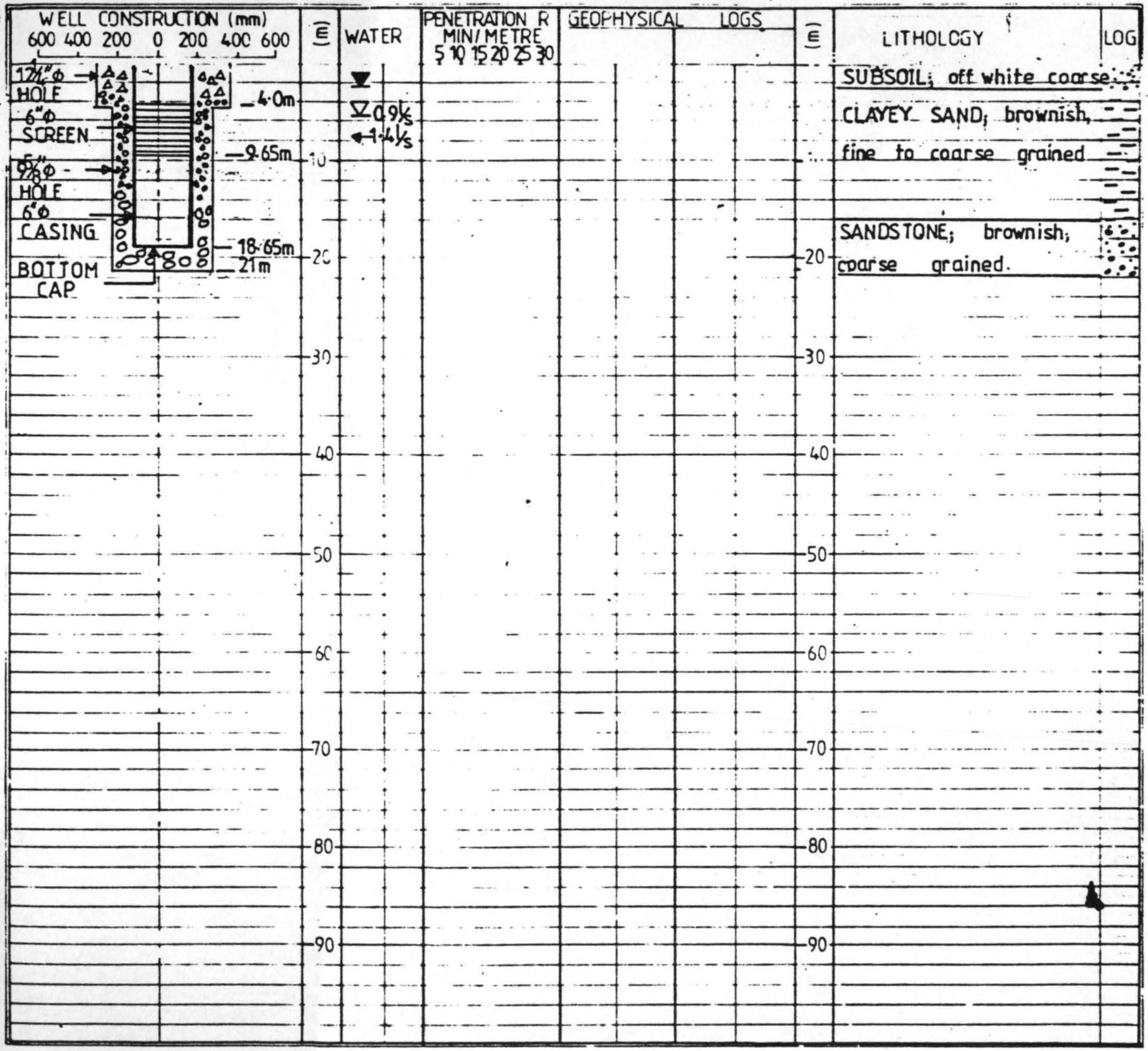
BOREHOLE No 13A
COMPOSITE WELL LOG

DATE	SCALE	DRAWING No
25 : 3 : 91	AS SHOWN	9003/49/B13A/7R
DRAWN ABRAM	CHECKED S A O	



49 BARO BOREHOLE No 17A
RIG 0021

COMPLETED ON 18 : 3 : 91
DRILLING MEDIUM AIR/FOAM

PUMPING TEST DATA

STEP DRAWDOWN TEST ON 22 : 3 : 91

Step	Discharge (l/s)	Duration (mm)	Sw (m)
1	0·2	100	0·41
2	0·5	100	0·68
3	0·7	100	1·05
4	0·9	100	1·70
5			
6			

CONSTANT DISCHARGE TEST ON 23 : 3 : 91
Discharge 0·7 L/S For 6000 Minutes SW = 6·16
REFERENCE POINT TOP OF CASING
DATUM LEVEL 0·63

KEY

- ▼ Standing water level
- ▽ First Water Strike
- Cement Grout
- Temporary Casing
- Gravel Pack
- Wedge Wire Wrapped Stainless Steel Well Screen
- back fill

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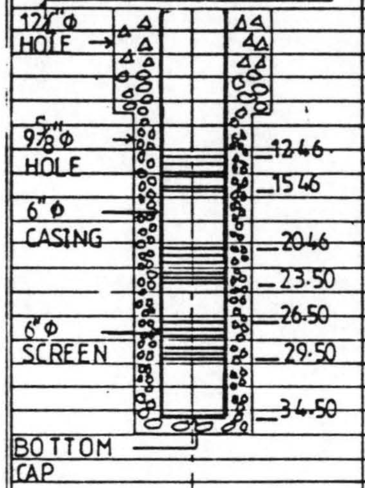
49 BARO BOREHOLE No 17A
COMPOSITE WELL LOG

DATE 25 : 3 : 91	SCALE AS SHOWN	DRAWING No 9003/49/17A/R
DRAWN ABRAM	CHECKED S.A.O	

WELL CONSTRUCTION (mm) 600 400 200 0 200 400 600	(m)	WATER	PENETRATION R. MIN/METRE 5 10 15 20 25 30	GEOPHYSICAL LOGS	(m)	LITHOLOGY	LOG
		▼				SUBSOIL, brownish, sandy	
						CLAYEY SAND, yellowish brown, fine grained, clay content ~ 40 %	
	10	▽ 0·4 l/s			10		
						CLAYSTONE; darkgrey indurated.	
	20	← 0·8 l/s			20	SANDSTONE; Off white to light brownish, medium	
		← 1·5 l/s				grained, well sorted,	
	30				30	finer with depth.	
	40				40		
	50				50		
	60				60		
	70				70		
	80				80		
	90				90		

49 BARO BOREHOLE No 18B
RIG 0022

COMPLETED ON 17 : 3 : 91
DRILLING MEDIUM: AIR/FOAM

PUMPING TEST DATA

STEP DRAWDOWN TEST ON: 19 3 91

Step	Discharge (l/s)	Duration (mm)	Sw (m)
1	0·4	100	0·41
2	0·7	100	1·11
3	1·1	100	1·90
4	1·4	100	2·86
5	1·8	100	4·26
6	2·1	100	5·36

CONSTANT DISCHARGE TEST ON: 20 : 3 : 91
Discharge 2·0 L/S For 6000 Minutes SW=9·84
REFERENCE POINT: TOP OF CASING
DATUM LEVEL 0·5

KEY
▼ Standing water level
▽ First Water Strike
Cement Grout
Temporary Casing
Gravel Pack
Wedge Wire Wrapped Stainless Steel Well Screen
Back fill

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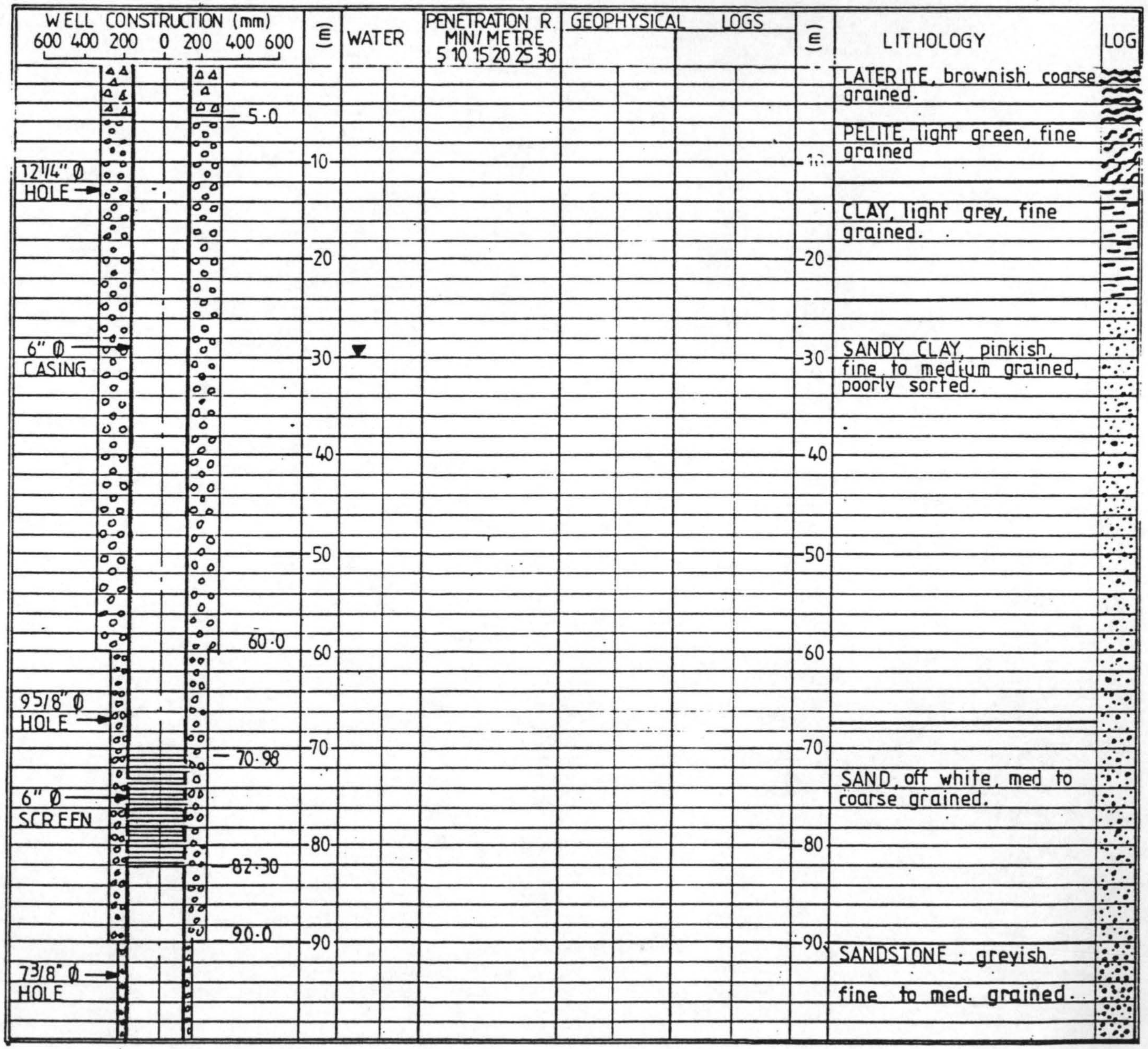
NIGER STATE WATER BOARD

49 BARO BOREHOLE No 18 B
COMPOSITE WELL LOG

DATE	SCALE	DRAWING No
25 : 3 : 91	AS SHOWN	9003/49/B18B/R
DRAWN ABRAM	CHECKED SAO	



6 ETSUGAIE BOREHOLE No 1
RIG 0008

COMPLETED ON 20:3:89
DRILLING MEDIUM: AIR AND FOAM

PUMPING TEST DATA

STEP DRAWDOWN TEST ON: 28:3:89

Step	Discharge (l/s)	Duration (mm)	Sw (m)
1	0·6	100	5·42
2	1·2	100	10·02
3	1·9	100	13·92
4	2·0	100	16·36
5	2·3	100	17·81
6	2·6	100	20·39

CONSTANT DISCHARGE TEST ON: 29:3:89
Discharge 2·0 L/S For 6000 Minutes SW=21·46
REFERENCE POINT: TOP OF CASING
DATUM LEVEL

KEY

- Cement Grout.
- Gravel Pack
- Back fill
- ▼ Standing water level
- ▽ First Water Strike
- Temporary Casing
- Wedge Wire Wrapped Stainless Steel Well Screen

Biwater (Nigeria)

Head Office
18b Keffi Street
Ikoyi Island
Lagos

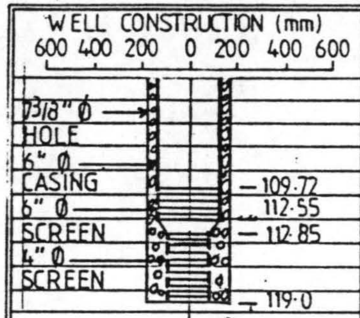
Telephone 682100
Telex 22482 BISHEL NG

BIWATER NIGERIA LTD

PROJECT 9003
NIGER STATE WATER BOARD

6 ETSUGAIE BOREHOLE No 1
COMPOSITE WELL LOG

DATE	SCALE	DRAWING No
9:7:89	AS SHOWN	9003/06/B01/R
DRAWN M F O	CHECKED STA	



(m)	WATER	PENETRATION R. MIN/METRE 5 10 15 20 25 30	GEOPHYSICAL LOGS	(m)	LITHOLOGY
					SANDSTONE, greyish, fine to med. grained.
110				10	
	← 2.5 L/S				SANSTONE, greyish, med to coarse grained.
120				20	
30				30	
40				40	
50				50	
60				60	
70				70	
80				80	
90				90	

6 ETSUGAIE BOREHOLE No 1
RIG 008

COMPLETED ON 20:3:89

DRILLING MEDIUM: AIR AND FOAM

PUMPING TEST DATA

STEP DRAWDOWN TEST ON:

Step	Discharge (l/s)	Duration (mm)	Sw (m)
1			
2			
3			
4			
5			
6			

CONSTANT DISCHARGE TEST ON:

Discharge L/S For Minutes SW=

REFERENCE POINT:

DATUM LEVEL

KEY

- Cement Grout
- Gravel Pack
- Back fill
- Standing water level
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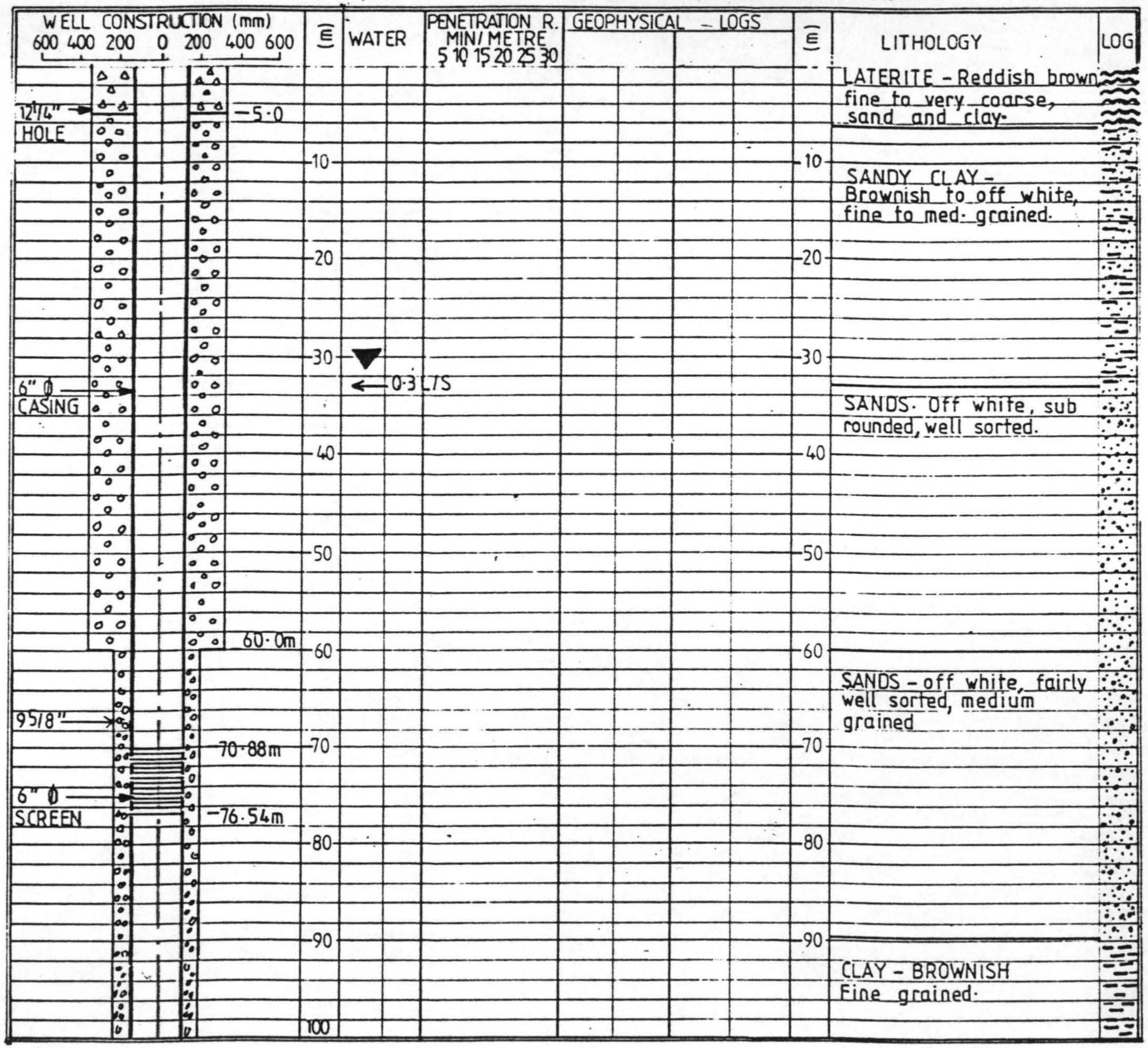
PROJECT 9003

NIGER STATE WATER BOARD

6 ETSUGAIE BOREHOLE No 1

COMPOSITE WELL LOG

DATE	SCALE	DRAWING No
9:7:89		
DRAWN M.E.O.	CHECKED STA	



6 ETSUGAIE BOREHOLE No 2
RIG 0014

COMPLETED ON 4:4:89
DRILLING MEDIUM: AIR / FOAM

PUMPING TEST DATA

STEP DRAWDOWN TEST ON 4:4:89

Step	Discharge (l/s)	Duration (mm)	Sw (m)
1	0·6	100	5·60
2	1·0	100	8·56
3	1·7	100	13·61
4	2·1	100	17·48
5	2·3	100	19·34
6	2·6	100	22·35

CONSTANT DISCHARGE TEST ON 5:4:89
Discharge 1·7 L/S For 6000 Minutes SW=50·46
REFERENCE POINT: TOP OF CASING
DATUM LEVEL

KEY
- Cement Grout
- Gravel Pack
- Back fill
- ▼ Standing water level
- ▽ First Water Strike
- Temporary Casing
- Wedge Wire Wrapped Stainless Steel Well Screen

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PROJECT 9003
NIGER STATE WATER BOARD

6 ETSUGAIE BOREHOLE No 2
COMPOSITE WELL LOG

DATE	SCALE	DRAWING No
7:7:89	AS SHOWN	9003/06/B02/R
DRAWN MFO	CHECKED FOO	

WELL CONSTRUCTION (mm)
600 400 200 0 200 400 600

9 5/8" Ø HOLE

6" Ø SCREEN

108.53

120.0

(m)

WATER

← 2.5 L/S

← 2.5 L/S

PENETRATION R. MIN/METRE
5 10 15 20 25 30

GEOPHYSICAL LOGS

(m)

LITHOLOGY

LOG

SANDS - off white fine to coarse grained, poorly sorted

Depth (m): 10, 20, 30, 40, 50, 60, 70, 80, 90

6 ETSUGAIE BOREHOLE No 2
RIG 0014

COMPLETED ON 4:4:89
DRILLING MEDIUM:
PUMPING TEST DATA
STEP DRAWDOWN TEST ON:

Step	Discharge (l/s)	Duration (mm)	Sw (m)
1			
2			
3			
4			
5			
6			

CONSTANT DISCHARGE TEST ON:
Discharge L/S For Minutes SW=
REFERENCE POINT:
DATUM LEVEL

KEY

Cement Grout
Gravel Pack
Back fill
▼ Standing water level
▽ First Water Strike
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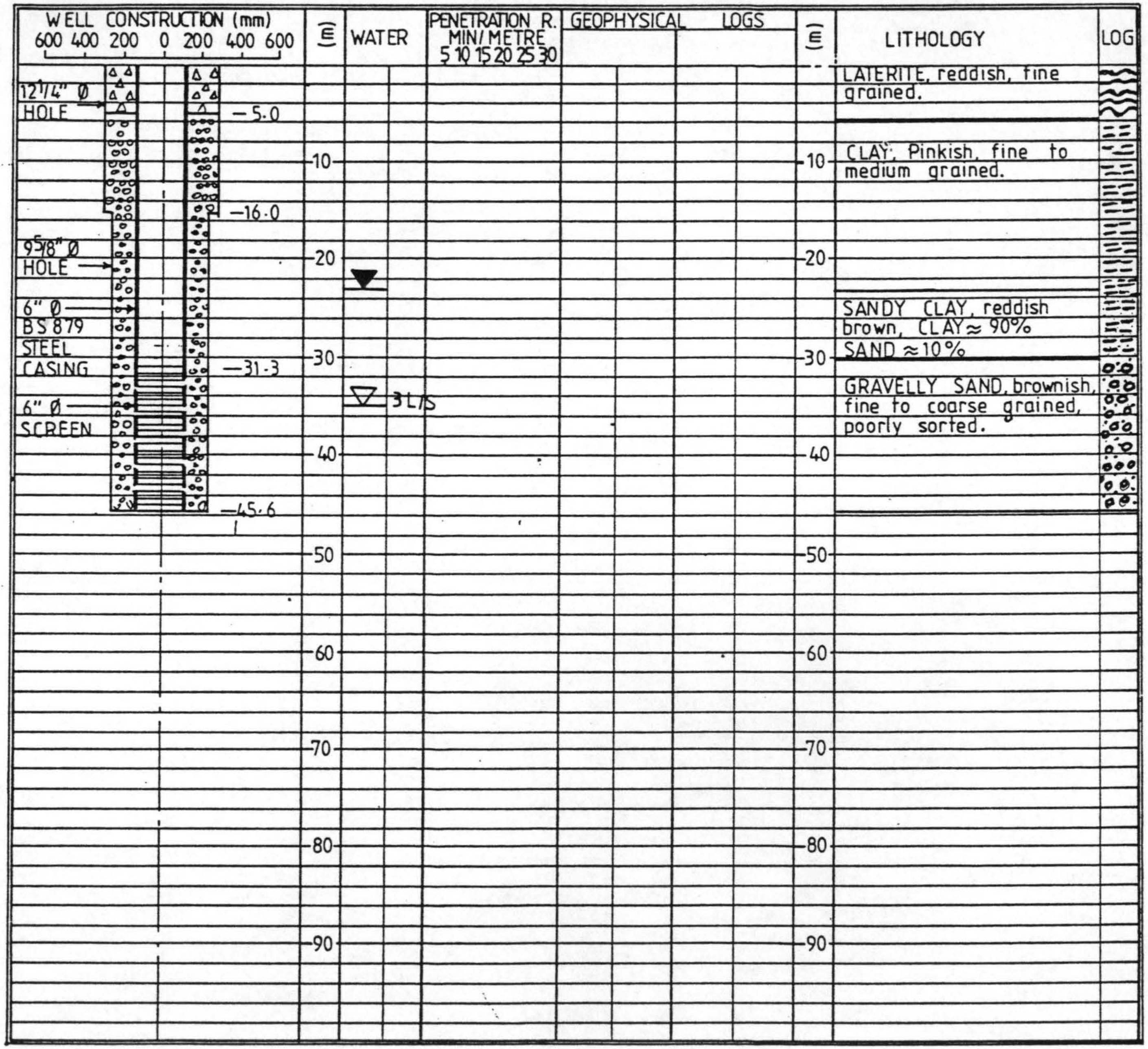
PROJECT
NIGER STATE WATER BOARD

6 ETSUGAIE BOREHOLE No 2
COMPOSITE WELL LOG

DATE	SCALE	DRAWING No
9:9:89	AS SHOWN	
DRAWN MEO	CHECKED EOO	



4 KUTIRIKO BOREHOLE No 1
RIG 0014

COMPLETED ON 9: 2: 89
DRILLING MEDIUM: AIR / FOAM

PUMPING TEST DATA

STEP DRAWDOWN TEST ON: 10 · 2 · 89

Step	Discharge (l/s)	Duration (mm)	Sw (m)
1	0·9	100	0·67
2	1·7	100	1·34
3	2·2	100	2·11
4	2·7	100	2·70
5	3·1	100	3·34
6	3·4	100	3·93

CONSTANT DISCHARGE TEST ON: 11 · 2 · 89
Discharge 3·4 L/S For 6000 Minutes SW=4·48
REFERENCE POINT: TOP OF CASING
DATUM LEVEL

KEY

- Cement Grout
- Gravel Pack
- Back fill
- Standing water level
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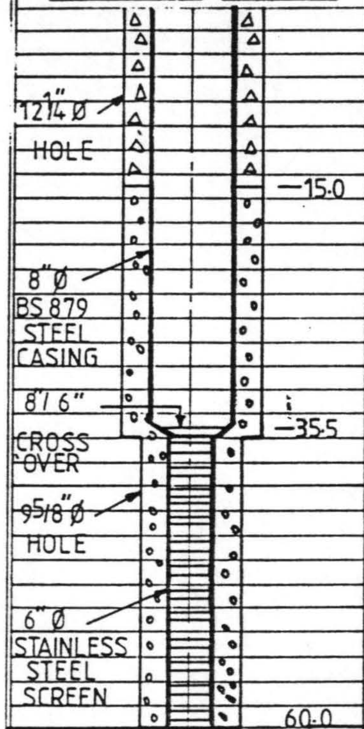
PROJECT 9003
NIGER STATE WATER BOARD

4 KUTIRIKO BOREHOLE No 1
COMPOSITE WELL LOG

DATE	SCALE	DRAWING No
21:4:90	AS SHOWN	9003/04/B01/R
DRAWN MFO	CHECKED GOCN	

WELL CONSTRUCTION (mm) 600 400 200 0 200 400 600	(m)	WATER	PENETRATION R. MIN/ METRE 5 10 15 20 25 30	GEOPHYSICAL LOGS	(m)	LITHOLOGY	LOG



Depth (m): 10, 20, 30, 40, 50, 60, 70, 80, 90

LITHOLOGY:

- LATERITE
- CLAY, pink with quartz fragments
- CLAY, white, Varigated.
- CLAY, brown with gravels and sand
- SANDSTONE, light brown, medium to coarse grained, poorly sorted, gravel and clay
- IRONSTONE

4 KUTIRIKO BOREHOLE No A
RIG
COMPLETED ON 3-3-82
DRILLING MEDIUM:
PUMPING TEST DATA
STEP DRAWDOWN TEST ON:

Step	Discharge (l/s)	Duration (mm)	Sw (m)
1			
2			
3			
4			
5			
6			

CONSTANT DISCHARGE TEST ON:
Discharge L/S For Minutes SW=
REFERENCE POINT:
DATUM LEVEL

KEY
- Cement Grout
- Gravel Pack
- Back fill
- ▼ Standing water level
- ▽ First Water Strike
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BIWATER NIGERIA LTD
PROJECT 9003
NIGER STATE WATER BOARD
4 KUTIRIKO BOREHOLE No 2
COMPOSITE WELL LOG

DATE	SCALE	DRAWING No
6-3-90	AS SHOWN	9003/04/B02/R
DRAWN daniels	CHECKED GOCN	

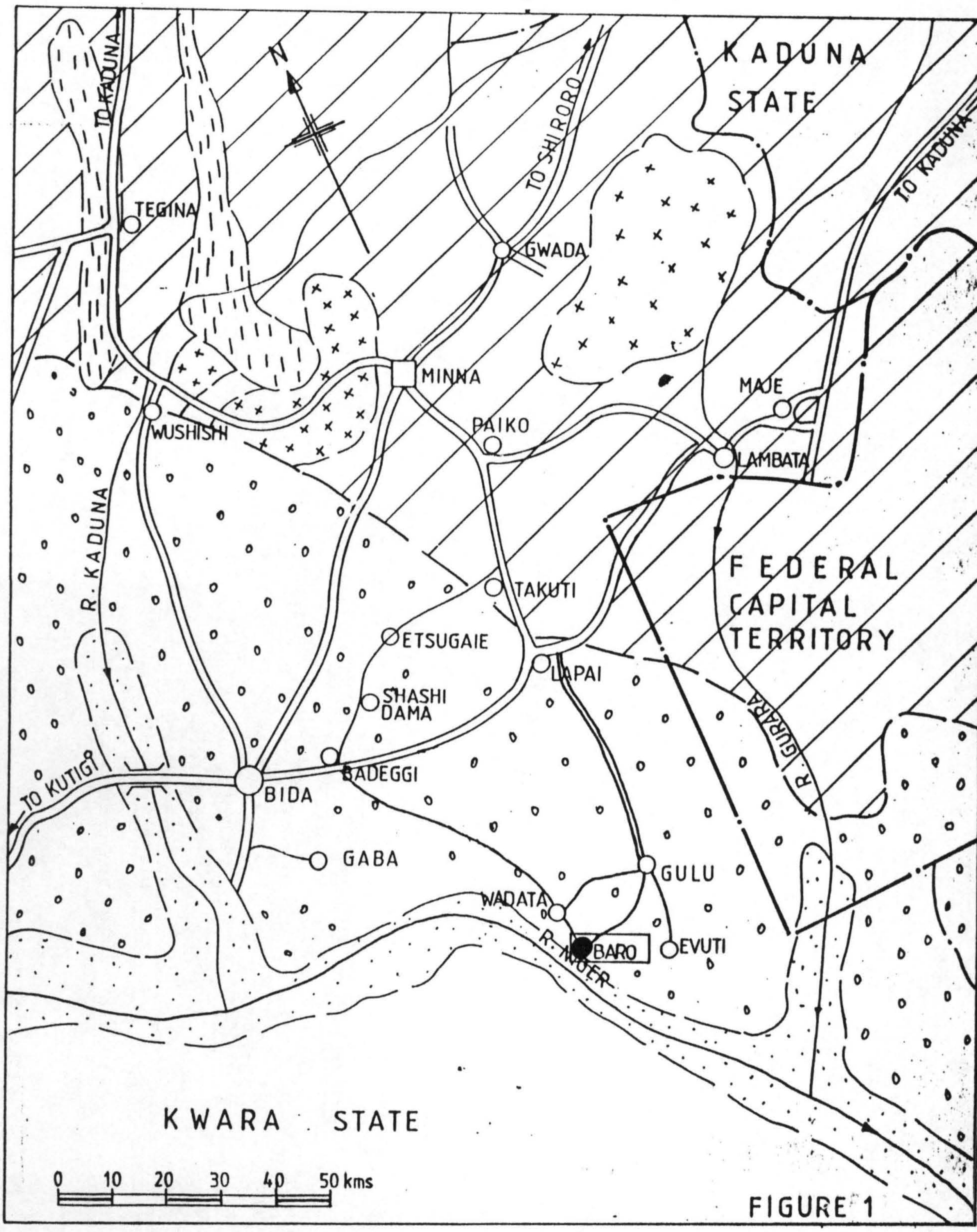

FIGURE 1

GENERAL LOCATION & GEOLOGY
SITE 49 BARO

ALLUVIUM	
NUPE SANDSTONE (Feldspathic Sandstone Siltstone)	
OLDER GRANITE	
UNDIFFENTIATED META-SEDIMENTS	
UNDEFFENTIATED BASEMENT COMPLEX	
GEOLOGICAL BOUNDARY (Inferred)	MAJOR ROAD
STATE BOUNDARY	MINOR ROAD
RIVER & FLOW DIRECTION	

Biwater (Nigeria)

DATE. 5/3/90	PROJECT: 9003
DRAWING No 9003/49/1/R	SCALE 1:1000000
DRAWN BY: daniels	CHECKED BY: GOCN

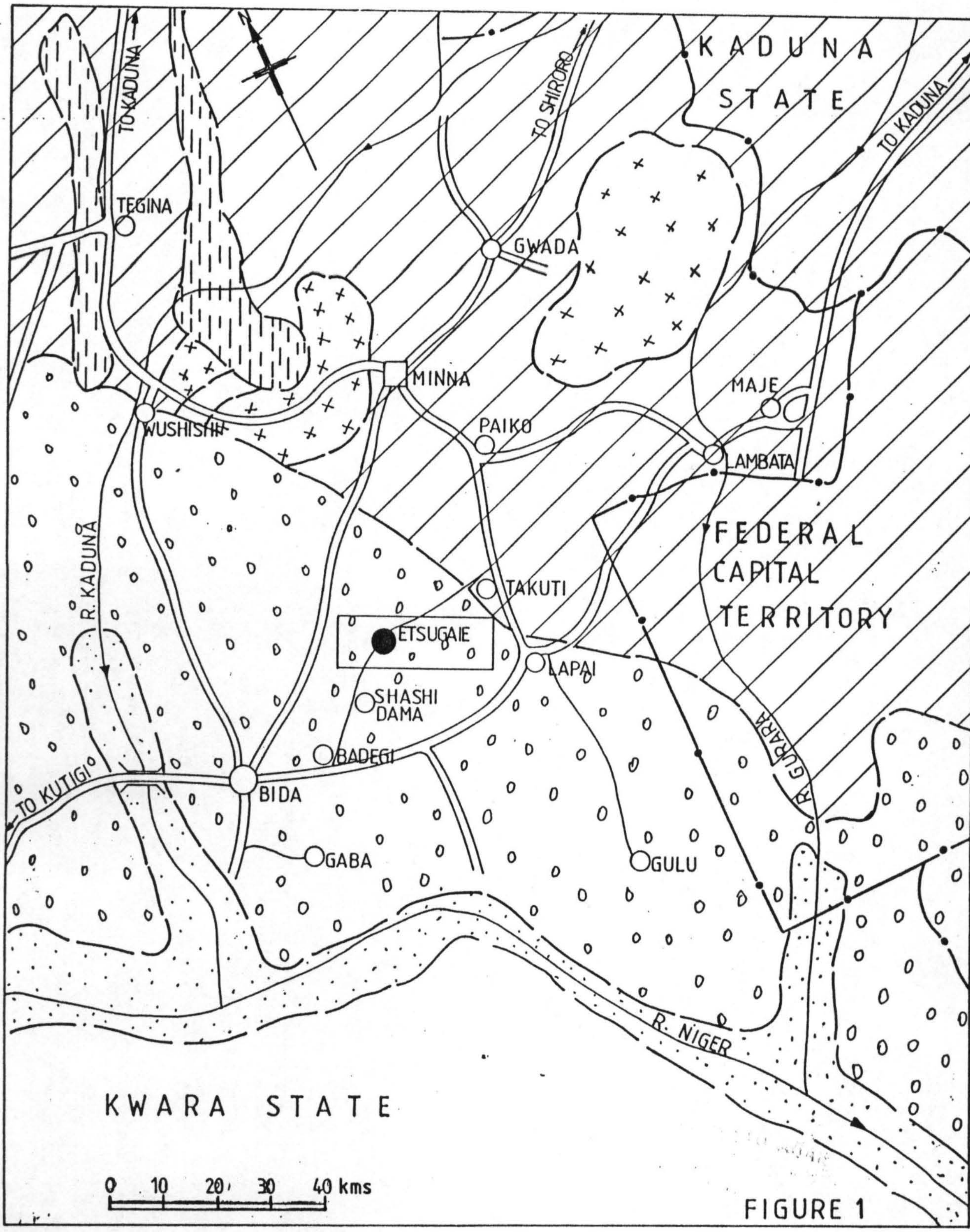

FIGURE 1

GENERAL LOCATION AND GEOLOGY
SITE 06-ETSUGAIE

	ALLUVIUM
	NUPE SANDSTONE(Feldspathic Sandstone & Siltstone)
	OLDER GRANITE
	UNDIFFERENTIATED META-SEDIMENTS
	UNDIFFERENTIATED BASEMENT COMPLEX
	GEOLOGICAL BOUNDARY (infered)
	STATE BOUNDARY = MAJOR ROAD
	RIVER AND FLOW DIRECTION — MINOR ROAD

Biwater (Nigeria)

DATE. 13/11/89	PROJECT: 9003
DRAWING No 9003/06/1/R	SCALE 1 : 1000000
DRAWN BY: Daniels	CHECKED BY: STA

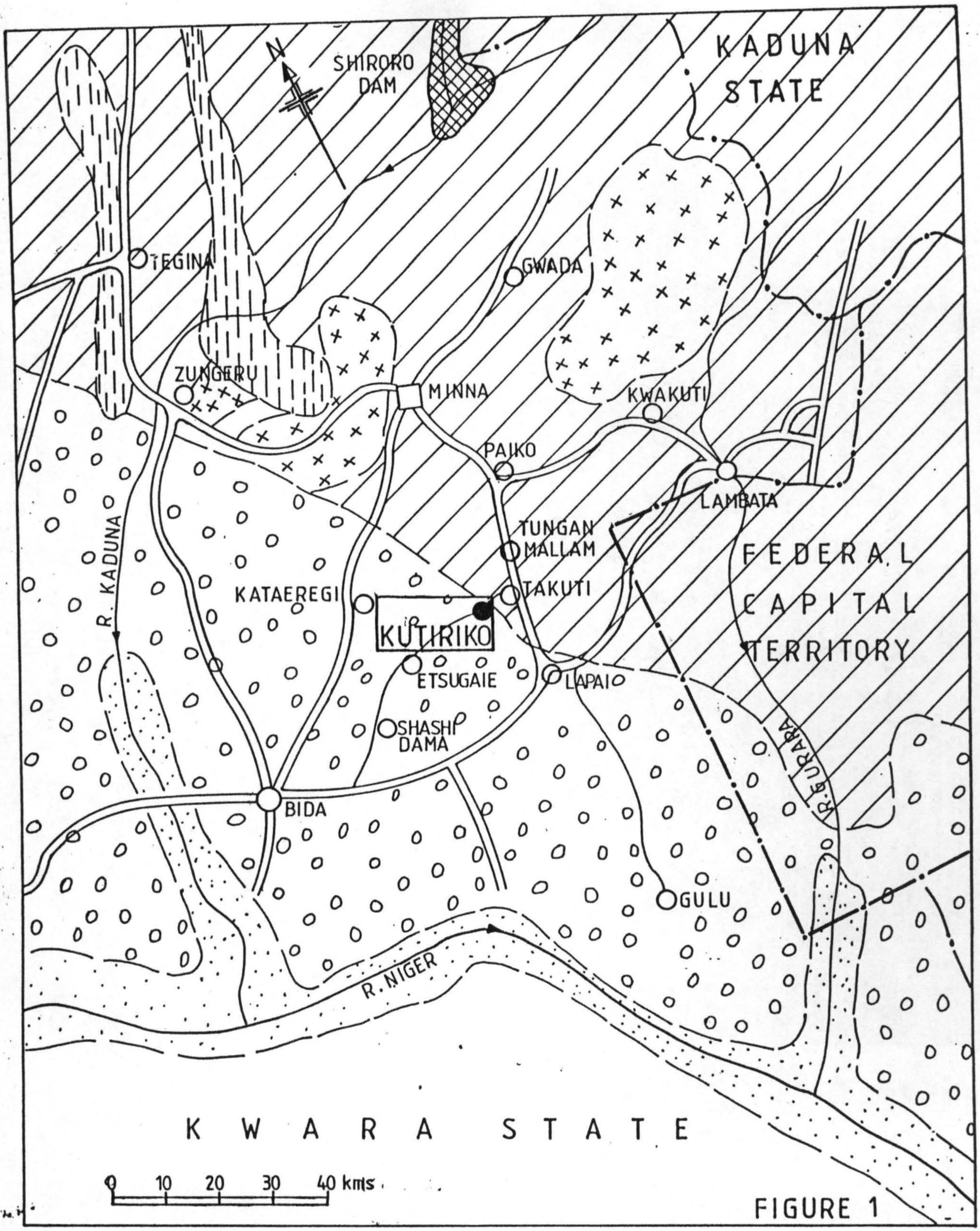

FIGURE 1

GENERAL LOCATION AND GEOLOGY
SITE 4-KUTIRIKO

- ALLUVIUM
- NUPE SANDSTONE (Feldpathic Sandstone & Siltstone)
- OLDER GRANITE
- UNDIFFERENTIATED META-SEDIMENTS
- UNDIFFERENTIATED BASEMENT COMPLEX
- GEOLOGICAL BOUNDARY
- STATE BOUNDARY
- RIVER & FLOW DIRECTION
- MAJOR ROAD
- MINOR ROAD

Biwater (Nigeria)

DATE:	PROJECT: 9003
DRAWING No 9003/6/1/R	SCALE 1:1000000
DRAWN BY: daniels	CHECKED BY: STA

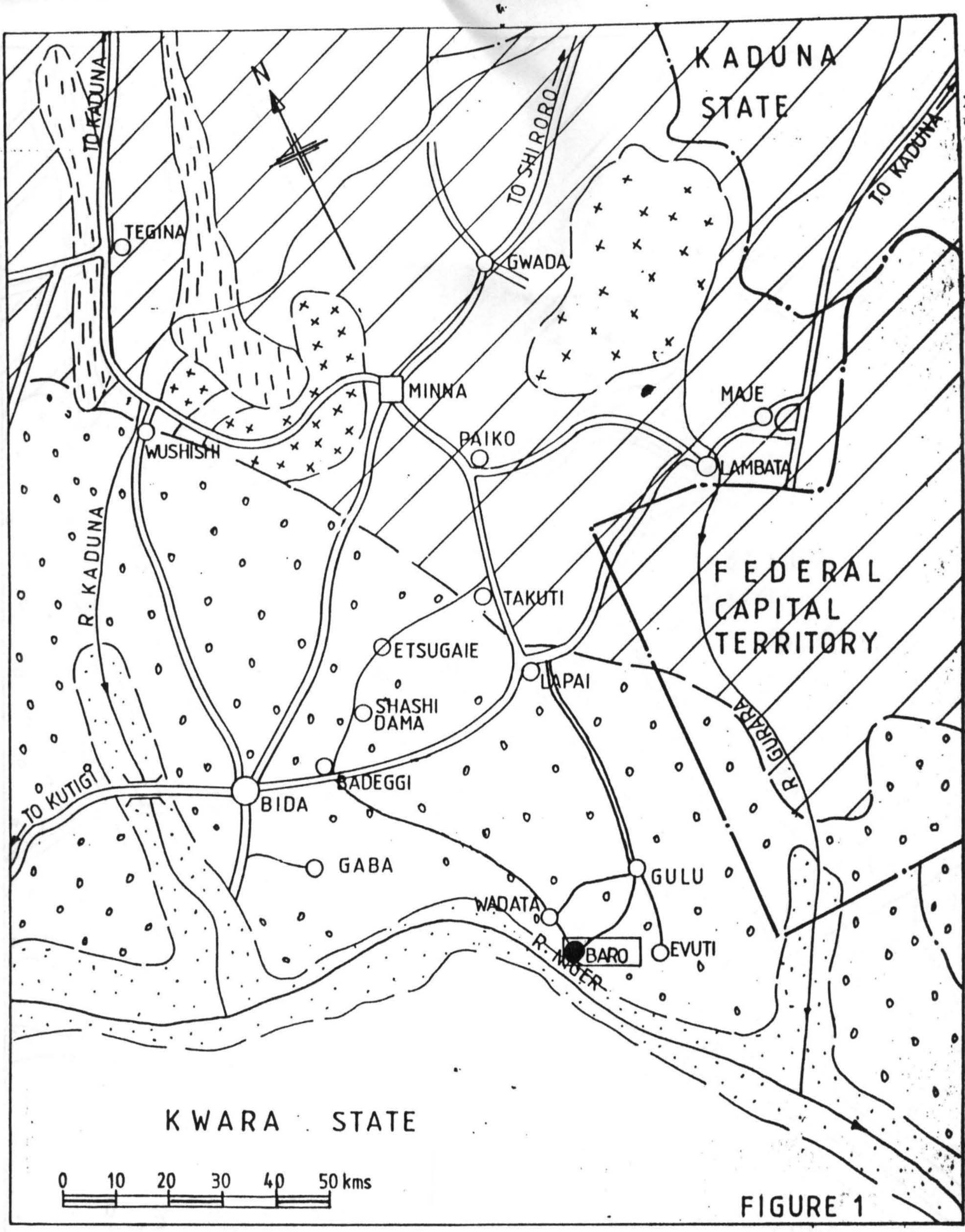

FIGURE 1

GENERAL LOCATION & GEOLOGY
SITE 49 BARO

- ALLUVIUM
- NUPE SANDSTONE (Feldspathic Sandstone Siltstone)
- OLDER GRANITE
- UNDIFFENTIATED META-SEDIMENTS
- UNDEFFENTIATED BASEMENT COMPLEX
- GEOLOGICAL BOUNDARY (Inferred)
- STATE BOUNDARY
- RIVER & FLOW DIRECTION
- MAJOR ROAD
- MINOR ROAD

Biwater (Nigeria)

DATE. 5/3/90	PROJECT: 9003
DRAWING No 9003/49/1/R	SCALE 1:1000000
DRAWN BY: daniels	CHECKED BY: GOCN

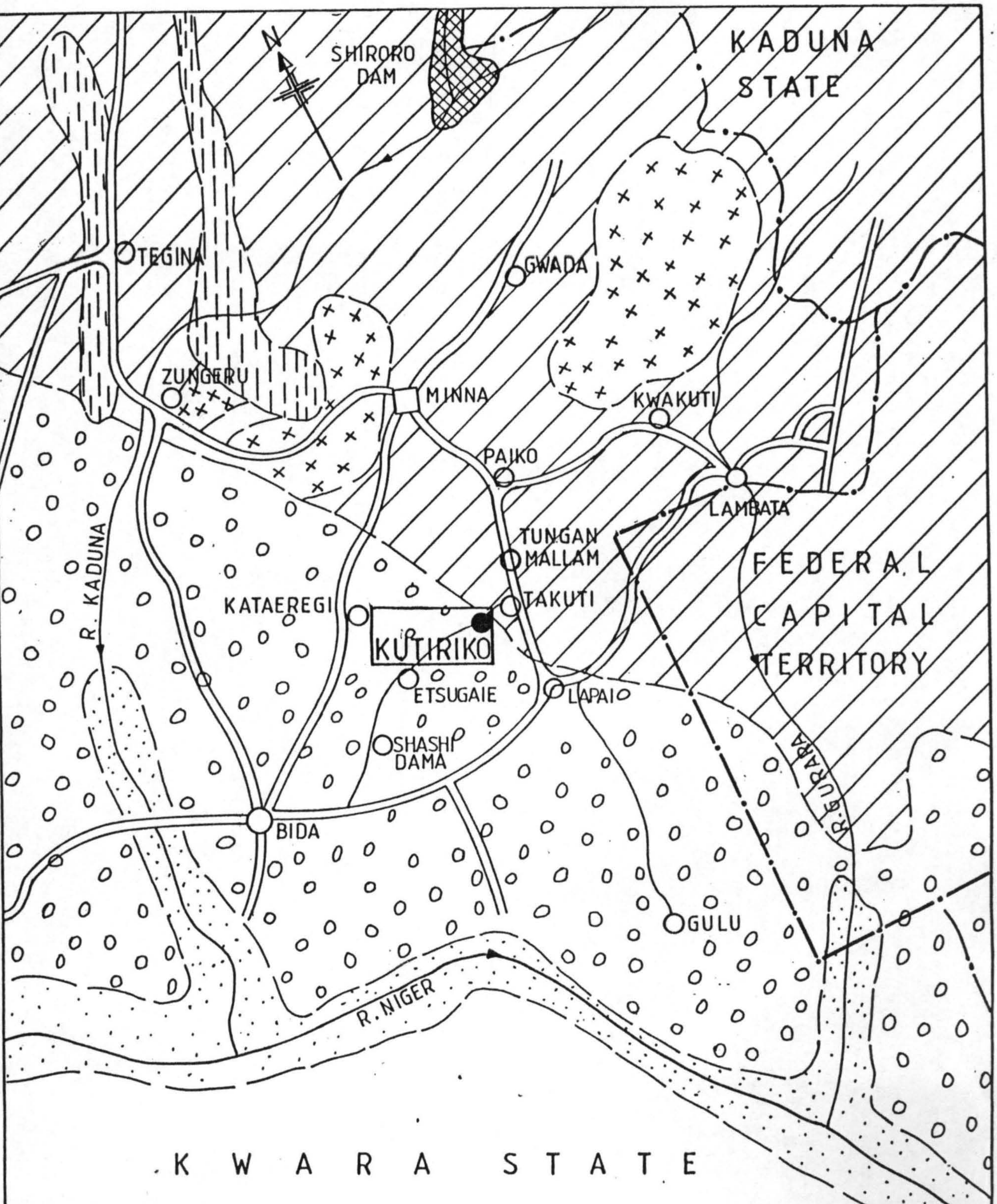

FIGURE 1

GENERAL LOCATION AND GEOLOGY
SITE 4-KUTIRIKO

ALLUVIUM	
NUPE SANDSTONE (Feldpathic Sandstone & Siltstone)	
OLDER GRANITE	
UNDIFFERENTIATED META-SEDIMENTS	
UNDIFFERENTIATED BASEMENT COMPLEX	
GEOLOGICAL BOUNDARY	
STATE BOUNDARY	
RIVER & FLOW DIRECTION	
MAJOR ROAD	
MINOR ROAD	

Biwater (Nigeria)

DATE:	PROJECT: 9003
DRAWING No 9003/6/1/R	SCALE 1:1000000
DRAWN BY: daniels	CHECKED BY: STA

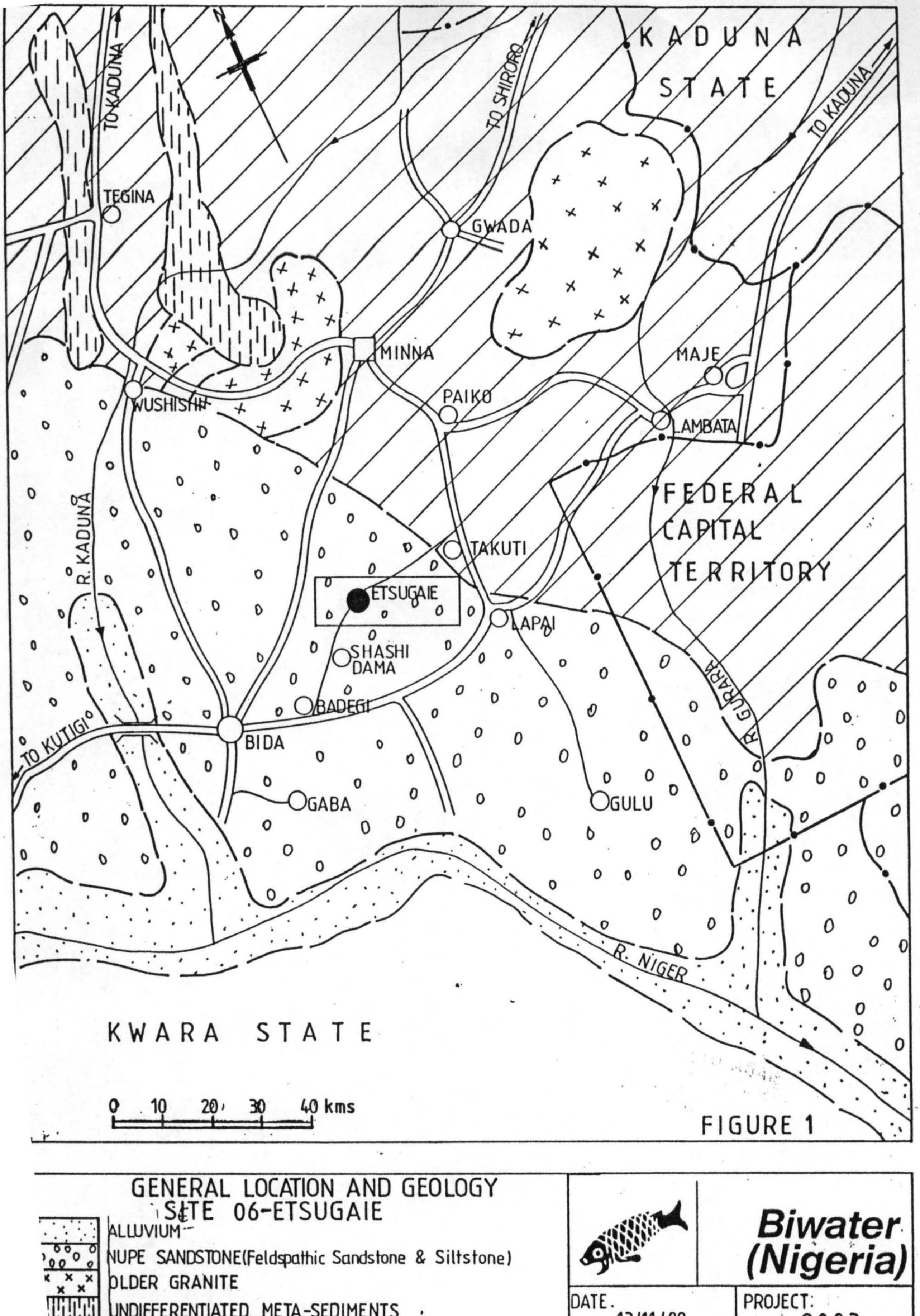

FIGURE 1

GENERAL LOCATION AND GEOLOGY SITE 06-ETSUGAIE

- ALLUVIUM
- NUPE SANDSTONE(Feldspathic Sandstone & Siltstone)
- OLDER GRANITE
- UNDIFFERENTIATED META-SEDIMENTS
- UNDIFFERENTIATED BASEMENT COMPLEX
- GEOLOGICAL BOUNDARY (infered)
- STATE BOUNDARY
- RIVER AND FLOW DIRECTION
- MAJOR ROAD
- MINOR ROAD

Biwater (Nigeria)

DATE. 13/11/89	PROJECT: 9003
DRAWING No 9003/06/1/R	SCALE 1 : 1000000
DRAWN BY: Daniels	CHECKED BY: STA