GROUND WATER RESOURCES INVESTIGATIONS

In

Bheri Zones

Western Terai, Nepal.

Prepared cooperatively by

The United States Geological Survey and the Department of Irrigation and Hydrology, Ministry of Food and Agriculture, HMG, Nepal.

Ground Water Resources Investigations in Bheri Zone, Western Terai, Nepal

by

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Contents

Tables

Abstract

This second interim report, based largely on field work from October 1972 to June 1973, describes the preliminary results of hydrologic studies and exploratory drilling to evaluate the water bearing properties of alluvial deposits underlying the Terai area of the Bheri Zone of the mid-western part of southern Nepal. The investigation and drilling were jointly undertaken by His Majesty's Goverment of Nepal (HMG)and the U.S. Agency for International Development (USAID) with technical assistance of advisors from the U.S. Geological Survey (USGH).

The Bheri Terai comprises abouth 1,800 square Kilometers of gently sloping cultivated lands and dry jungle lying between the Siwalik Hills on the north and the Indian border on the south.Monsoon rains occur from mid-June to October and the remaining months are largely dry.Most of the almost 227,500 people of the area live in villages and towns and subsist on crops grown during the monsoon and livestock. Dry season irrigation from streams and rivers is only practicable in areas nearby the major rivers.

Use of tubewells for irrigation in much of the Bheri Terai appears to present the best prospects for year-long irrigation and a three-crop economy .During the ground-water exploration operations in the Bheri area 45 test wells totalling roughly 26,500 feet were drilled on a 9-10km (Kilometers)east-west and a 5-6 Km north-south grid pattern.Aquifer tests to determine the hydraulic characteristics of the water-bearing beds were carried out at 27 selected test -well sites.

The areas where tubewells can be successfully develop for irrigation are not uniformly distributed in the Bheri Terai. Generally, the Bhabar zone and the flood plain areas of the Rapti, Babi, and Karnali Rivers are best suited to large-scale Ground-water exploitation. The central pert of the Bheri Terai presents the poorest potential for ground-water development. Aquifers occuring in the central part of the report are are relatively thin consisting of sand and gravel lenses interstratified with clay layers of variable thickness. Extensive areas with flowing artesian wells were not encountered in the Bheri Terai. Tubewells encountering positive artesian pressure are located only along the northern margins of the report area. Even though this area of positive artesian pressure is limited, successful drilling in flowing artesian zones requires the use of heavy barite based drilling mud to contain the artesian pressure until the aquifer can be fully penetrated by the drill and the well casing can be set and cemented. Without proper mud control and cementing, Wells in this zone of the report "blow out" resulting in uncontrolled flow from the annulus around the well and from the well itself.

The chemical quality of water from the artesian and semiartesian aquifers in the area is generally good and suitable with few exceptions, for domestic supply, livestock, industry, and irrigation .

Introduction

Purpose and Scope of Report

This interim report is the second of a series and summarizes date collected in the Bheri Zone during the fourth field season, extending from October 1972 to June 1973, in a project designed to explore the ground-water potential and geohydrology of the Western Terai region of Nepal. The report also presents preliminary conclusions regarding the occurrence, quantity and chemical quality of ground water in the Gangetic alluvium and Bhabar zone deposits underlying the Bheri Zone of the Western Terai region. Accompanying tabulations present part of the basic date on which a final interpretative report will be based. Although not in final form, this information will be useful to prospective users of ground water as well as to those planning large-scale tubewell irrigation projects in the area. Readers not technically grounded in the field will find the applicable basic principals of geohydrology described in the first of the report series, " Ground Water Resources Investigations in Lumbini Zone, Western Terai, Nepal. "

The present investigation of the Western Terai has been jointly sponsored by His Majesty's Government (HMG) Department of Irrigation and Hydrology, Ministry of Food and Agriculture and the United States Agency for International Devlopment (USAID). Technical advisors were assigned to the project by the United States Geological Survey (USGS).

Location and Extent of Area

The area of investigation lies entirely within the Terai section of the Bheri X Zone of Nepal and is located between 27°50' and 28°40 North latitudes and 81°15 and 82°50 ' East longitudes and includes the major part of the somewhat more extensive Banke and Bardia Districts.The area extends about 73 Kilometers east-west and ranges in width from23 to 30 Kms north-south and covers approximately 1.800 square kilometers (fig.1). the eastern limit of the Bheri Terai is marked by the Rapti River at a point where the drainage changes from east-west to south,forming a large bend, and an arbitrary line drawn northward from this point to the Siwalik Hills.This line marks the eastern boundary of the exploratory drilling although extrapolation of data from test holes on the west bank of the Rapti River indicate similar ground-water conditions for the narrow strip of flood plain east of the river in this area.

The western limit of the Bheri Terai is formed by the Karnali River, sometimes shown as the Girwa River on older maps.The northern limit lies along the base of the Siwalik Hills and the southern limit is the Nepal-Indian border.The principal towns in the area are Nepalganj and Gularia.

Economic and Cultural Features

Nepalganj,the population and economic center of the Bheri Terai, is served by a grass airstrip located 7 km west of the town .As this air field is inoperative during the monsoon,plans are extant for

construction of an all weather airport north of town. There is also a short Take-off and landing (STOL) aircraft landing field located at the Forestry Department headquarters on the Babai River in the western part of the Bheri Terai. The Indian Government railway terminates at Rupediha, adjacent to the border, about 4 Kms south of Nepalganj. There are no other transit railway entry points along the Nepal-Indian border in the report area,

Nepalganj is connected to the Indian road system by a few kilometers of surfaced road which currently (1974) ends at the northern edge of town. The 7 Kms of road exending west to the airstrip is also paved and from the end of this pavement west to Gularia the road is primarily a dirt track, although improved with small bridges and culverts. The extension of this track, east of Nepalganj, ultimately connects with the Dang Valley, in part, via the Rapti River drainge. The Government of India is constructing a link in the East-West highway system extending from Nepalganj to Butwal in the Lumbini Zone. In addition, preliminary plans for a joint HMG-USAID project to construct a road from Kohalpurwa on the East-West highway northward to the Surkhet Valley are in preparation. Gularia in the western part of the Bheri Terai is linked to India by a paved road which, however, terminates at the border. Use of this route is limited by the need to ford or ferry the Babai River, either of which proceedures can prove difficult during the monsoon. A well-maintained jeep track along the northern limit of the Bheri Terai connects Chisapani in the east to the Forestry Depertment camp on the Babai River in the west. A number of other of other north-south forest tracks are also exceptionally well-constructed and maintained

As elsewhere in the Nepal Terai, most dirt tracks are usable only in the dry season and then only by 4-wheel drive vehiclas or bullock carts. Monsoon travel off the surfaced roads is limited to travel on foot or by elephant.

The 1971 census of Nepal indicates a population of 227,500 for the Banke and Bardia Districts of the more extensive Bheri Zone. Parts of the Banke and Bardia Districts lie outside of the Terai and the concern of this report. The majority of the population, however, lives in the Terai sections of these districts. In contrast to much of the rest of the Western Terai, the population has a proportionately larger number of Moslems, a fact that is evidenced by the architectural style of many of the builings especially, in Nepalganj. The population also includes the indigenous Tharus as well as people from the mid-land and northern hills who are being re-settled in the Terai.

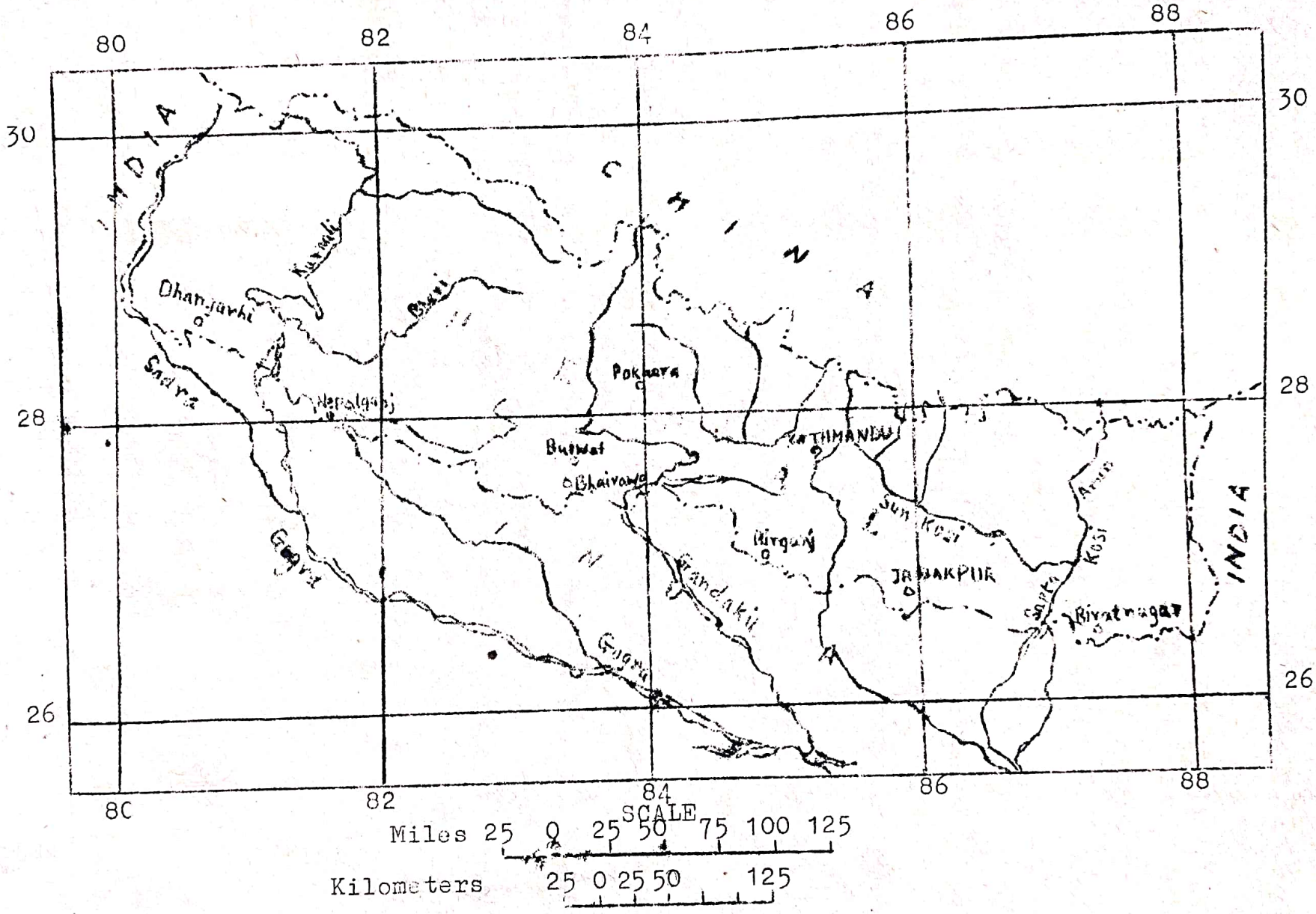

Figure 1. Map of Nepal showing the area of study

Previous Investigations

For non-hydrologists use of this report is keyed to the earlier interim report on the Lumbini Zone which describes some of the general geohydrological features of the Terai belt. As for the Lumbini Zone, the basis for planning the present investigation of the Bheri Zone was provided by W.V. Swarzenski and H.M. Babcock (1968).

Acknowledgements

This report is the product of the cooperative efforts of personnel of HMG, Ground Water Section, Department of Irrigation and Hydrology and U.S. advisors assigned to the project by US AID. It is the first result of approximately one year's field work. Project personnel in all catagories, professional, sub-professional, and administrative have each, according to his station and job, contributed to the success of the field operation. Thanks arealso due to the many government officials and private individuals who assisted from time to time in project objectives.

Géography

Topography and Drainage

The Bheri Terai is similar to Terai of the Lumbini Zone as the same basic geomorphic pattern persists. The Siwalic Hills with summit altitudes of 3,000 to 5000 feet from the northern boundary of the area. Coarse grained fluvial deposits have been laid down in the piedmont Bhabar Zone by streams debouching from these hills. The bhabar deposits form alluvial fans overlying and in part intercalated with the finer grained Gangetic alluvial deposits. Extensive Bhabar deposits occur, however, only near the Rapti, Babai, and Karnali Rivers. The same pattern of the Bhabar deposits persists in the Bheri Terai as in theLumbini Terai with large streams developing more extensive alluvial fans and smaller streams depositing small fans. The interfluvial areas between streams are often devoid of Bhabar deposits.

The Bheri Terai is traversed by three major rivers and numerous smaller rivers and streams. The Rapti River in the east drains the Rapti Valley before the westward flow swings to the south at the point where the valley merges into the Terai. The smaller Babai River flows Westward from the Dang Valley behind the Siwalik front to debouch from the hills in the mid-west of the Bheri Terai. The Karnali River, the largest river in Nepal,forms the far western limit of the Bheri Terai from the point of debouchment from the drills at Chisapani to its intersection with the Nepal-India border. Smaller rivers and streams heading in the Siwalik Hills flow only intermittently in their upper reaches south of the hills during the dry season. Flow is for the most part continous, although small, during the dry season downstream of the Bhabar Zones in the smaller rivers and streams. There are a few perennial natural lakes in the south-central and northwestern part of the Bheri Terai.

The instability of stream courses in the Nepal Terai is demonstrated by at least one classic example of stream piracy in this area. Older maps of the Bardia District show the town of Gularia on the eastern bank of the Babai River. It is presently(1974) located roughly 1 km west of the river. According to local reports sometime during the monsoon of 1960, the Babai River cut eastward to intersect a meander of a smaller stream. Consequently, the Babai now flows for a few kilometers in the captured bed of the smaller stream. This event caused the river to flow east of Gularia

although the older river channel to the westalso cerries fl w during the monsoon,effectively making an island of the town.Project personnel making a reconnaisance survey of the area were somewhat bemused until a local cultivator explained that, " it was a very old map and a very new river."

The surface Water section of the Department of Irrigation and Hydrology maintains gaging stations on the Rapti,Babai, and Karnali Rivers. Date from these stations are summarized in table 1.

Climatic Features

Meteorological stations are meintained at Nepalganj,Gularia,and chisapani on the Karnali River.Data from these stations are summarized in table 2.

Table 1.-Summary of Discharges of Major Streams in Bheri Zone, Nepal

Station	Catchment area in km	Years of Record	Max Flow in m^3/sec	Min Flow in m^3/sec	Ave Annual Discharge in m^3/sec
Karnali River at chisapani	42,890	1962-72	16,400	214	1333
Babai Nadi at Bargadaha	3,000	1967-72	16,400	2 .60	66 14
West Rapti River at Jalkundi	5,150	1964-72	2,500	1.05	99.65

Table 2- Monthly Rainfall, in millimeters, at Nepalgani, 1968-72, Gularia, 1957-72, And Chisapani (Kamala), 1953-72

Nepalgunj

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total Annual Rainfall
1968	60.2	7.6	10.0	7.0	NR	177.0	252.1	357.2	139.0	10.9	0.0	0.0	
1969	10.9	3.1	5.4	29.9	75.2	90.2	359.2	347.5	218.7	32.4	0.0	0.0	1172.5
1970	45.7	15.8	120	0.0	36.2	363.9	343.7	196.6	170.4	79.3	0.0	0.0	1263.6
1971	25.0	23.5	12.0	124.3	44.0	238.8	451.5	323.6	237.1	230.2	0.0	0.0	1707.0
1972	9.0	NIL	NIL	7.2	NIL	49.8	358.4	225.7	477.3	63.2	17.9	NIL	1206.5
Average	22.6	10.6	7.4	40.3	38.9	184.9	378.2	272.8	275.9	101.3	4.5	0.0	1337.4

Gularia

1957	29.7	NIL	83.9	5.1	12.7	144.3	477.9	399.8	142.6	13.7	4.1	7.2	1321.0
1958	40.5	2.3	1.3	36.4	21.8	19.5	383.3	665.4	104.0	112.2	NIL	30.2	1417.6
1959	102.9	35.6	28.5	33.6	86.3	234.7	272.2	291.6	165.1	90.9	2.3	NIL	1343.7
1960	NIL	NIL	93.5	NIL	8.4	124.7	545.0	335.3	347.4	236.5	NIL	NIL	1090.8
1961	63.9	157.0	NIL	3.2	32.0	213.9	386.4	365.7	213.1	250.3	NIL	50.4	1715.9
1962	47.6	5.6	43.4	NIL	NIL	41.8	94.3	196.7	200.6	NIL	NIL	2.5	632.5
1963	4.8	1.0	23.2	3.0	29.4	83.0	220.1	786.7	91.9	3.0	3.8	1.0	1250.9
1964	NIL	3.0	4.5	12.6	101.0	116.7	305.9	146.9	349.3	4.2	NIL	18.9	1063.0
1965	19.0	1.0	15.1	9.9	NIL	78.2	113.0	234.8	236.2	95.0	NIL	NIL	802.2
1966	43.8	NR	NR	NIL	8.7	152.0	326.4	179.4	64.6	38.6	9.4	0.6	
1967	0.0	0.0	30.8	4.6	13.6	120.8	312.4	376.2	139.0	0.0	0.0	12.2	1009.7
1968	13.6	17.0	0.0	16.0	2.0	237.1	566.9	417.8	366.6	0.0	0.0	0.0	1637.0
1969	18.0	10.0	3.0	13.2	69.0	82.6	434.6	603.0	246.2	0.0	0.0	0.0	1479.6
1970	54.0	2.0	33.5	0.0	64.0	430.0	404.2	223.8	139.0	46.0	0.0	0.0	1396.5
1971	NR 1/	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
1972	NIL	NIL	0.5	2.6	1.0	770.0	493.7	158.3	481.2	48.5	14.8	1.1	1971.7
Average	28.1	15.3	25.8	10.0	31.5	192.7	357.8	371.6	230.2	64.4	1.8	8.8	1338.0

1/ Indicates no records available.

Table 2 - continued.

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total Annual Rainfall
						Chisapani(Karnali)							
*1963	NR	NR	54.9	0.1	59.5	235.0	701.7	669.7	235.6	31.2	11.7	11.4	
1964	2.7	13.4	31.7	23.2	64.1	268.7	1093.3	354.5	512.6	26.6	NIL	23.4	2414.2
1965	35.3	4.8	38.6	21.6	NIL	127.7	489.8	808.7	384.3	53.8	34.5	NIL	1999.1
1966	16.8	14.8	NIL	NIL	34.2	328.8	575.8	848.8	181.5	59.8	4.8	13.8	2078.4
1967	0.0	0.0	54.2	9.2	9.2	175.2	785.6	507.8	401.3	3.8	0.0	33.4	1979.7
1968	139.8	18.6	16.1	20.8	3.6	442.0	690.9	619.2	339.8	49.3	0.0	23.1	2363.2
1969	9.9	10.7	16.8	19.6	41.6	232.5	695.0	596.7	508.7	23.4	0.0	0.0	2156.9
1970	63.0	17.6	22.1	3.8	74.9	538.0	756.3	364.9	217.6	41.2	0.0	0.0	2099.4
1971	18.5	50.1	39.6	184.6	157.5	609.3	575.8	596.7	395.8	107.7	32.8	1.3	2769.7
1972	1.3	114.2	2.8	18.5	30.7	91.0	755.0	604.2	510.2	29.5	7.6	0.3	2165.1
Average	31.9	27.1	24.7	33.5	46.2	312.8	712.9	589.1	383.5	43.9	8.9	10.6	2225.1

Rains tend to start later and be less intense as the monsoon moves westward across the Nepal Terai. Consequently, the Bheri Terai receives somewhat less rainfall than the Lumbini Terai although the same climatological patterns persist peraist. The monsoon rains start in June and end in September and only scattered rains occur during the remaining months of the year. Comparative date from Chisapani, Nepalganj and Gularia indicate higher average rainfall near the siwalik front than along the Indian border.

Agriculture and Industry

Most of the population of the Bheri Zone is engaged in agriculture or agriculturally related occupations.Probably some what more than 50 percent of the Bheri Terai,however,is covered by commercial forest which is currently (1974) the subject of an intense management study by the HMG Department of Forestry and the United Nation.Additionally,a Royal Game Preserve cocupies the northwestern sector of the report area.

Most existing irrigation systems in the Bheri Terai are based on stream flow. A canal system built by HMG to irrigate the area north of and immediately surrounding Nepalganj utiliz s flow from the Dudwa River.The amount of water available during the dry season,however,is insufficient to service the system. The system also suffers considerable loss of water immediately south of the headworks where the canals pass over sandy ground.

Roughly 12 tubewells have been drilled by the re-settlement authority in a new farm coplex west of Nepalganj .Whereas many of these wells have good yields,most have yet to be equipped with pump and are idle at present.

An area a few kilometers wide east and west of the Babai River is served by the most successful minor irrigation system based on stream flow yet observed in the Bheri Terai. Interestingly this system has resulted almost entirely from communal efforts of local cultivators.In late March or early May each perticipation village is assessed a proportional levee of labor to construct a temporary barrage across the Babi River at the point where the river leaves the Siwalik Hills. The workers arrive"enmasse" at the temporary construction camp and proceed to build a diversion dam of sticks logs and stones .The downstream distribution system was also built by local cultivators.When flow is diverted into the distribution system,

the control area east and west of the river becomes a maize of flowing canals. For the most part, when first available, the water is not utilized for irrigation, but is used instead for fire control and preparation of fields for paddy.

As might be expected, the three major rivers draining the Bheri Terai Yield considerable quantities of fish. Fishing rights in these rivers are regulated by a government agreement with the principal contractor, who sub-licenses individual fishermen. The contractor takes advantage of weather conditions to supply Nepalganj with fresh fish from the Rapti River as to solve the "refrigeration" problem and avoid spoilage. Netting begins far up stream in the cold season and fish are transported to market by horse caravan taking as much as 2 days in transit. As the weather warms up, fishing oprations move downstream nearer to Nepalganj and hauling distances to market become progressively shorter. During the very hot weather, fishing operations are confined to river pools directly west of Nepalganj only a short 6 to 8 km distance from market.

Major industries of the Bheri include the match factory and sugar mill at Nepalganj and also a factory manufacturing "Catch" and "Khair" located on the southern edge of town. Rice and oil seed mills are among the local minor industries.

Well Numbering System

The test wells in the Bheri Terai were drilled on a grid roughly 9 to 10 km east-west and 5 to 6 km north-south, although, for reason of access to sites, there are exceptions to this spacing. Numbering begins in the south-east corner of the report area and wells are numbered serially from south to north on each line. The six grid lines, in turn are numbered serially from east to west. For example, well 3/4 at the Agricultural Research Farm is the third well north of the southern most drill site on the third grid line west of the eastern boundary of the area. Test well locations are shown in figure 2.

Table 3 is a cross reference between test well numbers used in this report and test well numbers used to file records in the HMG, Department of Irrigation and Hydrology and USAID/ Kathmandu. The file numbers reflect the chronology of the drilling program. for example, HD 1/2 in the

Table 3. Cross-refence of Test Hole Numbers

Report and File Numbers

Report No.	File No.	Report No.	File No.	Report No.	File No.
1/1	HD1-4	2/8	HD2-7	4/1	NB-11
1/2	HD2-4	2/9	NB-21	4/2	HD2-9
1/3	HD2-6	2/10	HD1-2	4/3	NB-12
1/4	HD2-5	2/11	NB-1	4/4	NB-13
1/5	HD2-3	2/12	HD1-3	4/5	NB-14
1/6	HD1-7	3/1	NB-6	5/1	HD1-8
1/7	HD4-6	3/2	NB-20	5/2	HD2-10
1/8	HD1-5	3/3	NB-7	5/3	NB-18
2/1	HD1-1	3/4	NB-3	5/4	NB-19
2/2	NB-22	3/5	NB-4	5/5	HD2-13
2/3	NB-23	3/6	NB-5	5/6	HD1-9
2/4	HD2-14	3/7	NB-8	6/1	NB-16
2/5	ICM	3/8	NB-9	6/2	NB-17
2/6	NB-2	3/9	NB-10	6/3	HD2-11
2/7	HD2-2	3/10	HD2-8	6/4	HD1-10
				6/5	HD2-11

HD1 = Hydrlogy Department Rig 1

HD2 = Hydrology Department Rig 2

NB = N. B. Tubewells

Geohydrology

The northern limt of the Bhabri Terai lies along the base of the Siwalik Hills. Rocks exposed by streams cutting though the Siwalik Hills consist of interbedd d fine-grained sandstone with clay vugs, shale, conglomenr t e and freshwater limestone all of the Siwalik formation of l te Teriary age. The rocks dip ge erally northward. The Siwalkm beds east of the report area in the Rapti and Dang Valleys form large anticlines with the east-west Oriented axes along the erode valley floors. Smaller anticlines also occur north of Nepelganj on the Kohalpurwa - Surkhet road alignment . The siwalik Hills form the outermost folded belt of the Himalaya . The rocks of Siwalik Formation provide the source of most of the stream-deposited alluvial materials underlying the Bhabar zone and the contiguous Gangetic plain immediately to the south . Also the larger rivers crossing the Bhabri Terai have transported and deposited alluvium derived from older metamorphic rocks of the Mahabharat Range.

The Bhaba r zone deposits and Gangetic alluvium south of the siwalik Hills contain the principal aquifers of the Bhabri Terai. The deepest test holes in the Bhabri Terai ($2/_{11}$ and 33)penetrated unconsolidated deposits of fluvial origin throughout the entire 1.500 foot depths drilled. Siwalik bedrock was not encountered in any of the test holes. The alluvium appears to be of considerable thickness even near the contact with the Siwalik Formation, possibly indicating a westward extension of the hinge-line fault postul te d the Inchimi Fo e along the southern base of Siwalik Hills.

The Bhabar zone deposits consist of boulder, cobble, and pebble gravel and coarse and interbedded with some silt and clay. In the Bhabri Zone, the Bhabar deposit occur in broad alluvial fans extending downstream from the points where streams debouch from the Siwalik Hills except along the Rapti and Karnali Rivers. Along these major rivers, the Bhabar deposits are much more extensive and , in the case of the Karnali, blanket the flood plain as far downstream as the Nepal-Indian border and beyond. The Bhabar deposits contain large quantities of ground water and properly constructed wells in these deposits produce large yields. Bhabar deposits provide intake zones of recharge to the ground -water system and are much more extensive in the case of the Karnali, blanket the flood plain as far downstream as the Nepal-Indian border and beyond . The Bhabar deposits contain large quantiti

of ground water and properly constructed wells in these deposits produce large yields. Bhabar deposits provide intake zones of recharge to the ground-water system and are much more extensive in the Bheri Terai than the Lumbini Terai.

The Gangetic alluvium interfingering with, underlying, and bordering the Bhabar zone deposits consist of intercalated lenticular beds of silt clay, sand, and pebble gravel. In the interfluvial areas near the Siwalik foothills the proportion of silt and clay is greater than that of sand and grovel. The Gangetic alluvium constitutes roughly 70 to 80 percent of the bulk of the deposits underlying the Bheri Terai, The beds dip gently to the south and are contiguous with Gangetic alluvium of India.

As in the Lumbini Terai, the thickness and areal extent of aquifers in the Bheri Terai appears to be controlled by an ancient drainage pattern which is a subsurface reflection of the present drainge pattern. Aquifers underlying the present-day river flood plains are the thickest and most coarse-grained. Elsewhere in the Bheri Terai, aquifers are thinner and cosist generally of medium to fine sand.

Water in the Bhabar deposits occurs under both water-table and semi-confined conditions whereas water in the Gangetic alluvium generally occurs under confined conditions. Although confined, aquifers in the alluvium are seldom under sufficient head to yield artesian flow in tubewells at land surface. Only a small zone of artesian flow was encountered in the north-eastern part of the report area. Tubewells penetrating aquifers elsewhere in the Bheri Terai within the alluvium do not flow although the potentiometric surface is often near land surface.

Figure 6 shows areas of high and low potential for yields from tubewells and also of flowing and non-flowing artesian conditions. Generally, wells in the eastern, mid-western, and western parts of the Bheri Terai have higher yields and greater transmissivities than elsewhere, Wells tapping aquifers in the Bhabar deposits have the highest yields. In the central part of the Bheri Terai, yields tend to be less and the aquifers and finer grained than elsewhere in the area.

Exploratory Drilling

Exploratory drilling operations in the Bheri Zone were started in mid-November 1972 utilizing both of the Department of Irrigation and Hydrology drilling rigs, The first test hole 2/1 at Jamunaha was drilled to 1,000 feet and cased and screened to 435 feet. The entire operation required something less than 6 days for completion, a record in the annuals of drilling in Nepal. The drilling contractor arrived in December 1972 and commenced operations with a 1,500-foot hole at kohalpurwa , 2/11 . Subsequently, and until the end of seasonal drilling operations in mid-June 1973, a total of 45 test wells were put down for an aggregate footage of about 26,500 feet . Ten of the test wells penetrated to depths of 1,500 feet or more, of which two reached a depth of 1,500 feet The remaining wells averaged about 500 feet in depth.

The department of Irrigation and Hydrology drilling rigs, Operated by Nepali personnel, completed 23 test holes, including several drilled by the slower more difficult percussion method, whereas the contractor completed 22 test holes. These figures suggest a significant improvement in the HMG rigs and personnel when compared to provious seasons' results. The Ground Water Section thus appears able to carry on drilling operations without further technical assistance.

On the base line north and south of Nepalganj 11 wells were constructed. Five or more test holes were drilled on each of the remaining grid lines. Forty three of the test holes are cased and screened, of which 8 were used as producing wells for aquifer tests .The remaining wells were incorporated into the observation well network. Atresian pressure sufficient for flow at the land surface was encountered in only two test, at Udai, 1/8 and Thukali, 2/2 which are the northernmost holes on grid lines 1 and 2, respectively. Drilling operation were completed by mid-June 1973.

Aquifer Tests

Two major hydraulic characteristics that affect the development of an aquifer are its ability to transmit water and its capacity to yield water from storage. These charcteristics, which affect the water levels or artesian pressures and yields of tubewells, are called the transmissivity, first

defined by Theis (Ferris and others, 1962,P.72-73),and storage coefficient (Ferris and lothers, 1962,P 74-78),respectively.More recently the se terms have been redefined by Lohman and others (1972).When these aquifer characteristics are Known for an aquifer or part of an aquifer,it is possible to forecast approximate water-level of artesian pressure trends at different rates of withdrawal from producing tubewells.

To establish the transmissivities and storage coefficient of aquifers in the Bheri Terai,27 aquifer tests were made at selected sites.The tests were made on both flowing artesian and noon-flowing (subartesian)tubewells. The results of these tests are summarized in table 5 and are described in more detail in the following pages.

Piprahwa Site - An aquifer test using the Theis single well recovery method was conducted on tubewell 1/1,on February 1 and 2 to determine the transmissivity of the water-bearing formation. The tubewell,screened in coarse gravel and sand from 112 to 139 feet ,was pumped at 63 gpm (gallons per minute) for a period of 24 hours with a total drawdown of 3.2 feet. The plotted recery curve indicated an initial transmissivity of 42,200Gpd/ ft (gallons per day per foot) .After 50 minutes of pumping the slope of the curve altered indicating a possible hydrologic recharge boundary. The apparent transmissivity increased to 138,600 gpd/ft, This tubewell is located near the West Rapti river and may have intercepted the underflow of the river.

Daspurwa Site - Tubewell 1/2 , drilled on the flood plain of the West Rapti River was screened in coarse gravel with intermixed cobbles and pebbles from 41 to 49 feet. The tubewell was pumped at 59 gpm for 24 hours with a total drawdown of 1.2 feet. The plotted theis recovery curve indicated a very high transmissivity of 250,800 gpd/ft.This is a relatively high value but is considered of the right magnitude owing to the coarse texture of the Bhaber deposits and the thickness of the aquifer which may exceed 200 feet.

Halbalioli Site - A single well aquifer test,using the Theis recovery method,was conducted on tubewell 1/ near Halbalioli on January 21,1973. The tubewell,screened in coarse gravel and sand from 202 to 212 feet,was pumped at 53 gpm for 24 hours. The plotted recovery curve indicated an initial transmissivity of 26,600 gpd/ft,however,after about 50minutes of

pumping the slop of the curve altered indicating a possible hydrologic recharge boundary. The apparent transmissivity increased to 123,900gpd/ft This tubewell,like the one near Prahaw is located near the flood plain of hte West Rapti River.

Kandi Site - On June 29 and 30,1973 an aquifer test was conducted using two-flowing artesian tubewells near Kandi. Tubewell 1/5,screened in coarse sand and gravel from 374 to 395 feet,was pumped for 24 hours at 56 gpm. During this period the potentiometric surface declined 1.05 feet in observation well 1/6 located 30 feet away. The recovery rate coincided with drawdown to indicate a moderately high transmissivity in the range of 43, 500 to 56,800 gpd/ft. The storage coefficient ranged from 1.42 X 10-3 to 1. 11 X 10-3 . The hydraulic characteristics were compted using the Theis non-equlibrium and Cooper-Jacobs modified formulas.

Although the tubewells near Kandi are also located relatively near the Rapti River, they were screened in a deeper aquifer and may not intercept recharge from the river.

Manda Site - The Theis recovery method was used to determine the transmissivity of the aquifer penetrated by tubewell 1/7 at Manda.Tubewell 1/7 , screened in sand and fine gravel from 235 to 255 feet,was pumped for 24 hours at 35 gpm with a drawdown of 2. 16 feet. The plotted recovery indicated an average transmissivity of 26,400 gpm/ft.

Udai Site - An aquifer test was made on the flowing artesian well 1/8, near Udai on March 3,1973 . The well screened in sand and gravel from 209-226 feet,flowed for 44 hours at 140 gpm with a pressure decline of 6.2 feet.The plotted recovery by the Theis recovery method indicated a transmissivity of 18,500 gpd/ft, which is the average to low range .

Jamunaha Sita - The aquifer test conducted on tubewell 2/1,near Jamunaha, indicated a high transmissivity of 132,00 gpd/ft using the This recovery method . Tubewell 2/1 screened in gravel and coarse sand ,was pumped for 46 hours at 40 gpm with a total drawdown of 1.2 feet. The specific capacity of the well was 33 gallons per foot of drawdown .

Panchayat Training Center Site - The aquifer test conducted on tubewells 2/2 and 2/3 at the Panchayat Training Center indicated an average to low range of transmissivity. Tubewell 2/3, screened in a fine to medium sand with siltstone gravel from 141 to 160 feet,was pumped for 24

hours at 270 gpm with a drawdown of 40 feet. During this period the potentiometric surface declined 19.2 feet in observation well 2/2 located 50 feet away. The recovery rate coincided with drawdown to indicate a transmissivity in the range of 17,300 to 21,000 gpd/ft and a storage coefficient in the range of 2.59 x 10-4 to 1.39 x 10-6 . The hydraulic charcteristics of the aquifer were computed using the Theis non-equillbrium and Cooper -Jacobs modified formulas.

Police and Army Training Center Sites - Single well recovery tests indicate that the aquifers in this area north of Nepalganj have low transmissivities. On April 1.197 3 tubewell 2/6, at the Police Training Center, sereened in fine to medium sand from 326 to 34 feet, was pumped for 27 hours at 36 gpm with a drawown of 14.4 feet indicating a specific capacity 2.5 gallons per foot of drawdown. The plotted data indicated a low transmis ivity of 8,700 gpd/ft . Tubewell 2/9 at the Army Training Camp was pumped for 24 hours at 35 gpm with a total drawdown of 4.5 feet and a specific capacity of 7.9 gallons per foot of drawdown. The plotted data indicated a possible transmissivity of 15,600 gpd/ft using the Theis recovery method. This well was screened in multiple aquifers of fine to medium sand with some siltstone gravel from 154 to 162,255 to 270, and 378 to 391 feet to determine if the yield could be appreciably increased by tapping multiple water-bearing zones. A comparison of the charcteristics of the above two wells suggests that increased yields can be obtained by screening multiply aquifers.

Thukali Site -Tubewell 2/ 12 a flowing artesian well near Thukali, which had a static head of 21.5 feet above land suface ,was allowed to flow for 24 hours . at 63 gpm with a pressure decline of 0.95 feet. The plotted recovery indicated an anomoly in the date from 11 minutes to 200 minutes after the well was shut in. After 200 minutes the slope of the curve returned to correspond to that of the first 11 minutes. The computed transmissivity values ranged from 110,000 gpd/ft for the first and third limbs to 32,000 for the midle limb of the plotted curves. Using an average slope the transmissivity was computed at about 49,000 gpd/ft . Data from single well recov ry test is not sufficient to determine the cause of the anomoly. The aquifer characteristics, however, fall within the moderately high range and could be considered satisfactory for irrigation use.

Sainik Goan Site- The aquifer test conducted on tubewells 5"1 and 5/2 at Sainik Goan indicates a relatively low to averge transmissivity of 16,000 to 18,900 gpd/ft. Tubewell 3/1 was pumped at 40 gpm for 24 hours with a drawdown of 5.5 feet. The measured decline in the water level (Potentiometric surface) in the observation well 3/2, 50 feet away was 3.27 feet after 24 hours. Both wells were screened in medium to coarse sand with fine gravel from 142 to 172 feet. The computed storage coefficients were 2.95×10^{-4} and 2.35×10^{-4}. The hydraulic coefficients were computed using the Theis non-equilibrium and Cooper Jacobs modified formulas.

Odarapur Site - The aquifer test made on tubewell 3/3 near Odarapur suggest that the water-bearing formations in this area have a very low transmissivity. Tubewell 3/3, screened in fine to medium sand from 191 to 211 feet, was pumped at 37 gpm for 24 hours with a total drawdown of 56.6 feet. The plotted data indicated a very low transmissivity of 2,100 gpd/ft using the Theis recovery formula.

The sediments in this areas are generally fine textured, which could result in poorer hydraulic characteristics. Improper well development of the finer sediments may also have contributed to the unusually low values.

Agriculture Research Farm Site - Two aquifer tests were conducted at the Agriculture Research Farm on February 8 to 12, 1973 on separate zones. Tubewell 3/5 screened in medium to coarse sand with gravel from 305 to 380 and 400 to 418 feet, was pumped for 28 hours at 350 gpm with a drawdown of 21.5 feet. The measured decline in the water level in the observation well 3/6, 75 feet away was 9.5 feet. The recovery rate coincided with the drawdown to indicate an average to moderately high transmissivity of 29,400 to 36,900 gpd /ft. The indicated storage coefficients range from 2.86×10^{-4} to 3.97×10^{-4}. The Theis and Cooper-Jacobs methods were used to compute the hydraulic characteristics of the aquifer.

Tubewell 3/4, a shallow well screened in fine to medium sand from 100 to 119 ft, was pumped for 24 hours at 44 gpm with a drawdown of 43.8 feet. The Theis recovery method indicated a very low transmissivity value of 4,600 gpd/ft. This low transmissivity and the low

specific capacity of I gallon per foot of drawdown suggests that the shallow aquifers in this area will not produce enough water to sustain irrigation wells.

Modaha Site - The multiple well aquifer test conducted using tube wells 3/8 and 3/9 at Modaha on March 19,1973 indicated an average range of values of transmissivity. Tubewell 3/8, screened in sand and gravel from 190 to 238 feet, was pumped for 24 hours at 53 gpm with a total drawdown of 14.4 feet. During this period the measured decline in the water level in observation well 3/9, 50 feet away, was 3.3 feet. The recovery rate coincided with drawdownto indicate a transmissivity of 22,270 and storage coefficient of $4,66 \times 10^{-3}$ by the Theis non-equilibrium formula and a transmissivity value of 23,650 and storage coefficient of 4.55×10^{-4} using the Cooper-Jacobs modified formula.

A possible hydrologic boundary was encountered after 120 minutes at a distance of 547 feet from the observation well. The direction of the boundary could not be determined without additional observation wells. There is no surface indication of the boundary condition. Boundary conditions, however, could result from lithologic change within the formation or change in permeability of the aquifer in one or more directions. After encountering the anamoly the apparent transmissivity rate declined to 10,600 gpd/ft.

Amohia Site- The Theis single well recovery method was used to determine the transmissivity of the aquifer penetrated by tubewell 3/10 at Amohia. Tubewell 3/10 , screened in gravel and sand from 497 to 517 feet, was pumped for 24 fours at 53 gpm with a total drawdown of 8.7 feet. The plotted recovery data indicated a low transmissivity of 6.030 gpd/ft.

Kanthapur Site - The aquifer test conducted on tubewell 4/1 near Kanthapur indicated an average to moderately high transmissivity of 35,450 gpd/ft using the Theis recovery method. Tubewell 4/1, screened in medium sand with gravel from 380 to 428 feet, was pumped for 24 hours at 47 gpm with a drawdown of 4.1 feet.

Daurah Site - At Daurah a test by the Theis recovery method was made on tubewell 4/2 which was screened from 356 to 401 feet in fine to medium sand with gravel. The well was pumped for 24 hours at 47 gpm with a drawdown of 21 feet. The plotted data indicated a releatively low transmissivity of 13,860 gpd/ft.

Dhakela Site - On March 3, 1973 a multiple well aquifer test was conducted at Dhakela at the northern limit of the Bheri Terai near the foothills. Tubewell 4/5, screened in coarse gravel with sand and pebbles for 135 to 145 feet, was pumped at 360 gpm for 24 hours with a total drawdown of 22.3 feet. The water level in observation well 4/4, located 50 feet away, declined 8.5 feet during the pumping period. The hydraulic characteristic, computed using the Theis non-equilibrium and Cooper-Jacobs modified formulas, indicate a moderately high transmissivity in the range of 48,900 to 63,000 gpd/ft and storage coefficient of 3.07×10^{-4} to 1.53×10^{-5}.

The coarse texture of the deposits and the relatively shallow depth of the aquifer suggest that this tubewell may be near the southern limit of the Bhabar zone.

Indrapur Site - The Theis single well recovery test conducted on tubewell 5/1 near Indrapur indicated a transmissivity of 73,000 gpd/ft. The well, screened in gravel with sand from 410 to 426 feet, was pumped for 24 hours at 47 gpm with a drawdown of 5.0 feet.

Belbhar Site - Tubewell 5/4 near Belbhar was pumped for 24 hours at 310 gpm with a drawdown of 38.4 feet. The water level in observation well 5/3, 50 feet away, declined 14.3 feet. Both wells were screened in sand and gravel from 228 to 248 feet. The recovery rate coincided with drawdown to indicate an average to moderately high transmissivity of 29,100 to 35,600 gpd/ft. The storage coefficient ranged from 1.06 x10-3 to 2.5 x 10-5 . The hydraulic characteristics of the aquifer were computed by the Thies and Cooper-Jacob's modifief formulas.

Tubewell 5/2, screened in a slightly deeper zone from 260 to 290 feet, was pumped for 24 hours at 47 gpm with a drawdown of 6.8 feet. The plotted data indicated a transmissivity of 17,300 gpd /ft using the Theis recovery method.

Jabdahawa Site - The single well recovery test on tubewell 5/5 indicated an average to low transmissivity value. The well was pumped for 14 hours at 47 gpm with a drawdown of 6.2 feet. The plotted data indicated a transmissivity value of 19,600 gpd/ft.

Taratal Site - The aquifer test conducted at Taratal indicates a transmissivity in the high range for this area. Tubewell 6/1 was pumped for 12 hours at 44 gpm with a drawdownof 1.5 feet. The measured decline of the water level in observation well 6/2, 50 feet away stabilized at 0.40 feet after about 50 minutes. The recovery rate coincided with the drawdown to indicate a transmissivity ranging from 68,300 to 100,800 gpd/ft and storage coefficients of 1.17×10^{-4} to 2.07×10^{-4}. Both wells were screened in very coarse gravel with sand and pebbles.

After about 50 minutes of pumping the plotted curve of the observation well altered and flattened out suggesting a hydrologic recharge boundary of equilibrium conditions. Likewise it took only about 50 minutes for the observation well to recover. The anomaly was encountered at a distance of 1,075 feet from the observation well. The direction of the boundary could not be determined with only one observation well, however, surface observations suggest that recharge could be coming from the Karnali River flood plain located less than 2 km to the west.

The results of this test may only be approximate, owing to the relatively low yield of the test pump and the minimal effects recorded in the observations well, however, the hydraulic characteristics are believed to be of the proper magnitude.

Belwa Site - A theis recovery test made on tubewell 6/3 at Belwa indicated a high transmissivity of 85,100 gpd /ft. Tubewell 6/3, screened in coarse gravel with sand and pebbles from 259 to 276 feet, was pumped for 24 hour at 38 gpm with a total drawdown of only 0.95 ft.

Bhurkia Site - Tubewell 6/5 near Bhurkia, screened in gravel and sand from 224 to 255 feet, was pumped at 47 gpm for 24 hours with a drawdown of 2.70 feet. The plotted recovery data indicated a relatively high transmissivity value of 66,500 gpd/ft using the Theis recovery formula.

Well Interference and Spacing

In areas of artesian pressure, especially where the confined water is just beginning to be utilized, it is beneficial for the water economy to space tubewells to maintain optimum yields with minimum interference effects between wells. Failure to space wells properly results in premature decline of artesian pressure and loose of free flow in the tubewells. It is equally important in areas of non-flow to space wells so as to minimize decline of water levels and concurrent increased pumping lifts. The hydraulic characteristics and other hydrological data obtained from the aquifer tests indicate a wide range in the water yielding capacity of the aquifers of the Bheri Terai. Using data obtained from the aquifer tests it is possible to estimate approximately how long a well will flow or can be pumped at a given rate and also what the interference effects will be with respect to nearby tubewells in the same area.

Relatively samll effects were noticed in the tubewells tested in the western part of the Bheri Terai near the Karnali River where the artesian aquifers have a high transmissivity. Near Taratal, 6/1, a single well pumped at the rate of 500 gpm would cause a decline in artesian head, or the potentiometric surface, of 13.67 feet at a distance of 10 feet from the tubewell after 2,000 days(approximately 3 years). After pumping for 10,000 days at the same rate, the total decline would be 15.2 feet (fig.3) . If the discharge were increased to 1,000 gpm, however, the decline in water level or head at a distance of 10 feet from the tubewell would be 27.4 feet after 1,000 days of continuous pumping.

Single producing tubewells are not the rule, however, in any given area. More commonly tubewells are clustered in groups of tow or more so that the head in any one tubewell is the sum of its own drawdown, plus interference effects of other producing tubewells nearby. Graphs (fig.4) have been constructed using a method (Lang, 1961) that modifies the Theis non-equilibrium formula. This method helps resolve problems related to the proper spacing of two tubewells of the same construction and yield that tap a common aquifer. Thus, two

tubewells near Taratal each pumping at 100 gpm would have a combined pressure decline of 4.75 feet if spaced 1,000 feet apart or 4.1 feet if located 10,000 feet from each other when pumping continuously for 100 days. Likewise, if the discharge of the wells were increased to 1,000 gpm the combined pressure decline in each tubewell would be 47.5 feet if spaced 1,000 feet apart or 41.0 feet if spaced 10,000 feet apart. As shown above the total decline in head resulting from prolonged discharge will be the sum total of the interference figur- of all wells within the area of influence of each well. The pressure decling can be minimized by optimum spacing of wells and the judic-ious use of water. In other areas where the transmissivities are near 100,000 gpd/ft such as Belwa (6/3), Bhurkia (6/5) Indrapur (5/6) and Jamunaha (2/1) the decline in pressure head would be very similar to those described above. Relatively shallow tubewells, drilled near the flood plain of the major antecedent streams, such as tubewell 1/1 at Piprahawa and 1/4 near Halbaldoli, may exhibit similar characteristics after pumping for a short imme, owing to recharge from the streams.

Aquifer tests conducted at Kamdi, wells 1/5 and 1/6 and Dhakela wells 4/4 and 4/5, indicate moderately high transmissivities of about 50,000 gpd/ft$^{1}_{2}$ The estimated decline inhead that would result 10 feet. from tubewell 1/5 near Kamdi, yielding a constant 500 gpm, would be about 21.9 feet after 1,000 days. Likewise if the discharge were increased to 1,000 gpm the decline in head would be 43.8 ft. The predicted interference between two indentical wells in this area pumping at 100 gpm continuously for 100 days would be 7.42 feet if spaced 1,000 feet apart.

Near Dhakela, the estimated decline in head that would result 10 feet from the tubewell 4/5 yielding a constant 200 gpm, would be about 8.44 feet after 1,000 days of pumping. The predicted interfer-ence between two indentical wells in this area pumping at 100 gpm continuously for 100 days would be 7.04 feet is ppaced 1,000 feet apart and 6.3 feet if spaced 10,000 feet apart. Similar conditions are probably applicable in the area around Thukali, tubewell 2/12, along the northern boundary of the Bheri Terai.

The aquifer test conducted at the Agriculture Research Farm on tubewells 3/5 and 3/6 indicated transmissivity values of about 37,000 gpd/ft. The estimated decline in head that would result 10 feet from a single tubewell yielding a constant 500 gpm would be about 29.5 feet after 1,000 days of pumping. Likewise if the yield were increased to 1,000 gpm the decline in head would be 59.1 ft. The predicted interference between two identical wells in this area pumping at 100 gpm continuously for 100 days would be 9.64 feet. if spaced 1,000 feet apart or 8.2 feet is spaced 10,000 feet apart. If the pumping rate were increased to 500 gpm in each well the combined decline in head in each tubewell would be 48.2 feet if spaced 1,000 feet apart or 40.9 feet if spaced 10,000 feet apart. It is evident then that the spacing of wells should be greater near the Agriculture Farm than in areas having higher transmissivity values. The same conditions are also probably applicable in areas near Kanthapur well 4/1 and west of Piprahawa well 1/1.

Aquifer tests conducted on tubewells near Modaha 3/8 and 3/9 and Belbhar 5/3 and 5/4 indicate transmissivities in the average range of 20,000 to 30,000 gpd/ft. The sestimated becline in head that would result 10 feet from tubewell 3/8, near Modaha, yeilding a constant 200' gpm would be about 19.0 feet after 1,000 days, A Single well, near Belbhar, pumping at a constant rate of 100 gpm would have an estimated decline in head of about 7.3 feet after 1,000 days . The predicted interference between two identical wells in each of these areas yielding 100 gpm continuously for 100 days would be 15.8 feet at Modaha and 12.2 feet at Belbhar if each were spaced 1,000 feet apart. If spaced 10,000 feet apart the predicted interference would be 13.5 feet at Modaha and 10.2 feet at Belbhar. Similar conditions could be encountered in aquifers near Manda, well 1/7. and Halbaldoli, well 1/4.

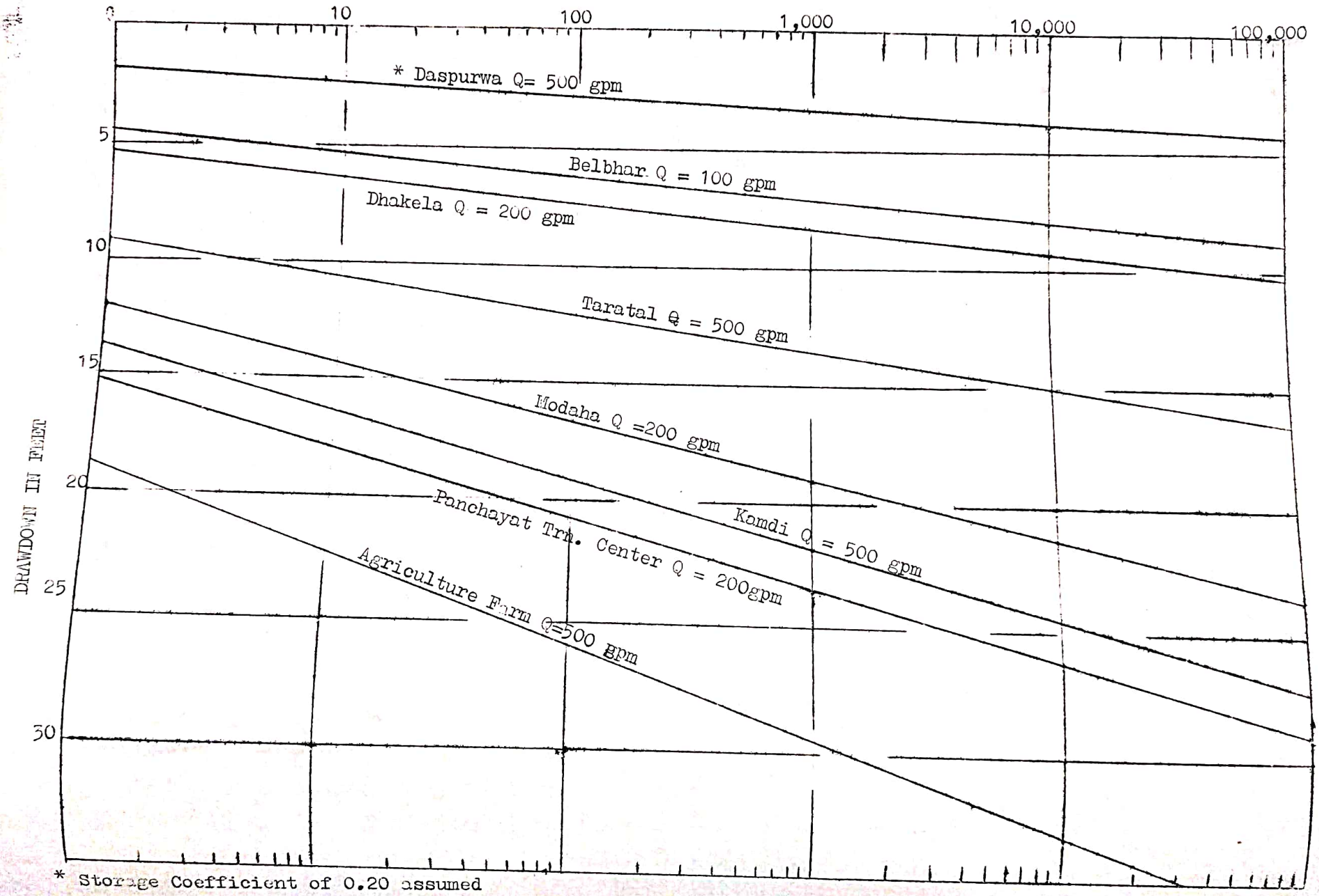

Figure 3-Graph showing Predicted Decline in Head at Distance of feet from Tubewell at Various Rates.

In the relatively shallow aquifers of tubewells 2/2 and 2/3 at the Panchayat Training Center and tubewells 3/1 and 3/2 at Sainik Goan, aquifer tests indicated transmissivity values of about 18,000 gpd/ft. which are in the average to low range. The estimated decline in head that would result 10 feet from tubewell 2/3 yielding a constant 200 gpm, would be about 23.5 feet after 1,000 days. Likewise, the decline in tubewell 3/1 at Sainik Goan, would be about 24.0 feet during the same period. The predicted interference between two indentical wells in each of these areas yielding 100 gpm continuously for 100 days would be 19.5 feet at Panchayat Training Center and about 21.0 feet at Sainik Goan if each were spaced 1,000 feet apart. If spaced 10,000 feet apart the predicted interference would be about 15.7 feet. Similar conditions could be encountered in aquifers near Udai well 1/8, Daurah well 4/2, and Jabdahawa well 5/5.

As shown in the above analyses, the interference between wells in these areas is quite high and hence wide spcing of wells would be required to keep well interference to a minimum. Review of the data collected for the entire Bheri Terai suggests that the deeper artesian aquifers generally have higher transmissivity value. Therefore, in those areas of relatively low transmissivity in shallow aquifers, the hydraulic bharacteristics of wells may be improved by drilling deeper and screening multiple aquifers.

A number of test sites, located for the most part in the center part of the Bheri Terai, indicate unusually low transmissivity values of less than 10,000 gpd/ft. Experience has shown that wells this catagory generally have very low yields and very high interference effects; thus the potential of the aquifers to supply sufficient water for irrigation is limited.

Tubewell 1/2, at Daspurwa, drilled on the flood plain of the west Rapti River indicated a very high transmissivity value of about 251,000 gpd/ft. Using an assumed value of 0.20 for specific. yield, future water level decling and well interference figures can be predicted as previously done with the multiple well aquifer tests. A single well near Daspurwa, discharging at a rate of 500 gpm would have a water level decling of about 3.5 feet at a distance of 100 feet from the well after.

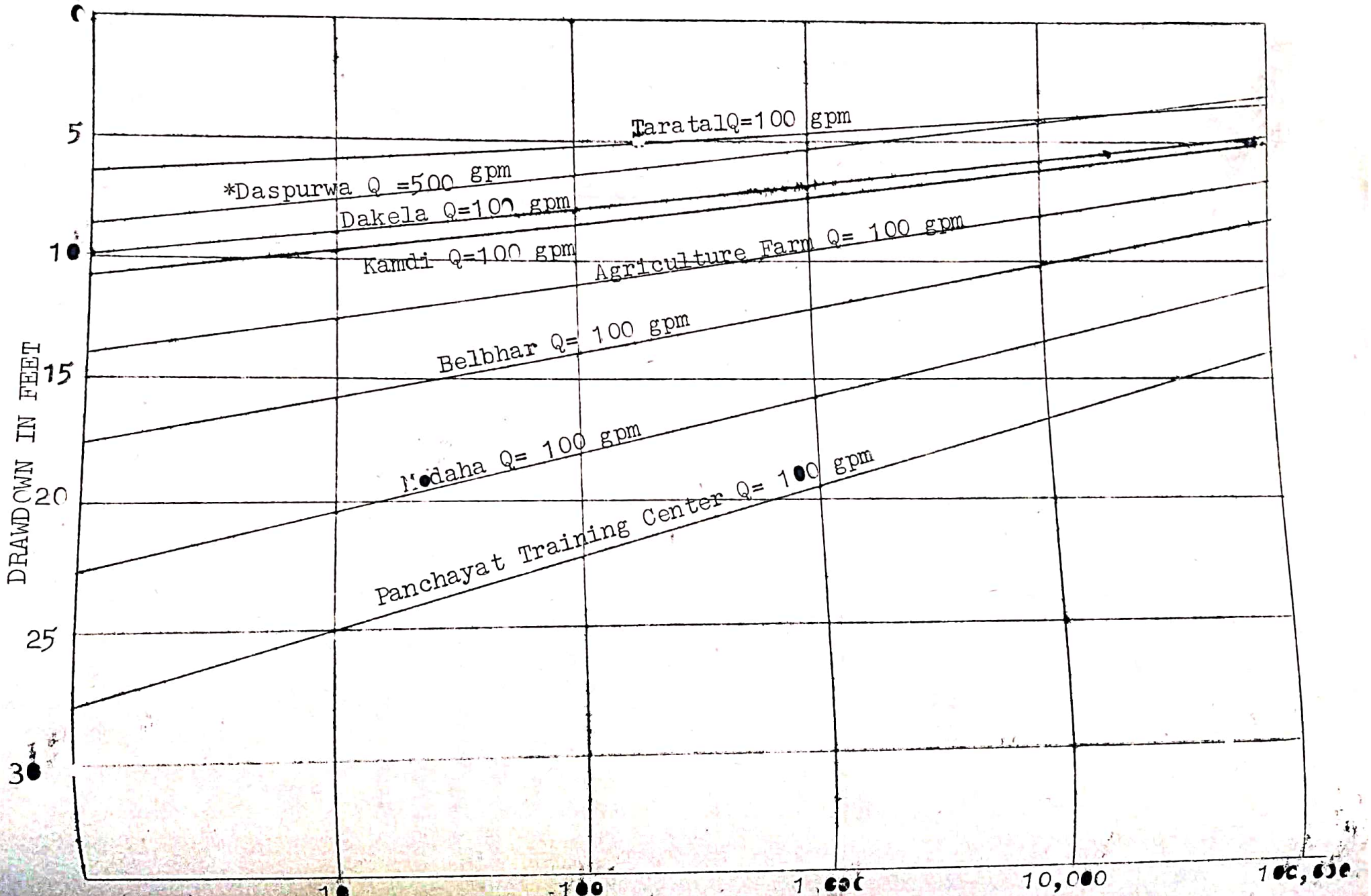

Figure 4 - Graph Showing Predicted Interference between 2 Tubewells

1,000 days continous pumping. If the discharge rate were increased to 1,000 gpm, however, the decling in water level would be 6.9 feet. The predicted interference between wells pumping at 500 gpm continuously for 100 days would be 5.5 feet with the wells spaced 1,000 feet apart. Predicted declines in water level and attendant interference between wells are minimal in this flood-plain area and well spacing would not be a proble, Tubewells drilled in the Bhabar zone of the Karnali River flood plain in the Western part of the Bheri Terai should have similar hydraulic characteristics.

Owing to lack of information at this writing all the previously predicted declines in water levels and pressure heads are based upon conditions at a specific time and have not taken into consideration annual recharge to the aquifers. During the high rainfall of the monsoon, the recharge is undoubtedly of considerable magnitude. Future monitoring of water levels and water use should provide information on the amount of recharge that may occur to the aquifer systems of the Bheri Terai.

Chemical Quality of Water.

The chemical quality of water form the artesian and semi-artesian aquifers of the Bheri Terai is generally good and is suitable with a few exceptions, for domestic supply, livestock, and irrigation. Analyses of water from 29 tubewells (table 6) show that all the water is potable and that most of the ion concentrations are below the maximum limits suggested by the U.S. Public Health Service (1961) for drinking water. The water from the aquifers in the Bheri Terai is moderately hard generally ranging from 100 to 350 parts per million (ppm) total hardness as $CaCO_3$.

The water from the aquifers of the Bheri Terai is suitable in chemical quality for irrigation on many types of soils. Most of the water analyses, when plotted on the classification diagram (fig.5) indicate a low to very low sodium hazard and a medium to high salinity hazard. The water analysis of well 3/4, the shallow test hole at the Agriculture Research Farm, indicated a medium sodium and high salinity hazard. This is not representative of the area, however, and may be the result of contamination of the sampel. The effects of the salinity hazard may be overcome by leaching of cultivated soils by excess irrigation or naturally with rainfall. The artesian water is predominantly a bicarbonate type with varying proportions of calcium, magnesium and sodiumions. The bicarbonate ion concentration is for the most part relatively high ranging from 150 to 450 ppm.

Areas of Ground Water Potential for Utilization

The following discussions amplify the information presented in figure 6.

Zone 1. -- The Bhabar zone, located principally along the flood plains of the major antecedent streams where they debouch from the mountains and to a lesser extent along the consequent streams where they leave the Siwalik Hills, formsapiedmost belt of extremely coarse deposits of boulder and cobble gravel. The coarse deposits contain water-table or subartesian aquifers that have very high transmissivities indicate that large yields can be obtained from properly constructed tubewells with relatively small drawdowns. Spacing of wells

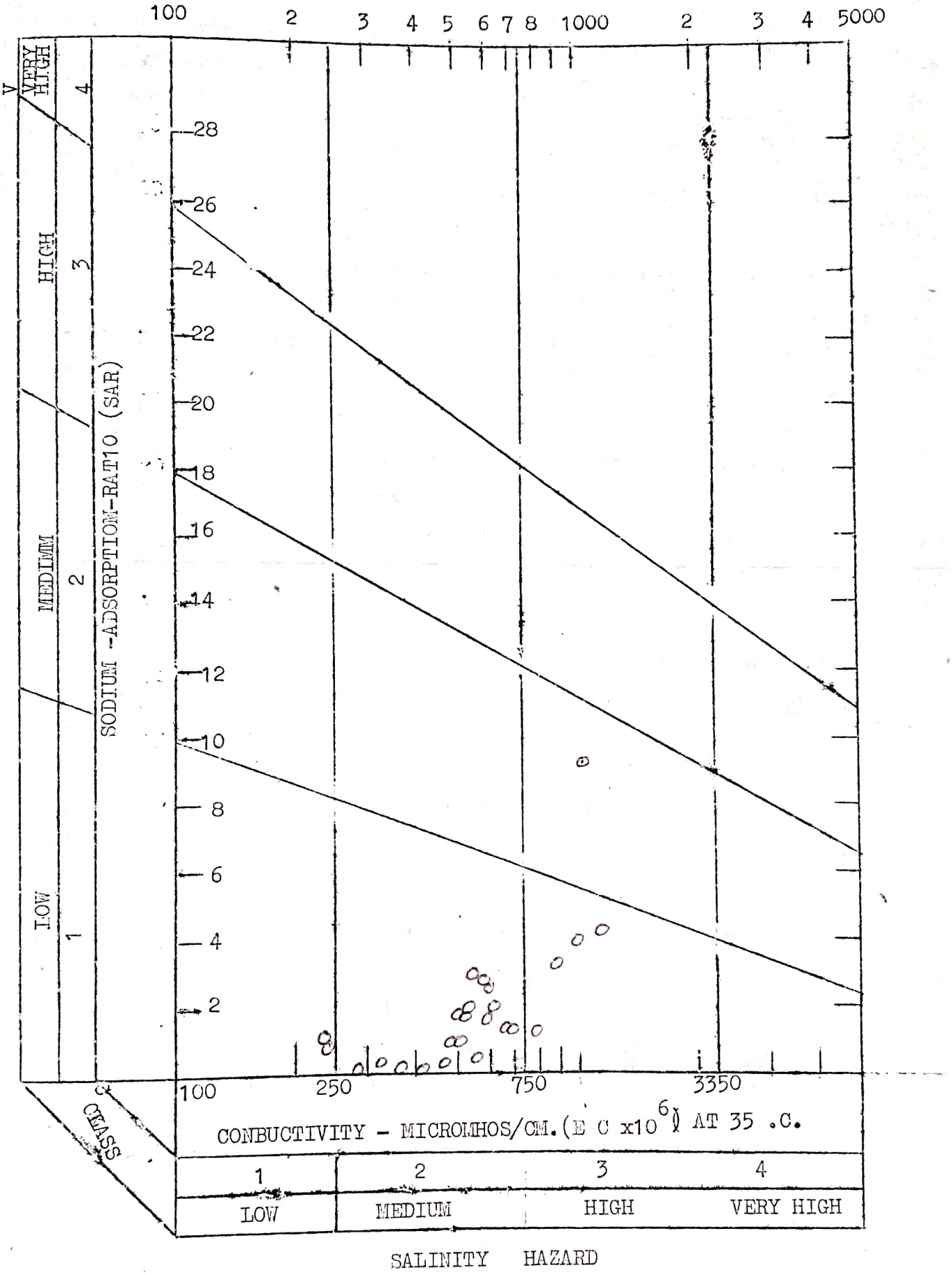

Figure 11. Diagram showing classification of water from Tubewells in Lumbini Zone, Western Terai, with Respect to Suitability for Irrigation.

drilled in these areas is not as critical as elsewhere in the Bheri Terai as interference effects between tubewells will be minimal. Zone 1 conditions exist primarily near the Rapti River in the eastern part of the Bheri Terai and near the Karnali and Babai Rivers in the west and to a lesser extent along a narrow belt near the mountain front.

Zone 2. - Aquifers with relatively high transmissivity values in the range of 50,000 to 100,000 gpd/ft are included in zone. 2. This zone extends from the Bhabar zone near the Rapti and Karnali Rivers and mountain front toward the center of the Bheri Terai. Well spacing near the outer limits of zone 2 would not be overly critical however, well spacing and judicious use of water would be matters of increasing importance towards the center of the Bheri Terai. The artesian aquifers of zone 2 appear to extend beneath the Bhabar zone as indicated by the deep artesian aquifer at Kamdi near the Rapti River.

Zone 3. - Areas with transmissivity values of 25,000 to 50,000 gpd/ft are included in zoen 3. Wells in this zone can be used for irrigation, although interference between wells will be more pronounced than in zones 1 and 2. Production wells should, therefore, be spaced further apart to minimize cumulative drawdown effects and attendant increase of pumping lifts.

Zone 4. - Aquifers with transmissivity values of less than 25,00 0 gpd/ft constitute zone 4. Production wells in this zone would have relatively low specific capecities, but could be used for small scale or supplemental irrigation. The yields of wells, however, with aquifer transmissivities of 15,000 to 25,000 could be increased by screeming multiple aquifers . Wells with transmissivity values of less than 10,000 gpd/ft shoudl be limited generally to domestic and public supply and in specialized industrial use where the high pumping unit costs could be justified economically.

General Conclusions and Recommendations

Conclusions.

1. The areas where tubewells can be successfully developed for irrigation are not uniformlly distributed in the Bheri Terai. Generally the Bhabar zone and the flood plain areas of the Rapti, Babe, and Karnali Rivers are best suited to large-scale ground-water exploitation. The tubewells along traverse number I are relatively close to the flood plain of the Rapti River system and there may be hydraulic continuity between the river and the aquifers less than 200 feet deep as indicated by tubewells 1/1 and 1/4. Similar conditions may exist along the Karnali River system along traverse number6inthe western part of the report area as indicated by the wells at Taratal. Transmissivity values in these areas from over 50,000 to more than 200,000 gpd/ft with yields sufficiently large to support intensive irrigation.

2. The central part of the Bheri Terai presents the poorest potential for ground-water development. Aquifers occuring in the central part of the report area are relatively thin consisting of sand and gravel lenses interstratified with clay layers of variable thickness. The deposits are generally fine-grained with transmissivity values ranging from less than 10,000 to somewhat more than 25,000 gpd/ft.

3. Extensive areas with flowing artesian wells awere not encountered in the Bheri Terai. Tubewells encountering positive artesian pressure are located only along the northern margins of the Bheri Terai.

4. Water levels and artesian pressure heads are predominantly below land surface in tubewells and pumps will be required to lift water for irrigation.

5. In many instances yields of production wells could be increased by multiple screening of two or more aquifers in the same well as indicated in tubewell 2/9.

6. The chemical quality of the Ground Water in the report area is generally good and suitable, with few exceptions, for domestic supply, livestock, industry and irrigation. The bicarbonate ion concentration is for the most part relatively high as is the case in other parts of the Western Terai.

Recommendations.

1. The observation well program established by the Ground Water Project in the Bheri Terai should be continued. Data obtained from this monitoring program will become increasingly important as the ground-water resource is developed and utilized. Whereas aquifer test data provide a basis for planning a production well program, long-term observations of water levels and pressure head are necessary for optimum utilizations and management of the ground water resource and for maintaining a favourable blance of natural and artificaial dishcarge versus recharge to the aquifer system .

2. Generally, most tubewells drilled for irrigation use should be located in zones 1,2, and 3 of the Bheri Terai and spacing of Tube wells should be planned to minimize interference between wells.

3. All tubewells constructed in the flowing-well artesian area should be properly cemented around the well annulus and the yield and the flow regulated by control valves. With drawals from flowing wells should be limited to the amount of water actually required for the crop. After the irrigation requirement is satisfied, valves on the wells should be closed and ramain closed until the next irrigation requirement. Conservation of pressure head and the ground-water resource by preventing needless waste of water will ential government supervision and enforcement.

4. Generally, new production wells should be preceded by pilot "slim hole" to verify geohydrologic conditions at a new site. This same slim hole can subsequently be reamed to the planned diameter of the production well.

5. A number of wells resulting from the Ground Water Project Investigations in the Bheri Terai have yields sufficient for irrigation. These have been turned over for use to the HMG Department of Irrigation. To establish some guidelines on the economics of Irrigation form tube wells in the Bheri Terai it is suggested that small pilot irrigation projects be established at several selected sites. Possible sites might included those near flowing tubewell 1/8 at Udai, tubewell 1/5 at Kamdi utilizing diesel enging to power the pump, and tubewell 2/3 at Panchayat

Training Center using electric power for pumping.

6. Yields from tubewells drilled in the less productive aquifers of zone 4 as well as in better aquifers of zones 2 and 3 can be increased by screening several aquifers. Caution neeeds ϕ6 be exercised, however, in screening several artesian aquifers in the same well where considerable head differential exists between aquifers. In such cases, the yield may decrease, at least until the head differentials equalize, and may be less than initial yield even after equalization.

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Explanation to Accompany Tables 4, 5 and 6.

1. Numbers are assigned to a series of north-south trending traverses beginning near the Rapti River at the eastern boundary of the area and progressing westward at 10 km intervals. Test holes are numbered in sequence in each traverse from the Indian border northward. Example: Traverse 3, borehole 2 is numbered 3/2.

2. Name of village near which corresponding test hole is located.

3. Approximate elevations, in feet above mean sea level, have been transferred from the benchmark at Rupediha Railway Station using transit or theodolite. Figures are to the nearest foot.

4. Depth of test hole in feet below land surface.

5. Day, month and year testhole was completed.

6. API line pipe (mild steel tubing) was used to case most of the tubewells and extends from tubewell head near land surface to the top of screen.

7. a. The screen set in most boreholes in perforated pipe.
   b. Depth, in feet below land surface, to top and bottom of perforated pipe or well screen.
   c. Type of material screened. (s) sand, (g) gravel, (f,m,c) fine, medium, coarse.

8. Pressure head at time well was drilled, in feet above (+) or below (-) land surface datum.

9. Yields in U.S. gallons per minute (gpm) by natural flow (f), by airlift (a), or pump (p) measured after initial development.

10. Drawdown, decline in head or potentiometric surface, in feet, resulting from pumping or natural flow.

11. Specific capacity, ratio of gallons per minute of yield per foot of decline in head resulting from pumping or natural flow of a well.

12. Other Information:

A. Abandoned hole, casing pulled and hole plugged.
T. Flow or pumping test carried out at tubewell.
F. Foxbore pressure recorder installed.
S. Stevens water-stage recorder installed.
G. Geologic log in table 7
E. Electric log in files.
C. Chemical analysis in table 6

13. Remarks.

Table - 4 Record of Selected Testholes in Bheri Zone Western Tarai Area, Nepal

Well No.	Location	Aproximate Elevation (ft.above Sea Level)	Total Depth in feet	Date Completed	Casing: Dia-meter	Casing: Dia-meter (Inches)	Screened Information: Setting (ft. below land Surface)	Screened Information: Meterial Screened	Intial Head (ft) ± LSD	Intial Yield: (GPM)	Draw-down (feet)	Specific Capacity (gal/ft	Other Infor-mation	Remarks
1/1	Piprahawa	438	253	10.1.73	6	6	112-139	g,w/s,c	-6.8	63(p)	3.20	19.7	T,G,E,C	Well located on west Rapti River flood plain.
1/2	Daspurwa	445	49	28.1.73	6	6	41- 49	g,w/peb &cob	-5.6	57(p)	1.20	47.5	T,G,C	Well located on W.Rapti River fl plain.Hole bottomed because of b caving.2nd well also caved in sa depth.
1/3	Daspurwa	445	205	4.2.73									A,G,E	Hole drilled to demonstrates meth to overcome caving.
1/4	Halbaldoli	450	456	6.1.73	6-4	4	202-212	g,w/cob.	-28.6	53(p)	1.70	31.1	T,G,E,C	Well.Loc. on the forest riv.te
1/5	Kamdi	460	713	24.12.72	6-4	4	375-394	g,w/s,peb	-34.3	56(p)	2.90	19.3	T,G,C	Obs. well for aquirfer test.
1/6	Kamdi	460	411	25.3.73	12-8	8	370-390	g	-34				T,G,E	Producing well for aquirfer tes
1/7	Manda	504	681	14.3.73	6-4	4	236-255	g,w/s,m,c,s,c	-69.44	35(p)	2.46	14;2	T,G,E	
1/8	Udai	520	605	5.2.73	6-4	4	209-226	g,s,c,w/cob	+35.16	140(f)			T,G,E,C	Flowing well
2/1	Jamunaha	479	1003	30.11.72	6-4	4	409-435	g,w/s,c	-44.7	40(p)	1.21	33.0	T,G,E,C	
2/2	Pan.Trn.Cr.		460	11.6.73	4	4	143-162	sw/g	-15.0				T,G,E	Obs. well for aquirfer test.
2/3	Pan.Trn. Cr.		166	15.6.73	10	10	141-160	s,w/g,sltst	-15.03	270(p)	40.12	6.7	T,G	Producing well for aquirfer tes
2/4	Irr.Compd.		111	12.6.73	6	6	16- 35	s,f-m	-11.4				G	Well to be use as domestic suppl
2/5	Nepalgunj Municipal	485	1200										E	Drilled by Indian cooparation Mission.
2/6	Pol.Trn.Cr.	486	989	24.12.72	6-4	4	326-347	s,f-m	-46.37	36(p)	14.38	2.5	T,G,E,C	Well to be used to supply P.car
2/7	Ranjha	489	803	15.12.72	4	4	365-375	s,m,c,w/sltst,g	-47.0				G,E,	Both well at Ranjha yield large
2/8	Ranjha	489	396	25.2.73	8-6	6	350-376	do do	-47.0				G,E	quantities of sand.
2/9	Army camp(R)		492	6.6.73	10-6	6	154-162 255-270 378-391	s,w/sltst. s s,w/sltst.					G,E,C	Well to be used to supply army camp.
2/10	Haldarpurwa	502	756	18.12.72	4	4	688-711	g,w/s	-18.0	65(a)			A,G,E	Well yields sand.
2/11	Kohalpurwa	543	1500	9.1.73	6-4	4	690-710	s,g	- 9.6	8	47.13	0.17	T,G,E,C	
2/12	Thukali	564	711	26.12.72	4	4	420-431	g,	+21.5	63(f)			T,G,C	Flowing well
3/1	Sainikgaon	458	1000	31.1.73	6-4	4	142-172	s,c-m,w/g	-27.0				T,G,E,C	Producing well for aquifer test
3/2	Sainikgaon	458	183	31.6.73	4	4	150-170	s,w/g	-27.0				T,G,E	Obs. well for aquifer test.
3/3	Odarapur	464	1500	13.2.73	6-4	4	191-211	s,w/g	-26.96	37(p)	56.62	0.65	T,G,E,C	

Table -4 Continued....

Well No.	Location	Approximate Elevation (Ft. above Sea Level)	Totle Depth in (ft)	Date Completed	Casing Dia-meter (in.)	Screened Information: Dia-meter (in.)	Setting (Ft, below Surface)	Material Screened	Intial Head (ft) ±LSD	Intial Yield (GPM)	Draw-down (Ft.)	Specific Capacity (Gal/ft)	Other Infor-metion	Remarks
3/4	Agr.Res.Farm:	478	1000	17.1.73:	6	6	100-119	s,w/siltstone	-18.13	44(p)	43.76:	1.01	T,G,E	Drilled to evaluate shallow aquife
3/5	Agr.Res Farm:	478	435	21.1.73:	12-8	8	305-380	s,c to m	-33.97	350(p)	21.46:	16.3	T,G,E	Irrigation well for research farm
							400-418							producing well for aquifer test.
3/6	Agr.Res.Farm:	478	402	24.1.73:	4	4	337-359	s,m,to c,w/g	-34.0				T,G	Obs. well for aquifer test.
3/7	Dahawa	489	1000	21.2.73:	6-4	4	319-329	s					A,G,E,	Well yields sand.
3/8	Modaha	500	1000	3.3.73:	6-4	4	190-238	g,w/s	+1.66f	53(p)	14.42:	3.7	T, G, E, C:	Producing well for aquifer test. Slight flow.
3/9	Modaha	500	250	8.3.73:	4	4	197-238	g,w/s	+1.66 f:				T,G	?bs. well for aquifer test. Slight
3/10	Amohia	573	713	18.3.73:	6-4	4	497-515	g	-17.0	53(P)	8.70:	6.1	T,G,E,C:	
4/1	Kanthapur	457	1000	16.3.73:	6-4	4	380-428	s,m,w/g	-32.85	47(p)	4.08:	11.5	T,G,E	
4/2	Daurah	464	713	31.3.73:	6-4	4	356-375	g,w/s,c	-47.55	44(p)	10.98:	4.01	T,G,E,C	
							388-401							
4/3	Machagarh	500	678	22.3.73:	6-4	4	652-667	g,w/p,mtc c	+58.0	5(a)			G,E	
4/4	Dhakela	552	1210	6.4.73:	4	4	125-145	g,w/peb &cob	-24.0				T,G,E	Obs. well for aquifer test.
4/5	Dhakela	552	152	12.4.73:	10-6	6	125-145	g & s	-23.72	360 p	22.28:	16.2	T,G,E	Producing well for aquifer test.
5/1	Indrapur	427	516	9.4.73:	6-4	4	410-428	g	-21.3	47(p)	4.96:	9.5	T,G,E,C	
5/2	Belbhar	440	490	12.4.73:	6-4	4	260-290	g,W/cobbles	-24.86	47(p)	6.76:	7.0	T,G,E	
5/3	Belbhar	440	330	24.5.73:	4	4	229-244	g	-21.0				T,G,E	Obs. well for aquirfer test.
5/4	Belbhar	440	297	27.5.73:	10-6	6	228-248	s,f to m w/g &silt	-23.45	310 p	38.36:	8.1	T,G,E	Producing well for aquifer test.
5/5	Jabdahawa	441	307	6.6.73:	6-4	4	270-280	g,w/s	-1.92	47(p)	6.23:	7.5	T,G,E,C	
5/6	Bachaiya Phat	493	104	10.6.73:	8-6	6	92-102	g	-32				G	
6/1	Taratal	489	285	5.5.73:	6-4	4	267-285	g	-48.07	44(p)	1.48:	29.7	T, G, E, C	Obs. well for aquifer test.
6/2	Taratal	489	1113	17.5.73:	10-6	6	269-284	g,w/pebbles	-47.1				T,G,E	Unsuccessful producing well for aquifer test.
6/3	Belwa	493	285	1.5.73:	6-4	4	259-276	g,w/s	-49.1	38(p)	0.95:	40.4	T,G,E,C	
6/4	Bandipur	526	207	23.6.73:	6-4	4	190-205	g,w/pebbles &cob.	-32.30				G,E	
6/5	Bhurkia	569	331	19.5.73:	6-4	4	224-255	g,w/s	-20.76	47(p)	2.76:		T,G,E,C	

Table 5 Summary of Aquifer Tests, Bheri Zone, Western Tarai Area, Nepal.

Well Number	Location	Screened Interval	Date Of Test	Duration: Hours	Yield: gpm	SWL In foot +LSD	Draw down (feet)	Specific Capacity	Transmissivity (gal/day/ft) Theis Non-equilibrium	Cooper & Jacob	Theis Recovery	Coefficient of Storage: Theis Non-equilibrium	Cooper & Jacob	Remarks
1/1(P)	Piprahawa	112 - 139	24	24	63	- 6.78	3.20	19.7			42,240			
1/2(P)	Daspurwa	41 - 49	5.3.73	24	57	- 5.61	1.20	47.5			2,50,800			Possible hydrolog recharge boundry ountered after 4
1/4(P)	Halbaldoli	202 - 212	22.1.73	24	53	-28.60	1.70	31.1			26,640			
11/6(0)	Kamdi	370 - 390	6.30.73		55	-								
1/5(P)	Kamdi	375 - 394	6.30.73	24	56	-34.30	2.90	19.3	43,540	49,280	56,860	1.42×10^{-3}	1.11×10^{-3}	
1/7(P)	Manda	235 - 255	13-4.73	24	35	-69.44	2.46	14.2			20,160			
1/8(f)	Udai	209 - 226	9.3.73	44	140	+35.16					18,480			
2/1(P)	Jamunaha	409 - 435	16.12.72	46	40	-44.70	1.21	33.0			132,000			
2/2(0)	Panchayat Training Center	143 - 162	14.7.73											
2/3(P)	P. T. C	141 - 160	14.7.73	24	270	-15.03	40.12	6.7	17,280	21,020	18,280	2.95×10^{-4}	1.39×10^{-4}	
2/6(P)	Police Trn. Center	326 - 347	4.1.73	27	36	-46.37	14.38	2.5			8,710			This well multi
2/9(P)	Army Trn. Camp	154 - 162 255 - 270 378 - 391	24.11.73	24	35	-47.02	4.45	7.9			15,660			eened to test i additional wate
2/12(f)	Thukali	420 - 431	21.2.73	24	63	+21.49					48,900			
3/2(0)	Sainik Gaon	150 - 170	18.11.73											
3/1(P)	Sainik Goan	142 - 172	18.11.73	24	40	-23.05	5.51	7.3	15,980	17330	18,880	2.95×10^{-4}	2.23×10^{-4}	
3/3(P)	Odarapur	191 - 211	2.4.73	24	37	-26.96	56.62	0.65			2,180			
3/4(P)	AgricResearch Farm	100 - 119	12.2.73	24	44	-18.13	43.76	1.01			1,640			
3/6(P)	Do Do Do	337 - 357	8.2.73											
3/5(P)	Do Do Do	305 - 380 400 -418	8.2.73	28	380	-33.97	21.46	16.3	36,500	36,950	29,400	7.86×10^{-4}	3.97×10^{-4}	
										23,650				
3/9 (0)	Modaha	197-238	19.3.73							1st limb:				
3/8(P)	Modaha	190-238	19.3.73	24	55	+1.66	14.42	3.7		22.270	10,600	4.66×10^{-3}	4.55×10^{-4}	Possible hydrolo boundary encounte after 120 minute pumping at -bou 550feet from obs.

Table 5 continued.

Well No.	Location	Screened Interval	Date of Test	Duration (hours)	Yield (gpm)	SWL ± LSD in ft. down (feet)	Draw down (feet)	Specific Capacity gal/day	Transmissivity (gal/day/ft) Thies non-equilibrium	Transmissivity (gal/day/ft) Cooper & Jacob	Transmissivity (gal/day/ft) Thies Recovery	Coefficient of Storage Thies non-equilibrium	Coefficient of Storage Cooper & Jacob	Remarks
3/3 P	Amuhia	497 - 515	25.3.73	24	-53	-17.02	8.70	6.1			6,030			
4/1 P	Kanthapur	380-428	23.4.73	24	47	-32.85	4.08	11.05			35,450			
4/2 P	Daurah	356-375 388-401	27.4.73	24	44	-47.55	10.98	4.01			13,860			
4/4 D	Dhakela	125-145	30.4.73											
4/5 P	Dhakela	125-145	30.4.73	24	360	-23.72	22.28	16.2	48,920	57,370	63,030	3.07×10^{-4}	1.53×10^{-5}	
5/1 P	Indrapur	410-426	3.5.73	24	47	-21.30	4.96	9.5			72,990			
5/2 P	Belbhar	260-290	7.5.73	24	47	-24.86	6.76	7.0			17,300			
5/3 O	Belbhar	229-244	8.6.73											
5/4 P	Belbhar	228-248	8.6.73	24	310	-23.45	38.36	8.1	28,520	29,130	35,620	1.06×10^{-3}	2.41×10^{-5}	
5/5 P	Jabdawa	270-280	10.6.73	14	47	- 1.92	6.23	7.5			19,620			
6/2 O	Taratal	269-284	6.6.73											
6/1 P	Taratal	267-285	6.6.73	12	44	-48.07	1.48	29.7	100,850	82,970	68,330	1.17×10^{-4}	2.07×10^{-4}	Equilibrium conditions after 50 mins. Possible hydrologic recharge boundary about 1075ft from obs. well.
6/3 P	Belwa	259-276	18.5.73	24	38	-49.10	0.94	40.4			85,100			
6/5 P	Bhurkia	224-255	24.5.73	24	47	-20.76	2.70				66,470			

Table 6 Chemical Analysis, in Parts Per Million of Water Samples from Selected Wells in Bheri Zone, Western Tarai rea, Nepal.

Well: No.	Location	Date Collected	Depth to: top of Aquifer ft:	** Meterial Screened:	Iron: Fe	Calcium Ca	Magnesium Mg	Calculated: Na + K	Bicarbonate HCO_3	Sulfate SO_4	Chloride Cl	Carbonate CO_3	Total Dissolved Solids	Total Hardness as $CaCO_3$	Alkalinity	Specific Conductance (micromhos at 25°C)	PH: *	SAR	HCO_3 Hazard (meq/liter)
1	Piprahawa	1.2.73	112-139	g,w/s,c	0.01	107	1	-	192	NIL	8	0	316	269	157	271	7.9	-	-
2	Daspurwa	5.3.73	41-49	g,w/Peb. & Cob.	0.01	68	18	3	296	NIL	6	0	552	224	243	466	8.1	0.06	-
4	Halbaldoli	22.1.73	206-212	g,w/Cob. Peb.	0.0	97	1	5	296	NIL	6	11	406	244	261	426	8.5	0.08	0.30
5	Kamdi	6.3.73	375-394	g,w/Peb.	0.04	20	41	22	316	NIL	5	0	322	218	269	488	7.3	0.34	0.81
7	Manda	13.4.73	235-245	g,w/s,m,c	-	40	30	60	422	NIL	6	0	398	222	346	683	8.0	1.59	2.46
8	Udai	9.3.73	209-235	g&s,w/peb	0.0	22	12	21	160	6	3	0	208	106	141	255	8.5	0.60	0.74
1	Jamunaha	16.12.72	409-435	g,w/s,c	0.0	8	41	99	402	26	38	26	642	187	372	918	8.9	3.95	3.69
3	Pan. Trn. Cr.	14.7.73	141-160	g,w&s-stone	80	8	31	64	326	NIL	5	8	340	148	267	569	8.6	0.26	2.66
6	Police Trn. Cr.	4.1.73	326-347	s,f to m	0.0	67	1	124	458	28	24	42	872	168	444	979	8.9	4.85	5.48
8	Ranjha		352-376	s,m,c,w/ siltstone & gr.	x	7	26	119	414	18	18	10	504	196	339	598	8.5	1.12	4.63
9	Army camp Ranjha	x	153-391	s,w/s-stone	x	40	30	137	614	4	7	0	646	222	503	738	7.2	1.49	5.59
11	Kohalpurwa	14.2.73	690-710	s,g	0.0	12	21	91	314	29	11	0	324	104	257	488	8.2	2.36	2.82
12	Thukali	13.12.73	420-431	g		78	29	6	288	4	4	0	384	316	318	523	7.1	-	0.02
	Sanik Gaon	18.11.73	142-172	s,c-m,w/g		36	27	132	576	NIL	15	0	704	202	472	837	7.5	1.42	5.42
	Odarapur	2.4.73	191-211	s,w/g	0.0	29	22	186	604	58	6	0	596	162	495	1025	8.1	5.46	6.64
	Agri. Farm	12.2.73	100-119	s,w/ sltst	0.1	8	21	216	656	33	9	56	722	108	630	1175	9.0	9.34	8.62
	Agri. Farm	8.2.73	305-418	s,c,to m		20	27	-	372	NIL	6	0	368	161	305	513	8.3	1.27	2.88
	Modaha	19.3.73	190-238	g,w/s	0.01	88	0	-	216	NIL	5	8	230	220	190	326	8.5	0.01	-
0	Amohia	25.3.73	497-519	g	0.04	15	22	60	304	NIL	5	0	430	126	249	513	7.9	2.27	2.42
	Kanthpur	23.4.73	380-428	s,m,w/g		68	18	3	296	NIL	6	0	552	244	243	466	8.1	0.06	
	Daurah	27.4.73	356-401	g,w/s,c	0.0	40	20	86	440	NIL	8	0	616	182	361	609	8.1	1.81	3.57
	Dhakela	30.4.73	125-145	g&s		23	32	38	320	NIL	6	0	352	188	262	569	7.6	1.39	1.47

Table - 6 Continued

Well No.	Location	Date Collected	Depth to top of Aquifer (feet)	** Meterial Screened	Iron Fe	Calcium Ca	Magnesium Mg	Calculated Na + K	Bicarbonate HCO_3	Sulfate SO_4	Chloride Cl	Carbonate CO_3	Total Dissolved Solids	Total Hardness as $CaCO_3$	Alkalinity	Specific Conductance (micromhos at 25°C)	PH	* SAR	HCO_3 Hazard (meg/liter)
5/1	Indrapur	3,5.73	410-426	g	0.01	75	40	-	400	NIL	6	0	386	354	328	539	7.8	0.01	-
5/2	Belbhar	7.5.73	260-290	g,w/cob		13	79		194	162	8	14	220	143	159	293	8.6	0.01	0,62
5/4	Belbhar	8.6.73	228-248	s,f-m, w/g & sltst	0.60	76	0	36	242	11	6	0	280	190	198	367	8.2	0.01	0.18
5/5	Jabdahawa	10.6.73	270-280	g,w/s	0.0	23	28	95	450	NIL	8	0	466	174	316	603	7.8	1.97	3.93
6/1	Taratal	6.6.73	267-285	g,	0.0	22	2	46	270	NIL	9	6		138		243	8.5	0.92	0.37
6/3	Beluwa	18.5.73	259-276	g,w/s	0.05		22	76	238	168	8	0	304	214	195	478	7.9	0.35	-
6/5	Bhurkia	24.5.73	224-255	g,w/s	0.08		22	19	204	22	6	4	220	264	174	331	8.4	0.01	0.16

*(SAR) Sodium Adsorption Ratio computed using an estimeted value for the Sodium ion (Na) concentration.

** Symboles explained in table - 4

Table of Well Logs

Test Hole No. 1/1
Location: Piprahawa
Drilled by: Hydrology Department
Altitude of Land Surface: 438 ft.
Staric Water level (Head):-7 ft.LSD

Drilling Started:27/12/72
Completed : 10/ 1/73
Log by:G.P.Chaturvedi

Lithologic Description	Thickness (feet)	Depth (feet)
Soil,yellow	2	2
Clay, grey, sandy	8	10
Sand, grey, medium to fine	5	15
Sand,medium to coarse	26	411
Gravel, Subrounded to subangular,well sorted	8	49
Clay,grey, sticky	20	69
Sand,fine W/ gravel	4	73
Clay,grey,mixed w/sand and gravel	8	81
Clay,grey,sandy	3	84
Clay,grey,plastic	12	96
Clay,grey w/sand and gravel	10	106
Gravel,well sorted w/coarse sand	30	136
Gravel,Subangulatr to subrounded,well sorted	3	139
Clay,grey, sticky	35	174
Gravel,subangular to subrounded,well sorted	13	187
Clay, grey, sticky	18	205
Gravel,subangular to subrounded	4	209
Clay, grey,sticky	2	211
Gravel,subangular to subrounded ,well sorted w/medium to coarse sand from 218 to 223	37	248
Clay,yellow,sticky	5	253

Well completion date

Casing 6 in to 149 ft.
Screened zone:112 to 139 ft/6 in.
Yield: 125 gpm (airlift)
63 gpm (Pump)
Drawdown: 3.2 ft.

Table 7 Well Logs

T st Hole No: 1/2

Location: Daspurwa — Drilling Started: 30/12/7

Drilled by: Hydrology Depatment — Completed: 28/1/73

Altitude of Land Surface: 445 ft. — Log by: T. M. Singh

Static Waer level (Head): -4.5.ft.LSD

Lithologic Description	Thickness (feet)	De (f
and , Clayey	2	
and, grey fine	5	
and, grey,medium to fine	6	
el,fine,subrounded to subangular ,quartz, quartzite & sandstone	7	
avel, subrounded to subangular, quartz,quartzite, feldspar,sandstone	8	
Gravel w/rounded pebbles and cobbles	21	

Well completion data

sing:	6 in to 50 ft.
creened zone	41 to 49 ft/6 in
ield:	120 gpm (airlift)
	57 gpm (pump)
awdown:	1.2.ft.

Table 7 Well Logs

Test Hole No. 1/3
Location: Daspurwa
Drilled by: Hydrology Department
Altitude of Land Surface: 445
Static Water le vel (Head): LSD

Drilling Started: 3/2/73
Completed: 4"/2/73
Log by: T. M. Sigh

Lithologic Description	Thickness (feet)	Depth (feet)
Sand, yellowinsh-grey, fine	11	11
Gravel, subrounded w/ quartzite	18	29
Gravel, subangular W/cobbles of quartz quartzite etc	5	34
Clay, grey, sticky	6	40
Gravel W/ pebbles, cobbles of quartzite, quartz & sandstone	9	49
Gravel, quartz, sandstone, & quartzite	10	59
Clay, grey, sticky	20	79
Clay, grey, sticky & plastic	10	89
Clay, greyish-yellow, sticky	18	107
Clay, grey, sticky	2	109
Gravel, subangular to dubrounded	10	119
Clay, yellow, sticky	24	143
Clay, yellowish-grey, sticky	7	167
Clay, yellow, sticky	17	167
Gravel, subrounded, quartzite	8	175
Gravel	30	205

Test hole - abandoned

Table 7 Well Logs

Test Hole No. 1/4

Location: Halbaldoli

Drilled by: Hydrology Department

Altitude of Land Surface: 450 ft.

Static Water level (Head) : -28 ft.LSD

Drilling Started: 1/11/7.

Completed: 6/1/73

Lithologic Description	Thickness (feet)	Depth (feet)
Subsoil yellow	9	9
Sand,brown, fine	17	26
Clay, grey, with siltstone	8	34
Clay, yellow, sandy	11	45
Gravel,fine w/sandstone,siltstone,quartz & quattzite	4	49
Clay, greyish-yellow, sticky	15	64
Clay, yellow, sticky	22	86
Clay, yellowish-grey,sticky & Plastic	8	94
Clay, grey, sticky,with siltstone	15	109
Clay, grey sticky & Plastic	8	117
Clay, greyish-yellow ,sticky	14	131
Gravel,subangular to subrounded,w/sandstone quartzite & quartz	3	134
Clay, yellow ,sticky	5	139
Clay, dark,sticky & Plastic	31	170
Clay, yellow, sticky	15	185
Clay ,greyish-yellow,with gravel	7	192
Clay, yellow, sandy	8	200
Gravel,pebbles & cobbles,subrounded to subangular w/quartz,quartzite,sandstone	12	212
Gravel,with coarse sand,pebbles & cobbles	5	217
Gravel,with coarse sand	5	222
Clay, yellow,sandy	12	234
Gravel,with yellow clay	6	240
Sand,fine to medium	10	250
Clay, yellow sandy	25	275
Clay, greyish-yellow	8	283
Clay,grey,sticky	7	290
Gravel,with coarse sand	15	305

Continued . . . . .

Table 7 Well Logs

Test Hole No. : 1/4 (cont)

Lithologic Description	Thickness (feet)	Depth (feet)
Clay, Yellow	15	320
Clay, yellow , sandy	15	335
Gravel, subangular to subrounded with fine to medium sand	46	381
Clay,grey, sandy	17	398
Clay, grey, with siltstone	15	413
Clay, grey	13	426
Clay, grey, with gravel	10	436
Clay, greyish-yellow,with gravel	5	441
Clay, grey	6	447
Clay,grey, with fine gravel	5	452
Gravel, fine,subrounded to subangular	4	436

Well completion data

Casing: 6 in to 102'4 in to 218 ft.

Screened Zone: 202-212 ft/4in

Yield: 53 gpm (Pump)

Drawdown: 1.7.ft.

Table 7 Well Logs

Test Hole No.: 1/5
Location: Kamdi
Drilled by: Hydrology Department
Altitude of Land Surface: 460 ft.
Static Water level (Head): -34 ft. LSD

Drilling Started: 19/12/72
Completed: 24/12/72
Log by: T.M. Singh

Lithologic Description	Thickness (feet)	Depth (feet)
Sub-soil, grey, sandy	3	3
Sand, brown, fine	19	22
Clay, yellow	6	28
Clay, yellow	4	32
Sand, greyish-brown, coarse w/fine gravel	11	43
Gravel, find with coarse sand	11	54
Clay, grey, sticky	8	62
Siltstone, with yellow clay	8	70
Clay, yellow, sticky, Plastic, with siltstone	5	75
Sand, greyish-brown	6	81
Clay, yellowish-grey with siltstone	12	93
Clay, yellow with siltstone	15	108
Clay, yellowish-grey, sticky and plastic, withsiltstone	23	131
Clay, yellowish-grey, sticky and plastic	8	139
Gravel, sub-angular, with siltstone	6	145
Clay, greyish-yellow, sticky, with siltstone	9	154
Clay, greyish-yellow, sticky and plastic	18	172
Gravel, with siltstone	9	181
Gravel, sub-angular to sub-rounded, with, [illegible] siltstone	10	191
Gravel, round to sub-rounded	9	200
Gravel & Pebbles, sub-rounded	16	216
Clay, yellow, sandy	6	222
Clay, yellow	8	230
Clay, yellow, sticky	10	240
Gravel, with clay	7	247
Clay, grey, sticky	16	263
Clay, yellow, sticky	9	272
Clay, grey stick and plastic	18	290
Clay, grey, sandy	15	305
Clay, yellow, sanduy	7	312
Clay, yellow, sticky	23	335

Continued . . . . .

Table 7 well Logs

Test Hole No. 1/5 (Cont.)

Lithologic Description	Thickness (feet)	Depth (feet)
Clay,yellow,sandy	15	350
Clay, grey	7	357
Clay,greyish-yellow,sandy	8	365
Clay,grey, sandy	10	375
Gravel & sand with pebbles,sub-angular to sub-rounded	19	394
Clay,yellow, sandy	7	401
Clay,yellow,sticky	25	426
Clay,yellow,sticky,plastic	15	441
Clay,greyish-yellow,sandy	24	465
Clay, grey, sandy	19	484
Clay, yellow	18	502
Clay , grey, sticky	7	509
Clay, grey	8	517
Clay, greyish-yellow	22	539
Clay, grey	8	547
Clay ,yellow, sticky	7	554
Clay, greyish-yellow	8	562
Clay, greyish-yellow, sticky	30	592
Clay, grey, sandy	18	610
Gravel, fine ,sub-rounded,with coarse sand	4	614
Clay, grey, sticky	16	630
Clay,yellowish-grey	7	637
Clay, grey, sticky and plastic	23	660
Clay, greyish-yellow, sticky	8	668
Clay, greyish- yellow	7	675
Clay,yellowish-grey	15	690
Clay, grey, sticky and plastic	23	713

Well Completion data

Casing: 6 in to 102 ft/4 in to 400 ft.

Screened zone: 375-394 ft/4 in.

Yield: 56 gpm (pump)

Drawdown: 2.9.ft.

Table 7 Well Logs

Test Hole No.: 1/6
Location: Kamdi
Drilled by: Hydrology Department
Altitude of Land Surface: 460 ft.
Static Water lever (Head): -34 ft.ISD.

Drilling Started 16/3/1973
Completed 25/3/1973
Log by: G.P.Chaturvedi

Lithologic Description	Thickness (feet)	Depth (feet)
Soil, brown, sandy	3	3
Sand,light brown,medium to fine	7	10
Sand,grayish-brown,medium to coarse	24	34
Clay,yellowish-grey	6.	40
Gravel fine,subrounded to subangular,w/coarse sand	22	62
Clay,dark,w/fine gravel	8	70
Gravel, fine subangular to subrounded	8	78
Gravel, fine w/grey clay	7	85
Gravel,fine, w/siltstone	12	97
Clay,grey, sand w/fine gravel	14	111
Gravel,fine subangular to subrounded w/fine sand	29	140
Sand ,fine well sorted	25	165
Clay,grey,sticky w/gravel of siltstone	6	171
Gravel,fine subangular to subrounded w/fine sand	9	180
Gravel,find round to subrounded w/coarse sand	21	201
Clay, grey sticky ,w/gravel,subangular to to subrounded		205
Gravel,fine ,subangular to subrounded	11	216
Gravel,fine,angular to subagular	4	220
Clay,yellow,sticky	11	231
Gravel,subangular to subrounded w/medium to fine sand	15	246
Gravel,fine ,subangular to subrounded w/gravel of siltstones	10	256
Clay,grey,sticky	4	260
Clay,grey,sticky,w/thin layers of siltone	16	276
Clay, grey,sticky, w/gravel	15	291
Gravel,mult-coloured, fine,subrounded	9	300
Clay,grey, sticky,w/gravel	6	306
Gravel,multicoloured,subangular	4	310
Clay,grey,sticky	11	321
Clay,grey w/fine gravel	15	336

-Table 7 Well Logs

Test Hole No.: 1/6 (Cont)

Lithologic Description	Thickness (feet)	Depth (feet)
Gravel, fine, subangular to subrounded w/ coarse sand	15	351
Clay, dark grey, sticky	15	366
Clay, dark grey, sticky, sticky , w/coarse sand & gravel	6	372
Gravel,multicoloured,subangular to subrounded	6	378
Clay,grey, sticky	2	380
Gravel,multicoloured,well sorted,subangular to subrounded	12	392
Clay,grey, stick		

Well completion date:

Casing: 12 in to 113 ft/8in .to 399 ft.

Screened zone: 370-390/8 in.

Yield: 265 gpm (Pump)

Drawdown: 36 ft.

Table / Well Logs

Test Hole No: 1/7

Location: Manda

Drilled by: Hydrology Department

Altitude of Land Surface: 540 ft.

Static Water level (Head) -69 ft. ISD

Drilling Started: 9/2/73

Completed: 14/3/73

Log by: G.P.Chaturvedi

Lithologic Description	Thickness (feet)	Depth (feet)
Soil, light yellow, sandy	2	2
Clay, light yellow, sandy	9	11
Clay, yellowish-grey, w/coarse sand and gravel	11	22
Clay, yellowish-grey, plastic and sticky	53	75
Clay, light grey, plastic and sticky	20	95
Clay, grey plastic and very sticky	20	115
Clay, yellowish-grey, plastic and sticky	25	140
Clay, light grey, plastic and sticky	95	235
Gravel, multicoloured, subangular to subrounded, well sorted w/medium to very coarse sand	2	237
Gravel, multicoloured, subangular to subrounded w/pebbles and cobbles	11	248
Gravel, multicoloured, sub-rounded to subangular, well sorted	7	255
Clay, yellowish -grey, plastic and very sticky	45	300
Clay, light grey, palstic and sticky	15	315
Clay, grey, plastic and very sticky	98	413
Gravel, multicoloured, subangular to subrounded, well sorted, mostly quartzite fragments	10	423
Clay, grey, plastic and sticky	62	485
Clay, yellowish-grey, plastic, sticky	15	500
Clay, grey, sandy	21	521
Sand, multicoloured, medium to v.cosrse w/fine gravel	17	538
Clay, grey, plastic and sticky	34	572
Gravel, multicoloured, subangular to surounded	4	576
Clay, light yellowish-grey, plastic and sticky	4	580
Gravel, multicoloured, subangular to subrounded well sorted w/v. coarse sand	18	598
Clay, grey, plastic and sticky	12	610
Clay, grey, plastic w/fine to medium sand	10	620
Clay, grey, plastic and sticky	43	663
Gravel, multicoloured, angular to subrounded, well sorted	12	675
Clay, grey, plastic and sticky	6	681

Well completion date

Casing: 6 in to 102 ft/4in to 262 ft.

Screened zone 235-255 ft/4 in

Yield: 35 gpm (pump)

Drawdown : 2.5, ft.

Table 7 Well Logs

Test Hole No.: 1/8

Location: Udai

Drilled by: Hydrology Department

Altitued of Land surface: 520 ft.

Static Water level(Head): + 35 ft. LSD

Drilling Started: 24/1/

Completed 5/2/73

Log by: G.P.Chaturvedi

Lithologic Description	Thickness (feet)	Depth (feet)
Soil, blackish-grey, sandy	2	2
Sand, light brown, fine to medium	10	12
Sand, light brown, medium to v.coarse	3	15
Sand, light brown, medium to v. coarse W/fine gravel	9	24
Gravel, multicoloured, angular to subrounded	5	29
Gravel, poorly sorted w/quartzite and sandstone boulders cobbles and sand	5	34
Clay, light yellow, plastic, very sticky	24	58
Clay, grey, sticky w/ gravel and cobbles	4	62
Gravel, poorly sorted w/cobbles	2	64
Sand, multicoloured, coarse to v.coarse, well sorted, w/gravel	2	66
Clay, light grey, plastic and sticky	15	81
Clay, light yellow, plastic and sticky	122	203
Sand, multicoloured, medium to v.coarse W/fine gravel	6	209
Gravel, multicoured, well sorted, subangular to subrounded, w/coarse sand, and cobbles	17	226
Sand, grey, medium to v. coarse	4	230
Clay, yellow, Plastic and sticky	80	310
Clay, yellow, sticky w/gravel	8	318
Clay, yellowish-grey, Plastic and sticky	45	363
Clay, light yellow, sticky w/gravel	15	378
Clay, yellow plastic and sticky	12	390
Gravel, multicoloured, well sorted, subangular to subrounded	17	407
Clay, yellowish-grey, Plastic and v.sticky	131	538
Clay, yellowish-grey, sticky w/fine gravel	24	562
Clay, dark grey, plastic, sticky w/fine gravel	43	60 5

Well completion data

Casing: 6 in to 82 ft/4 in to 234 ft.

Screened zone: 209 to 226 ft/4 in

Yield: 40 gpm (flow)

Table 7 Well Logs

Test Hole No.: 2/1 — Drilling Started: 13/11/72

Location: Jamunaha — Completed: 30/11/72

Drilled by: Hydrology Department — Log by: G. P. Chaturvedi

Altitude of Land Surface: 479 ft.

Static Water level (Head): -45 ft. LSD

Lithologic Description	Thickness (feet)	Depth (feet)
Soil,grey,sandy	1	1
Clay,yellowish-grey,plastic w/pieces of siltstone	9	10
Clay,grey,plastic,w/siltstone gravel	14	24
Clay,dark grey,plastic sticky	13	37
Clay,yellowish-grey,plastic & very sticky	36	73
Gravel,subangular to subrounded,poorly sorted, w/dark grey, sticky clay	15	88
Clay,dark grey,plastic and sticky	11	99
Clay,dark grey,sticky w/siltstone gravel	6	105
Sand,grey,medium to coarse w/gravel,some grey clay from 122 ft.	35	140
Sand,greyish-brown, coarse	27	167
Clay,grey,plastic,sticky	33	200
Clay,yellowish- w/fine sand, and gravel	15	215
Sand,fine to v. coarse w/gravel and grey clay	17	232
Sand,grey, medium to coarse	27	259
Sand,grey,fine to coarse w/gravel	17	276
Sand,fine to medium,clayey	4	280
Sand,gfey,fine to medium,clayey	11	291
Clay,dark grey,plastic and sticky	45	336
Sand, grey, medium to V. coarse w/grey sticky clay	13	349
Sand,grey,coarse to V.coarse w/fine gravel	17	366
Clay,grey sandy	3	369
Sand,grey,medium to coarse	12	381
Clay,grey,sandy	28	409
Gravel,fine ,poorly sorted w/grey V.coarse sand	11	420
Gravel,subangualr to subrounded,well sorted	15	435
Clay,grey,sandy	6	441
Sand,grey,coarse to v.coarse w/gravel	35	476
Clay,grey, w/fine sand	28	504
Clay,grey,sticky	87	591
Gravel,angular to subangular w/grey,coarse to medium sand	15	606

Table 7 Well Logs

Test Hole No.: 2/1 (Cont.)

Lithologic Description	Thickness (feet)	Depth (feet)
Gravel w/medium to coarse sand and grey clay	15	621
Clay, grey, sticky w/sand	15	636
Clay, grey,Plastic w/gravel from 645 to 651	30	666
Clay,grey sticky w/gravel	34	700
Clay,grey, plastic	71	771
Clay, grey, sandy w/gravel	15	786
Clay,grey,plastic	88	874
Clay, grey w/gravel and coarse sand	26	900
Clay, grey,plastic,sticky	2	902
Sand,v.coarse to coarse with some clay	18	920
Sand,grey,coarse to v. coarse and fine gravel w/grey clay	40	960
Clay,grey,sticky	12	972
Sand,grey coarse to v. coarse w/fine gravel	1 5	977
Clay,yellowish-grey,sticky	4	981
Clay,grey,sticky w/gravel	15	996
Clay,grey, w/sand	7	1003

Well completion data

Casing: 6 in to 90 ft/4 in to 442 ft.
Screened zone: 409-435/4 in.
Yield: 60 gpm (airlift)
40 gpm (pump)
Drawdown: 1.2 ft.

Table 7 Well Logs

Test Hole No. 2/2

Location: Panchayat Training Center

Drilled by: N.B. Tubewells

Altitude of Land Surface:

Static water level (Head): -15 ft. LSD

Drilling Started: 8/6/73

Completed: 11/6/73

Log by: S.B.Kansakar

Lithologic Description	Thickness (feet)	Depth (feet)
Sul-soil	5	5
Clay,yellow,sticky	17	22
Clay, grayish-yellow w/siltstone	20	42
Clay,grayish-yellow sticky	10	52
Clay, grayish- yellow w/ siltstone	10	62
Clay, grayish- yellow	23	85
Sand	12	97
Clay,silt sticky	17	114
Gravel,sub-rounded	4	118
Sand, fine to medium	8	126
Clay, yellow ,sticky	14	140
Clay, with siltstone	5	145
Sand,fine to medium w/ gravel	18	163
Clay, yellowish-gray	27	190
Clay, sticky	14	204
Clay, sandy	5	209
Sand,fine to medium w/ gravel	11	220
Clay ,sandy	11	231
Clay, yellow	43	274
Clay, yellow w/ siltstone	46	320
Clay,grayish-yellow w/ siltstone	10	330
Clay,sandy, w/ siltstone	11	341
Clay, yellow w/ siltstone	34	375
Clay, yellow	35	410
Sand with clay	15	425
Clay	5	430
Gravel,sub-rounded to angular,with sand	16	446
Clay	14	460

Well completion data

Casing : 4 in to 169 ft.

Screened zone 143 to 162 ft.

Table 7 Well Logs

Test Hole No. 2/3

Location: Panchayat Training Center

Drilled by: N.B. Tubewells

Altitude of Land Surface:

Static Water level (Head: -15 ft. LSD

Drilling Started: 13/6/73

Completed: 15/6/73

Log : S.B. Kansakar

Lithologic Description	Thickness (feet)	Depth (feet)
Sub-soil	2	2
Clay, yellow w/ siltstone	48	50
Clay, yellowish-gra-	35	85
Sand & gravel w/ siltstone	12	97
Clay, yellowish-gray	7	104
Clay,sandy	6	110
Clay,yellowish-gray w/siltstone	8	118
Sand,fine to medium	6	124
Clay,grayish-yellow	16	140
Sand & gravel w/siltstone	21	161
Clay, yellow	5	166

Well completion date

Casing: 10 in to 164 ft.

Screened zone :141 to 160 ft/10 in.

Yield: 270 gpm (pump)

Drawdown: 40 ft.

Table 7 Well Logs

Test hole No. 2/4

Logation : Irrigation Compd(Nepal gunj)

Drilled by: Hydrology

Altitude of Land surface

Static water level (Head): 011.4 ft. LSD

Drilling started: 10/6/73

Completed: 12/6/73

Log by T. M Singh

Y

Soil, gray

Lithologic Description	Thickness (feet)	Depth (feet)
Soil, gray	5	5
Clay, gray w/ siltstone	3	8
Sand, w/ siltstone	7	15
Sand, grayish yellow, fine to medium w/mica & quartz	15	30
Sand yellowish gray, fine to medium w/mica	8	38
Clay, gray w/ siltstone	27	65
Clay, gray	24	89
Clay, w/siltstone	22	111

Well completion data

Casing 6 in to 45 ft.

Sureen zone : 16 ft. to 35 ft/6 in.

Test Hole No. 2/6

Table 7 Well Logs

Location: Karkado (Police Trg. Center)

Drilling Started 21/12/72

Drilled by: N.B. Tubewells

Completed: 24/12/72

Altitude of Land Surface: 486

Log by Driller's log

Static Water level (Head): -46 ft. LSD

Lithologic Description	Thickness (feet)	Depth (feet)
Soil	5	5
Sand, fine	35	40
Clay, yellow w/ sand and siltstone	35	75
Clay, sandy	27	102
Sand, w/siltstone gravel	14	116
Clay, sandy, w/siltstone	10	126
Clay, yellow	62	188
Clay, yellow, sticky	32	220
Clay, yellow w/siltstone from 226'	15	235
Sand, fine-med.	11	246
Clay, yellow.	15	261
Sand, fine-med.	25	286
Clay, yellow	40	326
Sand, fine-med	22	348
Clay, yellow	21	369
Clay, sandy, w/siltstone	17	386
Sand, w/fine siltstone gravel	20	406
Clay, sandy	10	416
Clay, yellow	12	428
Clay, yellow, hard	13	441
Clay, yellow, soft	32	473
Sand, med. to coarse	12	485
Clay, yellow, sandy	40	525
Clay, yellow, w/siltstone Particles	15	540
Clay, yellow, soft	20	560
Clay, sandy, w/siltsone partiicles	15	575
Clay, grey, w/siltstone	25	600
Clay, yellow, soft	89	689
Clay, yellowish, soft	21	710
Clay, yellow, w/siltstone	25	735
Sand, w/siltstone gravel	14	749
Clay, yellow	11	760

Continued .....

Table 7 Well Logs

Test Hole No.: 2/6 (Cont.)

Lithologic Description	Thickness (feet)	Depth (feet)
Clay,w/sand & siltstone	11	771
Clay, yellow,soft	39	810
Clay,sandy	36	846
Clay,yellow,soft	15	861
Clay,sandy	10	871
Clay,yellow	28	899
Sand and siltstone gravel	7	906
Clay,yellow,sticky	34	940
Clay,sandy	5	949
Sand and siltstone gravel	11	960
Clay,yellow,sticky	29	989

Well completion data

Casing: 6 in to 135 ft/4 in to 357 ft.

Screened zone: 326 to 349 ft/4 in.

Yield: 36 gpm (Pump)

Drawdown: 14 ft.

NACP

1 ft = 0.3048 m

Table 1 Well Logs

Test Hole No.: 2/7

Location: Ranjha

Drilled by: Hydrology Department

Altitude of Land Surface: 489 ft. (149.05 m)

Static Water level (Head): - 47 ft. LSD (14.33 m)

Drilling Started 19/11/72

Completed 15/12/72

Log by: T. M.Singh

Lithologic Description	Thickness (feet)	Depth (feet)
Clay, yellow, sticky & plastic	9	9
Siltstone	3	12
Sand,grayish-yellow,fine to medium,with mica	8	20
Sand, gray,fine,with mica	8	28
Sand, yellow,fine to medium,with mica	7	35
Sand,grayish-yellow,fine to medium,with mica	8	43
Sand,gray,fine,with siltstone	8	51
Clay,yellow,with fine to coarse sand	19	61
Sand,coarse to fine w/siltstone	9	70
Clay,gray,with siltstone	8	78
Clay,yellow,with siltstone	17	95
Clay,yellow,plastic,with siltstone	14	109
Clay,yellowish-gray,with siltstone	15	124
Clay,grayish-yellow,plastic & sticky	26	150
Clay, yellow,sticky & plastic	17	167
Clay,yellow,sticky & plastic,with siltstone	25	192
Clay,grayish-yellow,sticky & plastic	7	199
Clay,yellow,plastic & sticky,with siltstone	8	207
Clay, grayish-yellow,sticky	16	223
Clay,yellow,sticky & plastic	35	258
Clay,yellow,plastic,with siltstone	10	268
Clay,yellowish-gray,sticky & plastic	7	275
Clay,gray,sticky & plastic	8	283
Clay,yellow,sticky & plastic	22	305
Clay,gray,with coarse to medium sand	10	315
Clay,yellow,plastic	22	357
Clay,yellow,sticky & plastic	8	365
Sand,coarse to medium,with siltstone and sandstone gravel	11	376
Clay,yellow,sticky	20	396
Clay, yellow,with siltstone	7	403

Continued .....

Test Hole No. 2/7

Table 7 Well Logs

Lithologic Desription	Thickness (feet)	Depth (feet)
Clay,yellow,sticky Plastic	8	411
Clay, yellowish--sticky	4	415
Clay,grayish-yellow,plastic & sticky	6	421
Clay,grayish-yellow,plastic & sticky	5	426
Clay,grayish-yellow,sticky,with siltstone	7	433
Clay, grayish-yellow,sticky	8	441
Clay, yellow,plastic,with siltstone	7	448
Clay,grayish-yellow,with siltstone	8	456
Clay,grayish-yellow,sticky	30	486
Clay,yellow,sticky & plastic	24	510
Clay,grayish-yellow,sticky	22	532
Clay,yellow,with siltstone	8	540
Clay,yellowish- gray, sticky	14	554
Clay,yellow,sticky & plastic	15	569
Clay,yelloow,sticky	14	583
Clay,grayish-yellow,sticky	9	592
Clay,yellow,plastic & sticky	5	597
Clay, yellow,with siltstone	10	607
Clay,yellow,sticky & plastic	13	620
Clay,gray,sticky	14	634
Clay,yellowish-gray,sticky & plastic	8	642
Clay,yellow,sticky & plastic	25	667
Clay,gray with siltstone	21	688
Siltstone with gray clay	9	697
Gravel,siltstone & sandstone with groy clay	12	709
Sand, coarse,with siltstone & sand stone gravel	6	715
Sand,coarse with siltstone	13	728
Clay,gray with siltstone	15	743
Clay, gray	15	758
Clay, gray,sticky & plastic	17	775
Clay, gray,with siltstone	13	788
Clay, gray,sticcky	15	803

Well completion data

Casing: 4 in. to 386 ft.

Screened zone: 365 to 375 ft/4 in.

Table 7 Well Logs

Test: Hole No.: 2/8 WRCD

Location: Ranjha

Drilled by: Hydrology Department

Altitude of Land Surface: 489 ft. (149.05 m)

Static Water level (Head): -47 ft. LSD (14.33 m)

Drilling Started 18/2/1973

Completed 25/2/1973

Log by: T.M.Singh

Lithologic Description	Thickness (feet)	Depth (feet)
CLay, yellow, sticky	11	11
Sand, grey , fine, w/mica	38	49
Sand, yellow, fine w/mica	8	57
Clay, yellow, w/siltstone	22	79
Clay, yellowish-grey w/siltstone	19	98
Clay,greyish-yellow W/siltstone	20	118
Clay, yellow, w/ siltstone	35	153
Clay, greyish-yellow w/siltstone	40	193
Clay	35	228
Siltstone w/yellow clay	8	236
Clay, yellow	22	258
Clay, sticky	9	267
Clay, yellow,sandy, sticky	6	273
Clay,w/siltstone	15	288
Clay	19	307
Clay,grey,sticky	15	322
Sand ,fine to coarse	5	327
Clay	24	351
Sand,fine to coarse	8	359
Clay	6	365
Sand,yellow,coarse	13	378
Clay	18	396

Well completion date:

Casing: 8 in to 150/6 in to 386 ft.

Sereened zone: 352 to 376 ft/6 in.

Table 7 Well Logs

Test Hole No.: 2/9 NA-D

Location: Army Camp (Ranjha)

Drilled by: N.B. Tubewells

Altitude of Lan Surface:

Static Water level (Head): -47 ft. LSD

Drilling Started: 2/6/73

completed 6/6/73

Log by: S.B. Kansakar

Lithologic Description	Thickness (feet)	Depth (feet)
Subsoil,yellowish-gray	3	3
Clay, sandy	7	10
Clay, yellow,sandy	15	25
Clay, sandy w/siltstone	20	45
Clay, yellowish-gray	7	52
Clay, sandy w/siltstone	3	55
Clay,yellowish-gray with siltstone from 75'	35	90
Clay, yellow	30	120
Clay, yellow w/siltstone	33	153
Sand,w/siltstone gravel	13	166
Clay,yellow w/ siltstone	22	188
Sand & siltstone	7	195
Clay,yellow w/ siltstone	5	200
Clay,yellow,sand w/siltstone	20	220
Clay,yellow ,sticky	46	266
Clay,yellow,sandy	10	276
Clay,yellow w/siltstone	12	288
Clay,sandy w/siltstone	42	330
Clay,yellow sticky	50	380
Sand & siltstone	20	400
Clay,yellow	11	411
Clay,and sand alternate layers	9	420
Clay,yellow w/layer of sand	72	492

Well completion date

Casing: 10 in to 115 ft/6 in to 395 ft.

Screened zone: 154-162, 255-270, 378-391 } 6 in.

Yield: 0.35 gpm (pump)

Drawdown: 4.5 ft.

Table 7 Well Logs

Test Hole No. 2/10

Location: Haldarpurwa

Drilled by: Hydrology Department

Static Water level (Head): -18ft. LSD

Drilling Started: 1/12/72

Completed: 18/12/72

Log by: G.P. Chaturvedi

Lithologic Description	thickness (feet)	Depth (feet)
Soil, yellow	2	2
Clay, yellow, sticky	13	15
Sand, fine	2	17
Clay, yellow, plastic	8	25
Clay, gray, plastic, sticky	20	45
Clay, yellowish-gray w/fine sand	15	60
Sand, medium to coarse	28	88
Clay, yellowish gray, w/sand and siltstone gravel	8	96
Clay, yellow, Plastic, sticky	15	111
Clay, yellow, sticky w/siltstone gravel	14	125
Gravel, angular to subangular, well sorted	13	138
Clay, yellow, plastic and sticky	48	186
Sand, medium to coarse w/gravel	30	216
Sand, light gray, medium to coarse	75	291
Clay, yellow, sticky	15	306
Clay, yellow, plastic w/coarse sand	15	321
Clay, yellow, sandy	105	426
Clay, yellow, sandy w/some siltstone gravel	15	441
Clay, yellow, sandy	60	501
Clay, yellow, sandy w/siltstone gravel	15	516
Clay, yellow, sandy	15	531
Clay, yellow, sandy w/siltstone gravel	15	546
Clay, yellow, sandy	15	561
Clay, yellow, sandy w/siltstone gravel	15	576
Clay, yellow, sandy	90	666
Clay, yellow, sandy w/gravel	22	688
Gravel, well sorted w/fine to medium sand	23	711
Clay, yellow, sandy	45	756

Well completion date

Casing: 4 in to 713 ft.

Screened zone: 688-711 ft/4 in.

Yield: 65 gpm (airlift)

Table 7 Well Logs

Test Hole No. : 2/11
Location: Kohalpurwa

Drilling Started: 13/12/72
Completed: 9/1/73

Drilled by: N. B. Tubewells

Log by: Drillors Log

Altitude of Land Surface: 543 ft.

Static Water level (Head) : - 8.0. ft. LSD

Lithologic Description	Thickness (feet)	Depth (feet)
Soil	2	2
Clay, sandy	8	10
Clay, grayish-yellow	12	22
Clay,gray	28	50
Sand and gravel	8	58
Clay	4	62
Clay,grayish-yellow,sticky	8	70
Clay,yellow,soft	10	80
Clay,yellow, w/siltstone	39	119
Clay,sandy, w/siltstone	30	149
Clay, yellow	23	172
Clay, yellowish-gray	23	195
Clay,yellow, w/siltstone	6	201
Clay,grayish-yellow,w/siltstone	33	234
Clay,grayish-yellow	21	255
Clay,yellow, w/siltstone	52	307
Clay,yellow	13	320
Clay,yellow,w/siltstone	7	327
Clay,soft,sandy,w/siltstone	10	337
Clay, yellow,soft	50	387
Clay	6	393
Sand	16	409
Clay, yellow	10	419
Clay,sandy, w/siltstone	14	433
Clay,yellow	29	462
Clay,yellow,soft, w/siltstone	28	490
Clay,yellow,sticky	40	530
Clay,sandy	41	571
Clay,w/siltstone	9	580
Clay,yellow,soft	22	602
Clay,sandy	10	612
Clay,yellow,soft	78	690

Continued .....

Test Hole No.: 2.11 (Cont.) T Well Logs

Lithologic Description	Thickness (feet)	Depth (feet)
Sand,fine,medium from 700 ft.	25	715
Clay,yellow,sticky	30	745
Clay,yellow,sticky,w/fine gravel to 755 ft.	45	790
Clay,sandy	10	800
Clay,yellow,sticky,w/siltstone from 842 ft.	51	851
Clay,sandy,w/siltstone from 870 ft.	26	877
Clay,gray sandy from 892 ft.	25	902
Clay,yellow,sticky	28	1030
Clay,yellow,sandy,w/siltstone	30	1060
Clay,yellow	7	1067
Sand,w/fine sandsto e & siltstone gravel	13	1080
Clay,yellow	21	1101
Clay,yellow,sandy,w/siltstone	14	1115
Clay,yellow	81	1196
Clay,sandy,w/siltstone	13	1209
Clay,soft	4	1213
Clay,sandy,w/siltstone	17	1230
Clay,yellow,soft	26	1256
Clay,yellow,sandy	24	1280
Clay,yellow,sticky	20	1300
Clay,sandy	16	1316
Clay,greyish-yellow,soft	68	1384
Clay,greyish-yellow,sandy,w/sandstone gravel	12	1396
Clay, greyish-yellow	26	1422
Clay,sandy,soft	9	1431
Clay,greyish-yellow,w/siltstone	69	1500

Well completion data:

Casing:	6 in to 125 ft/4 in to 730 ft.
Screened zone	690 to 710 ft/4 in.
Yield:	10 gpm (pump)
Drawdown:	47 ft.

Table 7 Well Logs

Test Hole No.: 2/12

Location: Thukali

Drilled by: Hydrology Department

Altitude of Land Surface: 564 ft.

Drilling Started 19/12/197

Completed 26/12/1972

Log. by: Geologist Parajuli

Static Water level (Head): +22 ft. LSD

Lithologic Description	Thickness (feet)	Depth (feet)
Soil, grey	3	3
Clay, yellow, sandy	3	6
Sand, fine to coarse w/gravel	4	10
Gravel, well sorted, subrounded, w/coarse sand	6	16
Gravel, well sorted, angular to subrounded	13	29
Clay, yellow, sticky	81	110
Gravel, fine, poorly sorted, angular to subrounded	3	113
Gravel, w/medium to coarse sand	6	119
Clay, yellow, sandy w/gravel	5	156
Clay, yellow, sticky	30	186
Gravel, subrounded w/coarse sand	3	189
Clay, yellow, plastic	3	192
Clay, yellow, sticky w/gravel as alternative layer of one two feet.	69	261
Clay, yellow, sandy w/gravel and coarse sand	75	336
Clay, yellow, sandy w/gravel	30	366
Clay, yellow w/gravel and medium to coarse sand	54	420
Gravel, subangular to subrounded, well sorted	11	431
Clay, yellow, sticky w/alternate layer of coarse sand	25	456
Clay, yellow, plastic	33	489
Gravel, subangular to subrounded w/sand	6	495
Clay, yellow w/fine sand	4	499
Gravel, well sorted, subangular to subrounded	10	509
Clay, yellow, sandy	8	517
Gravel, subangular w/coarse sand	3	520
Clay, yellow, sandy	8	528
Gravel w/sand	3	531
Clay, yellow, sandy	5	536
Gravel w/coarse sand	6	542
Clay, yellow, sandy w/some gravel	19	561
Clay, yellow, w/sand and gravel	30	591
Cl y, yellow, sandy	15	606
Gravel, subangular to subrounded w/coarse sand	6	612
Clay, yellow, sandy w/gravel	25	637
Gravel, angular to subangular	3	640
Clay, yellow, sandy w/gravel	43	683
Sand, fine to coarse w/gravel	11	694
Clay, yellow, sandy	17	711

Well completion data:

Casing: 4 in to 439 ft.

Screened zone: 420 to 431 ft/4 in.

Yield: 63 gpm (flow)

Table 7 Well Logs

Test Hole No.: 3/1
Location: Sainik Gaon
Drilled by: N.B. Tubewells
Altitude of Land Surface: 458 ft.
Static Water Level (Head) - 27 ft. LSD

Drilling Started 26/1/1973
Completed 31/1/1973
Log by: S. B. Kansakar

Lithologic Description	Thickness (feet)	Depth (feet)
Soil	2	2
Clay,yellow,sandy	7	9
Sand,fine	5	14
Clay, sandy	23	37
Sand,medium	20	57
Clay, sandy	27	84
Clay,sticky w/siltstone gravel	10	94
Clay, sticky	26	120
Clay, sandy	21	141
Sand,med to coarse, w/gravel	37	178
Clay, yellow,sticky	24	202
Sand,coarse, w/fine gravel	9	211
Clay, yellow	20	231
Clay,sandy w/sandstone gravel	7	238
Clay, yellow,sticky	17	255
Clay,yellow,sandy	10	265
Sand,coarse w/clay	10	275
Clay,sandy	20	295
Clay,w/sand & gravel	10	305
Sand,med-coarse	10	315
Clay,sandy w/gravel	66	381
Sand,w/gravel,sandy clay at 414	59	440
Clay,sandy, w/sand & gravel	45	485
Clay,sandy,w/some gravel from 505-515	32	517
Sand, fine	17	534
Clay,yellow	23	557
Sand,coarse w/gravel	10	567
Clay,yellow,sandy	16	583
Clay,sandy,w/gravel	7	590
Clay,sandy	31	621
Clay,sandy, w/gravel	26	647
Clay,w/sand & gravel	20	667
Clay,sandy w/gravel	10	677
Clay,sandy	57	734
Clay,yellow,sticky	11	745
Clay,yellow,sandy,loose	25	770
Clay,yellow	22	792
Clay,sandy	118	910
Clay,yellow,sticky	72	982
Clay,sandy	18	1000

Well completion date:
Casing: 6 in to 127 ft/4 in to 182 ft.
Screened zone: 142 to 172 ft/4 in.
Yield: 40 gpm (pump)
Drawdown: 5.5. ft.

Table 7 Well Logs

Test Hole No.: 3/2
Location: Sainik Gaon
Drilled by: N. B. Tubewells
Altitude of Land Surface: 458 ft.
Static Water level (Head): -27 ft. LSD

Drilling Started 29/5/1973
Completed 31/5/1973
Log by: S. B. Kansakar

Lithologic Description	Thickness (feet)	Depth (feet)
Sub-soil	2	2
Clay, sticky w/siltstone	5	7
Clay, yellow, w/clay balls	6	13
Clay, yellowish, sticky	4	17
Clay, yellow w/siltstone	4	21
Siltstone	16	37
Sand, fine to medium	21	58
Clay, gray, sticky w/siltstone	26	84
Clay, sand w/siltstone	34	118
Clay, yellowish-gay	12	130
Clay, grayish-yellow w/siltstone	13	143
Sand w/alternate layers of clay & siltstone	17	160
Sand	13	173
Clay, loose w/siltstone	10	183

Well completion data:
Casing: 4 in. to 175 ft.
Screened zone: 150 to 170 ft./4 in.

Table 7 Well Logs

Test Hole No.: 3/3

Location: Odarapur

Drilled by: N.B. Tubewells

Altitude of Land Surface: 464 ft.

Static Water level (Head): 27 ft. LSD

Drilling Started 1/2/19

COmpleted 13/2/1973

Log by: S. B. Kansakar

Lithologic Description	Thickness (feet)	Depth (feet)
Soil	3	3
Clay,sticky w/siltstone & clay balls	21	24
Clay, sticky	6	30
Clay, sandy	12	42
Sand & siltstone gravel	23	65
Clay	10	75
Clay, w/siltstone	20	95
Clay, sticky w/siltstone	30	125
Clay, soft w/siltstone	5	130
Clay, sticky w/siltstone	15	145
Sand	18	163
Clay,sandy	10	173
Clay,sticky, w/thin layer of siltstone at 185-187	20	193
Sand & gravel	26	219
Clay, sticky	5	224
Sand & gravel	14	238
Clay,sticky	35	273
Clay,sticky w/thin layer of gravel (siltstone)at 301-302 ft.	45	318
Clay,w/sand &gravel	25	343
Clay,soft	7	350
Clay,sandy	33	383
Sand	6	389
Clay,sticky	20	409
Clay,sandy	6	415
Clay,sticky w/siltstone	19	434
Clay,sandy,soft	8	442
Clay,sticky w/siltstone	4	446
Clay,sticky	14	460
Clay,sandy	10	470
Sand	10	480
Clay,sandy	10	490
Gravel	8	498
Clay,sticky	59	557
Clay,w/siltstone	23	580
Clay,sandy	31	611
Clay,w/siltstone	16	627
Clay,sticky	15	642
Clay ,soft	4	646
Sand	10	656
Clay,sandy	23	679

Continued.....

Test Hole No.: 3/3 (Cont.)

Table 7 Well Logs

Lithologic Description	Thickness (feet)	Depth (feet)
Sand	5	684
Clay,sticky	10	694
Clay,sandy	10	704
Clay,sticky w/sand & siltstone	13	717
Sand	24	741
Clay w/sand & siltstone	7	728
Clay,sticky	31	759
Clay w/layers of siltstone from 759-766	21	780
Clay,sticky w/some siltstone	11	791
Sand w/sandstone from 864-866	94	885
Clay,soft w/sand	11	896
Clay, w/ siltstone	10	906
Clay,sticky	64	970
Clay	18	988
Clay,sandy	17	1005
Clay,soft w/sand	77	1082
Sandstone,w/soft clay	14	1096
Clay,sandy	6	1102
Clay w/siltstone from 1155-1156	68	1170
Clay,sticky w/siltstone	10	1180
Clay,sticky	10	1190
Clay	10	1200
Clay w/sand	20	1220
Clay,sandy	20	1240
Clay,sandy w/some siltstone	42	1282
Sand	14	1296
Clay,sandy w/siltstone	34	1330
Clay,sandy w/siltstone	50	1380
Clay,sandy	10	1390
Clay	20	1410
Clay w/siltstone	26	1436
Clay,sandy w/siltstone	64	1500

Well completion data:

Casing Depth: 6 in to 126 ft./4 in to 227
Screened zone: 191-211 ft/4 in.
Yield: 60 gpm/airlift
37 gpm/(pump)
Drawdown: 57 ft.

Test Hole No. 3/4

Table 7 Well Logs

Location: Agriculture Farm

Drilling Started 11/1/1973

Drilled by: N. B. Tubewells

COmpleted 17/1/1973

Log by: Drillers Log

Altitude of Land Surface: 478 ft.
Static Water level (Head): -18 ft. LSD

Lithologic Description	Thickness (feet)	Depth (feet)
Soil	2	2
Clay,yellow,sticky w/gravel	8	10
Clay,sandy	32	42
Clay w/gravel	37	79
Sand,fine to coarse,w/siltstone gravel	63	142
Clay,w/gravel	25	167
Gravel	12	179
Clay,yellow,sticky	3	182
Gravel	4	186
Clay,yellow,sticky	9	195
Clay,sandy	15	210
Clay,yellow,sticky	13	223
Clay,sandy w/siltstone gravel	15	238
Clay,yellow,sticky	10	248
Clay,w/siltstone gravel	17	265
Clay,yellow	35	300
Clay,sandy	14	314
Clay,w/sand & gravel	23	337
Sand,med,to coarse,siltstone	19	356
Clay,sandy	45	401
Sand and yellow clay	11	412
Sand,coarse and siltstone	11	423
Clay,yellow,soft. w/siltstone from 486 ft.	73	496
Clay yellow	24	520
Gravel	4	524
Clay, yellow	52	576
Sand,fine	15	591
Clay,sandy	35	626
Clay,yellow,sticky	32	658
Clay,sandy	11	669
Clay,yellow	10	679
Sand,w/siltstone from 684-688 ft.	12	691
Clay,yellow	19	710

Continued.....

Table 7 Well Logs

Test Hole No.: 3/4 (Cont.)

Lithologic Description	Thickness (feet)	Depth (feet)
Clay,greyish-yellow w/siltstone	19	719
Sand, and siltstone gravel	22	741
Clay,yellow to greyish-yellow	22	763
Gravel and siltstone	8	771
Clay,yellow	39	810
Clay,yellow,sandy w/finr siltstone	45	855
Clay,sandy	27	882
Clay,yellow	9	891
Clay,sandy	18	909
Clay,yellow, w/some siltstone	22	931
Clay,grey,sandy from 941 ft.	18	949
Sand,coarse	2	951
Clay,grey, w/sand	4	955
Clay	45	1000

Well completion data:

Casing: 6 in to 129 ft.
Screened zone 100 ro 119 ft/6 in.
Yield: 44 gpm (pump)
Drawdown: ft.

Table 7 well Logs

Test Hole No.: 3/5

Location: Agriculture Farm

Drilled by: N.B. Tubewells

Altitude of Land Surface 478 ft.

Static Water level (Head) -34 ft. LSD

Drilling Started 18/1/1973

Completed 21/1/1973

Log by: S.B. Kansakar

Lithologic Description	Thickness (feet)	Depth (feet)
Soil	2	2
Clay,sandy w/clay balls	8	10
Clay,yellow,sticky	12	22
Clay, w/gravel	28	50
Sand,fine w/sandstone gravel	14	64
Clay, yellow, sticky	6	70
Clay w/gravel	9	79
Clay, yellow,soft	35	114
Sand,med.to coarse	24	138
Clay, yellow	21	159
Sand & Gravel	23	182
Clay, yellow, soft	13	195
Sand & gravel	15	210
Clay,yellow	20	230
Clay,sandy w/gravel	13	243
Clay,sandy	19	262
Clay w/gravel	8	270
Clay ,w/thin layer of sand from 283-285	32	302
Sand.med.to coarse w/gravel,thin layer of clay 305-307	81	383
Clay,yellow	12	395
Clay,w/sand	15	410
Clay,sandy	25	435

Well completion data:

Casing: 12 in to 127 ft/8 in to 424 ft.
Screened zone: 305 to 380 ft & 400 to 418/8 in.
Yield: 350 gpm (pump)
Drawdown: 22 ft.

Table 7 Well Logs

Test Hole No.: 3/6

Location: Agriculture Farm — Drilling Started 23/1/1973

Drilled by: N.B.Tubewell — Completed 24/1/1/1973

Altitude of Land Surface: 478 ft. — Log by. S. B. Kansakar

Static Water level (Head) -34 ft. LSD

Lithologic Description	Thickness (feet)	Depth (feet)
Soil	2	2
Clay,sandy, w/clay balls	38	40
Clay,sandy, w/clay balls	10	50
Clay, w/gravel	1010	60
Clay,thin layers of gravel	19	79
Clay,sandy w/thin layer of gravel	16	95
Clay	12	107
Sand & gravel	23	130
Clay	18	148
Clay, w/gravel	12	160
Sand,w/gravel	12	172
Clay, sandy w/gravel	10	182
Clay,w/gravel	12	194
Sand & gravel	24	218
Clay	27	245
Sand & gravel	15	260
Clay	20	280
Clay	22	302
Sand & gravel	80	382
Clay, w/gravel	20	402

Well completion data:

Casing depth: 4 in to 395 ft.

Screened zone 337-357 ft/4 in.

Table 7 Well Logs

Test Hole No. : 3/7

Location: Dahawa

Drilled by: N.B. Tubewells

Altitude of Land Surface: 489 ft.

Static Water level (Head): LSD

Drilling Started 16/2/1973

Completed 21/2/1973

lithologic Description	Thickness (feet)	Depth (feet)
Sub soil	2	2
Clay, yellow,sticky w/siltstone	19	21
Clay,grey w/some siltstone	29	50
Clay,yellow w/siltstone	10	60
Clay,yellowis-gray w/siltstone	30	90
Clay,yellow w/siltstone	40	130
Siltstone	10	140
Siltstone w/some clay	11	151
Clay,yellow w/siltstone	64	215
Clay,yellow,sticky	10	225
Clay,yellow,sticky,w/siltstone	21	246
Clay,yellows sticky	39	285
Clay,yellow,sticky w/siltstone	10	295
Clay,sandy w/siltstone	10	305
Clay,yellow,w/siltstone	15	320
Sand, w/siltstone	14	334
Clay, sandy w/siltstone	31	365
Clay,sandy	10	375
Sand	15	390
Clay, sandy w/siltstone	7	397
Clay,sandy,soft	20	417
Clay, w/siltstone	29	446
Clay, sticky w/s siltstone	23	469
Sand & siltstone	13	482
Clay,sticky w/gravel	21	503
Sand & gravel	2	505
Clay	52	557
Clay, w/siltstone	63	620
Clay	27	647
Clay,hard sticky w/gravel	7	654
Clay, w/gravel	46	700
Clay	30	730
Clay, sandy	20	750
Clay,w/siltstones	10	760

Continued.....

Table 7 Well Logs

Test Hole No. 3/7 (Cont.)

Lithologic Description	Thinckness (feet)	Depth (feet)
Clay,sticky	20	780
Clay,sandy	10	790
Clay,sticky	10	800
Clay,sticky w/sand & siltstone	45	845
Clay	15	860
Clay,w/gravel	20	880
Clay	60	940
Clay, w/siltstone	41	981
Clay	19	1000

Well completion data:

Casing: 6 in to 122 ft/4 in.to 339 ft.

Screened zone: 319 to 329 ft/4 in.

Test Hole No; 3/8

Table 7 Well Logs

Location: Modaha

Drilling Started 24/2/1973

Drilled by: N.B.Tubewells

Completed 2/3/1973

Altitude of Land Surface: 500 ft.

Log by: S. B. Kansakar

Static Water level (Head): +1.7.ft. LSD

Lithologic Decription	Thickness (feet)	Depth (feet)
Soil	2	2
Clay,sticky	5	7
Clay, w/siltstone	13	20
Clay,yellow,sticky w/siltone	36	56
Clay,sandy w/siltstone	6	62
Clay,sticky w/siltstone	10	72
Clay,sandy w/siltstone	8	80
Clay,yellow,sticky w/siltstone	10	90
Clay,sticky w/siltstone gravel	24	114
Clay,sticky w/siltstone	20	134
Clay,sandy w/siltstone	7	141
Sand & gravel	21	162
Clay,yellow sticky w/siltstone,thin layer of sand 190 ft.	28	190
Gravel & sand	25	215
Clay,yellow ,sticky w/siltstone	5	220
Gravel w/sand	18	238
Clay,yellow,sandy	8	246
Clay, & gravel ,in alternate layers	8	254
Clay,yellow,sandy & sticky	6	260
Clay,yellow	11	271
Clay,yellow,sandy	21	292
Clay	28	320
Clay, w/siltstone	20	340
Clay,sticky	40	380
Clay,sticky w/siltstone	50	430
Clay,soft w/siltstone	10	440
Clay, yellow w/siltstone	20	460
Clay,sandy (sand from 467-472)	23	483
Clay,soft w/siltstone	17	500
Clay,sticky w/siltstone	27	527
Clay,sandy w/siltstone	109	636
Siltstone gravel w/clay from 636-638	14	650
Clay w/siltstone layers	26	676
Clay w/siltstone gravel	14	690
Clay	68	758

Continued .....

Table 7 Well Logs

Test Hole No. 3/8 (Cont.)

Lithologic Description	Thickness (feet)	Depth (feet)
Clay, sandy w/ siltstone gravel	12	770
Clay, grayish-yellow w/siltstone	60	830
Clay, yellow, sticky w/siltstone	38	868
Clay, yellowish-gray, sticky	12	880
Clay, hard sticky w/siltstone	10	890
Clay, sandy w/siltstone	20	810
Clay, sticky w/siltstone	40	950
Clay, gray, sandy w/siltstone	20	970
Clay, grayish-yellow w/ siltstone	30	1000

Well Completion data:

Casing : 6 in to 122 ft/4 in to 248 ft.

Screened zone: 190 to 238 ft/4 in.

Yield: 53 gpm (pump)

Drawdown: 14 ft.

Table 7 Well Logs

Test Hole No.: 3/9

Location: Modaha

Drilled by: N.B. Tubewells

Altitude of Land Surface:

Static Water level (Head) +1.7 ft. LSD

Drilling Started 7/3/1973

Completed 8/3/1973

Log by: S. B. Kansakar

Lithologic Description	Thickness (feet)	Depth (feet)
Soil	2	2
Clay,sandy	6	8
Clay, yellow,sticky w/siltstone	15	23
Clay, yellow, sticky	20	43
Clay, w/siltstone	12	55
Clay	37	92
Clay,yellow w/siltstone	8	100
Clay,yellow w/siltstone gravel	10	110
Gravel, siltstone w/sand	3	113
Clay,yellow & gray	17	130
Sand	12	142
Sand & gravel	21	163
Clay w/siltstone	27	190
Gravel & sand	30	220
Clay,yellow	8	228
Gravel & sand	18	246
Clay	4	250

Well completion data:

Casing: 4 in to 245 ft.

Screened zone: 197-208 ft & 228-238 ft/4 in.

Table 7 Well Logs

Test Hole No.: 3/10
Location: Amohia
Drilling by: Hydrology Department
Altitude of Land Surfave: 573 ft;
Static Water level (Head): -17 ft. LSD

Drilling Started 12/3/1973
Completed: 18/3/1973
Log by: T.M. Singh

Lithologic Description	Thickness (feet)	Depth (feet)
Clay, yellow	15	15
Clay, yellow, sticky	8	23
Clay,yellow	64	87
Gravel	22	109
Clay	31	140
Gravel	5	145
Clay,yellow	65	210
Gravel	32	242
Clay	139	381
Clay, sandy	15	396
Clay	37	433
Gravel	16	449
Clay	52	501
Gravel	16	517
Clay	85	602
Gravel	18	620
Clay	26	646
Gravel	18	664
Clay	49	713

Well completion data:

Casing: 6 in to 99 ft/4 in to 522 ft.
Screened zone: 497-515 ft/4 in.
Yield: 53 gpm (pump)
Drawdown 6 ft.

Table 7 Well Logs

Test Hole No.: 4/1

Location: Kathapur

Drilled by: N. B. Tubewells

Altitude of Land Surface: 457 ft.

Static Water level (Head): 33 ft. LSD

Drilling Started 11/3/1973

Completed 16/3/1973

Log by: S. B. Kansakar

Lithologic Description	Thickness (feet)	Depth (feet)
Sub soil	2	2
Clay, yellow,hard &sticky	6	8
Clay,yellow w/siltstone	24	32
Gravel,siltstone w/sand	13	45
Clay,yellow & grey	19	64
Clay, yellow grayish-yellow w/siltstone	16	80
Clay,grayish-yellow,sticky	30	110
Clay,yellow,sticky w/siltstone	22	132
Sand & siltstone gravel	18	150
Clay w/sand & gravel,in alternate layers	20	170
Clay,grey,sandy	10	180
Clay,yellow,sandy	20	200
Clay,sandy	25	225
Clay,sandy w/siltstone	11	236
Clay,yellowish w/siltstone	6	242
Clay,sandy w/siltstone	6	248
Clay w/siltstone	20	268
Clay,sandy w/siltstone	32	300
Clay,yellowish-grey	10	310
Sand w/gravel	22	332
Clay,sandy	13	345
Sand & gravel	95	440
Clay,yellow,sticky	20	460
Clay,yellowish-gray w/siltstone	10	470
Clay,sandy	20	490
Clay,sandy w/gravel	50	540
Clay,sandy	20	560
Clay,grey,sandy w/gravel	10	570
Clay,grey w/gravel	13	583
Clay,sandy w/gravel	59	642
Clay,yellowish-grey	18	660
Clay,sticky w/siltstone	13	673
Clay,grayish-yellow,sandy	10	683
Clay,yellow soft	8	691

Continued.....

Test Hole No. : 4/1 (Cont.)

Table 7 Well Logs

Lithologic Description	Thickness (ffet)	Depth (feet)
Clay,yellow w/siltstone	14	705
Clay,soft	30	735
Clay, sandy w/siltstone	30	765
Clay,yellow,soft	85	850
Clay,greyish-yellow to grey,sandy w/thin layers of gravel from 850-860 ft.	45	895
Clay,grey, sandy	15	910
Clay, grey ,sticky	14	924
Clay,sandy	31	955
Clay,yellow,soft	45	1000

Well completion data:

Casing: 6 in to 124 ft/4 in to 438 ft.
Screened zone: 380-428 ft/4 in.
Yield: 250 gpm (airlift)
47 gpm (pump)
Drawdown: 4 ft.

Test Hole No. 4/2

Table 7 Well Logs

Location: Daurah

Drilling Started 25/3/1973

Drilled by: Hydrology Department

Completed: 31/3/1973

Altitude of Land Surface: 464 ft.

Log by T. M. Singh

Static Water level (Head): -48 ft. LSS

Lithologic Description	Thickness (feet)	Depth (feet)
Soil ,grey	10	10
Clay,yellow w/fine -med. sand & siltstone	6	16
Sand,yellow, fine to med	11	27
Cl ay,grey,sticky & plastic	33	60
Clay,grey w/siltstone	19	79
Clay,grey,sticky	30	109
Clay,yellow,sticky	8	117
Clay,yellowish-grey	16	133
Clay,yellowish-grey w/siltstone	22	155
Clay,grey w/siltstone	15	170
Clay,grey,sticky	7	177
Clay,greyish-yellow,sticky	8	185
Clay,yellow	15	200
Clay,yellow w/siltstone	30	230
Gravel,angular w/siltstone particles	3	233
Clay,yellow w/siltstone	29	262
Clay,yellow	12	284
Clay,greyish-yellow	11	295
Clay,yellow	18	313
Clay,yellow,sticky	17	330
Clay,yellowish-grey,sticky	28	358
Clay,yellow,sandy	4	362
Gravel w/fine to coarse sand	8	370
Clay,grey,sticky	10	380
Gravel w/coarse sand	28	408
Clay,grey	5	413
Clay,grey w/siltstone	22	435
Clay,yellow	8	443
Clay,grey,sandy	17	460
Clay,grey	20	480
Clay,grey w/siltstone	10	490
Gravel w/sand	6	496
Clay,yellow,sandy	11	507
Clay,greyish-yellow	38	545
Clay,grey,sticky	35	580
Gravel,fine w/med to coarse sand	8	588
Clay,grey	49	637
Clay,yellow w/siltstone	15	652
Clay,grey	36	688
Clay,grey,sandy	25	713

Well completion data:

Casing: 6 in to 98 ft/4 in to 418 ft.

Screened: zone: 356-375 &388-401 ft/4 in.

Yield: 44 gpm (pump)

Drawdown: 11 ft.

Table 7 Well Logs

Test Hole No. 4/3 — Drilling Started 19/3/1973

Location: Machagarh — Completed. 22/3/1973

Drilled by: N.B. Tubewells — Log by: S.B. Kansakar

Altitude of Land Surface: 500 ft.

Static Water level (Head): -58 ft. LSD

Lithologic Description	Thickness (feet)	Depth (feet)
Sub-soil,grey	2	2
Clay,yellow,sandy	6	8
Sand	24	32
Clay,yellow,sandy	22	54
Sand	8	62
Clay yellow,sandy	10	72
Clay,yellow w/siltstone	18	90
Clay,grey & yellow,sticky	20	110
Sand w/gravel & siltstone	5	115
Clay,yellow & grey w/thin layer of sand 120 to 122	10	125
Clay w/siltstone	52	177
Clay,sandy w/sand from 177-180	27	204
Clay,sandy w/siltstone	10	214
Clay,sandy	60	274
Clay,w/gravel	20	294
Clay,yellow	16	310
Clay,yellow w/siltstone	54	364
Clay,yellow,sticky w/siltstone	16	380
Clay,yellow & grey	10	390
Clay,yellow w/gravel	5	395
Sand & gravel w/thin layers of clay	27	422
Clay,yellow	20	442
Sand	10	452
Clay,yellow,sticky	43	495
Clay,soft	9	504
Clay,yellow,sticky	20	524
Clay,yellow,sticky w/siltstone	11	535
Clay,sandy w/siltstone	7	542
Clay,sandy w/ sandy & gravel	7	549
Clay,yellow,sticky w/thin layers of sand & gravel at 555-557 and from 565 to 567	51	600
Clay,sandy	53	653
Gravel w/sand	11	664
Clay w/gravel	14	678

Well Completion data:

Casing: 6 in to 127 ft/4 in to 672

Screened zone: 652 to 667/4 in.

Yield: 5 gpm (airlift)

Table 7 well Logs

Test Hole No.: 4/4
Location: Dhakela
Drilled by: N.B. Tubewells
Altitude of Land Surface: 552ft.
Static Water level (Head): -24ft. LSD

Drilling Started 26/3/1973
Completed 6/4/1973
Log by: S.B.Kansakar

Lithologic Description	Thickness: (feet)	Depth (feet)
Sub-soil, grey	2	2
Clay, yellow, sandy	3	5
Sand w/gravel	15	20
Clay, yellow, sticky	30	50
Clay, sandy w/siltstone	13	63
Sand, coarse to medium w/gravel	17	80
Clay, yellow w/gravel	20	100
Clay, yellow w/gravel &sand	28	128
Gravel w/pebbles &cobbles	17	145
Clay, yellow	12	157
Gravel w/pebbles & cobbles	10	167
Clay, yellow w/gravel	39	206
Clay, yellow	10	216
Clay w/gravel	24	240
Gravel, coarse	16	256
Clay, sandy	20	276
Clay, yellow, sticky	30	306
Clay, yellow w/gravel	31	337
Clay, yellow, sticky	10	347
Clay, yellow w/gravel	33	380
Gravel w/fine to medium sand	30	410
Clay, sandy	10	420
Clay, yellow, sticky	10	430
Clay,yellow w/gravel	10	440
Clay. yellow, sticky	20	460
Clay, yellow w/gravel	22	480
Sand, medium w/gravel	5	487
Clay, yellow, soft	8	495
Clay, yellow, sticky	30	525
Clay, yellow w/gravel	30	555
Clay, yellow, sticky w/gravel	35	590
Clay w/coarse gravel	20	610
Clay, sandy	10	620
Clay, yellow, sticky	32	652
Clay, sandy	8	660
Clay, sandy w/gravel	10	670
Clay, yellow, sticky	10	680
Clay,w/some gravel	40	720
Clay,yellow, soft	30	750
Clay, yellow, sticky	43	793
Clay, sandy	15	808

Continued.....

Table 7 Well Logs

Test Hole No.: 4/4 (Cont.)

Lithologic Description	Thickness (feet)	Depth (feet)
Sand, fine to medium		
Clay, sandy w/gravel	13	821
Clay, yellow, sandy	16	837
Clay, yellow, sandy	13	850
Clay, sandy w/gravel	10	860
Clay, yellow w/gravel	10	870
Clay, yellow, sticky	50	920
Clay, sandy	20	940
Clay, yellow w/gravel	8	948
Clay, yellow, sandy	12	960
Clay, yellow, sticky	20	980
Clay, yellow w/some gravel	30	1010
Clay, yellow, sticky	40	1050
Clay w/gravel	28	1078
Clay, yellow, soft	12	1090
Clay, yellow w/gravel	10	1100
Gravel w/medium sand	7	1107
Clay, yellow, sandy	5	1112
Clay, yellow w/gravel	8	1120
Clay, yellow, sticky	58	1178
Clay, soft	12	1190
	20	1210

Well completion data:

Casing: 4 in to 150 ft.

Screened zone: 125 to 145 ft./4in.

Table 7 Well Logs

Test Hole No.: J 4/5
Location: Dhakela
Drilled by: N.B. Tubewells
Altitude of Land Surface: 552 ft.
Static Water level (Head) -24 LSD

Drilling Started 11/4/1973
Completed 12/4/1973
Log by: S.B. Kansakar

Lithologic Description	Thickness (feet)	Depth (feet)
Soil, grey	2	2
Clay, yellow, sandy	10	12
Gravel	8	20
Sand, coarse, w/siltstone & gravel	10	30
Clay, yellow w/coarse sand	14	44
Clay, yellow, sticky	21	65
Gravel	10	75
Clay, yellow, sticky w/sand from 98-100 ft.	30	105
Clay, yellow, sticky w/siltstone	19	124
Gravel and sand	23	147
Clay, yellow	5	152

Well completion data:

Casing: 10 in to 97 ft/6 in to 146 ft.
Screened zone : 125 to 145 ft/6 in.
Yield: 360 gpm (pump)
Drawdown: 22 ft.

Test Hole No. : 5/1

Location: Indrapur

Drilled by: Hydrology Department

Altitude of Land Surface: 427 ft.

Static Water level (Head): -21 ft. LSD.

Table 7 Well Logs

Drilling Started 5/4/1973

Completed 9/4/1973

Log by: G. P. Chaturvedi

Lithologic Description	Thickness (feet)	Depth (feet)
Soil,yellow,sandy	10	10
Clay,yellowish-grey,sandy	5	15
Sand,grey,fine	23	38
Gravel w/grey clay	12	50
Clay,yellowish-grey	15	65
Sand,grey,fine	15	80
Clay,grey,sticky	38	118
Sand,grey,fine	12	130
Clay,grey w/gravel	34	164
Clay,grey,sticky	46	210
Sand,grey,medium to coarse w/fine gravel	29	239
Clay,yellow,sandy	7	246
Clay,yellowish-grey,sticky	15	261
Clay,yellowish-grey,sandy	15	276
Clay,yellow,sandy w/fine gravel	9	285
Gravel,angular to subrounded	3	288
Clay,yellow,sandy	13	301
Gravel,angular to subangular	3	304
Clay,yellowish-grey,sandy	20	324
Gravel,multi coloured,angular to subangular	10	334
Clay,yellowish-grey w/sand and gravel	17	351
Clay,grey, sandy	13	364
Clay,grey ,sticky	2	366
Clay,grey,plastic w/fine sand	30	396
Gravel	2	398
Clay,grey, w/gravel	12	410
Gravel	18	428
Clay,grey,sticky	14	442
Clay,yellowish-grey,sticky	19	461
Sand,grey,fine ,clayey	5	466
Clay,grey,sandy	11	477
Clay,grey,sandy w/gravel	39	516

Well completion data:

Casing: 6 in to 126' ft/4 in to 432 ft.

Screened Zone: 410-426 ft/4 in.

Yield: 47 gpm (pump)

Drawdown: 5 ft.

Table 7 Well Logs

Test Hole No.: 5/2

Location: Belbhar

Drilled by: Hydrology Department

Altitude of Land Surface: 440 ft.

Static Water level (Head): -25 ft. LSD

Drilling Started: 8/4/1973

Completed 12/4/1973

Log by : T. M. Singh

Lithologic Description	Thickness (feet)	Depth (feet)
Sub-soil,yellow	5	5
Clay,yellow	18	23
Gravel,subrounded w/yellow clay	10	33
Clay,yellow	8	41
Clay,grey	7	48
Clay,greyish-yellow	15	63
Clay,yellow,sticky	8	71
Clay,grey,sticky w/siltstone from 94/ft.	29	100
Clay,yellow	29	129
Sand,greyish-yellow,med to coarse	11	140
Clay,grey,plastic	75	215
Clay,yellowish-grey,plastic	15	230
Clay,grey,plastic	6	236
Gravel,angular,sandstone & siltstone	5	241
Clay,yellow,sandy	9	250
Clay,grey,sticky	10	260
Gravel,subrounded to subangular	20	280
Gravel,coarse w/cobbles	13	293
Clay,grey,sticky	5	298
Sand,coarse w/fine gravel	8	306
Clay,grey,sticky,plastic	28	334
Grqvel,subrounded to angular	16	350
Clay,grey	9	359
Gravel,subrounded to angular	11	370
Clay,grey,sandy	26	396
Clay,yellow	5	401
Sand,fine to med.w/some gravel	5	406
Clay,grey	19	425
Gravel,w/cobbles & pebbles	5	430
Clay,grey	2	432
Gravel	1	433
Clay,grey	5	438
Gravel	1	439
Clay,grey,sandy	18	457
Sand,yellow & grey,med.to coarse	23	480
Clay,grey,sandy	10	490

Well completion data:

Casing:	6 in to 101 ft/4 in to 295 ft.
Screened zone:	260-290 ft/4 in.
Yield:	47 gpm (pump)
Drawdown	6.8.ft.

Table 7 Well Logs

Test Hole No.: 5/3
Location: Balbhar
Drilled by: N.B. Tubewells
Altitude of Land Surface: 440 ft.
Static Water level (Head): -24 ft. LSD

Drilling Started: 20/5/1973
Compledted 24/5/1973
Log by: S.B. Kansakar

Lithologic Description	thickness (feet)	Depth (ffet)
Sub-soil	2	2
Clay,yellow,sticky	24	26
Clay,sandy	8	34
Clay,grayish-yellow	50	84
Clay,grayish-yellow w/siltstone	26	110
Clay,sandy w/siltstone	5	115
Clay,yellowish-gray w/siltstone	10	125
Clay,yellow,sticky w/siltstone	15	140
Clay,yellow,sticky	40	180
Clay,yellow,stickyw/siltstone	46	226
Gravel,sub-rounded	17	243
Clay,yellowish-gray	12	255
Clay,sandy with gravel	45	300
Clay,gray sticky	10	310
Clay,gray w/siltstone	10	320
Clay, gray,sticky	10	330

Well completion data:
Casing: 4 in to 247 ft.
Screened zone : 229 to 244 ft/4 in.

Table 7 Well Log

Test Hole. No.: 5/4 — Drilling Started 26/5/73

Location Belbhar — Completed 27/5/73

Drilled by: N. B. Tubewells — Log by: S.B. Kansakar

Altitude of Land Surface: 440 ft.

Static Water level (Head): -24 ft. LSD

Lithologic Decription	Thickness (feet)	Depth (feet)
Sub-soil	2	2
Clay, yellow w/siltstone	30	32
Clay,yellowish-gray	18	50
Clay w/siltstone	10	60
Clay,yellowish-gray,sticky	29	89
Sand & gravel w/siltstone	17	106
Clay w/ siltstone	10	116
Clay, yellowish-gray	10	126
Clay,yellowish-gray w/siltstone	26	152
Clay & siltstone with gravel layers	17	169
Clay,yellow w/siltstone	58	227
Sand,fine to medium, w/gravel & siltstone	18	245
Clay, grey	13	258
Clay w/alternate layers of sand,gravel & siltstone	22	280
Clay,grey w/siltstone	9	289
Clay	8	297

Well completion data:

Casing: 10 in to 114 ft/6 in to 251 ft.

Screened zone: 228 to 248/6 in.

Yield: 310 gpm (pump)

Drawdown: 38 ft.

Table 7 Well Logs

Test Hole No.: 5/5 — Drilling Started 11/4/73

Location: Jabdahawa — Completed: 6/6/73

Drilled by: N.B.Tubewells & Hydrology Department — Log by: T.M. Singh

Altitude of Land Surface: 441 ft.

Static Water level (Head): -1.9 ft. LSD

Lithologic Description	Thickness (feet)	Depth (feet)
Sub-soil	2	2
Clay, yellow	2	4
Sand w/gravel & pebbles	7	11
Gravel, hard w/cobble &Pebbles	3	14
Boulders, cobbles & pebbles w/gravel	7	21
Gravel & cobbles, angular	4	25
Gravel, subrounded to subangular	14	39
Clay, grey, sticky	49	88
Gravel w/sand	7	95
Clay, yellowish-black, sticky	16	111
Clay, yellow, sticky	61	172
Clay, grey, sticky	19	191
Clay, yellow w/siltstone	13	204
Gravel, fine to coarse w/sand and siltstone	11	215
Clay, greyish-yellow, sandy w/siltstone	33	248
Clay, grey,sticky w/siltstone	16	264
Clay, yellow & grey, sticky	11	275
Gravel, fine to medium, subrounded w/sand	12	287
Clay, grey, sandy	20	307

Well completion data:

Casing: 6 in to 107 ft/4 in to 286 ft.

Screen Zone: 270-280/4 in.

Yield: 260 gpm (airlift)

47 gpm(pump)

Draw-down: 6 ft.

Note: Hole drilled to 21 ft. by N. B. Tubewells, completed by Hydrology Department

Table 7 Well Logs

Test Hole No.: 5/6 — Drilling Started 4/6/73

Location: Bechaiya Phat Nursery — Completed: 10/6/73

Drilled by: Hydrology Department — Log by: G. P. Chaturvedi

Altitude of Land Surface: 493 ft.

Static Water level (Head): -32 ft. LSD

lithologic Description	Thickness (feet)	Depth (ft.)
Soil, black w/gravel	1	1
Boulders, pebbles & cobbles w/some clay	10	11
Boulders, pebbles & cobbles	19	30
Cobbles & pebbles w/coarse sand	5	35
Sand, grey, medium to v. coarse w/gravel, multi-coloured, subangular to subrounded	10	45
Gravel, multi coloured, subangular to subrounded, poorly sorted w/coarse sand	5	50
Sand, grey, fine to medium	12	62
Clay, yellow, sticky	5	67
Clay, grey, sandy	9	76
Gravel, multi coloured, well sorted	14	90
Gravel, multi coloured, subangular to subrounded	10	100
Gravel, multi coloured, subangular to subrounded, well sorted	4	104

: Drilling stopped due to break down.

Well completion data:

Casing: 8 in to 92 ft/6 in to 102 ft.

Screened zone: 92 to 102 ft/6 in.

Table 7 Well Logs

Test Hole No.: 6/1

Location: Taratal

Drilled by: N.B. Tubewells

Altitude of Land Surface: 489 ft.

Static Water lever (Head): -48 ft. LSD

Drilling Started 28/4/73

Completed: 5/5/73

Log by: S.B.Kansaker & s.Tuladh

Lithologic Description	Thickness (feet)	Depth (feet)
Sub-soil	5	5
Clay, yellow	10	15
Clay, w/sand	10	25
Clay, sandy	25	50
Sand w/siltstone	20	70
Clay w/siltstone	38	108
Sand	29	128
Clay, sandy w/siltstone	42	170
Sand w/siltstone	12	182
Clay,yellow, w/sand	24	206
Sand	29	235
Gravel	9	244
Clay,yellow,sandy	21	265
Gravel	20	285

Well completion data:

Casing: 6 in to 116 ft/4 in to 285 ft.

Screened zone: 267 to 285 ft/4 in.

Yield: 44 gpm

Drawdown 1.5. ft.

Table 7 Well Logs

Test Hole No.: 6/2
Location: Taratal
Drilled by: N. B. Tubewell
Altitude of Land Surface: 489 ft.
Static Water level (Head): -11 ft. LSD

Drilling Started: 10/5/73
Completed: 17/5/73
Log by: S. B. Kansakar & S. Tuladhar

Lithologic Description	Thickness (feet)	Depth (ft.)
Sub-soil		
Clay, yellow	3	3
Clay, sandy	4	7
Clay, yellow, sticky	3	10
Sand & sandstone, gravel	25	35
Clay, grey, sandy	30	65
Sand & sandstone, gravel	2	67
Sand	26	93
Clay, sandy	25	118
Sand	12	130
Sand w/siltstone	9	139
Clay, grey, sandy	46	185
Sand w/thin layers of clay	21	206
Clay, grey, sandy	18	224
Gravel & pebbles	36	260
Clay, grey, sandy	25	285
Clay, grey	215	500
Clay, grey, sandy	47	547
Sand	43	590
Clay, yellowish-grey w/siltstone	10	600
Clay, grey, sandy	14	614
Clay, grey, sandy w/siltstone	164	778
Clay, grey, sandy	14	792
	321	1113

Well completion data:

Casing: 10 in to 115 ft/6 in to 285 ft.
Screened zone: 269 to 284 ft/6 in.
Yield: 50 gpm (airlift)

Table 7 Well Logs

Test Hole No. : 6/3

Location: Belwa

Drilled by: Hydrology Department

Altitude of Land Surface: 493

Static Water level (Head): - 49 ft. LSD

Drilling Started 21/4/1973

Completed: 1/5/1973

Log by: T. M. Singh

Lithologic Desrription	Thickness (feet)	Depth (feet)
Clay, yellow	36	36
Gravel,siltstone,angular	11	47
Clay,yellow	18	65
Clay, black,w/sand	35	100
Clay, black	20	120
Sand fine to medium	17	137
Gravel & cobbles w/sand	18	155
Clay,yellow	5	160
Gravel w/sand	12	172
Clay,black w/sand	46	218
Sand ,fine to coarse	9	227
Gravel and cobbles	6	233
Gravel and cobbles w/sand	14	247
Clay,black w/ sand	4	251
Gravel w/sand	28	279
Clay, black,sticky	4	283
Gravel w/sand	2	285

Well completion data:

Casing: 6 in to 100 ft/4 in to 285 ft.

Screened zone: 259-276/4 in.

Yield: 38 gpm (pump)

Drawdown: 1 ft.

Table 7 Well Logs

Test Hole No.: 6/4
Location: Bandipur
Drilled by: Hydrology Department
Altitude of Land Surface: 526 ft.
Static Water level (Head): -32.3 LSD

Drilling Started: 30/4/1973
Completed: 15/5/1973
Log by: G. P. Chaturvedi

Lithologic Description	Thickness (feet)	Depth (feet)
Soil, grey, sandy	1	1
Clay, yellowish-brown, sandy	7	8
Sand, light brown, medium to v. coarse w/gravel	5	13
Gravel, multi coloured, angular to subangular, well sorted	3	16
Gravel, pebbles & cobbles, multi coloured, angular to subangular	5	21
Gravel, multi coloured, subangular to subrounded, well sorted	10	31
Gravel, pebble & cobbles, multi coloured, subangular to subrounded	3	34
Sand, light grey, very fine to medium	4	38
Clay, light grey, plastic, and sticky	52	90
Clay, dark grey, plastic	22	112
Gravel, dark grey	2	114
Gravel, multi coloured, subangular to subrounded w/cobbles and pebbles	17	131
Sand, light grey, v. fine to medium	3	134
Pebbles and cobbles, mostly quartzite	7	141
Sand, multi coloured, medium to very course w/gravel	19	160
Sand, grey, fine to coarse	22	182
Clay, grey, plastic, sticky	5	187
Gravel, multi coloured, subangular to subrounded, well sorted, w/pebbles and cobbles.	20	207

Well completion data:

Casing: 6 in to 89 ft/4 in to 205 ft.

Screened zone: 190 to 205 ft/4 in.

Table 7 Well Logs

Test Hole No.: 6/5
Location: Bhurkia
Drilled by: Hydrology Department
Altitude of Land Surface: 569 ft.
Static Water level (Head): -21 ft. LSD

Drilling Started: 9/5/1973
Completed: 19/5/1973
Log by: T. M. Singh

Lithologic Description	Thickness (feet)	Depth (ft.)
Soil, yellow, sandy	7	7
Clay, yellow, sticky	19	26
Sand, coarse W/fine gravel	3	29
Gravel w/cobbles and sand	5	34
Gravel, subrounded to subangular	22	56
Gravel, angular w/cobbles & pebbles	11	67
Gravel, subangular to angular w/sand	19	86
Cobbles, subangular to angular	34	120
Gravel & cobbles	15	135
Cobbles	6	141
Gravel, cobbles w/sand	9	150
Gravel, angular to subangular	37	187
Gravel, w/sand	16	203
Gravel & cobbles	15	218
Gravel & sand	31	249
Gravel, angular to subangular	11	260
Gravel w/sand	71	331

Well Completion data:

Casing: 6 in to 106 ft/4 in to 261 ft.
Screened zone: 225-255 ft/4 in.
Yield: 47 gpm (pump)
Drawdown: 2 ft.