Ed Bradley

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GROUND-WATER RESOURCES INVESTIGATION

IN THE AMRAN VALLEY, YEMEN ARAB REPUBLIC

By G. C. Tibbitts, Jr., and James Aubel

U.S. Geological Survey

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UNITED STATES DEPARTMENT OF THE INTERIOR

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Most geographic names in this report have been verified in the United States Board on Geographic Names (BGN) Official Standard Names Gazetteer, Yemen Arab Republic, 1976, as approved by the Board on Geographic Names, Geographic Names Division, Defense Mapping Agency, Hydrologic/Topographic Center, Washington, D.C. 20315. Other processing of names, compilation, review, editing, for cartographic and report use was done in the Office of International Hydrology, National Center, Reston, Virginia 22092.

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CONVERSION FACTORS

The following factors may be used to convert the International System (SI) of Units published herein to inch-pound units.

SI Unit	Multiply by =	Inch-Pound Unit
millimeter (mm)	0.0394	inch (in)
meter (m)	3.281	feet (ft)
kilometer (km)	.6215	mile (mi)
square hectometer (hm^2) (hectare)	2.471	acres
square kilometer (km^2)	.3861	square mile (mi^2)
cubic meter (m^3)	8.107×10^{-4}	acre-feet(acre-ft)
cubic meter per year per square kilometer (m^3/yr)/km^2	.0021	acre-feet per year per square mile (acre-ft/yr)/mi^2
cubic meter per second (m^3/s)	35.31	cubic feet per second (ft^3/s)
liter per second (L/s)	15.85	gallons per minute (gal/min)
square meter per day (m^2d) (transmissivity)	10.76	square feet per day (ft^2/d)
square meter/per day (m^2/d)	80.5	gallons per day per foot (gpd/ft)
degree Celsius (C°)	$1.8(^\circ C) + 32$	degree Farenheit ($^\circ F$)

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ABSTRACT

This report, based largely on intermittent field work from November 1974 to March 1978, describes the results of hydrologic studies and exploratory drilling to evaluate the water-bearing properties of the unconsolidated alluvial sediments and associated rocks in the semi-arid ʿAmrān Basin in north central Yemen Arab Republic. The investigation and test drilling were undertaken jointly by the Government of Yemen Arab Republic and the U.S. Agency for International Development with technical assistance from the U.S. Geological Survey and the American Peace Corps.

The ʿAmrān Valley extends approximately 45 kilometers northeast to southwest and averages 6 kilometers in width. The area described in the report covers about 800 square kilometers and lies at an altitude ranging from 2,100 to 2,300 meters above sea level (pl. 1, inset B). Most of the population of 64,777 lives in villages and small towns and subsists on locally grown crops and livestock products. Small-scale farming, based on irrigation from wells and, in part, on rainfall, is the chief occupation of the area. Dug and drilled wells equipped with pumps provide much of the water for irrigation.

Wells drilled in the unconsolidated alluvial fill of the south-central part of the valley have the highest yields. Wells penetrating the limestone and volcanic rocks occurring elsewhere in the report area generally have low to no yield except when located in fracture zones. Basalt flows occur interbedded with the wadi alluvium at several depths. A major basalt flow outcropping northeast of Raydah restricts ground-water flow to the northern part of the basin. Rocks cropping out in the ʿAmrān Valley range in age from Late Jurassic to Holocene.

Observation well and rain-gage networks were established in the basin in 1974; since that time selected wells have been measured periodically. Water levels in most wells throughout the area have declined during the period of record. In the area of heaviest pumpage, near the town of Amran, water levels declined at a rate of 2 meters per year during a period of above average rainfall. The water resources of the area are currently (1978) overexploited and water conservation measures should be instituted. Such measures should include limiting pumping for irrigation, prohibiting new well construction and deeping of existing wells, and lining of irrigation canals to prevent loss of water through leakage. Pumping tests conducted during the investigation show the ground water occurs under semi-confined leaky-aquifer conditions in the valley fill.

The chemical quality of the water from the unconfined and semi-confined aquifers in the area is generally good and suitable with few exceptions, for domestic supply, livestock support, industry, and irrigation.

INTRODUCTION

This report summarizes data collected during studies of the ground-water potential and the geohydrology of the ʿAmrān Valley, Yemen Arab Republic. Field work was done intermittently from November 1974 to March 1978. The report, in part, also presents conclusions regarding the occurrence, quantity, and chemical quality of ground-water in the alluvium, volcanics, and limestone bedrock of the area of investigation. Accompanying tabulations present the basic data on which the report is founded.

The present investigation of the ʿAmrān Valley area, a principal element of the Water Survey of North Yemen project, has been sponsored jointly by the Yemen Arab Republic Ministry of Agriculture and the Ministry of Economy through the Minerals and Petroleum Authority (MPA), and the United States Agency for International Development (USAID). Technical advisors were assigned to the project by the United States Geological Survey (USGS). The American Peace Corps assisted by detailing a geologist assigned to the Ministry of Public Works (MPW), Department of Rural Water.

The Government of the Yemen Arab Republic has begun the development of its internal capability to appraise, develop and manage the nation's water resources. Although appraisal of the ground-water potential at a given site was often an integral part of the development project, heretofore such appraisals were largely the work of expatriate consulting firms.

Over the period of this project, however, Yemeni personnel were assigned to the geohydrologic investigation of the ʿAmrān Valley as well as to water investigations elsewhere in the Republic. Many aspects of training in the multi-disciplinary science of hydrology are best accomplished by working on actual field investigations. Accordingly, personnel from the MPA, and Yemeni nationals hired by USAID were assigned units of field and laboratory work involving well inventories, hydrogeologic mapping, exploratory drilling, geophysical well logging, aquifer testing, sample descriptions utilizing a microscope, observation well monitoring, and the collection of meteorological data. On becoming proficient in one skill, personnel were rotated to other tasks for additional training. Also, 5 geology students and 2 general science students from Sana (Sanʿā) University were employed by the project during summer vacations for a total of 6 to 9 months each of on-the-job training in the previously mentioned aspects of work.

In addition to the on-the-job training, two participants were sent to the United States for further training. One field assistant studied basic drilling techniques for 3 months at the J. Sargent Reynolds school in Richmond, Virginia. One geophysical technician spent 7 months with USGS personnel at several locations in the United States. This training consisted of a 2-month course in hydrologic techniques and 5 months of training in field and office procedures.

As ground-water resources of the ʿAmrān Valley were poorly defined, the major effort in the investigation was necessarily directed towards test drilling and aquifer testing. During the project field operations, 2 rotary drill rigs with down-the-hole air hammer capability were assigned by the MPW to accomplish the test drilling.

Location and Extent of Study Area

The area of investigation referred to as the ʿAmrān Valley lies entirely within the Ṣanaʿāʾ Province or Governerate, and consists of parts of the Thulā, Arḥab, and ʿIyāl Surayḥ districts in the Ṣanʿāʾ Subprovince and all or parts of the ʿAmrān, As Sawd, As Sūdah, Jabal ʿIyāl Yazīd, Raydah, and Dhī Bīn districts in the ʿAmrān Subprovince (pl. 1). The area is located in the north-central part of the Republic between 15° 30' and 15° 55' North and 43° 45' and 44° 15' East and covers approximately 800 square kilometers (km^2) (fig. 1). The area extends about 45 km northeast to southwest and averages 6 km in width. The northeasterly limit is the border of the Dhī Bīn District and the southwesterly extent is the limestone escarpment in the Thulā District. The districts of ʿAmrān, Jabal ʿIyāl Yazīd, and Raydah comprise the major part of the study area. The names Qāʿal Bawn al Kabīr and Qāʿat Ḥamudah are commonly used on maps to designate the ʿAmrān Valley..

Well Numbering System

The test holes drilled by the project are identified by name on plate 1 and numbered serially at each test site. Wells from the well inventory table 5 are grouped by area on the map beginning in the Qāʿat Ḥamudah area in the northwest part of ʿAmrān Basin and the numbering proceeds serially by groups to the southern end of the valley.

Economic and Cultural Features

ʿAmrān, the largest town in the ʿAmrān Valley, has a population of 3,298[1] and Raydah, the second largest town, has a population of 1,637. The numerous remaining villages in the area all have less than 1,500 inhabitants each. The total population for the three districts of ʿAmrān, Jabal ʿIyāl Yazīd and Raydah is 64,777. The all weather road extending from Sana, the capital, to the Kingdom of Saudi Arabia border in the North, connects ʿAmrān and Raydah. Another all weather road under construction will connect ʿAmrān to the Tihāmah coastal plain to the west via the village of Ḥajjah. The valley floor is criss-crossed with numerous tracks that become impassable at times during the rainy season. Rains, however, are intermittent and most tracks are closed for no more than 3 or 4 days at a time. The two towns of ʿAmrān and Raydah are major trade centers for thousands of people living on the higher plateaus that surround the valley and there are a number of very steep and difficult trails connecting these towns to the top of the escarpment. The highway from the Kingdom of Saudi Arabia is heavily used as a major truck route to bring imported goods to the Yemen Arab Republic, and therefore, many items of foreign manufacture are available in the ʿAmrān Valley, some of which cannot be found elsewhere in the country.

1/ All population figures are based on the Housing and Population Census of 1975, as shown in Volume No. 5: "Data Bank of the Population Census 1975," by the Swiss Technical Co-operation Service.

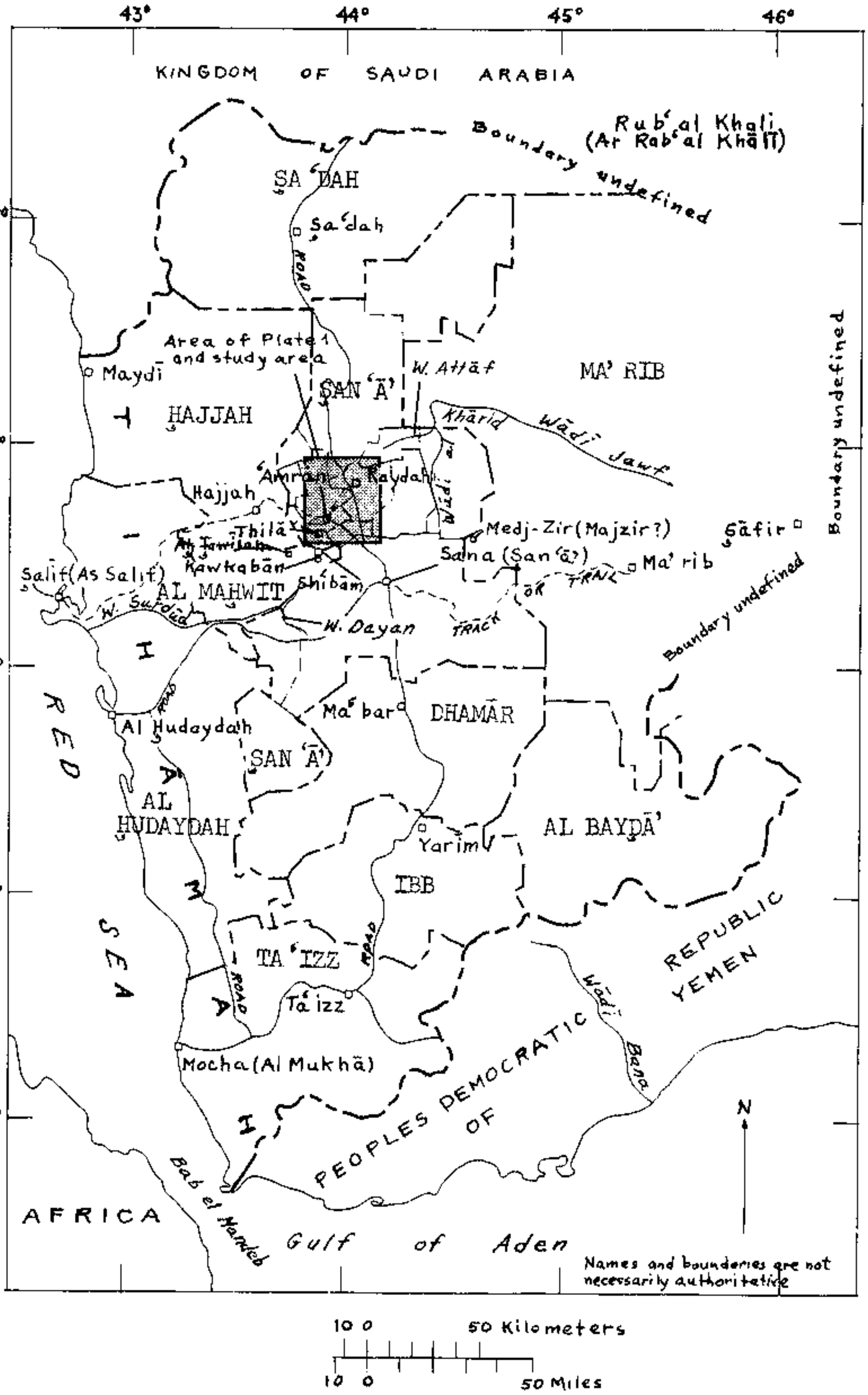

Figure 1--Map of Yemen Arab Republic showing study area.

EXPLANATION OF ADMINISTRATIVE BOUNDARIES USED ON FIGURE 1

Figure 1 shows boundaries and names of provinces in the Yemen Arab Republic. Also shown are the report area and the district boundaries within that area. This area is shown at larger scale on plate 1 as an inset index map in order to show the names of districts and other administrative areas.

Administrative subdivisions of the report area, and index map gazetteer

Report name	BGN approved standard name
Province of Sana	Liwā' Ṣan'ā'
Subprovince of Amran	Qaḑā' 'Amrān
District of Amran	nv, Nāḩiyat 'Amrān
District of As Sawd	nv, Nāḩiyat As Sawd
District of As Sudah	nv, Nāḩiyat As Sūdah
District of Jabal Iyal Yazid	nv, Nāḩiyat Jabal 'Iyāl Yazīd
District of Raydah	nv, Nāḩiyat Raydah
District of Dhi Bin	nv, Nāḩiyat Dhī Bīn
Subprovince of Sana	Qaḑā' Ṣan'ā'
District of Thula	nv, Nāḩiyat Thulā (BGN, Thilā)
District of Iyal Surayh	nv, Nāḩiyat 'Iyāl Surayḩ
District of Arhab	nv, Nāḩiyat Arḩab

Note.-Information source: Yemen Arab Republic, 1977, Preliminary Report No. 5, Databank of Yemen's Population and Housing Census, 1975: Zurich, Switzerland. This publication follows the BGN/PCGN Systen. Administrative names qualified above as not verified (nv), are not listed in the current (1976) BGN gazetteer of the Yemen Arab Republic. Underlined names are BGN short form designations.

New building is intense along the highway, and the towns of Raydah and ʿAmrān are growing rapidly. In a year's time, four petrol stations were being built over a distance of about 15 km. Agricultural development and general growth in the more rural areas away from the highway, appear to be decreasing, at least temporarily, owing to the lack of farm laborers. The problem of labor shortage is common to all of the Yemen Arab Republic since the higher wages available in Kingdom of Saudi Arabia attract much of the working population. According to the previously cited 1975 census figures, 26.5 percent of the population emigrated from four of the districts in the area to seek work elsewhere. The only major government facility in the area is a large military camp located at the southwest edge of ʿAmrān town. Future development plans include a cement factory near ʿAmrān town. The West German Agency for Technical Cooperation (GTZ) program for the area includes a 2-year feasibility study of rural development in agriculture, secondary roads, and village water supplies.

Previous Investigations

The basis for planning the present investigation was provided by James R. Jones, USGS, and Stanley M. Remington, USAID, who completed a reconnaissance study in early 1973 and proposed the present ground-water investigation of the ʿAmrān Valley. Previous ground-water investigations in the Yemen Arab Republic have, for the most part, been limited to spot studies of specific areas by consultants or foreign donors although some of these studies have been rather extensive. It is believed, however, that the ʿAmrān Valley study is the first such investigation undertaken by the YAR using appreciable Yemeni technical personnel and equipment.

A preliminary report on the geohydrology of the ʿAmrān Basin, based largely on data supplied by the project, was prepared for the GTZ by the Federal Institute for Geoscience and Natural Resources in 1978.

Acknowledgments

This report ultimately results from the combined efforts of all the personnel, past and present, assigned to the Water Survey of North Yemen Project. It would be difficult to equate the relative contribution of such diverse, yet interdependent, activities as well drilling, geophysical logging, chemical analysis of water and well inventory, to name but a few.

Messrs. Jamal Ahmed Zaifullah, Geophysical Technician, Ahmed Mohammed Seif Al Doubly, Field Assistant, and Ghalib Kaid Mohammed, Camp Manager, assisted during most of the investigation. Many private individuals and government officials also assisted during the course of the investigation. Special thanks are due to Mr. Ali Gaber Alawi, Director of the Minerals and Petroleum Authority, and Mr. Abdul Bari Salah, Director of the Department of Rural Water, both officials of the Yemen Arab Republic.

Messrs. Abdulla Ath Thari and Mahommud Al-Oudeni, geologists from the MPA were assigned to the project in 1976. Their professional assistance is appreciated.

Edward Sammel, Stavros S. Papadopulos, and E. V. Giusti, USGS, assisted in analysis of the aquifer test data.

GEOGRAPHY

The Yemen Arab Republic is divided into three major physiographic provinces. From west to east, these provinces are the coastal plain, the mountainous region, and the interior plateau. The ʿAmrān Valley lies entirely within the interior plateau physiographic province at altitudes ranging between 2,100 and 2,300 meters (m) (pl. 1, insert B). The valley is bordered on all but the southern side by steep limestone escarpments ascending from 400 to 800 m above the valley floor. The main axis of the valley is oriented southwest-northeast and is approximately 45 km in length.

The valley floor is, for the most part, flat and undissected. The alluvial deposits within the valley consist of windblown silt, loam, sand and pea gravels. At some locations, extensive lag gravel deposits predominate. At other scattered locations, large midden mounds (ancient rubbish heaps), likely dating from the Himyarite civilization, occur as low symmetrical hills. These midden mounds contain deposits of red clay pottery shards. A particularly prominent midden is located southeast of Raydah near the base of the escarpment.

Surface drainage is northeast towards the Wādī al Khārid (fig. 1) that, in turn, drains into the Wādī Jawf. Although there are no perennial streams in the area, surface inflow enters the valley from the south via the Wādī Dayān following seasonal rainstorms. Often intense rainstorms also contribute to sheet flooding which delivers large quantities of water and accompanying erosional debris to the valley floor. The writers observed a localized rainstorm during August 1975 that fell on the escarpment above Al Gusair in the north end of the valley. Although the storm lasted only about 20 minutes, the escarpment face in the immediate vicinity was quickly flooded and runoff continued for about 2 hours after the rainfall ceased. The resulting temporary rivulets flooded a 6 km^2 area south of Al Gusair on the Qāʿat Ḥamudah (Hamudah Plain). The entire process from the start of the storm to the time when the basin ceased filling, took about 2 1/2 hours.

The valley narrows to a width of approximately 1 km east of the town of Raydah where a recent basalt flow largely blocks the drainage. Otherwise, the intermontane valley ranges between 5 and 10 km in width. Smaller tributary valleys, oriented east-west, branch eastward from the main valley at ʿAmrān town; the Wādī Qumāmah, and north of Raydah; the Qāʿat Ḥamudah.

Of the total 800 km^2 of land in the ʿAmrān basin, only an estimated 200 km^2 are farmed. This is due, in part, to the fact that, in the center of the valley, the soils consist largely of sand and do not retain irrigation water. Locally, and for more limited areas, such conditions as midden mounds and exposure of bedrock also make farming impractical. The intermittent flow from desert rainstorms is channeled to farm fields. At times during the rainy season, much of the valley is subject to flooding although these floods are usually of limited areal extent.

CLIMATIC FEATURES

The area described in this report has semi-arid climate marked by sporadic and scanty rainfall, abundant sunshine, violent wind movement, wide diurnal and seasonal range in temperature, and low relative humidity except near the irrigated farm areas. The higher relative humidity is localized in and around areas of natural and irrigated vegetation as is characteristic of a semi-arid climate and results, in part, from evaporation from free water surfaces.

From the short period of available record, annual rainfall within the ʿAmrān basin ranges betwen 200 and 500 millimeters (mm). Storms are usually short, intense, and often localized. In the ʿAmrān valley, rain gages as close as 10 km apart have recorded differences in precipitation of as much as 50 mm on the same day. Since much of the agriculture in the area is dependent, in part, on supplemental irrigation from wells, this variability in rainfall chiefly affects the availability of vegetation for grazing. A year without any rainfall in an area, however, may mean that farmers will not attempt to start a major crop such as wheat. Sorghum, on the other hand, can be raised on rainfall alone in the wet years.

Rainstorms mainly occur in August and September and, in some years, continue into October. This period constitutes the principal rainy season during most years. There is a shorter rainfall season beginning in early May and continuing into June. Sporadic storms may occur at other times, most likely in December and January, but these months, like the remainder of the year, can be completely dry.

The project operated 4 rain gages in the ʿAmrān Basin during the period of investigation. These gages, which continue to be part of the hydrologic network for the Republic, are located, south to north, at Thilā, Al Jannāt (Jannat), Menjidah (Menjeda), and Raydah. In addition, German Technical Cooperation (GTZ) maintains a rain gage located between ʿAmrān and Raydah approximately 200 m east of the main road near Jub as Sulfa (coordinates: 44° 00' 30"E, 15° 40' 00' N). The gage at Thilā recorded 490 mm of precipitation during 1976 whereas the gage at Raydah registered only 167 mm; reflecting the localized pattern of desert rainfall. Annual precipitation at Sana south of the valley, ranged from a high of 388 mm in 1975 to a low of 202 mm in 1977. Rainfall data for the 5 ʿAmrān Basin stations and Sana are shown in table 1. A longer record for Sana however, shows an average annual precipitation of 300 mm. This figure is likely applicable to the ʿAmrān area.

TABLE 1.--Annual rainfall, in millimeters, ʿAmrān Basin and Sana

Station	1975	1976	1977
Thilā	255	490	NA
Al Jannāt (Jannat)	362	250	305
ʿAmrān	NA	283	NA
Menjidah	304	290	188
Raydah	388	167	202
Sana	392	225	202

The notion of a short and a long rainy season each year describes conditions recorded regionally over the longer term. Records for individual rain gages do not necessarily follow the same pattern in the short-term. For example, the heaviest monthly precipitation occured during March at the Al Jannāt stations in 1976 when 4 storms occurred during the month. Records from the other ʿAmrān stations, however, tend to reflect the regional rainfall pattern even in the short-term. The greatest number of storms recorded during a single month for the period of record was twelve. This frequency was recorded three times; at Raydah during August 1975 and at Thīla during both May and August 1976. The establishment of a field headquarters in the ʿAmrān Valley made possible daily checking of the rain gages for at least part of the time on some of the stations, during the period of investigation. Table 2 shows the month of highest rainfall and the number of storms during the month, during times when it is known that the gages were serviced daily. Personnel limitations precluded daily servicing of the gages at other times and, accordingly, when the gages were not serviced daily it is not known whether the measurements record precipitation for a single or several storms during a given month.

TABLE 2 - Month of highest rainfall and, when measured daily, the number of storms during month, ʿAmrān Basin (NA: not known)

Station	1975		1976		1977	
	Month	Storms	Month	Storms	Month	Storms
Thilā	July	NA	May	12	NA	NA
Al Jannāt	August	3	March	4	October	NA
Menjidah	August	9	May	NA	May	3
Raydah	August	12	May	NA	May	NA

Temperature observations made during 1976 at the German Technical Cooperation station are summarized in table 3. The extremes recorded during that year were 28.4°C in June and -0.4°C in January. The annual average temperature was 14.6°C. The ʿAmrān area was cooler by 1 to 2 degrees throughout the year than Sana. In the spring and summer, hot, sand-laden winds, usually of short duration, parch man, animal and plants alike.

So far as is known, no other meterological data were collected in the ʿAmrān Basin during the period of investigation.

TABLE 3 - Monthly maximum, minimum and mean temperatures in degrees Celsius for 1976 at the GTZ Station ʿAmrān Basin

Month	Maximum	Minimum	Mean
Jan.	22.0	-0.4	10.8
Feb.	23.4	3.4	13.4
Mar.	24.3	7.3	15.8
Apr.	23.9	7.2	15.6
May	25.2	10.0	17.6
June	28.4	8.2	18.3
July	26.7	11.0	18.9
Aug.	26.1	9.6	17.9
Sept.	24.0	5.7	14.9
Oct.	21.4	4.1	12.3
Nov.	17.7	2.2	10.0
Dec.	19.3	0.9	9.2
Year	28.4	-0.4	14.6

AGRICULTURE AND INDUSTRY

Small-scale farming, based on irrigation and, in part, on rainfall is the chief occupation of the area, although the grazing and sale of livestock also provides agriculture income. Dug and drilled wells equipped with pumps provide much of the water for irrigation. Agricultural activity is on the decline in the area, however, due to the migration of farm labor seeking higher wages in the Kingdom of Saudi Arabia and elsewhere. Consequently, care of the family farm is often left to the women and children who remain behind. The decline of agricultural activity is shown by the general deterioration of terraced farm land surrounding the valley. Once breached by runoff, these terraces require immediate repair to prevent destruction of the enclosed farm land by erosion. At the present time (1978), there is neither sufficient labor nor sufficient financial incentive to effect repairs and considerable terraced farm land is being destroyed.

Alfalfa is the most important local forage crop and is an important source of farm income. Wheat and sorghum are the most important cultivated grains in the area. A variety of garden vegetables are raised also, chief among them being potatoes, onions, tomatoes, melons, peppers and beans. A few grape vineyards are scattered throughout the eastern part of the area. "Qat" a small tree producing a leaf which when chewed produces the effect of several cups of coffee, is grown on some of the terraced fields. Sale of Qat production in excess of family use can be very profitable.

Livestock, chiefly sheep and goats, and livestock products are major sources of agricultural income in the area. Animals graze in the surrounding highlands in the winter and are fed supplemental fodder, usually alfalfa, during the rest of the year. Cattle and camels are not numerous, but most farms have at least one for plowing or possibly milking. Some poultry and rabbits are raised, mostly for local consumption.

Water for irrigation is a limiting factor in agricultural production in the ʿAmrān Basin. Although many areas are unfit for farming owing to the type of soil, given adequate irrigation many other areas now unused could be cultivated. Further, lack of technical knowledge and skills in water conservation, irrigation practices, soil drainage, and farming methods prevent better agricultural production.

Cottage industries are virtually unknown in the area except for some basketweaving and pottery making for family use. Almost all utensils and tools are purchased from outside sources. Small scale quarrying of limestone and basalt blocks for building is a minor industry as is the open pit mining of sand for cement. There are no large industries in the area, but a cement factory is planned for a location near ʿAmrān town. The water requirement for a cement factory is considerable and carefuly consideration should be given to the priority of water allotment. It is unlikely that the industrial, agricultural, municipal, and domestic water requirements can be met simultaneously from the ground water resource.

IRRIGATION

Before the widespread introduction of turbine pumps in the early 1960's, irrigation from wells was limited to small plots of alfalfa and vegetables. Water was raised from dug wells by the means of animal power. After the introduction of turbine pumps, irrigation increased and field size expanded. Water levels in the dug wells, however, began to drop and deepening wells either by digging or with a drill rig became the rule. In the central part of the valley the bottom of the water table is commonly marked by a basalt bed which usually precludes further deepening by hand. These basalt beds are interfingered with alluvial sediments that are water bearing both above and below the basalt. Where basalt was encountered, a drilling rig became a necessity if the well was to be deepened further.

The irrigation method used in the ʿAmrān Basin involves flooding the field and allowing the water to stand and infiltrate. Irrigation water is spread to fields by way of unlined ditches; leakage and consequent waste of water can be considerable. In sandy soil, losses from unlined irrigation ditches can range up to 70 percent although in clayey loams, the waste factor is nearer 10 percent. There are several general practices that are important to the overall effective utilization of irrigation water. Chief among these is the use of lined ditches to prevent the waste of water by leakage. The construction of lined canals, however, is usually beyond the financial resources of individual farmers in the ʿAmrān area. Sprinkler, trickle and perhaps other irrigation methods undoubtedly would increase irrigation effectiveness and conserve water.

Field infiltration rates range from 1.5 mm per hour for clayey tilled soil to 150 mm per hour for sandy undisturbed area (personal communication, GTZ). There are an estimated 2,000 hectares of land irrigated by either channeling, direct rainfall to fields or from wells, in the ʿAmrān Basin. Much of the arable land is suitable for mechanized farming and larger scale irrigation. A limiting factor, however, is the availability of ground water.

GEOHYDROLOGY

Rocks in the Yemen Arab Republic range in age from Precambrian to Holocene (pl. 1 and table 4). Precambrian rocks, primarily granite gneiss and mica schist, are exposed in deeply incised wādīs 10 to 20 km west of the ʿAmrān Valley. The Kohlan Series of Early Jurassic age unconformably overlies the Precambrian rocks at these same locations. The Kohlan Series in this area ranges upwards to 150 m in thickness and consists of massive white sandstone interbedded with thinner beds of conglomerate and violet fine-grained sandstone. The oldest formation cropping out in the Amran Basin, however, is the Amran series of Late Jurassic age. The contact between the Kohlan and Amran Series, though not exposed in the ʿAmrān Basin, is gradational with no break in sedimentation.

The Amran Series crops out over a large part of the northern third of the Yemen Arab Republic extending northwards from Shibām, 20 km south-southwest of ʿAmrān town to Ṣaʿdah. In the area bound roughly by latitudes

TABLE 4.--Generalized stratigraphic section for ʿAmrān Basin and nearby areas, Yemen Arab Republic.

QUATERNARY

Alluvial deposits

Loess, loam, silt, clay, sand, gravel, and boulder erratics. Principal aquifer in area where significant thickness of unconsolidated permeable sediments occur at depth. Very fine and surficial deposits not water bearing. Thickness exceeds 300 m at some locations. Interbedded with basalt layers.

Younger volcanics

Dark grey to black basalts. Not proven to be aquifer in report area. Essentially unexplored; 5 dry test holes drilled in lava flow northeast of Raydah. Ground water occures in fracture zones, tubes, and along bedding plains in volcanic rocks. In Sana area wells penetrating similar rocks can have large yields. Thickness unknown, but exceeds 200 m as proven by test drilling. Occurs on the southern and eastern flanks of report area.

TERTIARY

Medj-Zir Series

Predominantly fine to coarse grained crossbedded continental sandstone with lenses of conglomerate and gravel and interbedded shale; upper part rich in hematite. Cannot be separated from underlying Tawilah Group on the basis of stratigraphic relationship. Fair to good aquifer. Outcrops southwest of ʿAmrān Valley in Thīla-Shibām area. Thickness to 150 m at Shibām.

CRETACEOUS

Tawilah Group

Predominantly coarse grained crossbedded continental sandstone interbedded with shale and clay stones; cut by numerous basalt dikes. Good aquifer especially in the fracture zones. Wells tapping this formation supply part of municipal water for Sana city. Outcrops southwest of ʿAmrān Valley in Thilā-Shibām area. Thickness to 350 m at Shibām.

UPPER JURASSIC

Amran Series

Fossiliferous, massive to fine bedded, limestone of shallow water origin with intercalated sandy layers; shale interbedded; major solution structures rare in report area. Generally, poor aquifer except in fracture zones. Cut by basalt dikes. Forms eastern, western and northern flanks of ʿAmrān Valley. Thickness to 800 m in Wādī Attāf.

LOWER JURASSIC

Kohlan Series

Massive white sandstone with interbedded conglomerate beds; contact with overlying Amran Series is gradational with no break in sedimentation. Water-bearing properties unknown, but potentially good. Occurs west of report area in steep cliffs ranging up to 150 m in thickness.

PRECAMBRIAN

Basement

Predominantly granite gneiss and mica schist exposed in deeply incised wādis west of report area. Poor aquifer, limited amounts of ground water occur in fracture and fault zones.

15°30' and 16°55'N and longitudes 43°20' and 45°45'E, rocks of the Amran Series predominate although interspersed with occasional volcanic plugs and flows, along with scattered granite plugs, stocks and plutons, as well as more extensive alluvial and volcanic deposits. The flanks of the famous Himyarite dam at Ma'rib, 110 km east of Sana and one of the seven wonders of the ancient world, are cut into limestone of the Amran Series and the massive headworks are also constructed of the same material. The Amran Series formerly covered the entire area of the Yemen Arab Republic and beyond, with parts of the Tihāmah possibly excepted. Post Jurassic erosion largely removed the covering limestone mantle from most of the eastern and southern two thirds of the country. Outliers of the Amran Series occur, however, in the Tihāmah, in the northwest and southwest as horsts uplifted through the Yemen Volcanics, to the east in the area of Ṣāfir and in the Rub' al Khali, and south along the Wādi Bana near the frontier with the People's Democratic Republic of Yemen.

The Amran Series is everywhere calcareous although facies change with location. In the 'Amrān Basin, the formation consists of fossiliferous, yellowish-white limestone of shallow water origin; an origin evidenced by both the fossil assemblage and the occurrence of intercalated sandy layers. The bedding is horizontal to subhorizontal. The flanks of the 'Amrān Valley are formed by alternately interbedded layers of massive cliff-forming limestone, sandy fine-bedded limestone and shale that, in turn, weathers to form less abrupt slopes. The limestone is faulted and cross faulted and heavily jointed, but caves, sink holes or smaller solution structures are rare. The thickness of the Amran Series underlying the alluvium of the valley floor is unknown, but the thickness exposed by the cliffs on the valley flanks ranges between 400 and 600 m and exceeds 800 m in the Wādi Attāf, to the northeast of the valley.

To the southwest of the 'Amrān Basin, sediments of the Tawilah Group and Medj-Zir Series form elevated plateaus that are visible from the southern end of the valley. Although the Tawilah group appears bare of fossils, it is considered Cretaceous in age because of geometric position. Both formations consist of coarse, crossbedded, white sandstone with conglomerates, gravels and interbedded shale. The Medj-Zir Series is of probable Tertiary age. The volcanic formations exposed in the report area are primarily dark-grey to black basalt flows of Tertiary to Holocene age. The very dark basalt flows occuring northeast of, and to a very limited extent, within the valley were extruded during historical times. The historical age of these darker flows is assumed because of their similarity to flows in the Hamdān volcanic field north of Sana. At the Hamdān location, lava flows of similar litho-logic character and color have inundated the works of man. Numerous basalt cones and craters occur east of and parallel to the ʿAmrān Valley.

Beds of basalt also occur interfingered at depth within the alluvium filling the valley. The interbedded basalt layers likely result from a succession of lava flows at different intervals as the valley filled with sediments rather than intrusion as sills. This is evidenced by the fact that the basalt beds are persistent over distance within the alluvium. Further, wells penetrating the alluvial sediments may encounter multiple beds of basalt interspersed at different depths in the alluvial section. These basalt beds tend to confine water in the underlying sand and gravel and act, at least in part, aquitards.

The alluvial deposits filling the ʿAmrān Valley constitute the principal aquifer system in the area. Together with the interbedded basalt layers, the alluvium has a thickness in excess of 300 m at some locations near the valley center. These alluvial deposits consists of loess, loam, silt, clay, sand, and gravel with occasional limestone boulder erratics. The sandy material, in all likelihood, was eroded and transported from the Tawilah-Medj-Zir escarpment to the southwest. Limestone gravels, which are often waterbearing at depth, are derived from the Amran serils surrounding the valley. The lithology of the unconsolidated sedimentary section reflects periods of successive flooding, ponding, and probably also periods of desiccation. Coarser material was deposited in the valley trough by floods during times of higher rainfall when water ponded in the valley. The occurrence of loess in the upper part of the alluvial section indicates a period of desiccation when these wind-borne sediments could accumulate.

Alluvial sediments are thickest along the main axis of the valley and feather out against the flanking limestone and basalt escarpments. Mobile sand dunes occur at random throughout the ʿAmrān Valley, but are most evident in the Qāʿ at Ḥamudah area.

Structure

The ʿAmrān Valley is formed by a northeast-southwest tending graben structure (pl. 1, inset A) thought to have been formed contemporaneously with the Red Sea rifting that started in the Oligocene. Approximately 45 km to the northeast the graben changes direction to east northeast-west southwest and changes again, in the Wādī Attāf, to an east-west orientation. North of Raydah the graben is cut by major cross faults oriented north northwest-south southeast that likely account for the escarpment forming the northern boundary of the Qāʿ at Ḥamudah plain. Parallel faults on both sides of the valley form a series of steps on the valley flanks as successive blocks of bedrock slipped into the depression. The apparent throw of these faults exists within the graben structure and accounts, in part, for the variation in depth to bed rock at different locations beneath the sedimentary valley fill. Small horsts resulting from the same tectonic action that caused the faulting arise in the graben floor and some are seen in outcrop above land surface within the valley proper. The outcrop of Amran limestone occurring as an outlier 1 km east of Raydah at the site of the Kharif #6 test hole is a typical example of an exposed horst. The availability of ground water in the alluvial sediments forming the graben fill is partly controlled by local subsurface structural conditions. When horst blocks rise to near or above land surface, water-bearing deposits may be thin to non-existent. Faults and variations in the thickness of alluvial fill due to subsurface tectonics in some instances can account for the large difference in yield between closely spaced wells.

Water-Bearing Characteristics

The coarse sediments interbedded in the alluvial fill of the Amran Valley contain the principal ground-water resources in the report area. Locally, where structural conditions are favorable, the Amran limestone can be productive. Likewise, in favorable structural situations, the volcanics have the potential of yielding worthwhile quantities of water to wells as these rocks do elsewhere in the Yemen Arab Republic. Limited test drilling in the report area, however, failed to discover any usable quantities of water in the basalts. Admittedly, the test drilling in the volcanics was limited to a restricted area northeast of Raydah and, therefore, the negative results obtained are not conclusive for other areas of volcanic rocks in the report area. In one hole near Raydah, perched water was encountered, but quickly depleted by pumping. Other test holes at this same general location were dry even at depths as much as 60 m below the level of the water table in the nearby alluvium.

Other geologic formations mentioned in this report, although important to the overall understanding of the areal geohydrology, are not locally potential water sources since they neither crop out nor are known to occur at depth within the area. The Precambrian outcrops in the deeply incised wādīs to the west of the ʿAmrān Valley are characteristically a poor aquifer everywhere in the Yemen Arab Republic and ground water occurs, for the most part, only in fracture zones. The Kohlan serils overlying the Precambrian is largely unexplored, but has the potential of being a high yielding aquifer since it is composed primarily of losely cemented sandstone. In the outcrop area west of the ʿAmrān Valley, however, the Kohlan Series shows little potential for yielding water to wells. This is owing to the fact that the formation occurs in cliffs resting on exposed basement rocks precluding the possibility that water could be retained within the formation even when available from recharge.

The sandstones of the Tawilah Group, although not present in the report area, are the best aquifers in the Yemen Arab Republic and wells penetrating this formation have high yields where considerable thicknesses of the formation occur below the water table. The Medj-Zir Series consists of coarse sandstone and is, therefore, a potentially high yielding aquifer. Although relatively unexplored, large yields could be expected from this formation at locations where significant thickness exists.

At the onset of the project, test drilling efforts were directed at obtaining water supplies for villages situated on the slopes of the highlands flanking the ʿAmrān Valley. Consequently, well sites were located on the limestone outcrops at the base of the escarpment or in the narrow valleys reentrant to the escarpment. The majority of these wells penetrated Amran limestone throughout most of their depth. The second test well at Menjidah yielded 14.5 liters per second (L/S) by airlift and the test well at Al Ḩajz yielded 6 L/S, also by airlift. The upper 43 m of the Menjidah well penetrated 8 m of gravel and 35 m of basalt before encountering Amran limestone and the limestone was overlain by 37 m of limestone breccia at the Al Ḩajz site. With the exception of these two wells, other wells constructed in the Amran limestone near the flanking escarpments had poor to no yield.

Yields of dug and drilled wells in the wādī alluvium where located at distances from the escarpments, on the other hand, consistently range between 3 and 18 L/s. Many of the dug wells, however, have been deepened several times. This reflects, in part, an effort to follow a declining water table and, in part, an effort to meet increasing demand for irrigation water. Many of the dug wells first bottomed on basalt which, in effect, marked the bottom of the unconfined water table. When water levels in the overlying unconsolidated aquifer declined, efforts to deepen the well by digging into and through the basalt were often attempted. Owing to the hardness of the volcanic rock, efforts to excavate the basalt with hand tools were, as a rule, unsuccessful. This work was further complicated by the necessity of keeping the hole dry by pumping as the work proceeded. Accordingly, well owners usually hired a local contractor equipped with a cable-tool drilling rig to penetrate the basalt and the underlying alluvium.

Water in the sediments under the basalt occurs under confined or partially confined conditions and water levels in wells penetrating one or more basalt layers may be higher than the local water table. Generally, when the dug wells are deepened, the yields increase. This is also the case in dug wells in the alluvium where basalt is not encountered.

Deepening drilled wells is practical only when the well has been initially constructed without a metal bail plug at the bottom of the casing string. When the well is left open at the bottom it may be possible later to drill it deeper. If part of the well is uncased, initially producing water from the open hole through the aquifer section, there is a serious danger of collapse during subsequent deepening. Wells that are screened in the aquifer and equipped with a metal bail plug sealing the bottom of the casing string generally cannot be successfully deepened. Any attempt to drill through the bail plug will likely lead to separation of the well casing up the hole and destruction of the well. When practical, deepening of selected drilled wells should produce increased yield. Of course, the benefit of deepening any well in the ʿAmrān Valley is limited by the aquifer thickness at the well site.

Ground Water Occurrence

The ultimate source of fresh ground water is precipitation and, with the exception of some desert regions, the ground water reservoir is periodically recharged by rainfall or infiltration from streams through pore spaces in the soil to the zone of saturation, the upper surface of which is the water table. Water-table conditions exist where the aquifer is not confined by overlying impervious strata. Unconfined water occurs in the permeable sand and gravel resting on top of the first relatively impermeable bed, either clay or basalt, at depths ranging from 6 to 50 m below land surface in the alluvial fill of the ʿAmrān Valley. The water in the zone of saturation, sometimes referred to as "phreatic water," moves by gravity flow from sources or points of recharge to areas of discharge. This migration, coupled with evapotranspiration and artificial withdrawal by pumping plus recharge by precipitation, accounts for fluctuation of water levels in wells tapping the water table. Natural discharge and withdrawal by pumping together with migration down slope results in lowering the water table, especially during the dry season. Water levels recover during the rainy season, reflecting recharge to the ground-water body and also the effect of decreased pumping when precipitation substitutes for irrigation from wells.

Water in the alluvium occurs under semi-confined conditions and, at some locations, possibly under confined conditions. When ground water is confined or semi-confined, it is often termed artesian. Although the popular concept of "artesian" connotes water from a well flowing above land surface, in the hydraulic context "artesian" refers to ground water under conditions producing hydrostatic head. Artesian conditions occur where the water moving down-gradient through permeable water-bearing strata passes beneath impermeable strata that form a confining bed. If the materials beneath the water-bearing strata are also impermeable, water acquires a hydrostatic head related to the vertical distance between the altitude of land surface at the point of confinement and the slope of the potentiometric surface, and the bottom of the confining bed at the point of discharge.

The lenticular character of the alluvial aquifer indicates that water, for the most part, occurs in these beds under semi-confined conditions. Further, analysis of the four pumping tests conducted by the project in the ʿAmrān Valley show leaky aquifer conditions. A leaky aquifer is defined as a semi-confined aquifer whose confining bed will conduct significant quantities of water into or out of the aquifer, but the term is somewhat of a misnomer. Although water does leave the aquifer, it is the confining bed or aquitard that is leaky. The aquifers in the alluvium filling the ʿAmrān Valley below the partially confining strata of either clay or basalt are in hydraulic continuity with other water-bearing strata occurring either above or below the producing aquifer.

The hydraulic gradient of the water table in the ʿAmrān Valley reflects the surface drainage and slopes to the northeast towards the Wādī Attāf and a mutual discharge area. The natural hydraulic gradient is locally altered where pumping wells are concentrated as is the case around ʿAmrān town, Raydah, and in the eastern Qāʿ at Ḥamudah. The gradient of the water table is steepest near the valley flanks and flattens towards the center of the valley where the alluvial sediments are the thickest. Dug wells along the margin of the valley range in depth from 10 m to over 70 m in the eastern Qāʿ at Ḥamudah. Generally, irrigation wells in the center of the valley are over 50 m in depth and may range up to 100 m where deepened with a drilling rig. Depths to water are greatest, on the other hand, near the flanks of the main valley and occur at shallower depths below land surface towards the center of the valley.

Wet-season and some all-weather springs and seeps issue, at places, from the escarpments flanking the valley as well as from fractures in the limestone bedrock in wādīs reentrant to the main valley.

HISTORY OF EXPLORATORY DRILLING

During most of the test drilling program, two Ingersoll-Rand T4 drilling rigs were assigned to the project. These rigs are designed primarily for drilling in hard consolidated rocks, such as volcanics, utilizing compressed air and down-the-hole hammers. Although originally equipped with a small mud pump for conversion to the direct rotary drilling method, these rigs proved unsuited for drilling in alluvium and limestone where lost circulation problems were common. Accordingly, it was necessary to equip these rigs with large capacity auxiliary mud pumps in order successfully to complete many of the test holes. The drilling difficulties encountered are best illustrated by the drilling sequence at the middle Raydah site. A successful observation well was completed at this site in March of 1976. Subsequent attempts nearby to construct production wells over a period of several months ended in abandoned holes owing to lost circulation problems. The production hole that was eventually completed in February 1978 had been spudded in the preceding September. Equipment breakdown admittedly contributed to the time necessary to complete this well, but again, circulation problems were the major cause of delay.

The initial phase of the ʿAmrān Valley ground-water investigation provided for exploratory drilling to obtain village water supplies. First efforts, beginning in June 1974, centered in the volcanic area 4 km northeast of Raydah and were directed at finding drinking water for the village of Kharif. Five test holes in the basalt bedrock of this area proved, for all practical purposes, dry although one test encountered limited amounts of perched water. It was necessary eventually to move onto the alluvial plain south of the volcanics to obtain water for Kharif. At the new location, the first hole was reported dry and the second produced 2.5 L/s by airlift which, however, was sufficient for the village when pumped continously into reservoir storage. Initially samples of the well cuttings were not always collected and some well logs are incomplete for wells completed during the early test drilling efforts.

Subsequent efforts to provide village water supplies centered on Al Ḥajz southwest of ʿAmrān town and Al Gusair in the northern end of the valley. The well at Al Ḥajz yielded 6 L/s. Two holes drilled at Al Gusair location near the head of a north to south draining wādī were dry. The third hole, located downstream in a wider section of the wādi, yielded 4 L/s. Although this well was a welcome addition to the village water supply, it was obvious that larger yields sufficient for irrigation of crops would be obtained only in the thicker sections of alluvium along the main valley axis.

Among the first efforts to explore conditions away from the flanking escarpments included the ʿAmrān town and the nearby Al Jannāt sites. Owing to poor design, the ʿAmrān town well proved disappointing although the geophysical log indicated the presence of water-bearing strata. Yield by airlift of the Al Jannāt well was only ½ L/s. An earlier effort at Al Jubi northeast of ʿAmrān town and the first project test hole near the axis of the southern part of the ʿAmrān Valley, yielded 3 L/s by airlift. A test hole at Al Sheikh approximately in the center of the northern part of the valley was dry. The area where yield from wells would be sufficient for irrigation accordingly was narrowed to the central part of the valley south of the volcanic intrusion and flows that outcrop east of Raydah.

The production well at Menjidah yielded 14.5 L/s and was the first hole drilled near the center of the southern valley axis. This hole, however, penetrated Amran limestone throughout much of its depth and consequently, did not explore the alluvial section as intended. The relatively high yield from this well as contrasted to yield from other wells constructed in the limestone is probably due to location at the mouth of a small wadi reentrant to the main valley. This tributary wadi was probably formed by erosion along a fracture zone that could, in turn transmit water to wells. South to north, the Warehouse, Raydah South, and Raydah Middle groups of wells were located to test and evaluate the hydraulics of the alluvial aquifers. As was the case with Menjidah, one or more observation wells were constructed at these sites along with the production well. Drilling, developing, and conducting aquifer tests at these sites continued into the spring of 1978.

DRILLING METHODS

A complete description of well-drilling methods is beyond the scope of this report. It is desirable, however, to describe briefly methods used in the investigation and by others constructing wells in the area, particularly with reference to inherent drilling problems. Wells in the area are drilled by the percussion (cable-tool), direct rotary, and air rotary (down-the-hole hammer) methods. Further, dug wells are constructed with hand tools and, when basalt is encountered, often blasted downwards with explosives.

The percussion (cable-tool) methods of drilling involves raising and dropping a heavy string of drill tools consiting of a bit, drill stem and drilling jars attached to a steel cable. The cable passes from a collecting reel over a pulley wheel at the top of the derrick before connecting to the tool string. The string of tools is activated up and down by means of a pitman arm and the resulting blows crush material (strata) struck by the bit. The crushed material is removed from the hole with a bailer. The percussion method often produces a hole of several different diameters, with the largest diameter at the surface. When it becomes difficult to drive the larger tubing the diameter of the hole is reduced and drilling is continued with a smaller bit. Several different diameters of well tubing each smaller than the preceeding one may be necessary to complete a well.

Percussion drilling is particularly well suited to very coarse sediments and is also suited to very hard rocks such as basalt. When it becomes necessary to deepen a dug well bottomed on a basalt layer interfingered with wadi alluvium, the well owner often hires a local driller with a percussion rig to deepen the well. The rig is positioned on a platform constructed over the open dug well and a length of pipe is then secured to the bottom of the hole to act as a tool guide. In theory, the equipment should be able to penetrate the basalt at a rate of roughly a meter per 8 hour shift. In practice, the rig may remain over the well for months. Antiquated equipment in part accounts for the delay, but inexperience in cable-tool drilling techniques is a more important factor. When drilling very hard rocks by the percussion method, it is necessary to keep the drill bit to gage. A percussion bit can be brought to gage by heating on a forge and reshaping with a sledge hammer or by resurfacing with an electric welding machine. The welding procedure puts a harder surface on the face of the bit and is the preferred method. Local percussion drilling contractors, however, are seldom equipped with a welding machine. Much of the time lost in deepening dug wells through the basalt beds is due to stuck tool strings resulting from the bit being out of gage causing the hole to be out of round or out of gage.

The direct rotary method of drilling involves rotating a string of drill tools with attached bit in an open hole. Simultaneously, drilling fluid is circulated from a mud pit by a pump down the hollow rods and out the openings in the bit to return back up the open hole to the mud pit. The returning column of drilling fluid carries material cut by the bit to land surface and thence to the mud pit near the well head. Drilling fluid consists of water mixed with local clay and often other material used to increase its density (weight). Bentonite, a volcanic clay that swells when wetted, is the preferred material used to make up the drilling mud. Both rock roller bits and drag bits are used in rotary drilling. Rock roller bits are best for drilling in sand, gravel, and hard rock; drag bits perform best in silt and clay.

Most of the test wells constructed as a part of this investigation were drilled by the rotary method. Owing to problems with lost circulation, it was necessary to equip the drilling rigs with large capacity auxiliary mud pump. Even with the large capacity pumps, however, it was not always possible to maintain circulation in zones of high permeability in the alluvium, a condition that sometimes resulted in the collapse and eventual abandonment of the well. In general, it was found that zones of lost circulation could be penetrated if sufficient drilling fluid was available on the first try. This often meant making up an extra pit of mud as a standby before drilling the very permeable zones. When zones of lost circulation were penetrated without additional drilling fluid immediately available, the hole invariably collapsed and subsequent efforts to restore circulation to continue drilling were, for the most part, unsuccessful.

Air rotary drilling involves much the same principle as direct rotary drilling except that cuttings are removed by a column of compressed air mixed with foam rather than by a mud column. Compressed air and foam circulate down the hollow rods and the air activates the down-the-hole hammer bit at the bottom of the tool string. The hammer bit vibrates up and down in short strokes in an action similar to a jack hammer, the result of which can fracture and penetrate the hardest rocks. Short-toothed rock roller bits and button bits can also be used with the air rotary method to drill hard rocks.

Although the air rotary method can be used to drill unconsolidated alluvium when these deposits are essentially dry, the method is unsuitable for very permeable sands and gravels containing abundant water as is the case at some locations in the project area. The rigs used to drill the test holes in the ʿAmrān Valley had both direct and air rotary capability. Often it was desirable to drill the interbedded basalt strata with the air rotary method and use the direct rotary method to drill the alluvial section of the well.

GEOPHYSICS

Geophysical well logs were run on many of the test holes during the investigation utilizing project procured equipment. This equipment was capable of recording the resistivity, spontaneous potential, natural gamma rays, and the density (gamma gamma) of formations penetrated by the test wells. In addition, the logger was also capable of continously measuring the diameter of an open borehole by means of a caliper logging attachment. The resistivity and spontaneous potential were measured simultaneously utilizing a single down-the-hole tool (sonde) and single recording module. To record other formation characteristics it was necessary to change the down-the-hole tools and record through separate module systems.

Possibly the most useful logs for ground-water exploration are the resistivity and spontaneous potential, both of which must be run in a open uncased hole. The resistivity log measures the resistivity of rocks penetrated by the borehole under direct application of an electric current or an induced electric current. The spontaneous potential log measures the natural potentials developed between borehole fluid and surrounding rock material. Used together these measurements identify water-bearing zones, rock types, and the quality of water in permeable formations throughout the depth of the open hole. Resistivity and spontaneous potential logs are particularly useful in delineating aquifers in unconsolidated sediments and consequently, proved an important tool in designing wells in the ʿAmrān Valley.

Natural gamma logs measure the natural-gamma radiation of rocks penetrated by a borehole. The gamma gamma (density) log utilizes a source of radiation within the sonde and records gamma radiation from this source after it is backscattered and attenuated within the borehole and surrounding rocks. Natural gamma and gamma gamma logs may be run both in open holes and in cased holes.

All of the described logging systems are useful in geologic correlation between wells and in locating water-bearing zones penetrated by a single borehole. This geophysical capability was particularly important to the ʿAmrān Valley study because of the inexperience of the Yemeni drilling crews. If information was not collected during drilling operations or was lost or unrecorded, it was often possible to retrieve that information by geophysical logging procedures.

Copies of the down-the-hole geophysical logs run by the investigation project are on file with the Hydrology Section of the Ministry of Petroleum and Minerals.

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 properties, which affect the water levels or artesian pressure and yield of wells, are quantified in terms of transmissivity (a rate of movement) and storage (a dimensionless coefficient) and were first defined by Theis (Ferris and others, 1962, pp. 72-78). In 1972, these terms were redefined by Lohman and others. When these characteristics are known for an aquifer or part of an aquifer, it is possible to forecast approximate water level or artesian pressure trends at different rates of withdrawal from producing wells.

To establish the transmissivity values and storage coefficients of aquifers in the ʿAmrān Valley, four aquifer tests were made at selected sites. In addition, a third formation constant had to be determined to evaluate aquifer hydraulics since the semi-confining beds overlying or underlying the aquifer transmitted water upwards or downwards by leakage. This constant is called leakance, or the leakage coefficient as defined by Hantush and Jacob (1955) and Hantush (1956).

Some difficulty was encountered in performing the aquifer tests. The problems, were, for the most part, related to newly purchased pumping equipment. The direct drive turbine pumps used by the drilling section were unavailable for use in aquifer testing and, as a consequence, an electrical submersible pump with generator was purchased. This new equipment proved difficult to regulate and pumping rates, therefore, were somewhat erratic. Results of these tests, however, are judged to be within acceptable limits when the data are matched to the Hantush-Jacob leaky-aquifer model. Data from these tests do not match the Theis curve except for some of the early responses. Semi-log plots and recovery data, therefore, can be misleading and accordingly, all plots consist of logarithmic values of drawdown versus the parameter time divided by well radius squared (log d versus log t/r^2). Obtained values of the transmissivity are about 1/2 to 2/3 those determined from semi-log plots whereas storage coefficients are higher than those obtained from semi-log plots.

<u>Al Jubi Site</u>--An aquifer test was performed at the Al Jubi site on September 5, 1977. The aquifer at this site consists of mixed volcanic and limestone gravel and was screened with slotted pipe between 85 and 104 m. The well was also gravel packed. The pumping rate varied somewhat, but averaged 12 L/s (190 gal/min). Figure 2 shows the drawdown curve for the Al Jubi test. Data prior to 6 minutes are erratic and something unexplained happened to drawdown between 60 and 90 minutes. Matching the data between 6 and 20 minutes, and 90 and 450 minutes, transmissivity, $T \cong 454\ m^2/d$ (36,000 gpd/ft) and the storage coefficient, $S \cong 2 \times 10^{-3}$. Apparent leakage is a significant .026.

<u>Warehouse Site</u>--The aquifer test conducted at the Warehouse site between July 10 and 15, 1977, utilized a pumping well screened with a commerical continuous slot screen. The 6 m length of screen was set at the bottom of a 23 m sand bed and extended into the underlying basalt bed. This test was badly flawed by a 40 percent decrease in pumping rate during the test (fig. 3). Assuming a harmonic mean pumping rate of 2 L/s (130

gal/min), T ≅ 75 m^2/d (6,000 gpd/ft) and S ≅ 1 x 10^{-3}. Departure of the drawdown from the Theis curve is partly due to the decreasing pumping rate, but may be partly due to a leaky aquifer. Confidence in T and S is high, but the leakance of .011 is somewhat questionable.

Raydah South Site--An aquifer test was made at the Raydah South site (fig. 4) August 21 to 24, 1977, utilizing a 3-well complex. The production and one of the observation wells were screened with slotted pipe and gravel packed between 49 m and 61 m. Both of these wells were finished in gravel. The second observation well was screened with a commercial 40 slot screen and gravel packed from 53 m to 59 m. Apparently the third well tapped a fractured basalt rather than the gravel bed penetrated by the other two wells accounting, in part, for the difference in response between the observation wells. The production well was pumped at 9.5 L/s (152 gal/min).

Analysis of data from observation well number 1 indicates a T ≅ 248 m^2/d (20,000 gpd/ft) and S ≅ 2 x 10^{-3}. The data from the second observation well show T ≅ 372 m^2/d (30,000 gpd/ft) and S ≅ 5 x 10^{-4} which is consistent with the fractured rock hypothesis. Apparent leakance is 9.34 x 10^{-3}. Data from the pumped well cannot be analyzed with any confidence owing to difficulty with the airline measurements.

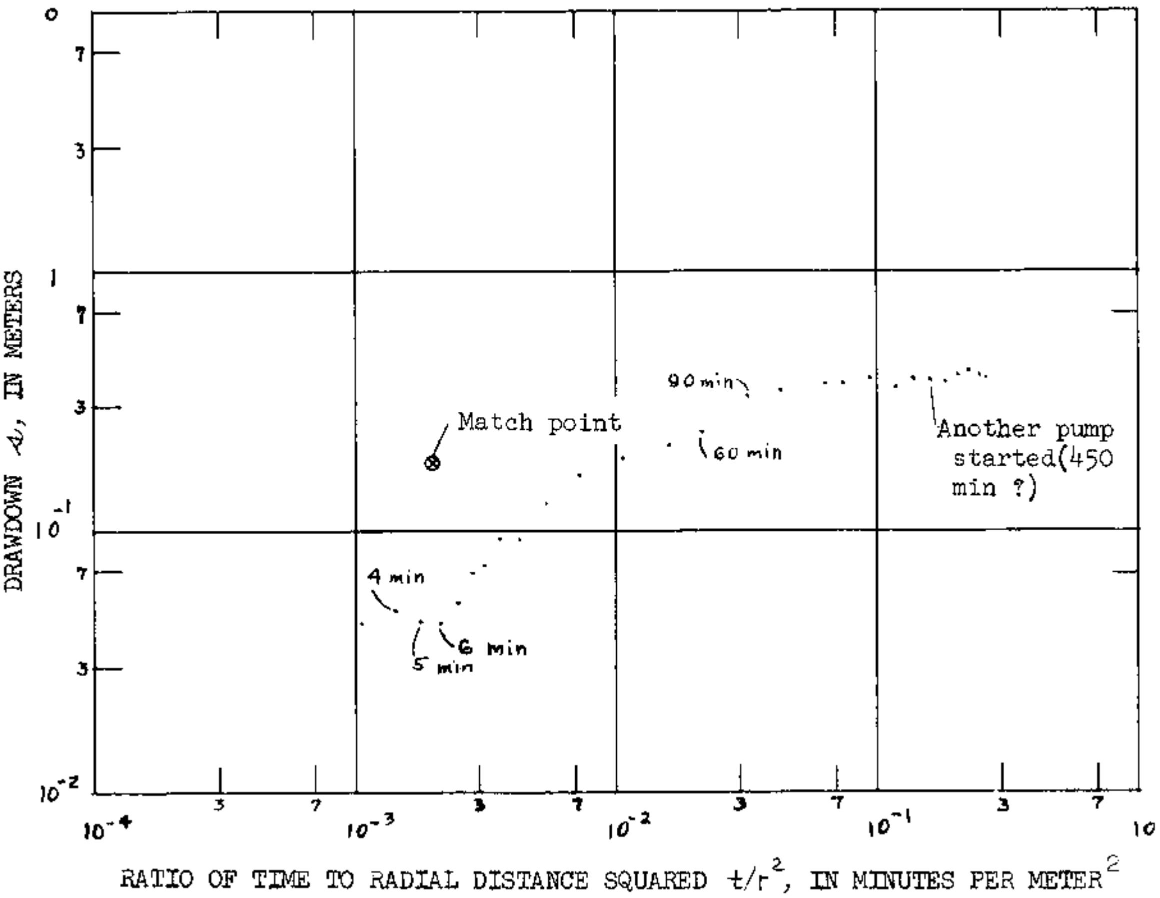

Figure 2--Aquifer test plot, Al Jubi Site.

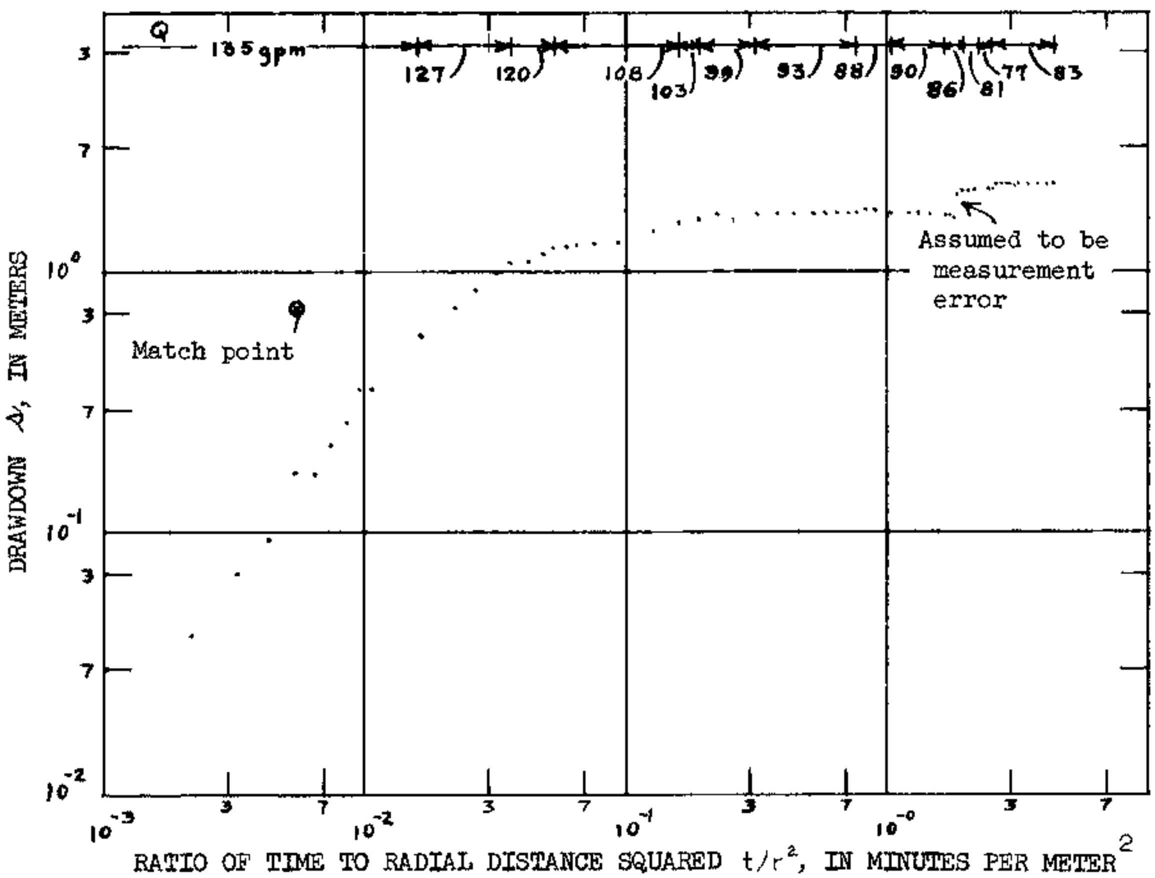

Figure 3--Aquifer test plot, Warehouse Site

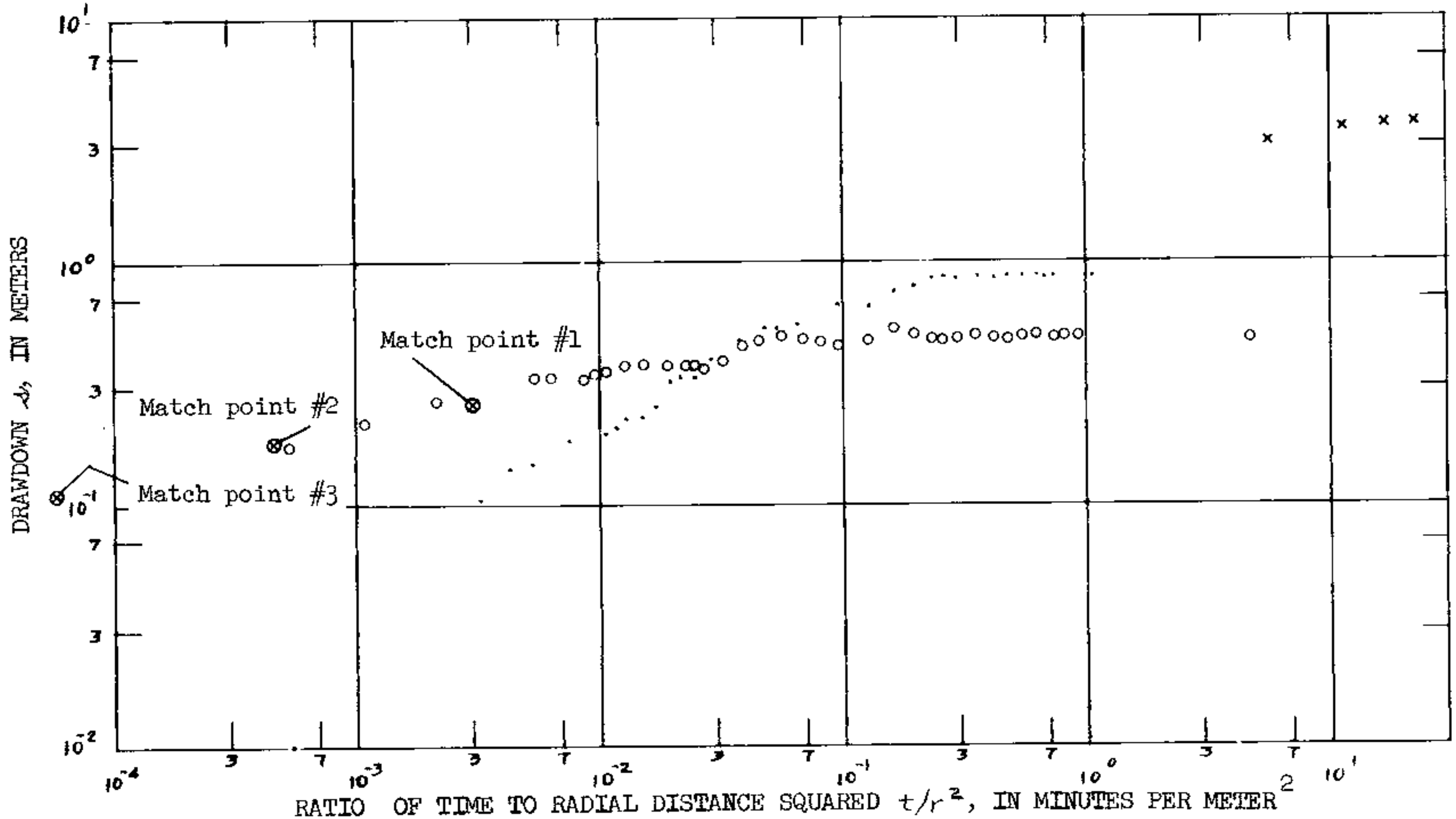

Figure 4--Aquifer test plot, Raydah South Site

Raydah Middle Site--The aquifer test conducted at the Raydah Middle site between February 6 and 9, 1978, utilized a pumping well screened between 168 and 183 m with 15 m of slotted screen. The well was pumped at 9.7 L/s (154 gal/min) with a drawdown of 2.15 m. The aquifer at this site consists of a fractured basalt. Figure 5 shows the test curve for this site and analysis of the data shows a $T \cong 860\ m^2/d$ (69,500 gpd/ft) an $S \doteq 9.8 \times 10^{-5}$, and a leakage coefficient of 2.5×10^{-3} per day. In addition, well loss was estimated to be in the order of 1 meter. Attempts to analyze the pumping and recovery cycle from the observation well separately yielded inconsistent results and therefore, these data were combined and used in the type-curve method of analysis. Fluctuations in the observed data near the end of the test may result from barometric effects.

Figure 6, shows a semi-log plot of the recovery cycle data from the pumped well. It can be shown that for small r/B, such as would be the case in the pumped well, that the early part of the semi-log data plot should be a straight line having a slope of:

$$\frac{\Delta s}{\text{cycle}} = \frac{2.3Q}{4\pi T}$$

Where: s = drawdown, in meters
s* = recovery, in meters
Q = well discharge, in cubic meters per day
T = aquifer transmissivity, in square meters per day

Hantush (1956) shows that for small r/B and large u, for the early time interval, the values of W(u, r/B) are the same as Theis' W (u) explaining why the equation above is valid (symbol definition given below). The transmissivity determined in the analysis of the early part of the recovery data should fall on a straight line that has a slope s*/cycle = 0.177 m. In this case, well losses are assumed to be constant with time and would not affect the slope. Such a line drawn in figure 8 shows the value of transmissivity is reasonable.

The observed steady-state drawdown or recovery in the pumped well is in the order of 2.1 to 2.3 meters. The theoretical drawdown or recovery (fig. 7), without well losses would depend on effective well radius. The inset on figure 8 shows the theoretical drawdown or recovery for effective radii ranging from 0.1 to 0.5 meters. Assuming that the effective radius of the well is in this range, well losses would range from 0.75 to 1.20 meters.

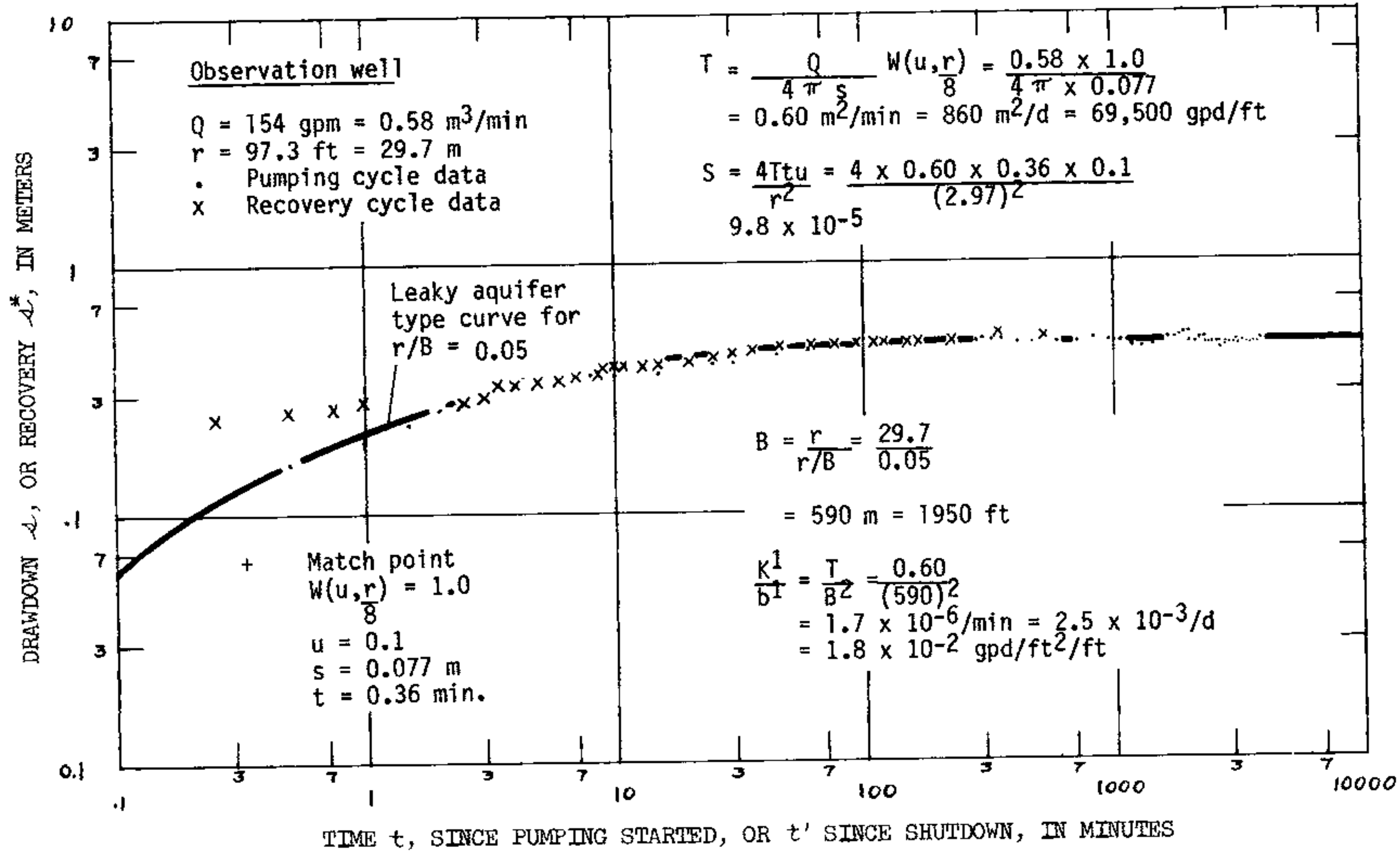

Figure 5--Aquifer test plot, Raydah Middle Site

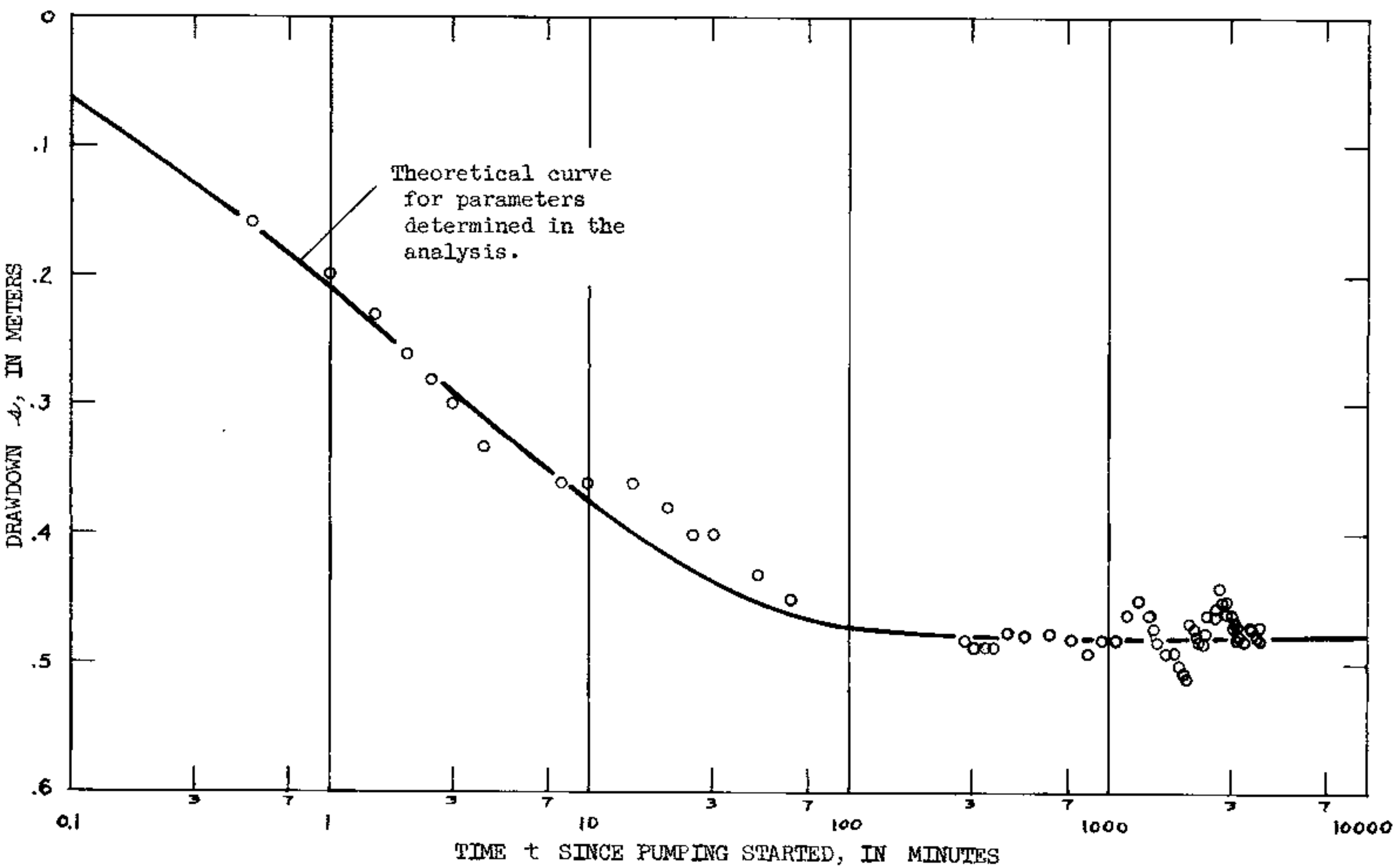

Figure 6--Observation well pumping-cycle data, Raydah Middle Site

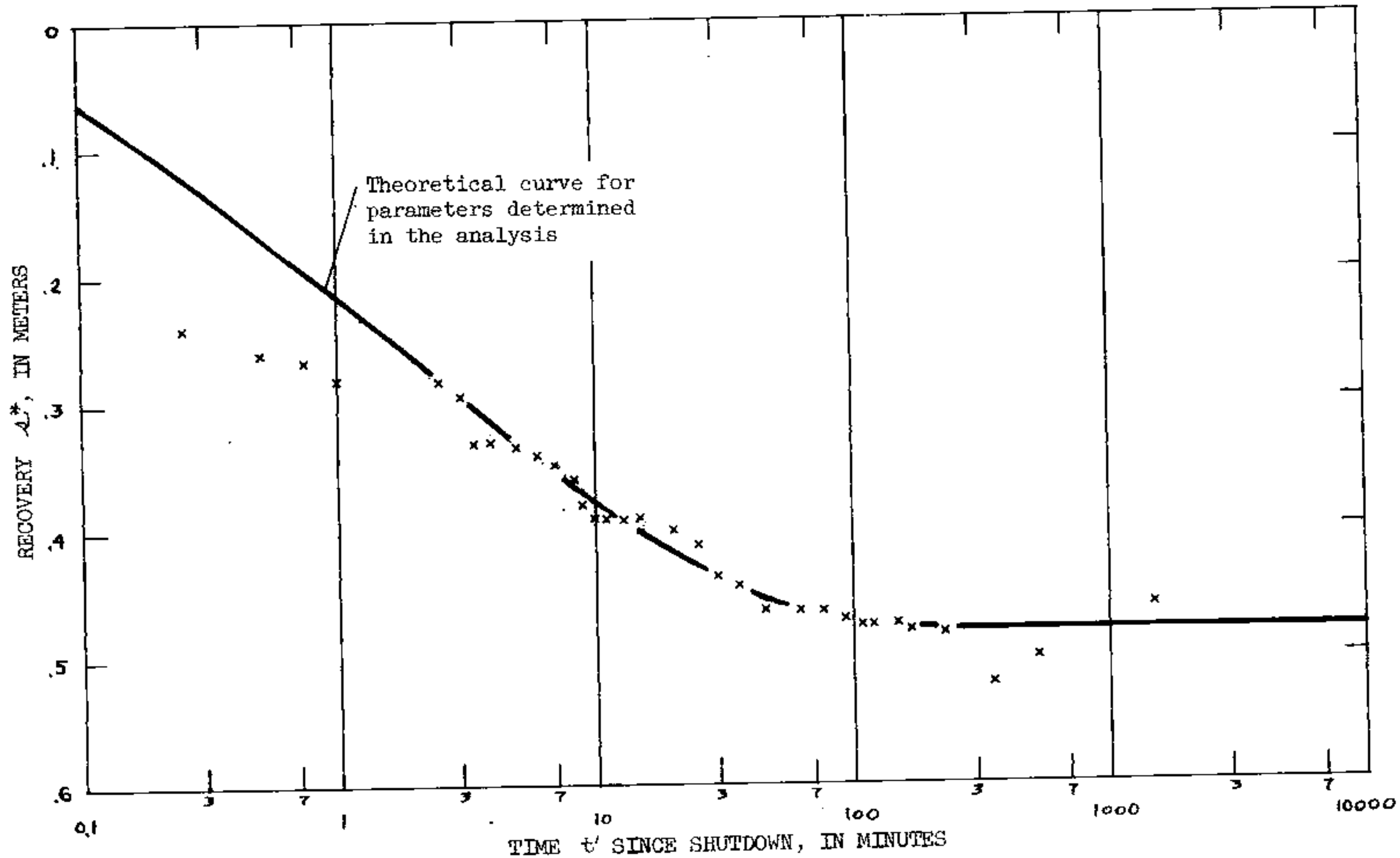

Figure 7--Observation well recovery-cycle data, Raydah Middle Site

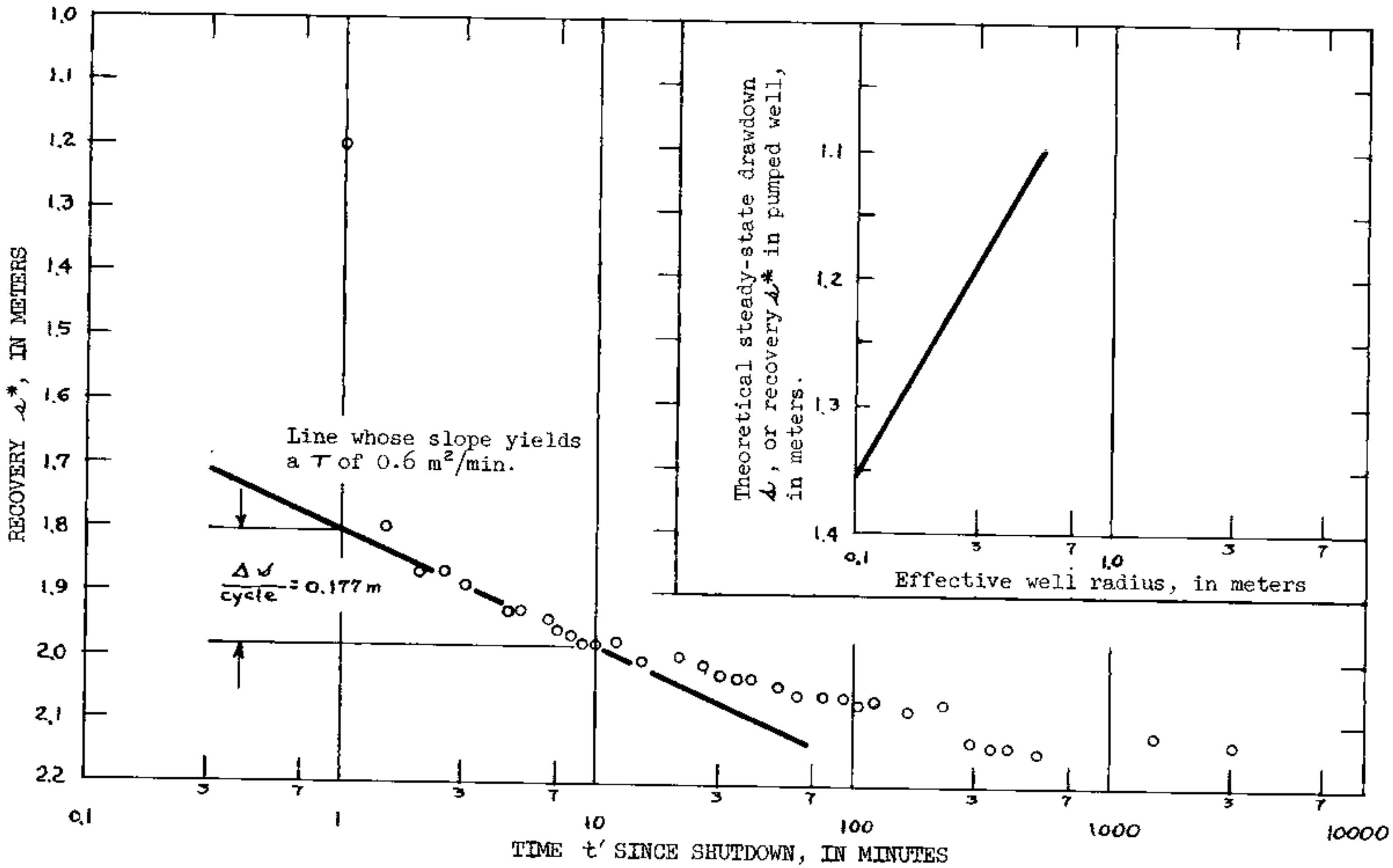

Figure 8--Pumped-well recovery-cycle data, Raydah Middle Site

The pumping tests carried out at four sites in the ʿAmrān Valley provided the necessary hydrogeologic information for computing rates of drawdowns for varying levels of ground water development.

All the data plots of figures 9, 10, 11, 12, as well as the lithologic information obtained from well drillers indicated that the aquifers of the ʿAmrān Valley are leaky and receive substantial amounts of water from the overlying aquifers when stressed.

The equation used to compute potential drawdown for various levels of pumpage is that of Hantush and Jacob (1955; see p. 320-324 of Freeze and Cherry, 1979). This equation can be written as:

$$s = .08 \frac{Q}{T} W\ (u,\ r/B)$$

where s = drawdown in meters, (m)
Q = well discharge in cubic meters per day (m^3/d)
T = transmissivity of the aquifer in square meters per day (m^2/d)
W (u, r/B) = well function for the leaky aquifer, a set of dimensionless numbers given in tables, for example Hantush (1956), as a function of u and r/B which in turn are given by:

$$u = \frac{r^2 S}{4Tt} \quad \text{and} \quad \frac{r}{B} = r \sqrt{\frac{1}{T} \cdot \frac{k'}{b'}}$$

where r = radial distance from the well, in meters (m)
B = aquifer thickness in meters
S = storage coefficient of the aquifer, dimensionless
t = time, in days (d)
$\frac{k'}{b'}$ = leakage coefficient, day^{-1}, where k' = permeability in meters per day and b' = thickness in meters of the leaky aquifer

The graphs illustrating the rate of drawdown as a function of distance from the well and for various levels of pumpage are given in figures 9, 10, 11, and 12.

Although the initial computations were made for different time periods (such as 1 week and 50 years) the results indicated that time was not a significant factor for the levels of pumpage that were chosen (that is, steady-state conditions prevailed).

The pumpage levels used in the computations were in line with those used during the pumping tests and thus conform realistically to the existing field conditions at the sites.

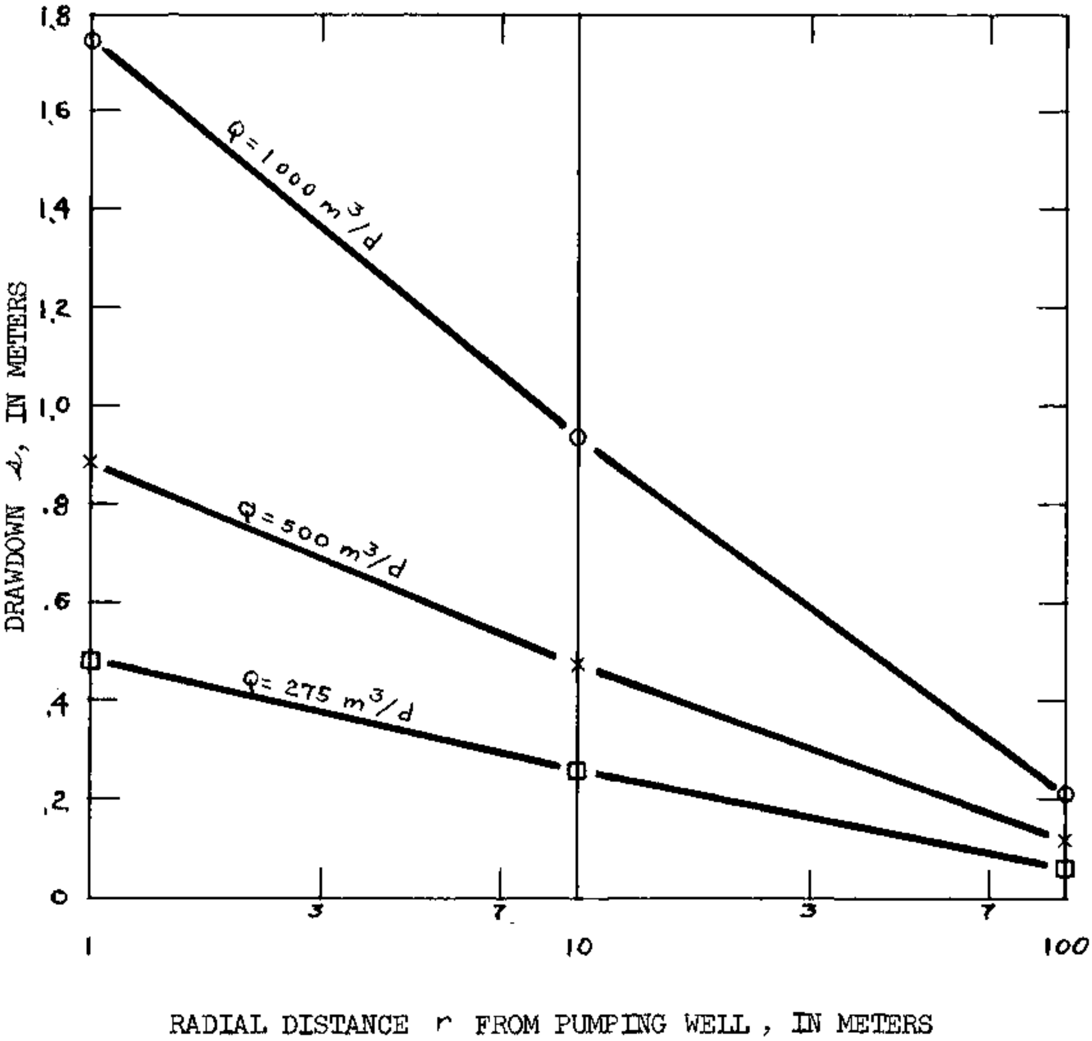

Figure 9--Distance-drawdown curve for various levels of discharge, Al Jubi Site.

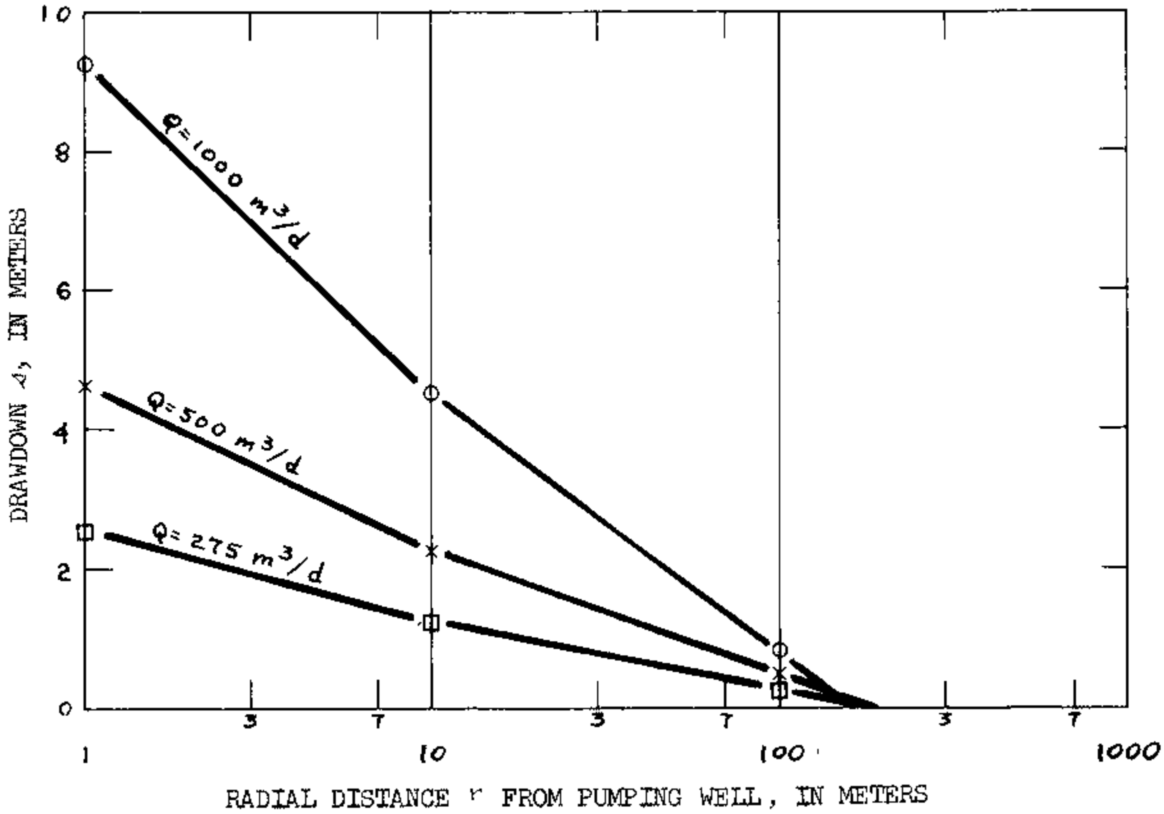

Figure 10--Distance-drawdown curve for various levels of discharge, Warehouse Site.

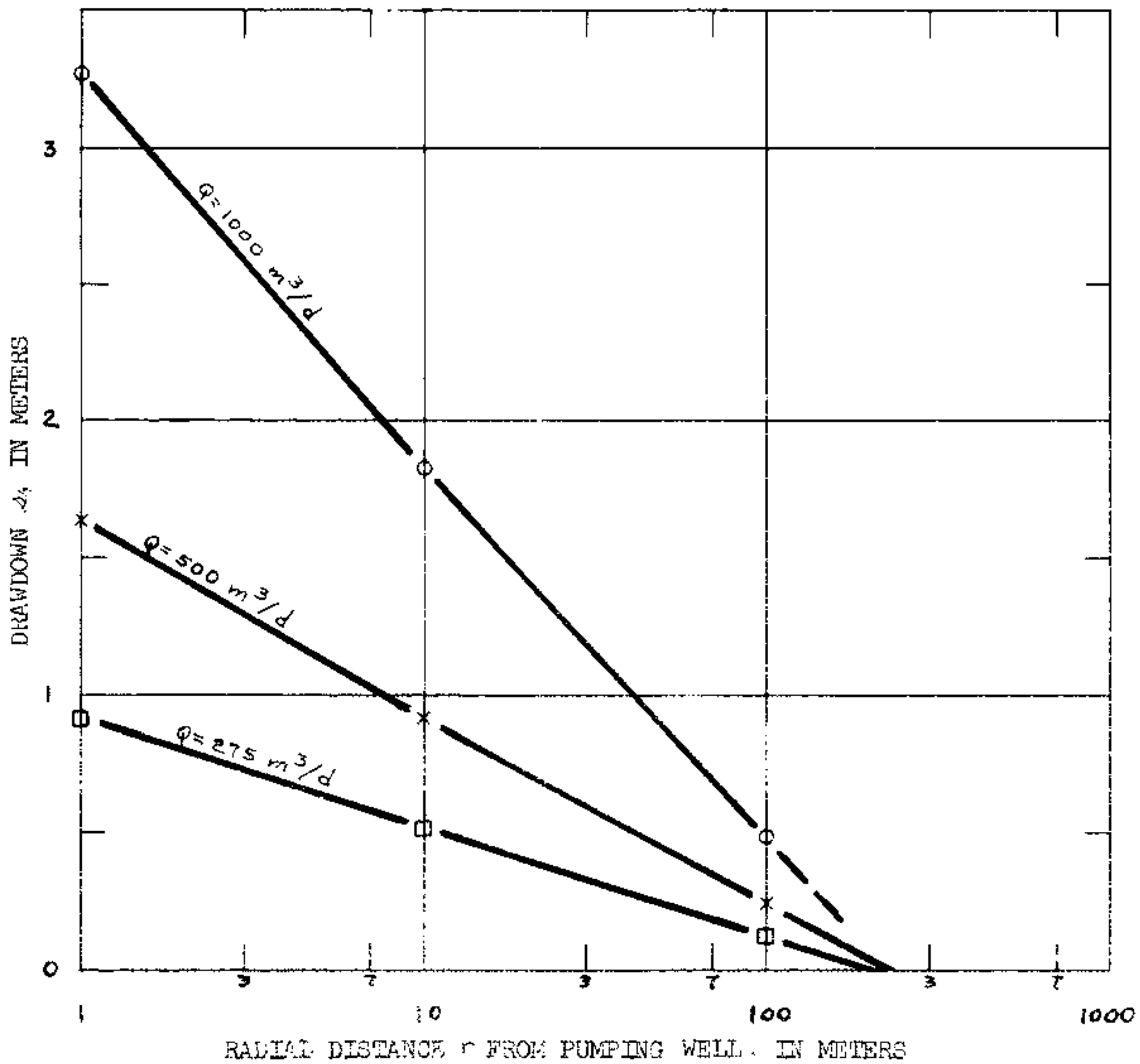

Figure 11--Distance-drawdown curve for various levels of discharge, Raydah South Site

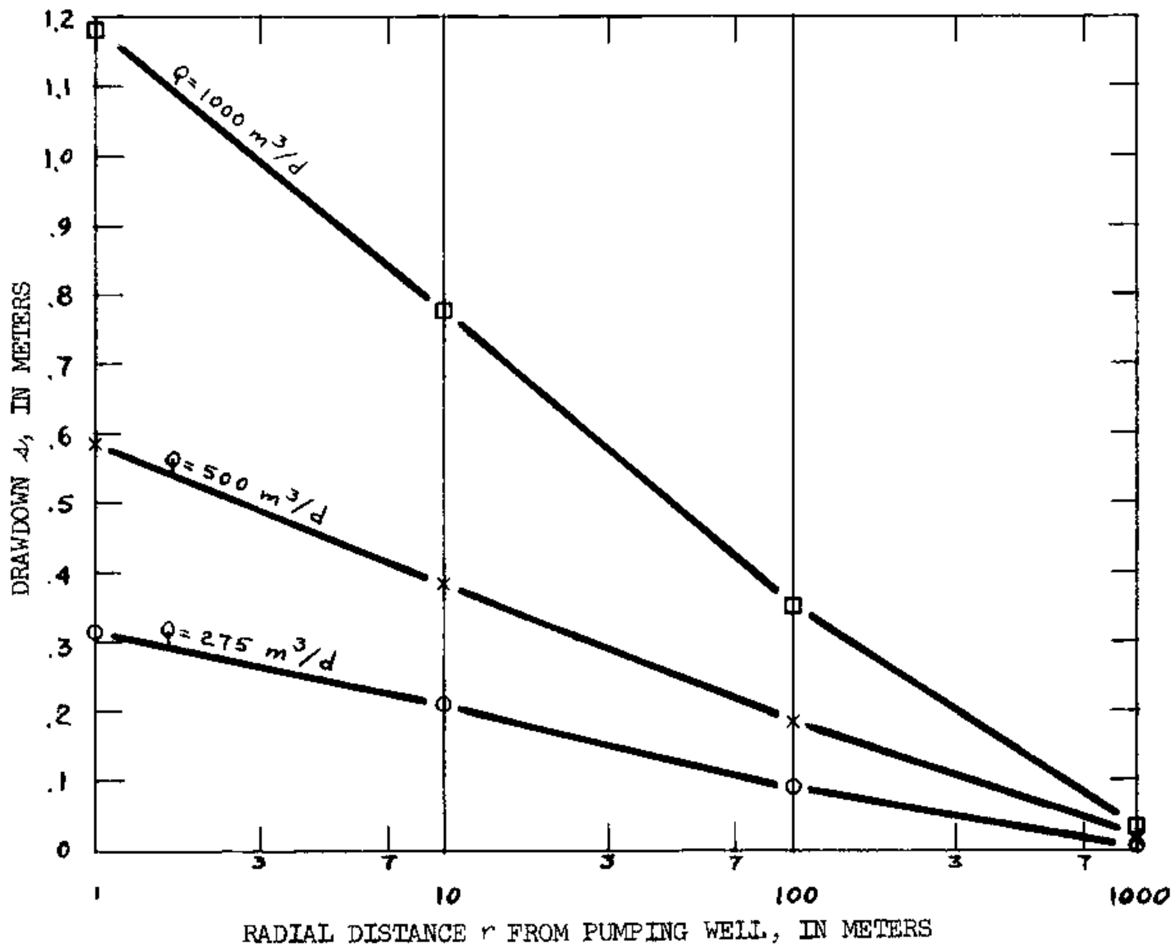

Figure 12--Distance-drawdown curve for various levels of discharge, Raydah Middle Site.

The chemical quality of water from the unconfined and semiconfined aquifers in the 'Amrān Valley is generally good and is suitable, with few exceptions, for domestic supply, livestock, and irrigation. Analyses of water from 16 wells in the report area (table 7) show the ion concentrations are below the maximum limits suggested by the U.S. Public Health Service (1962) for drinking water. The water from aquifers in the report area is generally moderately hard, usually from 110 to 250 milligrams per liter (mg/L) total hardness as $CaCO_3$.

The water from the aquifers of the Amrān Valley is suitable in chemical quality for irrigation on many types of soils. Most of the water analyses, when plotted on a classification diagram (fig. 13) indicate a low to very low sodium hazard except for 2 analyses which plot in the high salinity hazard range. The effect of the salinity hazard may be overcome by leaching cultivated soils with excess irrigation or naturally with rainfall. Most of the water is predominately a calcium-magnesium-bicarbonate type (fig. 14) except for water from the well drilled by USAID to supply the village of Al Ḥjaz 7 km southwest of 'Amrān town (# 383). Water from Al Ḥjaz well is a calcium-magnesium-sulfate type indicating that gypsum is present in the subsurface section. The bicarbonate ion concentration of the water sampled ranges from 130 mg/L to a relatively high 300 mg/L.

The diagram for the classification of irrigation water (fig. 13) developed by the U.S. Salinity Laboratory of the Department of Agriculture (1954), is based on electrical conductivity in micromhos/cm ($EC \times 10^6$) and on the sodium-absorption ratio (SAR). Electrical conductivity is commonly used for indicating the total concentration of ionized constituents of a natural water and is closely related to the sum of the cations or anions as determined by chemical analysis. Conductivity is a measure of the salinity hazard of water for irrigation. SAR, used as a measure of the sodium hazard, is a calculated value in which the concentration of the ions involved are expressed in milliequivalents per liter (meq/L) and is defined by the Salinity Laboratory as:

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

The classifications of irrigation water discussed above were designed primarily for use in arid regions, such as the 'Amrān Valley, where these classifications are directly applicable. Water classified as having a high salinity hazard can, however, be used occasionally on a supplemental basis with little danger to all but the most sensitive crops. Only two of the wells sampled (fig. 13) show water with a high salinity hazard and the remainder of the analyses show a medium salinity hazard. All of the analyses indicate a low sodium hazard.

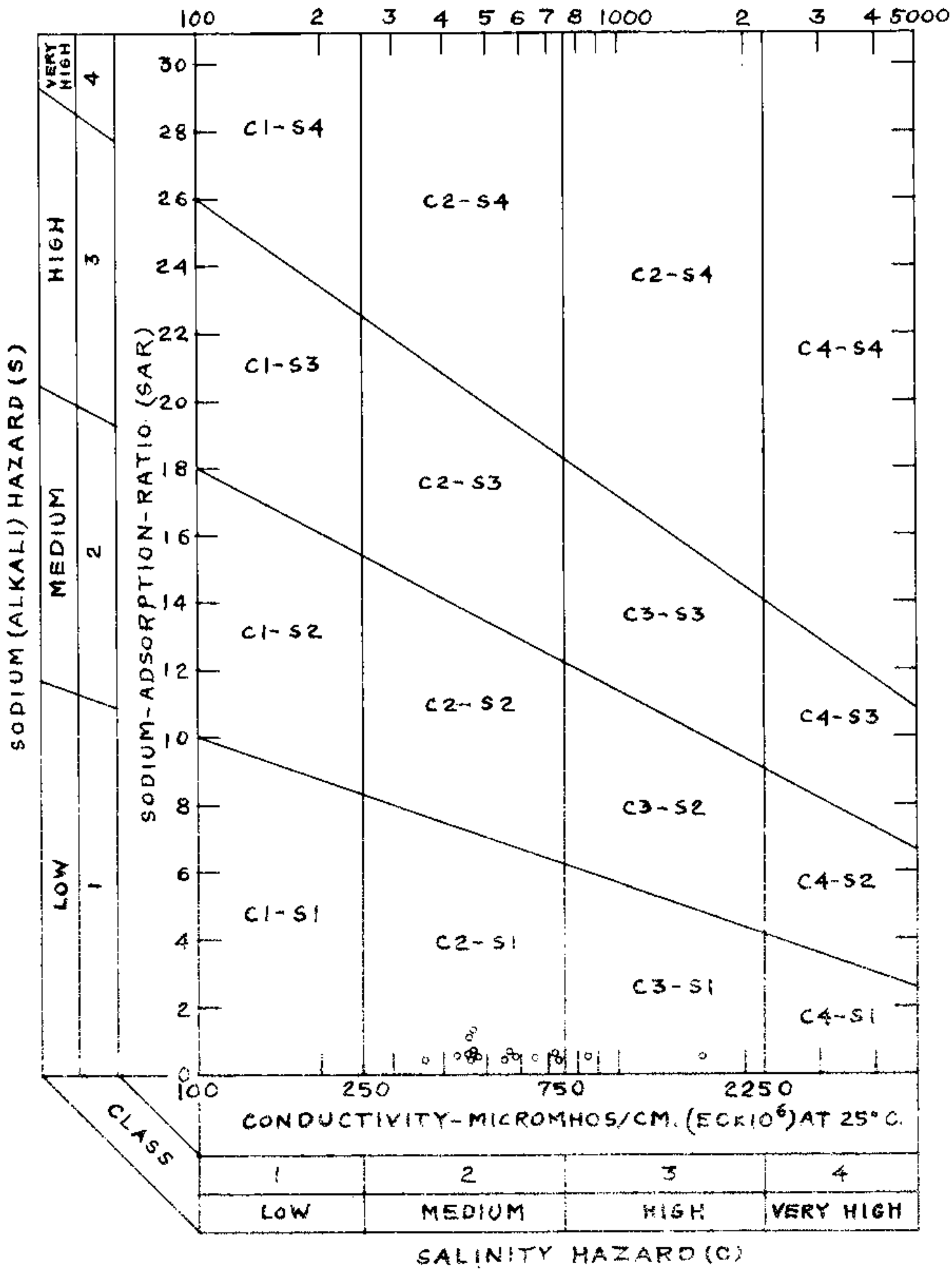

Figure 13--Diagram showing classification of water in ʿAmrān Valley, Yemen Arab Republic with respect to suitability for irrigation.

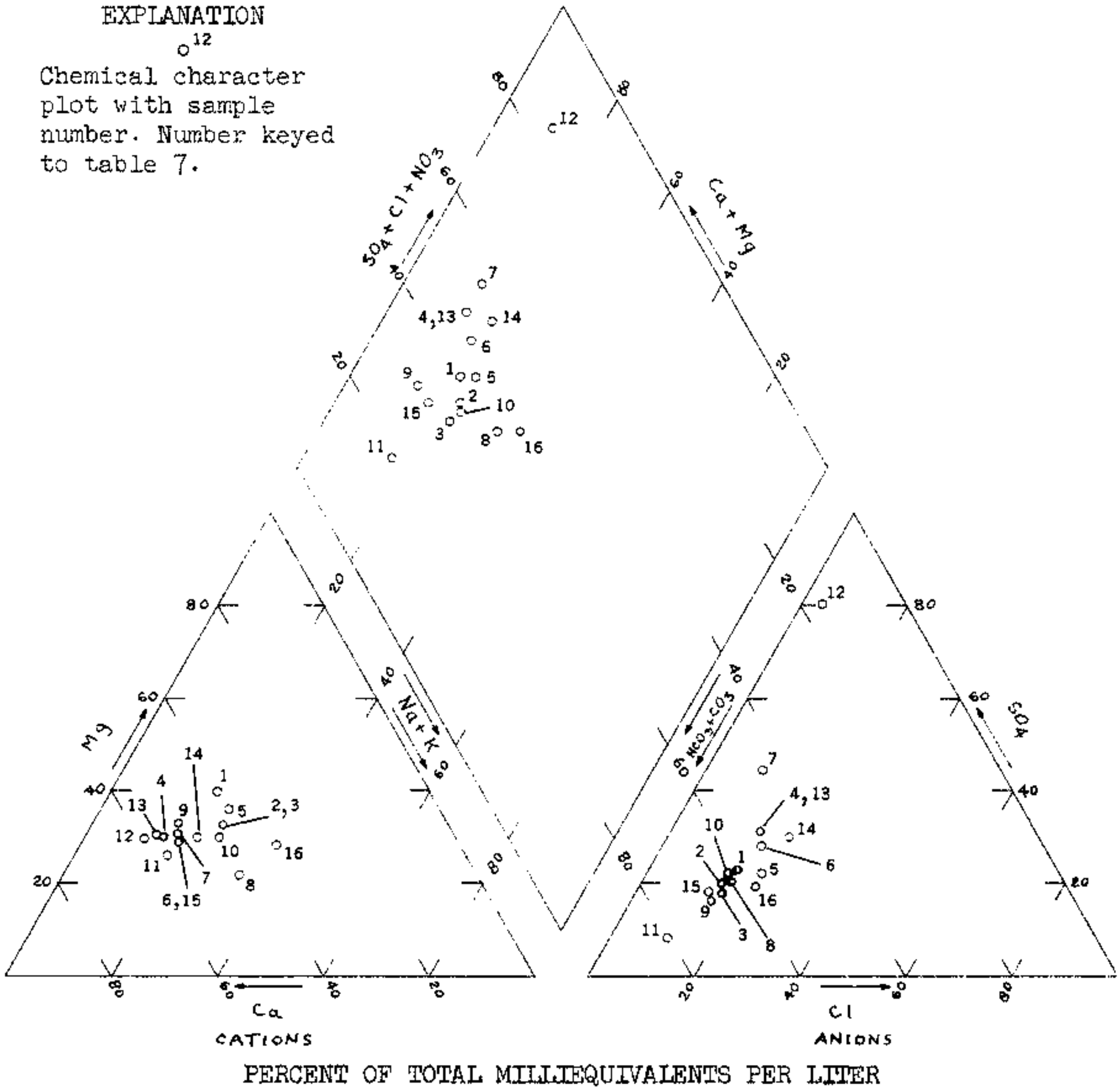

Figure 14--Piper diagram showing chemical character of water ʿAmrān Valley, Yemen Arab Republic (After Piper, 1944).

Conductivity was measured in the field for water from most of the wells inventoried during the investigation. These field conductivities ranged between 340 and 780 micromhos/cm with the majority of the water tested having less than 750 micromhos/cm. Field measurements, therefore, show that most water from wells in the area have conductivities in the medium salinity hazard range.

Six of the water samples were analyzed for boron which is essential for the growth of all plants. Concentrations of boron are reported in micrograms per liter (UG/L in table 7) and over 33 UG/L boron would affect the growth of crops sensitive to that element. The concentrations of boron reported from the ground water of the ʿAmrān Valley, however, pose no threat to crops.

RECHARGE AND WATER USE

Currently, one of the more popular methods of evaluating the water resources of an area involves calculating the "water balance." Formulas vary in detail, but generally include adding yearly recharge by rainfall percolating downwards to the aquifer system to annual inflow of water from surrounding areas and subtracting the annual use of water and the annual evapotranspiration, plus outflow to arrive at a figure for the change in water storage within the aquifer system. Changes in storage are reflected in the rise or fall of water levels in wells throughout the study area. When all of the above factors are known, even within reasonable limits, a water balance can indeed be predictive of the water in storage in the aquifer system. When on the other hand, one or more of the hydraulic parameters are unknown or estimated, a less mathematical approach based more on reason is indicated.

For the ʿAmrān Valley it is known that water levels are declining during a period of above average rainfall; as much as 2 m per year in an area of heavy usage. Additionally, the principal aquifer system is continuous within a narrow graben structure bounded by precipitous limestone cliffs. The limestone in these cliffs is undoubtedly in hydraulic continuity where contiguous with the wādī alluvium. The Amran serils, however, is a poor aquifer regionally and the low yield seasonal springs issuing from the valley flanks are probably indictative of the small amount of water in transit through this formation. Consequently, recharge to the valley is in all likelihood largely restricted to a part of the limited rainfall and a part of the limited surface inflow. Topographic, structural, and geologic conditions are not very favorable to recharge and these constraints coupled with facts of low rainfall and the decline in water levels in wells leads to the inescapable conclusion that the aquifer system is currently being over produced and the water mined.

The annual pumpage from the ʿAmrān Valley, based on information obtained during the well inventory, is estimated to be 11 x 10^6 m^3/year of which 90 percent is extracted from the Al Bann Plain (Qāʿal Bawn al Kabīr) that forms the central and southern part of the valley. Naturally, this is also the area with the greatest decline in water levels in wells. Other evidence indicating that water is being removed from storage is indicated by the progressive deepening of existing wells. As water levels and yields decline many existing wells are dug or drilled deeper in an effort to maintain sufficient water for irrigation. Pumping costs, of course, increase and there is also a practical limit beyond which an existing well can be deepened and still expect to increase or maintain yield. Additionally, some of the shallow wells, for the most part near the valley flanks, have gone dry indicating overproduction of the water resources. It is apparent, therefore, that pumpage should be restricted and the drilling of new wells and the deepening of existing wells prohibited; most prudently as an immediate measure. Current knowledge indicates that over the long term there is not sufficient ground water available in the ʿAmrān Valley to meet present demands. Projected future requirements which, among other things, include a cement factory would compete with existing use and contribute greatly to the rate of mining water from the aquifer.

Based on the well inventory, there are currently between 400 and 500 dug and drilled wells in the ʿAmrān Valley. Approximately 45 new wells are constructed annually which is balanced somewhat by the fact that as many as 10 existing wells are abandoned each year. Many of the older wells have been deepened at least once and many several times. Approximately 80 percent of all wells are equipped with motor-driven pumps ranging in type from centrifugal to deep well turbines.

An observation well network was established in the area in 1974 by the USAID project and since that time selected wells have been measured periodically. Water levels in the area around ʿAmrān town and at Al Jannāt declined at a rate of 2 m per year from 1975 to 1978. Elsewhere in the study area water levels declined at a more gradual rate generally averaging about 0.3 m per year. Everywhere, however, the regional trend is downward. Recharge is noticeable in 1975 following a heavy rainfall but not clearly indicated in other years. Figures 15, 16, and 17 developed by Wagner and Nash (1978) show water level fluctuations in 7 observation wells in the ʿAmrān Valley as related to rainfall. It should be noted that rainfall was greater than normal during this 1975-77 period.

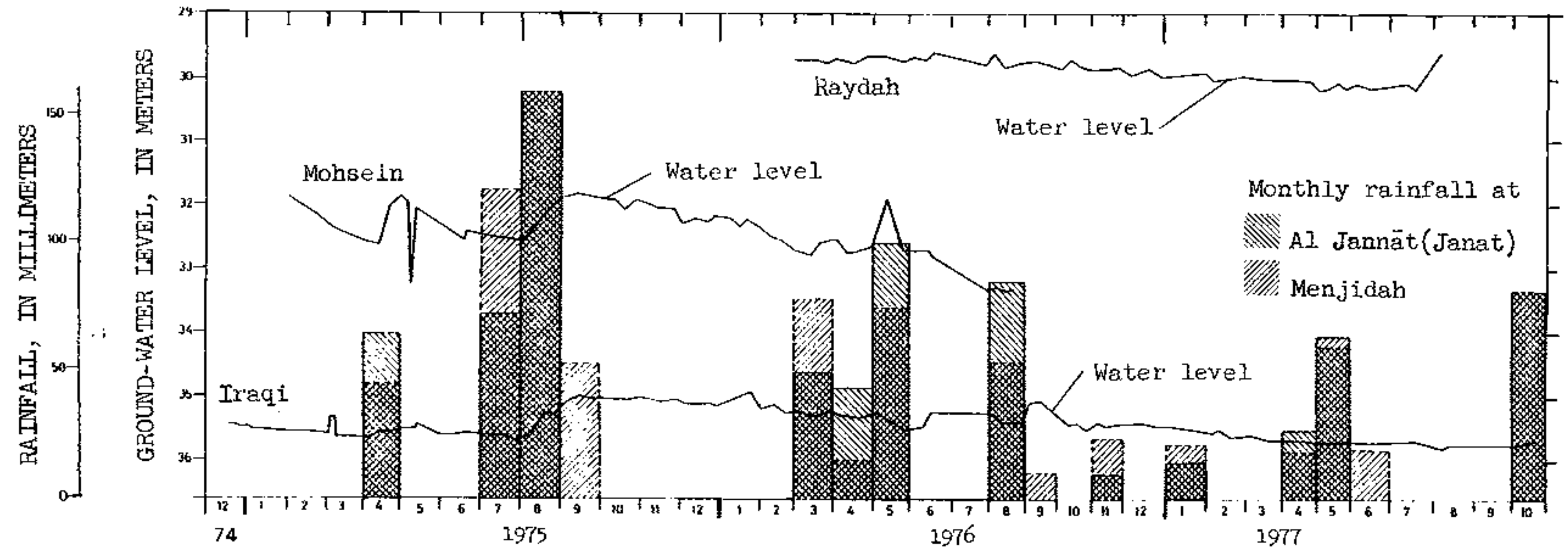

Figure 15--Ground-water level fluctuations at Raydah, Mohsein, and Iraqi and monthly rainfall 1975-1977, ʿAmrān Valley, Yemen Arab Republic (After Wagner and Nash, 1978).

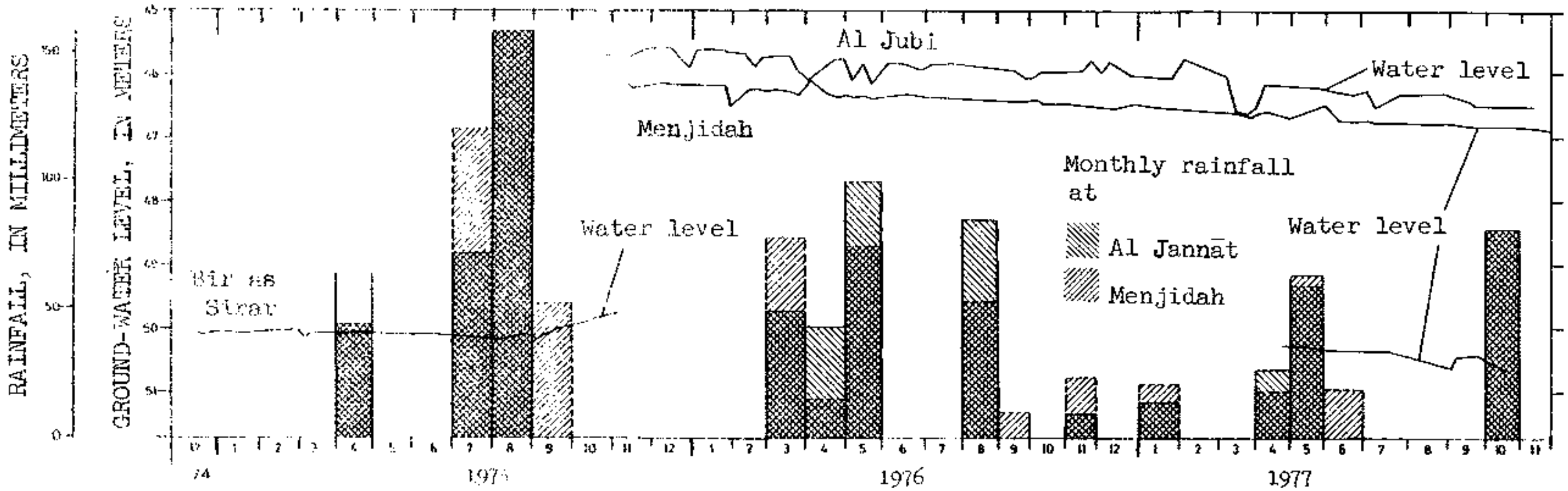

Figure 16.--Ground-water level fluctuations at Al Jubi, Menjidah and Bir as Sirar, monthly rainfall 1975-1977, ʿAmrān Valley, Yemen Arab Republic (After Wagner and Nash, 1978).

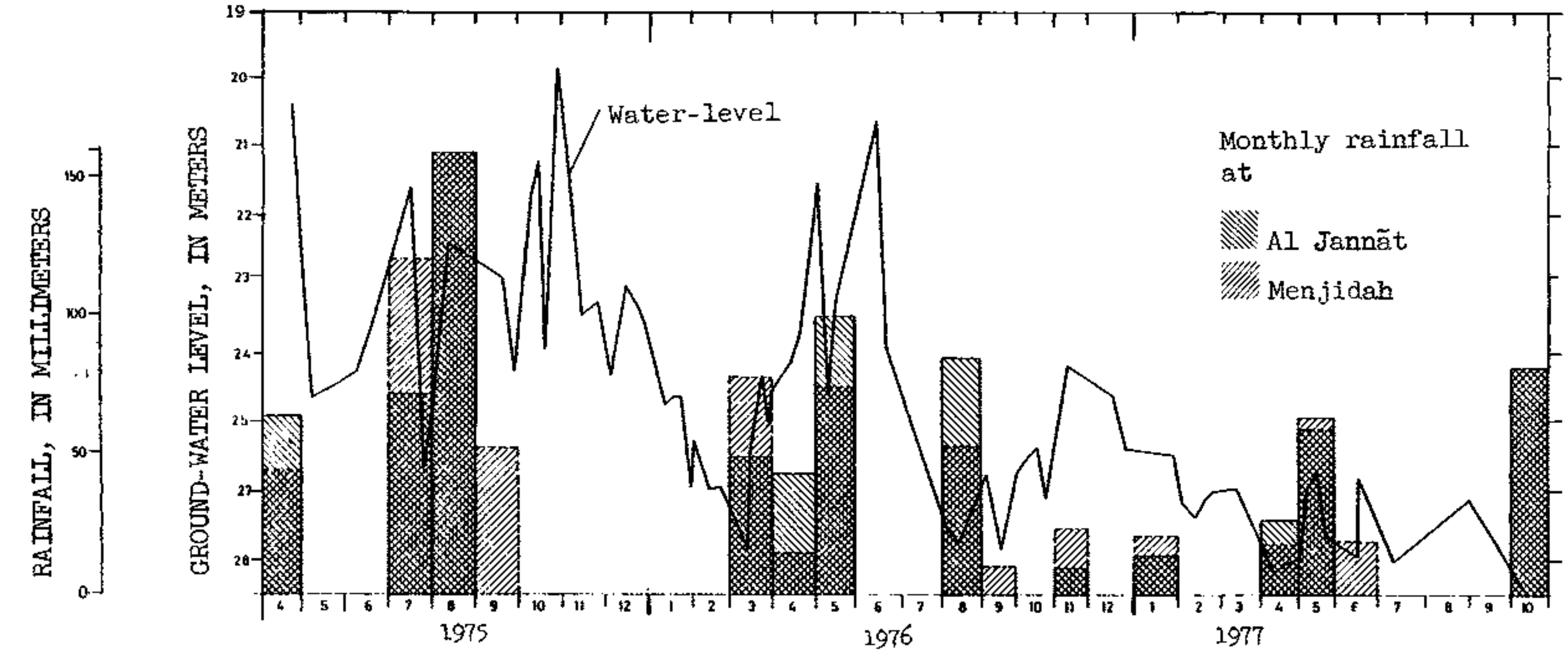

Figure 17--Ground-water-level fluctuations at Al Jannāt and monthly rainfall 1975-1977, ʻAmrān Valley, Yemen Arab Republic(After Wagner and Nash, 1978).

CONCLUSIONS

1. The area where wells can be successfully developed for irrigation lies in the south-central part of the ʿAmrān Valley. Generally, the permeable alluvial sediments are thickest in that area and drilled or dug wells may penetrate one or more water-bearing beds at depth. Aquifers within the alluvial formation contain the principal water resource in the study area. The Amran limestone and the Quaternary volcanics yield significant quantitites of water to wells only where these rocks are tapped in fracture zones.

2. The alluvial aquifer system is currently (1978) being over-exploited and ground water is being mined. Water levels in wells are declining and discharge is in excess of recharge.

3. Analyses of four aquifer tests on drilled wells screened in the unconsolidated sediments and basalt constituting the valley fill show leaky aquifer characteristics.

4. The basalt flow northeast of Raydah acts to retard ground-water movement to the valley north of this flow. Wells north of this basalt flow generally have low yields and the valley fill may be essentially dry even at considerable depth.

5. The chemical quality of water from aquifers in the basin is generally good and suitable, with few exceptions, for domestic supply, livestock, industry and irrigation. As applied to irrigation of crops, the salinity hazard is medium and sodium hazard low for the great majority of the water tested. Boron, although present, does not constitute a hazard to agriculture in the concentrations encountered.

6. Enough data are not yet available to establish a meaningful water budget for the basin. Additional observation wells are required in the northeastern part of the valley and the observation well network needs to be expanded to include more wells in tributary wadis.

7. Current irrigation practices are inefficient with regard to water conservation. Alternatives to the open ditch and flooding methods of irrigation need to be researched and the results applied to local cropping procedures.

RECOMMENDATIONS

1. The observation well and rain gage (monitoring) program established by the USAID project in the Amran Basin should be continued. Data obtained from the monitoring program will become more important, particularly as a management tool, as the ground-water resource is increasingly exploited. Although aquifer test data provide a basis for predicting effects of pumping on water levels, long-term observations of water levels are more useful in defining regional water-level trends. This is particularly true relative to achieving the optimum utilization of the resource and balancing the natural and artificial discharge with recharge to the aquifer system.

2. Five to ten percent of the wells throughout the area should be reinventoried annually. This effort should be limited to wells other than the observation wells where data are already collected periodically. Such a reinventory would fill in possible gaps in the observation well network and may define problems that are not otherwise immediately obvious.

3. In view of the declining water levels, restrict the use of water from wells for irrigation. Considering the political and social mores extant in the area, probably the only possible way to limit pumpages is to prohibit drilling of new wells and the deepening of existing wells; even this strategy may be impossible to enforce. The prohibition should stay in effect until pumping levels stabilize; at which time the policy can be reviewed. It may then be possible to gradually increase pumpage, balancing discharge and recharge.

4. Drill a deep test well in the southern center of the Amran graben (pl. 1, inset A). The alluvium and interbedded basalt layers have not been completely penetrated by any of the test holes along the center axis of the valley. This well should be continued to a depth of at least 100 m into the underlying limestone bedrock. The hole should be logged geophysically and permeable zones tested as encountered. This would establish whether or not productive aquifers exist below the depths thus far tested. To obtain maximum information, this hole should be sited solely on geohydrological considerations, avoiding any and all pressures to become a future water supply well. The upper section of the hole where characteristics are now known should be cemented off to preclude any leakage to or from overlying aquifers. Equipment should be on hand to take cores as indicated, both by the wire line and core barrel methods. This will be an expensive test and the question of using or not using surface geophysical methods will undoubtedly be considered. If suitable surface geophysical equipment is in country, the additional expense would likely be well justified. If, on the other hand, such equipment along with operating personnel must be contracted out-of-country, the expense of the geophysical investigation could approach the cost of the test well.

5. Conduct isotope studies to determine the age of the water from wells. These studies should provide an additional insight into the volume and mechanism of recharge.

6. Experiment with alternative methods of applying irrigation water, especially those methods that conserve water as, for example, spray and drip irrigation. Research simple and economical methods of lining currently used irrigation distribution ditches.

7. Decide priorities on water use. Obviously domestic, livestock, and municipal water have the highest priorities. This decision recognizes that the ground-water resource is not being replenished as rapidly as it is being used. Once this fact is recognized, industrial use and expanded irrigation take second place.

8. Obtain data on ground water inflow to and outflow from the Amran Basin that is needed to establish a water balance. Data on inflow can likely be obtained by installing observation wells in wadis tributary to the Amran Basin. To obtain information on outflow, several observation wells should be installed in the northeastern end of the valley in order to observe water-level fluctuations near the area where ground water flows out of the basin.

9. Establish the elevation of measuring points of observation wells in relation to land surface and sea level by means of a leveling survey. The water-level contours in this report are based on an altimeter survey of measuring points and accordingly, show only the general trends of ground-water flow and hydraulic gradient. The water-level data will become much more useful when more precise measuring points for wells are established.

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Tables 5 - 7

KEY TO WELL INVENTORY TABLE 5

Well#: numbered serially by areas, but in no specific order within an area.

Location: hwy, Km72; means 72 Kilometers from Sana'a on the Sana'a - Sa'adah highway. Other directions are given from prominent landmarks.

Owner: owner's name, and in parenthesis the name of the well.

Approximate Age: The date when the well was first completed, however, on many wells it is probably the date when first deepened;

- v.old = very old
- d.m.x = deepened many times
- d.s.x = deepened several times
- d.4x = deepened four times
- n.d. = not deepened
- – = no report

Type: kind of well; dug = by hand local labor
drilled; C.T. = cable tool rig
R = rotary, direct method

Total Depth: given in meters; * = not corrected to L.S.D.
Rpt = Reported, Dyn = Dynamic

Depth to Water: given in meters; * = not corrected to L.S.D.

Type of Pump or Method of Lift:
- T = turbine, right-angle drive
- S.P. = electric submersible pump
- 63m = means pump is set to 63 meters depth

Yield: given in liters/second.

Use: use of well; D = domestic and number of persons using
A = agriculture-irrigation and number of square meters irrigated.

Aquifer: type of water bearing rock;
- all. = alluvium
- l.s. = limestone
- basalt = volcanic rock, consolidated
- cal. = calcrete

Date of Inventory: the date when the well was inventoried, two dates, one in parenthesis, means that the well was inventoried twice; measurements made the second time are also in parenthesis.

Remarks: who drilled the well, pumpage, specific conductance, etc.;

SC = 600 @ 21.7	means The Specific Conductance in micromhos/cm at 21.7° Celsius.
WS:	means Wet season, or rainy season
DS:	means Dry season, or times without rains
P:	means Pumpage, or general average of pumpage
h/d,d/w,m/y.	means hours/day, days/week, months/year pumped
n.p.	means not pumped
Water Sample	See table 7 where sample location shows well number; lab ID given here

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic.

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
1.	Qa' Hamudah, E. side of Hamedah vill.	Cooperative (Bir Hamudah)	1972 D. 1 x	Dug	74.4*	61.0*	T.	6.2	D 1500 A 1762m²	Sand	5 Nov. '75	SC=600 @ 21.7°C WS:1.5h/d,7d/w,3m/y DS: " " 9m/y
2.	Qa'Hamudah, 1km W. of Mujahed's house, & 500m W of hwy.	Moh'd Ali Al Molahi (Bir Al Molahi)	1970 D. 6 x	Dug	56.1*	46.4*	T. 51m	3.0	D 500 A 220m²	Alluvium	4 Nov. '75	SC=580 @ 21.1°C WS:15min/d,3d/w,2m/y, DS:4h/d,7d/w,3m/y.
3.	Qa' Hamudah, 800m NW of Bir Kolaby	Haj Ahmed Al Madan (Bir Seran)	1973 –	Dug 0-77.0 Drilled 77.0-117.0 C.T.	117.0* Rpt.	63.2*	T. 87m	11.3	D 50 A 4400	Sand	13 Nov.'75	SC=625 @ 21.7°C WS:- DS:12h/d,7d/w,4m/y.
4.	Qa' Hamudah, N of Al Brar & 2Km S of Mashel	Moh'd Hussein Taher (Bir Jaran)	1973 D. 4 x	Dug	55.9*	47.6*	T. 52.5m	-	D 5-10 A 220	All.	5 Dec. '75	WS: 1h/d,2d/w,4m/y, DS: 2.5h/d,7d/w,8m/y.
5.	Qa' Hamudah, 1.5 Km N of Al Brar	Saleh Mohsin Saeed (Bir Al Basaly or Dhubr)	1972	Dug	63.1*	47.7*	T. 60m	4.5	D 30 A 660	Loam	5 Nov. '75	SC=420 @ 21.7°C WS: 4h/d,3d/w,1m/y. DS: 1h/d,7d/w,5m/y.
6.	Qa' Hamudah, Dahyan village 200m W of hwy. at Km 72.	Moh'd Ali Al Abyad (Bir Al Mehjany)	1969 D. 4 x	Dug	58.6*	52.4*	T.	–	D 500 A 132	All.	4 Nov. '75	WS: 1h/d,7d/w,4m/y. DS: 2-3h/d,7d/w,8m/y.
7.	Qa' Hamudah, 1 Km E of Beit Al Amri & 1.5Km S of Bir Al Sagir	Haj Hussein Al Sheghdri (Bir Dhofran)	1972 D. 2 x	Dug	62.0	54.2	T. 60m	7.6	D 200 A 132	All.	2 Nov. '75	SC: 560 @ 23.9°C WS: 1h/w DS: 1h/d
8.	Q.H. 1 Km NE of Al Brar, 4 Km W of hwy. Km72	Mobkhat Saleh Al Brari (Bir Mobkhat)	1973 d.4x	Dug	61.7	49.6	T. 60m	8.5	D 15 A 1100	All.	4 Nov. '75	SC=500 @ 20.5°C WS: - DS: 8h/d,7d/w,4m/y. Water sample 121916

TABLE 5.--Well inventory data, Auran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
9.	Qa'Hamudah, 1Km W of Al Hamdi well	Hussein Haza (Bir Al Mesali)	old d.m.x.	Dug	66.3	48.7	T. 64.5m	7.6	D few A 1980	All.	27 Oct.'76	SC=410 @ 22.2°C P: 12h/d.
10.	Q.H. Aum Serar, W of hwy & 1Km N of Bir Al Hamdi	Moh'd Saeed Doman (Bir Doman)	1973 d.m.x.	Dug	61.6*	-	T.	3.7	D 200 A 1320	All.	12 Nov.'75	SC=460 @ 21.1°C WS: 1h/d,7d/w,4m/y. DS: 5h/d,7d/w,8m/y.
11.	Q.H. 1.25 Km E of Bir Al Hamdi	Haj Ali Moh'd Sirran (Bir Sirran)	1967 d.m.x.	Dug	37.6	34.7	T.	-	D 400 A 528	Basalt	27 Oct.'75	WS: 15min/d. DS: 6h/d.
12.	Q.H. 2.5 Km SE of Sorbat Village	Moh'd Saleh Seraw (Bir Seran)	1965 d.10 x.	Dug	57.91*	41.81*	T. 55m	-	D 500 A 220	All.	12 Nov.'75	WS:1/2h/d,3d/w,4m/y. DS:1-1/2h/d,7d/w,5m/y.
13.	Q.H. NE of Beit Al Khatony 3 Km W of hwy Km 71	Ahmed Abdullah Al Gobari (Bir Jearan)	1974 d.3 x.	Dug	89.1	53.2	T. 63m	-	D 20 A 748	All.	25 Oct.'76	WS: 6h/d,7d/w,4m/y. DS: 8h/d,7d/w,8m/y.
14.	Q.H. 1Km S of village Meshely & 500m N of Bir Meshely	Nassir Bin Saleh Sa'ad (Bir Al Sultan)	1974	Dug	-	-	T. 66m	-	D 50 A 880	All.	12 Nov.'75	WS: 1-1/2h/d DS: 1/4h/d Deepening at time of inventory
15.	Q.H. Al Ardah, 4Km S of Al Brar village	Cooperative (Ghayl Najla)	-	Natural Spring	-	-	Not improved	very slight	few animals	l.s.	25 Oct.'76	SC=340 @ 15.5°C Reported to be poor quality water.
16.	Q.H. Tiryada, 4Km S of Al Brar	Cooperative (Ghayl Al Rookhah)	-	Natural Spring	-	-	Not improved	very little	few animals	l.s.	25 Oct.'76	SC=370 @ 15.5°C Reported to be poor quality water.
17.	Q.H. 1Km W of hwy, Km 74	Saleh Yahya Askiny (Bir Saleh Yahya Askiny)	1965 d.m.x.	Dug	64.7	43.0	T. 63m	4.7	D 50 A 176	All.& Calcrete	11 Nov.'75	SC=570 @ 21.1°C WS: - DS: 1h/d.

TABLE 5.--Well inventory data, Aaran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
18.	Q.H. Al Keda, N of Al Kolaby village	Ali Ahmed Al Kolaby (Bir Beit Kasim Kolaby)	1973 d.2 x.	Dug	69.2*	68.2*	T.	3.8	D 35 A 176	All.& l.s.	3 Nov. '75	SC=520 @ 21.1°C WS:1-1/4h/d,7d/w,4m/y. DS:3h/d,7d/w,8m/y.
19.	Q.H. Sallei, SW of Hamedah Village	Ali Hussein Al Leheim (Bir Al Leheim)	1962 d.m.x.	Dug	70.5*	59.9*	T. 70m	6.8	D 200 A 660	All.	3 Nov. '75	SC=519 @ 22.2°C WS: 1h/d,7d/w,4m/y. DS: 4h/d,7d/w,8m/y.
20.	Atais Hamedah, 2.5 Km N of Raydah	Shaikh Ahmed (Bir Atais)	1962 Drilled	Dug and Drilled C.T.	48.8*	44.2*	T. 48m	-	D 200 A 440	All.& l.s.	20 Oct.'76	WS: 1h/d,7d/w. DS: 2h/d,7d/w. Old dug well deepened by the Egyptians during the Revolution.
21.	Q.H. E of Beit Al Amri village	Yahya Kaid Al Amri (Bir Al Amri)	1973 d.5 x.	Dug	57.9*	52.9*	T. 55m	6.8	D 40 A 1540	All.& l.s.	2 Nov. '75	SC= 540 @ 20.5°C WS: 1/2h/d,7d/w,3m/y. DS: 8h/d,7d/w,5m/y.
22.	Q.H. 1.5 Km NE of Beit Danep Village	Saleh Ahmed Gofah (Bir Gofah)	1973 d.1 x.	Dug	74.6*	60.4*	T. 72.5m	6.8	D 600 A 220	Sand	10 Nov.'75	SC=490 @ 21.1°C WS: 4h/d,3d/w,3m/y. DS: 1-1/2h/d,7d/w,5m/y.
23.	Q.H. 2 Km S of Huseil village Korysh valley	Moh'd Ahmed Abdullah Ghazi (Bir Ghazi)	1974 d.m.x.	Dug	70.9*	46.0*	T. 67.5m	9.7	D A 4360	All.	12 Nov.'75	SC=400 @ 25.5°C WS: 1/4h/d,7d/w,4m/y. DS: 18h/d,7d/w,4m/y.
24.	Q.H. Near road at Beit Al Amri village, 200m W of Bir Qasim	Moh'd Qasim Al Amri (Bir Moh'd Qasim)	1972 d.m.x.	Dug	55.2	52.9	T.	5.3	D 100 A 1930	l.s.	12 Nov.'75	SC=600 @ 16.7°C WS: 1/4h/d DS: 12-24h/d.
25.	Q.H. 350m E.of Bir Zaid Ali & 500m N of Al Brar Village	Ahmed Abdullah Al Ashwal (Bir Al Ashwal)	1969	Dug	61.5*	-	T.	-	A	All.	23 Jun.'75	P: 4h/d @ 2h intervals.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
26.	Q.H. 1Km N of Beit Al Gahdany village	Ali Saleh Dhaber (Bir Jearan)	-	Dug	65.1*	-	T.	6.2	-	-	28 Oct.'75	SC=450 @ 22.2°C
27.	Q.H. 800m N of Al Brar village	Abdullah Abdan (Bir Abdan)	1973 d.3 x.	Dug	65.6*	50.9*	T. 62.5m	5.2	D 2000 A 352	All.	28 Oct.'75	SC=505 @ 16.7°C WS: n.p. DS: 2h/d,7d/w,6m/y.
28.	Q.H. 300m N. of Beit Al Amri village	Ali Hussein Al Amiry Qasim (Bir Raihan)	1973 d.6 x.	Dug	-	-	T. 63m	-	D 20 A 440	All.	3 Nov. '75	WS: - DS: 3h/d,7d/w,6m/y.
29.	Q.H. 200m N. of Bir Al Lhi	Abdullah Bin Saleh Nasir (Bir Selil)	1971 d.m.x.	Dug	64.0	55.8	T.	2.2	D 6 A 264	-	3 Nov. '75	SC= 540 @ 16.7°C WS: n.p. DS: 2h/d.
30.	Q.H. Al Briar Valley	Cooperative (Bir Al Briar)	Old d.m.x.	Dug	60.8*	55.6*	T.	-	D A 572	All.	27 Oct.'75	WS: - DS: 6h/d,7d/w,8m/y.
31.	Q.H. 600m NW of Beit Kolaby village	Abdullah Saleh Al Kolaby (Bir Al Kolaby)	1972 d.4 x.	Dug	69.5*	58.0*	T.	4.5	D 90 A 264	All.	3 Nov. '75	SC=500 @ 21.1°C WS: 1/4h/d,4d/w,3m/y. DS: 3h/d,7d/w,2m/y.
32.	Q.H. Aq' Sha'ah	Haj Saleh Ismail (Bir Al Haj Salil)	1975 n.d.	Drilled C.T.	120.0* Rpt.	-	T. 120m	17.0	A 4400	l.s.& Basalt	10 Nov.'75	SC=480 @ 22.2°C WS:1h/d,3d/w,4m/y. DS: - Drilled by Al Watary Co.
33.	Q.H. Al Sarah Valley 3 Km E of Hamadah vill.	Abdullah Zin Ahamdy (Bir Abdullah Zin)	1973 d.2 x.	Dug	63.3*	-	T. 60m	-	D 25 A 44	All.	17 Nov.'75	WS: - DS: 1/2h/d,7d/w,8m/y.
34.	Q.H. Merahib Amir valley,2Km S of Misse vill. & N of Al Brar	Yahya Abdullah (Bir Merahib Amir)	1970 d.m.x.	Dug	63.9*	51.5*	T. 60m	-	D 75 A 572	All.	4 Nov. '75	WS: - DS: 6h/d,7d/w,8m/y.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
35.	Q.H. 200m E of hwy, & 500m S of Beit Mujahid	Murshid Bin Moh'd Al Hermeli (Bir Al Hermeli)	1969 –	Dug	61.4*	41.7*	T. 58.75m	–	D 300 A 308	All.	4 Nov. '75	WS: ½h/d. DS: 6h/d.
36.	Q.H. 1.5 Km N of Al Brar, Al A'ala village	Saleh Ahmed Al Cahtany (Bir AlMukram)	1973 d.2 x.	Dug	56.3	54.2	T.	6.8	D A 320	All.	26 Oct.'76	SC=520 @ 19°C WS: n.p. DS: 12h/d.
37.	Q.H. SW of Bir Basale, & 5 Km nearer Brar village	Ali Saleh Taher (Bir Al Jirra #1)	1972	Dug	64.9	60.3	T.	–	–	–	18 Mar.'75	–
38.	Q.H. W of Bir Basale, 500m N of Jirra #1	Moh'd Hussein Jaher (Bir Al Jirra #2)	1974	Dug	54.5	50.2	T. 52.5m	–	–	All.	18 Mar.'75	–
39.	Q.H. Beside the road in Brar village	Haj Ali Al Faqi (Bir Al Faqi Ali)	1971 d.1 x.	Dug	61.0*	55.9* Dyn	T.	4.0	–	All.	23 Jun.'75	SC=520 @ 22.2°C P: 8-10h/d.
40.	Q.H. Aq' Shah, S of Bir Al Awari & N of Bir Ahmed Al Madan	Saleh Ahmed Gufe (Bir Gufe)	1971 d.4 x.	Dug	72.0* Rpt	70.0* Rpt	T.	–	–	Loam	29 Jun.'75	P: ½h/d.
41.	Q.H. S. side of Al Brar village	Saleh Mohsin Al Birari (Bir Basale)	1974 d.m.x.	Dug	58.0	49.1	T. 57m	–	–	–	18 Mar.'75	P: 3h/d @ ½h/intervals
42.	Q.H.	–	1973	Dug	75.0* Rpt	64.6*	T. 72.5m	–	–	–	15 Jan.'75	SC=675 @ 22.2°C P: 2h/d.
43.	Q.H. 750m NW of Bir Mohsin Al Hamadi	Lahein Haza (Bir Marekh)	1973 d.1 x.	Dug	63.7 Rpt	57.8	T. 64m	3.6	–	All.& Basalt	11 Mar.'75	SC= 540 @ 22.2°C P: 12-24h/d.
44.	Q.H. 200m NW of Bir Jahlan	Ali Mohammed Al Faqi (Bir Al Faqi)	1973	Dug	–	65.9	T.	6.8	–	Cal. & All.	22 Jun.'75	SC=495 @ 26.7°C P: 12h/d.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
45.	Q.H. Beit Al Amri, 750m E of Hamada village	Ali Nagi Al Amri (Bir Marhab)	1975	Dug	55.8	-	None	-	-	Silty loam	19 Apr.'75	New well and pump has not been installed
46.	Q.H. W of the hwy, Km 72, 1.25 Km	Moh'd Al Surehe (Bir Surehe)	1974 n.d.	Drilled C.T.	175.0* Rpt	Trace	None	-	-	Loam	10 Jun.'75	Drilled by Al Watary Co. Only a trace of water found.
47.	Q.H. 3Km W of hwy, Km 72.	Ministry of Agriculture (USAID Km 72, or Al Sheikh)	Jun. '75	Drilled R.	244.0	None	None	-	-	Loam	28 Jun.'75	Drilled by USAID/025 Only a trace of water found. Borehole was not developed or cased
48.	Q.H. 350m N of Bir Haj Ali Audhan #2, near Al Brar village	Jahlan Mohsin (Bir Jahlan)	1973	Dug	68.5*	63.6*	T.	-	-	All.	22 Jun.'75	P: 6h/d @ 1h intervals
49.	Q.H. 350m E of hwy, Km 72	Mubajed Abu Shawareb (Bir Mujahed)	1973	Drilled C.T.	173.8 Rpt	-	S.P.	-	-	Loam	25 Jun.'75	-
50.	Q.H. 400m E of Bir Al Hamdi	Ali Hussein Al Malahi (Bir Al Dhar)	-	Dug	-	53.9 Dn.	T.	3.9	-	All.& l.s.	17 Jun.'75	SC=495 @ 21.1°C P: 1h/d.
51.	Q.H. 1.75 Km SW of Hamuda village	(Bir Salil)	1972	Dug	67.2	64.4	T. 65m	-	-	Loam	11 Mar.'75	P: 6h/d, @ 2-3h intervals
52.	Q.H. 750m S of village Museil, 1.5 Km S of Sarbat	Ali Hussein (Bir Ali Hussein)	1973	Dug	68.0* Rpt	66.9*	T.	-	-	All.	17 Jun.'75	P: 3h/d.
53.	Q.H.	Hassan Sa'ad As Sirihy	-	Drilled C.T.	165.9 Rpt	43.9 Rpt	T. 125m	-	-	-	4 Feb. '75	SC=585 @ 23.3°C
54.	Q.H. 350m S of Bir Marekh	Ali Ali Al Atish (Bir Al Atish)	1973	Dug	-	65.9	T. 70m	-	-	All.& Sand	11 Mar.'75	P: 1-1½h/d.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
55.	Q.H. 200m N of Bir Haj Ali Audhan #2.	Saleh Kassim	1975	Dug	-	-	None	-	-	-	22 Jun.'75	-
56.	Q.H. 1Km N of village Brar, & 350m SW of Bir Zira.	Ali Abdullah Al Khubari (Bir Al Khubari)	1974	Dug	55.0	51.6	T.	-	-	All.	18 Mar.'75	SC=515 @ 22.2°C P: 10-12h/d, 45min per time @ 15min intervals
57.	Q.H. 1Km NW of Bir Dhubr, 750m W of Bir Al Hamdi, 500m S of Bir Ghazi	Haj Ali Audha (Bir Qa' Al Sharif or Audha #1)	1974	Dug	55.4	44.2	T. 52.5m	-	-	All.	22 Jun.'75	P: 8h/d; 2h per time @ 1h intervals
58.	Q.H. First well 500m of Brar village SE of Hamda	Haj Ali Audha (Bir Haj Ali Audha #2)	-	Dug	54.2	53.2	T.	-	-	-	22 Jun.'75	-
59.	Q.H. 2 Km SE of Bir Al Hamdi	Hamed Sinan Sirar (Bir Sirar)	1969 d.1 x.	Dug	37.1	34.4	T.	-	-	Basalt	24 Jun.'75	P: ½h/d.
60.	Q.H. 2.5Km W of Hamudi vill.	Shaik Mohsin Al Hamudi	1974	Dug	65.0* Rpt	60.0* Rpt	T.	4.5	-	All.& Basalt	15 Jan.'75	SC=560 @ 22.8°C P: 12h/d.
61.	Q.H. 300m N of Bir Zaid	Kaid Al Lahei (Bir Al Lahei)	-	Dug	66.3 Rpt	53.3 Rpt	T. 65m	-	-	All.	22 Jun.'75	P: 12h/d.
62.	Q.H.	Moh'd S'ad Dhawma Sarubi	1973 n.d.	Dug	71.6	59.1	T.	-	-	-	15 Jun.'74	-
63.	Q.H. 150m W of Bir Yahya, at the base of Beit Al Amri village	Saleh Kassim Al Amri (Bir Kassim)	1974	Dug	62.2*	57.7*	T.	-	-	Loam	24 Jun.'75	P: 3½h/d.
64.	Q.H. 45m W of Bir Moh'd Kassim	Ali Nagi Al Amri (Bir Ali Nagi)	1975	Dug	-	55.7	-	-	-	Calcrete	24 Jun.'75	Well was in the process of deepening at time of inventory.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
65.	Q.H. 700m S of Hamada village	Haj Ahmed Al Amri	Old	Drilled C.T.	151.0* Rpt	-	T.	-	-	All.	23 Jun.'75	P: 12h/d.
66.	Q.H.	Moh'd Said Doum Sabry	1972	Dug	-	45.2	-	-	-	-	15 Jan.'75	-
67.	Q.H. W of hwy, at Km 72.5	Fahd Al Dhabri	-	Drilled	100.0* Rpt	50.0* Rpt	T.	-	-	-	15 Jun.'74	SC=475 @ 23:3°C P: 20h/d.
68.	Q.H. Al Ghola, Al Gusair area, NW of Raydah, Midrik.	Sa'ad Yahya Shaikh (Bir Miare)	1970 d.2 x.	Dug	70.6	-	T. 67.5m	-	D 500 A	-	17 Jun.'75	P: 1½-2h/d.
69.	Q.H. Al Gusair Al Ghola area, N of Km76, abt. 3 km.	Cooperative Al Gusair vill (Bir Al Gusair #3 or Al Ghola #3)	Nov. '75	Drilled R	305.0	(80.1)*	T.	4.1	D	All.& l.s.	17 Nov.'75 (16 May'76)	Drilled by USAID 025 Water sample 121915
70.	Q.H. 100m E of Bir Doumy	Saleh Ahmed Sarhan Al Sabry	1975	Dug	-	-	-	-	-	-	15 Jan.'75	-
71.	Q.H. Brar vill opposite Hamda, only well in center of vill.	Said Yahya & Cooperative (Bir Al Biraren)	old d.m.x.	Dug	65.0	55.6	T.	-	D 400	All.	22 Jun.'75	P: 1-1½h/d.
72.	Q.H. 800m SE of Hamda vill.	Abdullah Hassan (Bir Hassan)	1974 d.1 x.	Dug	-	-	T. 60m	-	-	-	23 Jun.'75	P: ½h/d.
73.	Q.H. 100m S of Al Amri drilled well, 800m S of Hamada village	Yahya Ahmed Al Shagtari (Bir Al Shagtari)	1973	Dug	66.7	54.7	T. 62.5m	-	-	-	23 Jun.'75	P: 8h/d.
74.	Q.H. 300m E of Bir Jahlan, Al Brar village	Zaid Ali Suwid Saleh (Bir Zaid)	1972 d.1 x.	Dug	58.4	52.8	T. 57.5m	-	-	All.	23 Jun.'75	P: 4-6h/d in 2h times @ 2h intervals.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (1/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
75.	Q.H. Beit Dhaneb, 15Km N of hwy, 2.5Km N of Raydah	Moh'd Yahya Al Wari (Bir Al Mahaj)	-	Dug	-	-	None	-	-	Loam	19 Apr.'75	The well is not used
76.	Q.H. 750m SE of Bir Mujahed	Kassim Al Shaybari (Bir Shurari #2)	1965	Dug	44.2	50.0	T.	-	-	Basalt	25 Jun.'75	P: 12-24h/d.
77.	Q.H. Qa' Shab, S of Bir Al Madin, 600m SE of Sha'b Vill.	Tahan Angad Al Shabi (Bir Angad #1) or Ahmed Abdullah Angad (Bir Shadrah)	1974/1975	Drilled C.T.	120.0* Rpt	60.0* Rpt	T. 100m	17.0	D 20 A 4400	All.& Loam	29 Jun.75	SC=595 @ 21.1°C The well was in the process of drilling at time of inventory; Al Watary Co. WS: n.p. DS: 12h/d, 7d/w.
78.	Q.H. Qa' Sha'b 500m S of Sha'b Village	Ahmed Abdullah Angad (Bir Angad #2)	old d.m.x.	Dug	80.0	-	T.	-	D 1500 A 1320	All.	10 Nov.'75	WS: ½h/d DS: 6h/d.
79.	Q.H. 1.75Km SW of Bir Qusair drilled by USAID 025.	Moh'd Saleh Uwayden (Bir Uwayden)	1970	Dug	88.2 Rpt	85.5	T. 87.5m	-	-	Loam	17 Jun.'75	P: 1h/d.
80.	Q.H. 1.5Km SE of Hamda Vill.	Moh'd Sagir Al Hamdi (Bir Al Sagir)	1970	Dug	-	56.6	T.	4.3	A	All.	23 Jun.'75	P: 5h/d.
81.	Q.H. 500m N of Bir Abdau, Beit Brar.	Haj Moh'd Chalib (Bir Chalib #1)	1974	Dug	-	-	T. 67.5m	-	-	All.	23 Jun.'75	P: ½-1h/d. Deepening at time of inventory.
82.	Q.H. 25m N of Bir Ghalib #1	Said Aziz Chalib (Bir Ghalib #2) or Haj Ali Ghalib	1974 d.1 x.	Dug	55.0*	-	T. 54m	-	-	-	18 Dec.'75	-
83.	Q.H. 1.75Km NE of Bir Ghazi	Moh'd Jouney (Bir Al Jouney)	1973	Dug	61.8	61.6	T.	-	-	Loam	25 Jun.'75	P: 5h/d; @ 3h and 1h intervals.

TABLE 5.--Well inventory data, Aaran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
84.	Q.H. 700m N of Brar, 200m N of Bir Al Lahei	Ahmed Musa'ad Al Birari (Bir Al Musa'ad)	1973	Dug	69.0* Rpt	57.5*	T. 64.5m	5.2	–	All. & Loam	22 Jun.'75	SC=495 @ 26.1°C P: 5h/d
85.	Q.H. 1Km NW of Bir Al Bir	Mansoor Saleh Ali (Bir Al Muradain)	1974	Dug	–	–	T. 50m	0.9	–	All.	7 Apr. '75	P: ½h/d.
86.	Q.H. 100m from the hwy.	Moh'd Ali	–	Dug	63.8	61.5	T.	–	D A	Basalt	26 Jan.'77	P: ½h/d.
87.	Q.H.	Saleh Ahmed	1975	Drilled C.T.	150.0* Rpt	–	–	–	–	–	12 Nov.'75	Drilled by Al Sneidar Co. Pump not installed at time of inventory.
88.	Q.H. 200m SE of Bir Ghazi	Hussein Haza (Al Bir)	1974	Dug	59.0 Rpt	58.4 Dyn	T.	–	–	Calcrete	17 Jun.'75	P: 2h/d, @ 1h intervals
89.	Q.H. 3.5Km NW of Raydah Vill. Qa' Sharif.	Saleh Siran (Bir Saleh)	–	Drilled C.T.	120.0* Rpt	–	T.	13.8	–	All.	20 Oct.'76	SC=420 @ 22.0°C
90.	Q.H. 4Km N of Raydah, Majil-lala area	Moh'd Ali Abysed (Bir Moh'd Ali)	v.old	Dug	60.1	53.1	T. not used	–	–	–	19 Oct.'76	Well has not been used since 1974, pump broken
91.	Q.H. Qa' Sharif 2.5 Km NW of Raydah	Moh'd Al Hamdi (Bir Al Hamdi)	1975 n.d.	Drilled	180.0* Rpt	–	T. 132m	9.7	D 20 A 4400	All.	20 Oct.'76	SC=450 @ 21°C WS: 1h/d, 7d/w. DS: 24h/d, 7d/w.
92.	Q.H. Al Thar, 3 Km NW of Raydah	Shaikh Moh'd Saleh (Bir Thar)	1959 d.m.x.	Dug	61.6	46.3	T. 55m	–	D 100 A 880	All.	20 Oct.'76	WS: n.p. DS: 1h/d, 7d/w.
93.	Q.H. S of Muja-hid Shawarb well 1.1 Km E of hwy	Murshed Moh'd (Bir Murshed)	1968	Dug	61.2	42.2	T.	–	–	Loam	25 Jul.'75	P: 5h/d @ 2½h intervals.
94.	Q.H. Al Brar village, W of hwy.	Ali Moh'd Al Brari (Bir Al Malial)	1972 d.2 x.	Dug	61.9*	51.8*	T.	–	D 40 A 352	All.	2 Nov. '75	WS: 1h/d, 5d/w, 4m/y. DS: 5h/d, 7d/w, 8m/y.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
95.	Q.H. 350m N of Bir Al Molahi, 1km W of Mujahid's house.	Moh'd Ali Al Labyedh (Bir Al Labyedh)	1967	Dug	58.5	53.0	T.	–	–	Loam	29 Jun.'75	P: ½-1½h/d.
96.	750m SE of US-AID Kharif #6 well.	Moh'd Ajaser (Bir Ajaser)	1966	Dug	41.0 Rpt	38.4 Dyn	T. 39m	8.5	D 200 A 2200	All. & Basalt	30 Dec.'74	SC=410 @ 23.3°C P: 24h/d.
97.	2km NE of Raydah Village	Kharif area Cooperative (Bir Kharif #6)	Oct. '74	Drilled R	85.4	33.5*	T.	-	D	l.s. & All.	26 Jul.'75	Drilled by USAID/Min. of Public Works.
98.	Majafir, 4Km SE of Raydah, 150m S of Bir Mahat	Moh'd Ali Abdu (Bir Al Majafir)	1972	Dug	33.5	32.0	T.	-	D 250 A 3080	Basalt	28 Apr.'76	WS: n.p. DS: 12h/d,7d/w.
99.	Al Gowahel, E of hwy. Km 65	Ali Ahmed Al Gesamy (Bir Al Gowahel)	1971 d.1 x.	Dug	41.3	36.5 Dyn	T. 37.5m	9.7	D 3 A 2200	l.s.	12 Oct.'75	SC=540 @ 21.1°C WS: – DS: 16h/d,7d/w,10m/y
100.	Awtan Al Sality 100m W of hwy Km64.	Rashid Al Mujahid (Bir Al Sality)	1974 d.2 x.	Dug	44.3	39.0	T. 42m	3.4	A 880	All.	12 Aug.'75	SC=600 @ 20.5°C WS: – DS: 7h/d,7d/w,9m/y.
101.	Qata Al Firna, Suflah, 1.5Km SW of Jubal vill, & 4Km W of hwy.	Abdullah Alalye (Bir Alalye)	1972 d.4 x.	Dug	64.7	59.1	T. 60m	1.9	D 400 A 440	All.	11 Aug.'75	SC=590 @ 22.2°C WS: 3h/d DS: 2h/d.
102.	2Km S of Jubal village & 4Km W of hwy.	Senan Ibn Mokbil (Bir Al Kazo'a)	1971 d.1 x.	Dug	59.6*	55.8*	T.	3.8	D 400 A 704	All.	11 Aug.'75	SC=580 @ 22.2°C P: 12h/d, 7d/w.
103.	Jub Al Suflah, 1.5Km W of hwy 150m N of vill Km64.	Saeed Saleh Ga'rah (Bir Al Hunaish)	1970 d.5 x.	Dug	53.3	41.4	T.	5.7	D 200 A 220	All.	11 Aug.'75	SC=520 @ 21.7°C WS: 4h/d,7d/w,2m/y. DS: 3h/d,7d/w,10m/y.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
104.	Wadi Al Sahyl, 350m NW of hwy, Km64.	Yahya Ibn Abu Shibah (Bir Al Sahyl)	1973 d.1 x.	Dug	43.8*	37.7*	T. 40m	-	A 2640	l.s.	6 Aug. '75	WS: 1-20h/d,2-3d/w, 2-3m/y. DS: 20h/d,7d/w,9-10m/y
105.	Al Suflah, 60m W of hwy, 1.7 Km of Km64.	Saeed Saleh Abu Shaibah (Bir Al Daiah)	1971 d.8 x.	Dug	47.2	38.0	T. 44m	5.7	D 25 A 1320	sand	5 Aug. '75	SC=480 @ 21.1°C P: 16h/d,7d/w.
106.	Jub Al Suflah, S of Raydah, 5 Km W of hwy,Km 64.	(Bir Al Kharigah #1)	1970 d.1 x.	Dug	46.3	42.1	T. 44m	4.3	D 200 A 264	All.	10 Aug.'75	SC=490 @ 21.1°C P: 3h/d.
107.	Jub Al Suflah, 5Km W of hwy Km64.	Dhan Saleh Al Zyadi (Bir Al Kharigah #2)	old d.6 x.	Dug	42.3	41.6	T.	4.3	D 200 A 880	All.	10 Aug.'75	SC=520 @ 21.1°C WS: 11h/d,7d/w,2m/y. DS: 6h/d,7d/w, 6m/y
108.	250m W of hwy, Km 64.	Haj Saleh Al Otmi (Bir Al Daher)	1970 d.m.x.	Dug	46.4	39.8	T.	5.2	D 400 A 66000	All.	13 Aug.'75	SC=600 @ 21.1°C P: 12h/d.
109.	200m W of hwy Km 64.	Ali Sagir Mujahid (Bir Al Sherka)	1970 d.m.x.	Dug	46.6*	38.8*	T. 45m	3.8	D 20 A 1320	All.	12 Aug.'75	SC=580 @ 20.5°C P: 12h/d.
110.	Jub Al Suflah, 100m S of village, 2Km W of hwy, Km 64.	Aiddah Moh'd Al Soraimi (Bir Gahran)	old d.3 x.	Dug	56.3	54.5	T. 55m	5.7	D 100 A 2640	l.s.	11 Aug.'75	SC=490 @ 21.1°C WS: - DS: 7h/d,7d/w,6m/y.
111.	Al Awaid, 800m W of hwy, Km61.	Ahmed Nasir Al Mahjary (Bir Al Anidah)	1972 d.10 x.	Dug	55.2	53.7	T. 50m	-	D 100 A 1100	l.s.	13 Aug.'75	WS: - DS:10h/d,7d/w,9m/y.
112.	Al Dayah vill. 50m W of hwy, Km65.	Hussein Dahan (Bir Hussein Dahan)	1972 n.d.	Dug	44.1	36.3	T. 42.5m	7.6	D 10 A 2200	l.s.	5 Aug. '75	SC=580 @ 21.1°C WS: 13h/d,7d/w,2m/y. DS: 13h/d,7d/w,10m/y.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
113.	Jub, Jabal Yazed, 700m NW of hwy Km65.	Yahya Nasir (Bir Om Sinam)	1971 d.1 x.	Dug	53.4	41.2	T. 50m	7.6	D 25 A 880	All.& l.s.	6 Aug. '75	SC=560 @ 21.1°C WS: 8h/d,7d/w,2-3m/y DS: 8h/d,7d/w,9-10m/y
114.	Helal, 300m S of Jub Al Suf-lah vill, 3Km W of hwy, Km64.	Hussein Moh'd & Moh'd Kassim (Bir Usilan)	old d.1 x.	Dug	53.2	43.9	T. 50m	6.8	D 800	All.	10 Aug.'75	SC=480 @ 21.1°C P: 1-2h/d,7d/w.
115.	Wadi Al Matana, 150m E Juh Al Suflah, 250m W of hwy, Km63.	Abdullah Ahmed Al Shaibah (Bir Al Must-amea)	1974	Dug	48.4*	-	-	-	-	All.	3 Aug. '75	-
116.	Al Ainha, 200m W of hwy, Km64.	Nasher Sa'ad Al Soalah (Bir Al Ainah)	1970 d.1 x.	Dug	43.0	37.7	T. 40m	6.2	D 9 A 1100	All.	13 Aug.'75	SC=620 @ 21.1°C WS: - DS: 13h/d,7d/w,11m/y
117.	Wadi Al Dahdah, 400m SW hwy, Km66, 2.6Km S Raydah.	Abdullah Hizam & Saleh Mohsin (Bir Al Dhah)	1965 d.m.x.	Dug	49.6	37.0	T. 46m	4.0	D 20 A 880	All.& Calcrete	5 Aug. '75	SC=495 @ 21.1°C WS: 12h/d,7d/w,2m/y. DS: 10h/d.
118.	Al Mandar, 500m W of hwy, Km66.	Odah Yahya Al Cosamy(Bir Al Mandar)	old d.4 x.	Dug	49.0*	39.2*	T.	6.8	D 16 A 1760	All.	13 Aug.'75	SC=580 @ 21.1°C P: 17h/d,7d/w,12m/y.
119.	Beit Marhab, 1.2Km NW hwy, Km65, 500m W of Bir Sinam	Hussein Moh'd Mared (Bir Marhab Zaid)	1969 n.d.	Dug	50.2	37.1	T. 43.75m	8.5	D 5 A 1320	All.	6 Aug. '75	SC=600 @ 21.1°C WS: ½h/d,7d/w,3m/y. DS: 15h/d,7d/w,9m/y.
120.	Elaw Al Ga', 5 Km E of hwy,Km 63, 500m S of USAID resthouse	Ali Hussein Dahan (Bir Ganaf)	1972 n.d.	Dug	48.8*	43.1*	T.	-	A 1760	-	18 Oct.'75	WS: 4h/d,7d/w,2m/y. DS: 4h/d,7d/w,10m/y.
121.	Aubdi, 400m E of hwy, Km63.	Moh'd Ali Morfek (Bir Aubdi #1)	1972 d.m.x.	Dug	-	-	T. 45m	-	D 10 A 1760	-	18 Oct.'75	WS: 5min/d. DS: 12h/d.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
122.	100m E of Bir Aubdi #1.	Saleh Moh'd Al Ashwal (Bir Aubdi #2)	1970 d.m.x.	Dug	40.2	37.6	T. 37m	6.2	D 15 A 1760	All.	8 Oct. '75	SC=660 @ 22.2°C WS: ½h/d. DS: 16h/d.
123.	Dehiah, 300m E of hwy, Km64.5.	Saleh Hassan Nasir Al Selah (Bir Dehiah)	1970 n.d.	Dug	42.7	38.8	T. 40m	5.2	A 2200	All.	13 Oct. '75	SC=620 @ 21.1°C WS: - DS: 15h/d,7d/w.
124.	300m E of hwy Km65.	Shaikh Hussein Kaid (Bir Al Jawhil)	1963 d.m.x.	Dug	41.7*	36.1*	T.	-	-	-	13 Oct. '75	-
125.	200m E of hwy Km64.	Saleh Abu Shaibah (Bir Al Howri)	1971 d.1 x.	Dug	40.1*	35.7*	T. 38.75m	8.5	A 22000	All.	13 Oct. '75	SC=600 @ 23.3°C WS: 1h/d. DS: 14h/d.
126.	500m E of hwy Km68.	Abdo Ayash (Bir Al Dhubar)	1974 n.d.	Dug	43.2	35.8 Dyn	T.	9.7	D 55 A 3080	All.	12 Oct. '75	SC=700 @ 23.3°C WS: 1h/d. DS: 12h/d.
127.	500m N of Bir Al Jubi, 500m E of hwy, Km65.	Sa'ad Norei (Bir Merhab Al Tariq)	1972 d.m.x.	Dug	45.9	40.5 Dyn	T. 40m	4.5	D 10 A 1760	All.	16 Sep. '75	SC=620 @ 21.1°C WS: ½h/d. DS: 12h/d.
128.	Makir Al Jahrain, 220m E of Raydah, Km69.	Moh'd Saleh Searan (Bir Searan)	1972 d.5 x.	Dug	-	-	T. 42.5m	-	D 200 A	All.	3 Sep. '75	-
129.	Al Caraig, 1Km E of hwy, Km65.	Ali Saleh Mared (Bir Al Gasum #1)	1968 n.d.	Dug	44.9	36.2	T. 41.6m	5.2	D 30 A 1760	All.	13 Oct. '75	SC=480 @ 21.1°C WS: - DS: 24h/d,7d/w.
130.	Al Kassom, 550m E of hwy, Km66.	Ali Saleh Al Ziady (Bir Al Gasum #2)	1973 d.I x.	Dug	40.8*	33.9*	T. 38.75m	11.3	D 25 A 2640	All.	3 Sep. '75	SC=450 @ 21.1°C WS: 13h/d,7d/w,1m/y. DS: 13-20h/d,7d/w, 11m/y.
131.	Al Juby, Gasum, 1.5Km E of hwy.	Yahya Al Ziadi (Bir Al Gasum #3)	1969	Dug	40.0	34.5 Dyn	T.	8.5	D 200 A 1320	All.	7 Apr. '76	SC=440 @ 21.1°C WS: 2h/d,7d/w. DS: 12h/d,7d/w.

TABLE 5.--Well inventory data, Auran Valley, Yemen Arab Republic - Continued

WELL	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
132.	Al Gasum, 200m E of hwy, Km65.	Shaika Dahaw Dechim (Bir Al Gasum (4)	1968	Dug	41.4	34.4	T. 37.5m	[illegible]	D 25 A 1320	All.	12 Oct.'75	SC=400 @ 21.1°C WS: 1h/d. DS: 12h/d.
133.	800m E of hwy Km66.	Hamid Kaid Al Harmaly (Bir Al Dalah)	1965 d.4 x.	Dug	42.3*	-	T.	6.2	D 24 A 1760	All.	16 Sep.'75	SC=480 @ 23.3°C WS: - DS: 20h/d,7d/w,9m/y.
134.	1.5Km E of hwy, Km62.	Hussein Saleh Al Merani (Bir Al Awasan)	1969 d.6 x.	Dug	45.0*	44.4* Dyn	T. 45m	3.0	D 200 A 330	Basalt	22 Sep.'75	SC=590 @ 21.1°C WS: - DS: 22h/d,7d/w,9m/y.
135.	Bargogah, 5 Km E of hwy, Km60.	Hussein Ali Mokbil (Bir Bargogah)	1970 n.d.	Dug	60.0*	48.5*	T. 56.25m	-	D	Basalt	20 Oct.'75	Reported that the well contains only a small amount of water.
136.	300m E of hwy, Km63.	Abdallah Mohsin Al Faqih (Bir Sha'abah)	1970 d.6 x.	Dug	41.4*	36.7*	T. 40m	3.3	D 3 A 1100	All.& Calcrete	19 Oct.'75	SC=480 @ 20.5°C WS: 6h/d,1d/w. DS: 12h/d,7d/w,5m/y.
137.	Jaub Moharith, 1 Km E of hwy, Km64.	Yahya Mohsin Salab (Bir Salab)	1971 d.3 x.	Dug	41.4*	40.1* Dyn	T.	8.5	D 60 A 2200	All. & Calcrete	19 Oct.'75	WS: 7h/d,4d/w,2m/y. DS: 16h/d,7d/w,5m/y.
138.	Dahr Nesair, 300m E of hwy, Km63.5.	Saleh Hussein Aziyadi (Bir Al Dahr)	1971 d.7 x.	Dug	[illegible]	[illegible]	T. 40m	6.8	D 10 A 1320	All.	19 Oct.'75	WS: 4h/d,1d/w,3m/y. DS: 12h/d,7d/w,6m/y.
139.	Al Dahr, 200m E of hwy, Km64.	Saleh Moh'd Ga'arah (Bir Ga'arah)	1971 d.4 x.	Dug	42.4*	40.6* Dyn	T. 42.5m	7.6	D 8 A 1760	All.	18 Oct.'75	SC=500 @ 21.1°C WS: 6h/d,3d/w,3m/y. DS: 14h/d,7d/w,9m/y.
140.	4Km E of hwy, Km60, 500m of Bir Al Monady.	Nasir Ali At Tami (Bir Medha)	1970 d.m.x.	Dug	45.9*	37.3*	T.	-	D A	All.	23 Sep.'75	WS: ½h/d. DS: 6h/d.
141.	4Km E of hwy, Km60.	Reshid Bin Hussein At Tami (Bir Al Monady)	1968 d.4 x.	Dug	56.5*	45.7*	T. 56.25m	5.7	D A	All.& Calcrete	23 Sep.'75	SC=620 @ 21.1°C WS: - DS: 12h/d,7d/w,9m/y.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
142.	500m SW of Menjidah village, 4 Km E of hwy, Km64.	Cooperative (Bir Menjidah #2).	Oct. '75	Drilled R.	143.3	(46.4)*	None	14.5	-	l.s.	10 Oct.'75 (1 Sep.'76)	Drilled by USAID/025 for exploration, turned over to village for domestic use, pump not installed at time of inventory. Water Sample 121901
143.	Qa' Agebat, 400m E of hwy, Km60.	Moh'd Yahya Al Saraimy (Bir Agebat)	1970 d.4 x.	Dug	46.3*	45.2*	T.	-	D 18 A 1100	All.	15 Sep.'75	WS: - DS: 12h/d,7d/w,9m/y.
144.	Al Segaiah, 30m E of hwy, Km62.	Aidah Diss (Bir Al Segaiah)	old d.m.x.	Dug	44.8*	43.8*	T.	5.2	D 13 A 1320	All.	18 Aug.'75	SC=420 @ 21.1°C WS: - DS: 22h/d,7d/w,9m/y.
145.	3Km E of hwy, Km 63, 100m E of Al USAID resthouse.	Ali Ahmed Al Mongedy (Bir Elau Al Ga'a)	1972 d.1 x.	Dug	43.7*	39.3* Dyn	T. 40m	4.0	D 9 A 1540	All.	15 Sep.'75	SC=490 @ 21.1°C WS: - DS: 24h/d,7d/w,9m/y.
146.	Al Menjidah, 8 Km E of hwy Km 63.	Ahmed Hamid (Bir Al Zilah)	1969	Dug	38.3*	36.0*	T.	-	D 20 A 1760	-	19 Sep.'75	WS: 16h/d,6d/w,3m/y. DS: 18h/d,7d/w,9m/y.
147.	Al Menjidah, 300m E of USAID resthouse.	(Bir Saleh)	-	Dug	47.8*	39.2* Dn.	T.	5.7	-	-	9 Sep. '75	SC=550 @ 21.1°C
148.	Al Arar, 150m E of hwy, Km 61.5m.	Moh'd Abdullah Morafik (Bir Al Arar)	1973	Dug	38.2*	-	-	-	-	Basalt	11 Aug.'75	-
149.	Jenah, 1Km E of hwy, Km60.	Nasir Monassir (Bir Jenah)	1968 d.m.x.	Dug	46.4	42.0	T. 45m	-	D 250 A 980	All.	20 Oct.'75	WS: 1h/d. DS: 12h/d.
150.	Seed, 500m E of hwy, Km61.	Mugbil Thais (Bir Seed)	1970 d.m.x.	Dug	44.9	44.3	T.	-	D 35 A 1100	Basalt	20 Oct.'75	WS: ½h/d. DS: 12h/d.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
151.	Menjidah, 1Km E of hwy, Km64.	Shaikh Abdullah Bin Hussein Al Akhmar (Bir Merhab)	1970	Dug	46.2*	38.0* Dn.	T.	7.6	-	-	16 Sep.'75	SC=610 @ 21.1°C WS: ½h/d. DS: 12h/d.
152.	Ga'a Jaub, 5Km E of hwy, Km63, 500m N of USAID resthouse.	Abdullah Akbah (Bir Abdullah)	1973 n.d.	Dug	52.2*	37.9*	T. 45m	9.7	D 4 A 1760	-	17 Sep.'75	SC=500 @ 21.1°C WS: 1h/d,2d/w,3m/y. DS: 16h/d,7d/w,9m/y.
153.	Al Awasej, 6Km E of hwy, Km61.	Ali Moh'd Al Jehrani (Bir Al Jehrani)	-	Dug	49.1	39.7	T. 45m	-	D 4	-	23 Sep.'75	-
154.	Al Dahr, 200m E of hwy, Km64.	Saleh Sagir Al Mujahed (Bir Al Dahr)	1970 n.d.	Dug	42.1	37.4	T. 37.5m	5.2	D 3 A 1760	All.	17 Sep.'75	SC=620 @ 21.7°C WS: ½h/d. DS: 12h/d.
155.	Menjidah, 3Km E of hwy, Km63, 500m N of USAID House.	Mebkat Sa'ad Serhan (Bir Al Zilah)	1968 n.d.	Dug	42.8	38.4 Dn.	T.	7.6	D 25 A 2640	All.& Basalt	17 Sep.'75	SC=600 @ 18.3°C WS: 3h/d,2d/w,3m/y. DS: 14h/d,7d/w,9m/y.
156.	Menjidah, 50m S of USAID house, 3Km E of hwy, Km63.	Saleh Manea (Bir Jereb Badi)	1971 d.m.x.	Dug	44.2	-	T. 42.5m	4.9	D 30 A 1760	All.& Calcrete	24 Feb.'76	SC=575 @ 21.1°C WS: n.p. DS: 16h/d.
157.	Al Eiana, 2Km E of hwy, Km60.	Hussein bin Hussein Al Montaser (Bir Al Eiana)	1970 d.m.x.	Dug	53.2	43.0	T. 47.5m	-	D 200 A 1760	All.	20 Oct.'75	WS: ½h/d. DS: 12-14h/d.
158.	2Km E of hwy, Al Juby.	Shaikh Ahmed (Bir Atheya)	-	Dug	-	-	T. 34m	5.2	D 30 A 880	-	5 Apr. '76	SC=370 @ 22.2°C WS: n.p. DS: 12h/d,7d/w.
159.	Al Juby, 1.25Km E of hwy.	Saleh Hamid Atawil (Bir Aniz)	1971 d.l x.	Dug	-	-	T. 37.5m	6.8	D 20 A 1320	All.	7 Apr. '76	SC=460 @ 22.2°C WS: n.p. DS: 12h/d,7d/w.

TABLE 5.--Well inventory data, Aaran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
160.	500m E of Raydah Sa'a.	Yahya Abdullah Al Gazy (Bir Al Gainda'a)	1965 d.m.z.	Dug	39.6*	31.5*	T.	-	A 1320	All.	15 Sep.'75	DS: 13h/d,7d/w,10m/y.
161.	Market Site,200m S of Bir Al Ban-et, Raydah.	Al Haj Mujahid (Bir Marhab Gagshar)	1971 d.m.x.	Dug	35.1	31.8 Dyn	T. 32.5m	9.7	D 20 A 1760	All.	25 Apr.'76	SC=410 @ 25.5°C WS: - DS: 12h/d,7d/w.
[illegible]	3Km E of Raydah, Beit Al Jibra.	[illegible] Marmil (Bir Marmil)	1972	Dug	55.2	53.1	T. Two pumps	6.8 x 2 = 13.6	D 1000 A 8800	Basalt	17 Oct.'76	SC=360 @ 18°C WS: - DS: 24h/d,7d/w.
[illegible]	Beit Harash, 2 Km E of Raydah.	Saleh A. Abdullah (Bir Al Hodigi)	1971	Dug	54.9*	43.6*	T. 45m	-	D A	Basalt & All.	17 Oct.'76	DS: ½h/d.
164.	[illegible] Ayash, 500m N of Raydah	Al Haj Moh'd Ayash (Bir Beit Ayash)	1964 d.m.x.	Dug	43.9*	39.5* Dyn.	T. 47m	3.8	D A 1100	Basalt & All.	17 Oct.'76	SC=440 @ 20°C WS: 1h/d,7d/w. DS: 17h/d,7d/w.
165.	Al Mahatah, 1Km [illegible] of Raydah, 200m S of Bir [illegible]	Saleh Moh'd (Bir Al Mahatah)	1971 d.5 x.	Dug	41.8*	33.3*	E. 35m	5.7	D 100 A 748	All.	9 Sep. '75	SC=400 @ 25.5°C WS: 9h/d,7d/w,1m/y. DS: 10h/d,7d/w,11m/y.
[illegible]	Al Mahatah	Nabit Makbil (Bir Al Meram)	1960	Dug	42.1*	[illegible]	T. 40m	7.6	D 30 A 1760	All.	10 Sep.'75	SC=490 @ 22.2°C WS: 12h/d,7d/w,2m/y. DS: 18h/d,7d/w,10m/y.
167.	[illegible] of Raydah	Saleh Al Roshidy (Bir Al Moktabia)	1970 d.1 x.	Dug	41.3*	33.2*	T. 40m	5.7	-	All.	9 Sep. '75	SC=400 @ 21.7°C WS: 2h/d,7d/w,2m/y. DS: 3h/d,7d/w,10m/y.
[illegible]	300m E of Raydah [illegible] School.	Saleh Abdullah Seran (Bir [illegible])	1960	Dug	46.5*	33.2*	T. 45m	4.5	D 200 A 1320	L.s.& All.	17 Sep.'75	SC=441 @ 21.7°C WS: ½h/d,7d/w,2m/y. DS: 12h/d,7d/w,10m/y.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
169.	6Km E of Raydah Al Sera.	Thabet Harmel (Bir Al Sera)	1960	Dug	55.0*	-	T. 52.5m	5.0	D 125 A 3080	Basalt	9 Sep. '75	SC=380 @ 22.2°C WS: 16h/d,7d/w,3m/y. DS: 16h/d,7d/w,9m/y.
170.	Qa' Shams, 21Km NE of Raydah.	Abdu Ali Ibn Zaid (Bir Soudan)	1971	Drilled C.T.	175.0* Rpt	-	S.P.	-	D 3000 A 1760	l.s.	7 Sep. '75	WS: 9h/d,7d/w,8m/y. DS: 18h/d,7d/w,3m/y.
171.	Dhibin area, 1Km S of Dahyan.	Faiz Aziz (Bir Faiz)	1969 d.m.x.	Dug	-	-	T. 54m	6.2	D A	All.	27 Jul.'75	P: ½h then wait ½h-1h to recover.
172.	Qa' Al Babr, E of Jub.	Ali Saleh Al Shabadani	1974 d.1 x.	Dug	43.9*	39.5*	T. 43m	5.7	D 40 A 528	All.	12 Aug.'75	SC=510 @ 21.1°C WS: 3-4h/d,5d/w. DS: 3-4h/d,7d/w.
173.	Jub, S of Raydah	Yahya Saleh Gara (Bir Gara)	1970 d.m.x.	Dug	-	-	T. 52.5m	-	D 400 A 440	-	10 Aug.'75	WS: 3h/d. DS: 3h/d.
174.	Qa' Menjadah, Ali Asfal,250m W of Bir Al Hadhyer, 1Km E of hwy.	Shaikh Abdullah Al Ahmer (Bir Al Bardah)	1973	Dug	38.1*	36.2*	T.	-	D 6 A 3080	All.	16 Sep.'75	WS: - DS: 12h/d,7d/w,9m/y.
175.	Khawgan, 600m S of Bir Al Shagof	Ahmed Saleh Ahmed (Bir Al Mahd)	1971 d.4 x.	Dug	37.5*	31.3*	T.	5.7	D 100 A 2420	All.	8 Sep. '75	SC=415 @ 22.8°C WS: ½h/d,7d/w,2m/y. DS: 24h/d,7d/w,10m/y.
176.	2Km E of hwy.	Ali Ghanim Al Wahli (Bir Al Shagof)	1960 d.2 x.	Dug	46.2	31.7	T. 32.5m	8.5	D 24 A 2200	All.	18 Sep.'75	SC=440 @ 21.7°C WS: ½h/d,7d/w,2m/y. DS: 22h/d,7d/w,10m/y.
177.	Al Basc, E of hwy, 500m S of Bir Al Shamy	Abdullah Yahya (Bir Al Sadah)	1971 d.1 x.	Dug	32.1*	30.2*	T. 31.25m	6.2	D 42 A 2640	Basalt	8 Sep. '75	SC=380 @ 23.9°C WS: 20h/d,7d/w,2m/y. DS: 20h/d,7d/w,10m/y.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
178.	Aniz area, 600m S of hwy.	Ali Yahya Al Tawil (Bir Al Tawil)	1969 d.5 x.	Dug	38.7*	32.3*	T.	6.8	D 30 A 1232	All.	3 Sep. '75	SC=520 @ 21.1°C P: 10h/d,7d/w.
179.	Sadal area, 2Km E of hwy.	Moh'd Abdu Al Gabry (Bir Al Gabry)	1971 d.1 x.	Dug	36.7*	29.9* Dyn	T.	7.6	D 20 A 2200	Basalt & All.	7 Sep. '75	SC=380 @ 22.2°C WS: 8h/d,7d/w,3m/y. DS: 16h/d,7d/w,9m/y.
180.	3.25Km SE of Raydah.	Saleh Mokbil (Bir Al Jadha)	1970 d.1 x.	Dug	-	-	T.	-	D 200 A 2200	l.s. & All.	4 Apr. '76	SC=400 @ 23.3°C WS: 12h/d,7d/w. DS: 18h/d,7d/w.
181.	Al Diah, S of Raydah, 200m E of hwy, Km67.	Moh'd Nagi Al Khom (Bir Al Khom)	1974	Dug	38.2*	31.4*	T. 38m	13.6	A 1760	All.	15 Sep.'75	SC=490 @ 21.1°C WS: - DS: 22h/d,7d/w,9m/y.
182.	Al Matrah, 1Km E of Raydah	Yahya Moh'd Nasir (Bir Ramah)	1963 d.m.x.	Dug	46.8	30.2	T. 45m	-	D 200 A 2200	All.	14 Sep.'75	WS: 3h/d. DS: 6h/d.
183.	Al Sufan, 3Km S of Raydah, 500m SW of Bir Al Jabri.	Yahya Bin Yahya Al Shami (Bir Al Shami)	1964 d.m.x.	Dug	36.8	29.0 Dyn	T. 36m	8.5	D A 660	All.	8 Sep. '75	SC=390 @ 22.2°C P: 6h/d.
184.	3Km NE of Raydah.	Hussein Ibn Hadi (Bir Athuber)	1975	Dug	-	32.3	T. 42m	6.2	D 50 A 1320	All.& Calcrete	4 Apr. '76	SC=340 @ 21.1°C WS: - DS: 15h/d,7d/w.
185.	Al Hasine, 300m SW of Raydah.	Ali Dohan Thabit (Bir Al Washi)	1972	Dug	37.5*	31.6* Dyn	T. 36m	7.6	D A 2200	Basalt	25 Apr.'76	SC=415 @ 25.5°C WS: - DS: 5h/d.
186.	Al Makir, 280m NE of Raydah.	Nagi Atash (Bir Al Makir)	1962 d.3 x.	Dug	39.6*	31.9*	T.	9.7	D 1000 A 2200	All.	11 Nov.'75	SC=490 @ 22.2°C WS: ½h/d,7d/w,3m/y. DS: 21h/d,7d/w,4m/y. Water Sample 121905

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
187.	Kharif, 3Km E of Raydah	Saleh Abdullah Al Hodaiki (Bir Al Hodai-ki).	1970 d.m.x.	Dug	53.6*	36.9*	T.	17.0	D 200 A 44	Basalt	11 Nov.'75	SC=380 @ 21.1°C WS: ½h/d,1d/w,4m/y. DS: ½h/d,7d/w,8m/y.
188.	W side of hwy 2Km N of Km64.	Muflih Ga'arah (Bir Al Dayah)	1972	Dug	45.3	36.9	T. 42.5m	8.5	D 30 A 1980	All.	8 Jul. '75	SC=480 @ 21.1°C WS: 1-3h/d,2-3m/y. DS: 15h/d,7d/w,9-10m/y.
189.	Al Diah, 200m E of hwy, Km66.	Nasir Ali Kos-allan (Bir Beit Al Rag-awy).	1971 d.7 x.	Dug	51.3*	34.2*	T. 50m	3.4	D 100 A 880	All.	3 Sep. '75	SC=480 @ 21.1°C WS: 1h/d,7d/w,1m/y. DS: 8h/d,7d/w,11m/y.
190.	150m NE of Iraqi well #1, Raydah	Moh'd Saleh	1971	Dug	41.7	35.5	T.	-	-	-	21 Dec.'74	-
191.	1Km S of Raydah, W side of hwy.	Abdullah Hizam & Saleh Mohsin (Bir Al Dhea#1)	1967	Dug	46.0	-	T. 46m	3.8	-	All. & Calcrete	19 Mar.'75	P: 6-8h/d.
192.	2Km S of Raydah, W side of hwy.	Sa'ad Saleh Abu Shebe (Bir Al Dhea #2)	1971	Dug	46.7	-	T. 32m	2.8	D A	Loam	19 Mar.'75	SC=540 @ 23.3°C P: 6h/d; 2½h/time @ ½h intervals.
193.	4Km S of Raydah, W side of hwy.	Sa'ad Saleh Garee (Bir Al Dhea #3)	1973	Dug	45.4	-	T. 45m	5.0	-	Sand	19 Mar.'75	SC=475 @ 22.8°C P: 12h/d.
194.	350m SE of well Iraqi #2, Raydah	-	1970	Dug	45.0	39.2	T.	3.1	-	All.	21 Dec.'74	SC=430 @ 23.3°C P: 2-3h/d.
195.	Shebari village, NE of Raydah.	Shaikh Ali Saleh Shebari (Bir Shebari)	old	Dug	-		T.	4.0	D 500 A 660	Basalt	18 Dec.'75	SC=447 @ 24.4°C USAID/025 observation well. Water sample 121902
196.	Al Menjedah	Hussein Ali Ash Shaby	-	Dug	-	None	None	-	-	Basalt	5 Mar. '75	The well was abandoned b/c there was not water

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
197.	Arhab area, N of Kharif.	Hussein Mohsin Al Qatwany	-	Dug	54.6	53.7	T.	-	-	-	20 Jan.'75	P: 23½h/d.
198.	3Km E of hwy, Km 63, next to USAID resthouse.	Yahya Bin Yahya (Bir Al Qa')	1971	Dug	-	-	T. 42m	4.7	D 20 A 2200	All.	4 Sep. '77	SC=560 @ 29°C WS: 6h/d,7d/w,6m/y. DS: 12h/d,7d/w,6m/y. Water sample 121914
199.	Qa' Al Auben, 2.5Km E of hwy Km56, 2Km N of Al Dhuber well.	Haj Hadi Saleh (Bir Al Dhuber)	1970 d.m.x.	Dug/ Drilled C.T.	Dug 0-55.0 Dr. 55-105.0 Rpt	51.0 Rpt	T. 52.5m	6.2	D 300 A 1100	All.	8 Mar. '76	SC=560 @ 22.2°C WS: - DS: 12h/d.
200.	Qa' Agabat, 200m E of hwy,Km58.5	Ali Hussein Al Suraime (Bir Badah)	1969 d.m.x.	Dug	59.1	-	T. 57m	5.2	D 30 A 1100	All.	15 Sep.'76	SC=600 @ 21.1°C WS: 6h/d,3d/w,2m/y. DS: 22h/d,7d/w,10m/y. Water Sample 121906
201.	Al Hedaly, 200m E of hwy, Km57.	Ahmed Moh'd Al Ciny (Bir Al Hedaly)	1974 d.3 x.	Dug	55.1	48.1	T. 52.5m	-	D 60 A 2200	All.	26 Aug.'75	DS: 12h/d,7d/w,6m/y.
202.	Al Mukazek, 30m E of hwy, Km56.	Shaikh A'yah Ahmed (Bir A'yad).	1969 d.m.x.	Dug	52.9	47.8	T. 47.5m	-	D few A 26400	All.	26 Aug.'75	SC=595 @ 21.7°C P: 24h/d, possible.
203.	1Km E of hwy, Km66.	Min. of Agr. (Bir Raydah Middle #1)	May '76	Drilled R	305.0	(32.9)	None	-	-	Basalt	May 1976 (6Feb. '78)	Drilled by USAID/025.
204.	1Km E of hwy,Km 66, 25m N of Raydah Middle #1	Min. of Agr. (Bir Raydah Middle #4)	Feb.'78	Drilled R	184.5	32.9	None	-	-	Basalt	12 Feb.'78	Drilled by USAID/025. Water Sample 121910
205.	2Km SE of Raydah Village	Min. of Agr. (Bir Raydah South #1)	Feb.'76	Drilled R	61.0	30.04	None	-	-	All.	11 May '77	Drilled by USAID/025.
206.	2Km SE of Raydah Village & 30m S of Well #1.	Min. of Agr. (Bir Raydah South #2)	Mar.'76	Drilled R	61.0	29.9	None	-	-	All.	24 Jan.'77	Drilled by USAID/025.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL NO.	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
[illegible]	2Km SE of Raydal Village, & 30m E of Wells #1 and #2.	(Bir Raydah South #3) Min. of Agr.	Aug.'77	Drilled R	61.0	30.4	None	-	-	All.	22 Aug.'77	Drilled by USAID/025 Water Sample 121903
208.	1.5Km E of hwy, Km54.	(Bir Warehouse #1) Ministry of Agriculture	June'76	Drilled R	305.0	43.0	None	-	-	All.& Basalt	6 Jul. '77	Drilled by USAID/025
[illegible]	1.5Km E of hwy, Km64 & 30m S of Well #1	Min. of Agr. (Bir Warehouse #3)	Apr.'77	Drilled R	125.0	42.7	None	-	-	All.& Basalt	6 Jul. '77	Drilled by USAID/025 Water Sample 121908
210.	Diah Al Sawadin 2Km W of hwy, Km58.	Al Haj Hussein Al Tomis	1972 d.l x.	Dug	57.0	48.2	T. 52.5m	3.4	D 200 A 2200	All.	27 Aug.'75	DS: 14h/d,7d/w,9m/y
211.	Sarat Al Isharef, 1Km W of hwy, Km58	Moh'd Saeed Al Khawi (Bir Al Khawi)	1967 d.3 x.	Dug	58.1	50.1	T. 55m	3.4	D 10 A 26400	All.& l.s.	18 Aug.'75	SC=600 @ 21.7°C DS: 14h/d,7d/w,9m/y.
212.	Al Remah, 1Km E of hwy, Km 57.5m	Hussein Mohsin Al Godwani (Bir Al Remah)	1973 d.l x.	Dug	54.9*	47.6* Dyn	T. 53.75m	8.5	D 30 A 1980	All.	21 Oct.'75	SC=600 @ 21.7°C WS: ½h/d,7d/w,1m/y. DS: 18h/d,7d/w,4m/y.
213.	Al Tebuhan, 3Km E of hwy Km57.4	Resam Yahya Hujeira (Bir Hujaira)	1975	Dug	50.1	47.4	T. 51m	-	D A	All.	21 Oct.'75	The well was in the process of deepening at the time of inventory
214.	Bad'ah, 4Km E of hwy, Km58.	Haj Hussein Jubi Baderdin (Bir Al Jubi)	1974 n.d.	Drilled C.T.	96.0* Rpt	-	T. 70m	-	A 4400	Sand & Basalt	11 Nov.'75	WS: n.p. DS: 14h/d,7d/w,3m/y. Drilled by Al Watary Co.
[illegible]	1Km E of hwy, Km58.	(Bir Al Jubi or Km58) Min. of Agr.	Jun.'75	Drilled R	103.7	45.6	None	-	-	Sand & All.	17 Dec.'75	Drilled by USAID/025 for testhole.
[illegible]	2Km NE of hwy, Km57.	Ayola Bin Ali (Bir Biqwan)	1974 d.s.x.	Dug	60.5	50.2 Dyn	T. 57.5m	-	D,A	All.	27 Aug.'75	P: 12h/d

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
217.	2.5Km W of hwy, Km58.	Moh'd Ali Al Bony (Bir Al Soud)	1973	Dug/Drilled C.T.	Dug 62.5 Drilled 62.5-115.0* Rpt	51.2*	T. 75m	9.7	D 400 A 3520	l.s. & All.	27 Aug.'75	SC=600 @ 21.7°C WS: n.p. DS: 23h/d,7d/w,9m/y. Dug well deepend by Al Watary Co.
218.	2.5Km W of hwy, Km57.	Abdullah Hussein Al Itim (Bir Mounjed)	old	Dug/Drilled C.T.	Dug 0-65.0 Drilled 65.0-116.0 Rpt.	51.2	T. 90m	-	A 880	l.s.	1 Sep. '76	P: 4h/d,7d/w,9m/y. Dug well deepened by Al Watary Co.
219.	4Km W of hwy, Km56, 1Km S of village Dhebai	Sinan Jamil (Bir As Saura)	1962 d.m.x.	Dug/Drilled C.T.	Dug 0-60.0 Drilled 60.0-142.0 Rpt	46.2	T. 90m	-	A	All.	8 Mar. '76	Dug well deepened by Al Watary Co.
220.	10m E of hwy Km56, Al Dhubar area	Shaikh Fathal (Bir Fathal)	-	Drilled C.T.	100.0 Rpt	58.0 Rpt	T.	11.3	-	-	11 Nov.'75	SC=610 @ 21.1°C P: 12-24h/d. Drilled by Al Watary Co.
221.	1.4Km E of hwy, Km57, Al Serar area.	Yahya Kaid Shareb (Bir Shareb)	1974 d.l x.	Dug	57.3*	53.3*	T. 55m	5.7	D 500 A 1540	All.	21 Oct.'75	SC=695 @ 21.7°C WS: 4h/d,2d/w,2m/y. DS: 12h/d,7d/w,7m/y.
222.	4Km E of hwy, Km59.5.	Shara' Ali Mohsin Al Raboa 'i (Bir Joja'a)	1971 d.3 x.	Dug	46.3*	45.3*	T. 45m	13.6	D 2000 A 3300	Basalt	20 Oct.'75	SC=645 @ 17.8°C WS: 6h/d,2d/w,3m/y. DS: 22h/d,7d/w,6d/y.
223.	1.4Km E of hwy, Km57, Al Serar area.	Hofid Saleh Al Hofidy (Bir Al Hofidy)	1974 d.l x.	Dug	56.4*	52.5*	T. 55m	5.7	D 1000 A 1760	All.	21 Oct.'75	SC=690 @ 21.1°C WS: 2h/d,3d/w,2m/y. DS: 14h/d,7d/w,3m/y.
224.	2Km W of hwy, Km57, Serret Al Asharaf area.	Yahya Nasir (Bir Yahya Nasir)	1974	Dug	54.2	48.2	T. 52.5m	-	-	All.	27 Aug.'75	P: ½h/d. Well was being deepened at time of inventory.
225.	Badat Jub, W side of hwy, Km58.3.	Haj Abdullah Bedreddin (Bir Bedreddin #1)	1975	Drilled C.T.	82.4	47.1	T. 60m	17.3	D A 132000	Sand	13 Aug.'75	SC=560 @ 21.7°C P: 12h/d. Drilled by Al Watary Co.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
226.	Badat Jub, W side of hwy, Km58.6	Haj Abdullah Bedreddin (Bir Bedreddin #2)	1975	Drilled C.T.	-	-	T.	-	-	-	6 Apr. '75	Drilled by Al Watary Co.
227.	Merhab al Jub, 300m W of hwy, Km59.5.	Nagi Abdullah Al Mahjary (Bir Al Mahjary)	1974 d.m.x.	Dug	64.2	45.9	T. 63m	3.5	D 150 A 880	All.	18 Aug.'75	SC=400 @ 21.1°C P: 12h/d.
228.	Marhab Al Jub, 300m W of Bir Mahjary, 600m W of Km59.5.	Sa'ad Saleh (Bir Al Anda)	1975 n.d.	Drilled C.T.	115.0* Rpt	-	T. 93m	5.8	D 150 A 1320	All.	18 Aug.'75	SC=440 @ 21.1°C P: 12h/d. Drilled by Al Watary Co.
229.	600m W of hwy, Km59.	Abdullah Al Ceny (Bir Al A'nedah)	1973 d.6 x.	Dug	65.1*	49.9*	T. 65m	5.8	A 880	All.	18 Aug.'75	SC=500 @ 23.9°C P: 12h/d,7d/w.
230.	500m W of hwy, Km59.	Moh'd Haza Al Ceny (Bir Al Safya)	1974 d.1 x.	Dug	53.5	46.9	T. 50m	-	D 4 A 2200	-	18 Aug.'75	P: 24h/d,7d/w.
231.	W side of hwy, Km58.	Shaikh Abdullah Bedreddin	old	Dug	45.8	30.2	T.	3.0	-	-	31 Oct.'74	SC=580 @ 22.2°C.
232.	E side of hwy, Km56.3.	Shaikh Alyth Al Sawadya (Al Shaikh Alyth)	1969 d.5 x.	Dug	-	46.2 Dyn	T.	-	-	-	28 Dec.'74	P: 12h/d.
233.	Kenah area, 1Km W of hwy, 500m NE of Al Mahjar Village.	Ali Senan (Bir al Daik)	1974 d.1 x.	Dug	67.0*	59.3*	T. 65m	4.5	D 200 A 1760	All.	13 Aug.'75	SC=500 @ 21.7°C P: 16h/d,7d/w.
234.	W side of hwy, Km56.2	Saleh Hussein Suhail (Bir Al Sebil)	1970	Dug	(38.1)	(32.9)	T. 39m	8.5	D A 2640	All.& l.s.	25 Jan.'76 (22Jul.'75)	SC=640 @ 21.7°C WS: n.p. DS: 12-24h/d.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
235.	Batn Al Serah, 600m W of Hwy, Km54.	Hizam Jamil (Bir Batn Al Serah).	1972	Dug/Drilled C.T.	87.9*	39.3*	T. 75m	13.6	A 3960	All.& Basalt	2 Sep. '75	SC=560 @ 23.3°C P: 15h/d,7d/w,2m/y.
236	[illegible]m N of Al Jannat.	Moh'd Agebat (Bir Omaisha)	v.old d.m.x.	Dug	48.7	-	T. 38m	6.8	D 50 A 2200	All.	3 Feb. '76	SC=625 @ 22.2°C DS: 12-24h/d.
237.	Sherara, 500m W of Hwy, Km59.	Haj Ahmed Al Zubair (Bir Al Zubair #1)	v.old d.m.x.	Dug	36.1	33.6	T. not working	-	-	-	2 Feb. '76	The well is not used
[illegible]	Sherarah, 16m S of Bir Al Zubair #1.	Haj Ahmed Al Audri (Bir Al Zubair #2)	1974 d.m.x.	Dug/Drilled C.T.	Dug 0-29.0 Drilled 29.0-80.0* Rpt	40.0* Rpt	T. 69m	9.7	D 50 A 3740	Basalt	2 Feb. '76	SC=570 @ 21.7°C DS: 12-24h/d. Dug well deepened by Al Watary Co.
[illegible]	Beit Dikam, 1.5 Km NE of Beit Al [illegible].	Saleh Ali Dikam (Bir Al Me'hlo)	old d.m.x.	Dug	42.6	28.5	T. 42.5m	-	D 50 A 1320	l.s.	2 Feb. '76	SC=650 @ 25.5°C DS: 12-24h/d.
240.	Beit Al Sufari, 1.5Km W of Al Jannat.	Abdullah Moh'd Al Sufari (Bir Al Nejar)	v.old d.m.x.	Dug	30.1	28.2 Dyn	T.	4.0	D 100 A 1320	All.	2 Feb. '76	SC=625 @ 21.1°C DS: 12-24h/d.
[illegible]	1Km NW of Cesar Jannat.	Saleh Moh'd Al Shijemah	v.old d.m.x.	Dug	34.2	32.3 Dyn	T.	7.0	D 50 A 2640	l.s.	1 Feb. '76	SC=625 @ 22.2°C DS: 18h/d.
[illegible]	Jannat, 20m N of Beit Al Senhani.	Saleh Saeed Al Senhani (Bir Al Tawil)	v.old d.m.x.	Dug	39.1	30.8 Dyn	T.	3.8	D 100 A 1320	All.	1 Feb. '76	SC=625 @ 21.1°C WS: 1h/d. DS: 15h/d.
243	Jannat, 100m NW of Bir Al Ashwal.	Moh'd Saeed Al Dubri (Bir Omer)	v.old	Dug	25.1	23.8	T. Not used	-	-	-	1 Feb. '76	The well is not used
244.	Jannat, 1Km N of Jannat Vill.	Moh'd Nasir Al Ashwal (Bir Al Ashwal)	v.old d.m.x.	Dug	36.8	35.0 Dyn	T.	5.7	D 50 A 440	All.	1 Feb. '76	SC=600 @ 21.1°C DS: 5h/d.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
245.	30m S of Gesar al Jannat.	Haj Moh'd Al Shedadi (Bir Al Dar)	v.old d.m.x.	Dug	28.9	26.3	T. Not used	-	-	-	25 Jan/'76	The well has not been used since 1974 due to insufficient water
246.	Gesar Jannat, 200m E of hwy, Km52.4	Ahmed Nasir Al Agarie (Bir Sarie)	v.old d.m.x.	Dug	-	32.6	T. 34m	8.5	D 40 A 3520	l.s.	5 Aug. '75	SC=690 @ 22.2°C WS: 12h/d,7d/w,7m/y. DS: 24h/d,7d/w,5m/y.
247.	Jannat, 100m S of Bir Al Haid.	Ali Hussein Owda (Bir Al Kizana)	v.old	Dug	30.0*	Trace	T.28m Not used	-	-	-	22 Jul.'75	The well has not been used since 1975.
248.	1Km W of Jannat 300m E Bir Ashwal.	Abdullah Adlan (Bir Adlan)	v.old d.m.x.	Dug	(38.9)	(27.3)	T. 35m	4.0	A 1540	All.	24 Feb.'76 (19Jul.'75)	SC=580 @ 22.2°C WS: n.p. DS: 16h/d.
249.	100m W of hwy, Km51.	Zaid Al Remala (Bir Hanaberah)	v.old d.m.x.	Dug	42.7	-	T. 40m	6.8	D 100 A 3520	All.	24 Feb.'76	SC=620 @ 23.3°C P: 12-24h/d.
250.	300m W of hwy, Km52.	Ahmed Ali Hussein (Bir Al Museref)	-	Dug	30.7*	-	T. 75m	4.0	-	All.	24 Feb.76	SC=795 @ 22.2°C
251.	W side of hwy at Km51.9.	Ahmed Ali Sheban (Bir Al Jadida)	1970 d.m.x.	Dug	39.9	37.4 Dyn	T. 38m	1.7	D 30 A 880	All.	25 Feb.'76	SC=740 @ 22.2°C
252.	S side of Jannat mosque, center of Vill.	Cooperative (Bir Al Shergi)	v.old d.m.x.	Dug	30.3	23.2	T. 27.5m	-	D 500	All.	25 Feb.'76	WS: 1h/d. DS: 1½h/d.
253.	700m W of hwy, Km50.	Ahmed Yahya Al Hadik (Bir Ghaitha)	v.old d.m.x.	Dug/Drilled C.T.	Dug 0-35.0 Drilled 35.0-100.0 Rpt	-	T. 52.6m	8.5	D 50 A 6600	All.& Basalt	17 Feb.'76	SC=500 @ 24.4°C WS: n.p. DS: 14h/d. Dug well deepened by Al Watary Co.
254.	Jannat, 400m E of Bir Mukadam	Ahmed Hussein Sheban (Bir Sherara)	v.old d.m.x.	Dug	-	-	T. 42.5m	6.2	D 15 A 1320	Basalt	24 Feb.'76	SC=575 @ 22.2°C WS: ½h/d. DS: 16h/d.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
255.	15m W of hwy, Km51.4.	Ayet Bin Saleh (Bir Saleh)	v.old d.m.x.	Dug	47.5	-	T. 47.5m	3.8	D 30 A 880	Basalt	25 Feb.'76	SC=580 @ 23.9°C WS: n.p. DS: 12h/d.
256.	500m S of Jannat, 100m E of Bir Al Jehubah	Hizam Dawood (Bir Al Elya #1)	v.old d.m.x.	Dug	-	-	T.	7.6	D 250 A 3520	-	17 Feb.'76	SC=520 @ 22.2°C
257.	Sherarah, 500m S of Jannat.	Haj Yahya Moh'd (Bir Al Elya #2)	old	Dug	48.9	43.2	T. Not used	-	-	-	17 Feb.'76	The well is not used
258.	400m W of hwy, Km50.	Yahya Ali Hadig (Bir Al Derb)	v.old d.m.x.	Dug	37.1	32.5	T. Not used	-	-	All.	17 Feb.'76	The well has not been used since 1974 due to broken pump.
259.	Jannat, 300m E of Beit Owda Village.	Saleh Al Sofarey (Bir Mukadam)	old	Dug	32.9	28.4	T. Not used	-	-	-	3 Feb. '76	The well has not been used since 1972 due to broken pump.
260.	1.5Km E of Jannat.	Hussein Ali Sheban (Bir Sheban)	v.old d.m.x.	Dug	(41.5)	(30.3)	T. 36m	5.7	D 40 A 176	All.	28 Jan.'76 (20Jul.'75)	SC=640 @ 22.2°C WS: ½h/d. DS: 12h/d.
261.	1Km N of Jannat	Said Moh'd Agebat (Bir Basa'd #1)	1973	Dug	30.2*	26.1*	T. 27.5m	7.6	D 30 A 3520	All.	16 Jul.'75	SC=555 @ 21.1°C WS: n.p. DS: 17h/d.
262.	8m W of Bir Basa'd #1	Moh'd Agebat (Bir Basa'd#2)	v.old d.m.x.	Dug	24.9	24.2	T. Not used	-	-	-	16 Jul.'75	The well has not been used since 1974 due to broken pump.
263.	Jannat, 1Km W of Amran.	Ali Moh'd Abdu (Bir Enazari #1)	v.old d.m.x.	Dug	28.0	20.9 Dyn	T. 26m	8.5	D 100 A 2200	Basalt	9 Mar. '76	SC=545 @ 20.0°C WS: ½h/d,7d/w. DS: 12h/d,7d/w.
264.	Jannat, 1Km W of Amran.	Ali Moh'd Abdu (Bir Enazari #2)	v.old d.m.x.	Dug	28.3	19.8	T. 26m	8.5	D 100 A 2200	Basalt	9 Mar. '76	SC=575 @ 20.0°C WS: ½h/d,7d/w. DS: 12h/d,7d/w.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
265.	6Km NW of Amran 2.5Km N of Beit Rumyan.	Ali Yahya Al Berish (Bir Khelba)	1963 d.m.x.	Dug	49.8	37.8	T. 47.5m	8.5	D 200 A 1100	All.	18 Jan.'76	SC=700 @ 21.1°C WS: ½h/d. DS: 6h/d.
266.	4Km NW of Amran 1.5Km W of Beit Al Faqih.	Hizam Saleh Shobail (Bir Al Kushaih)	1974 d.s.x.	Dug	41.7	39.0 Dyn	T. 40m	9.7	D 20 A 4400	All.	17 Jan.'76	SC=450 @ 21.1°C WS: ½h/d. DS: 14h/d.
267.	8Km NW of Amran Beit Khatem	Ahmed Saleh Khatem (Bir Khatem)	1974 d.m.x.	Dug	33.6	30.3	T.	5.7	D 500	l.s.	17 Jan.'76	SC=420 @ 21.1°C WS: ½h/d. DS: ½h/d.
268.	500m W of hwy, Km50.	Moh'd Abdul-lah (Bir Dawood)	old	Dug/Drilled C.T.	Dug 0-49.0 Drilled 49.0-80.0 Rpt	-	T. 45m	9.7	-	Basalt	2 Feb. '76	SC=560 @ 22.2°C WS: ½h/d. DS: 12-24h/d. Dug well deepened by Al Watary Co.
269.	500m NW of Jannat.	Mohsin 'Araig (Bir 'Araig)	v.old d.m.x.	Dug	(36.7)	(29.1)	T. 35m	9.8	D 100 A 2200	All.	3 Feb. '76 (19 Jul.'75)	SC=660 @ 21.7°C WS: 1h/d. DS: 12-24h/d.
270.	15m W of hwy Km51.	Ali Moh'd Al Hedbah (Bir Al Sherqa)	1968 d.m.x.	Dug	37.6*	15.5* Dyn	T.	4.0	D A 880	All.	23 Jul.'75	SC=700 @ 23.3°C P: 15h/d.
271.	Jannat, 200m W of Bir Jubran #2.	Moh'd Nasir Nagi (Bir Ashahidi)	v.old d.m.x.	Dug	37.5	28.0 Dyn	T. 32m	11.3	-	All.	26 Jul.'75	SC=590 @ 26.1°C P: 12-24h/d.
272.	1.3Km N of Amran inter-section, 20m E of hwy at Km50.	Hassan Amridin Al Dera (Bir Ressam)	old d.m.x.	Dug/Drilled C.T.	Dug 0-35.0 Drilled 35.0-75.0 Rpt	-	T. 35m	4.0	D 20 A 880	All.	26 Jan.'76	SC=550 @ 21.1°C DS: 12h/d. Dug well deepened by Al Watary Co. Well was USAID/025 observ-ation well.
273.	15m W of hwy, Km51.	Ahmed Moh'd Sadallah (Bir Sadallah)	v.old	Dug	(35.8)*	(24.7)*	T. 32.5m	8.5	D A	-	28 Jan.'76 (19Jul.'75)	SC=660 @ 22.2°C P: 12-24h/d.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
274.	500m W of hwy, Km50.5	Shaikh Ahmed Mirzah (Bir Jubran #1)	v.old d.m.x.	Dug	(32.0)	(26.5)	T. 32.5m	9.7	D 100 A 6160	All.& Sand	16 Feb.'76 (20Jul.75)	SC=625 @ 22.2°C P: 12h/d.
275.	30m S of Bir Jubran #1.	Ali Merzah (Bir Jubran#2)	v.old d.m.x.	Dug	35.5	30.6	T. 35m	5.2	A 2200	All.& Basalt	16 Feb.'76	SC=640 @ 21.1°C DS: 5h/d.
276.	500m W of Bir Ali Zait, Km 50.5	Ali Mirzah (Bir Al Shahdi #1)	v.old d.m.x.	Dug	34.5	31.9 Dyn	T.	4.5	D 30 A 3080	All.	16 Feb.'76	SC=580 @ 23.9°C DS: 16h/d. Water Sample 121904
277.	15m N of Bir Al Shahdi #1.	Moh'd Nasir Nagi & Haj Saleh Moslah (Bir Al Shahdi #2)	v.old d.m.x.	Dug	(35.7)*	(28.0)*	T.35m Not used	-	-	-	16 Feb.'76 (20Jul.75)	The well has not been used since 1974 due to broken pump.
278.	7Km NW of Amran 3Km E of Beit Badi	Mohsin Omeri (Bir Al Ma'red)	1962	Dug	40.2	39.4	No pump Draw by hand	-	D 50	All.& Calcrete	18 Jan.'76	SC=590 @ 21.1°C
279.	Al Mawd, 2Km W of hwy, Km 54.	Ahmed Muotehi (Bir Muoti)	1974 d.2 x.	Dug	62.9*	55.0*	T. 60.5m	-	A 660	All.& l.s.	1 Sep. '75	DS: 5h/d, 7d/w,10m/y
280.	30m E of Beit Owda Village.	Hussein Mukharish (Bir Mukharish)	v.old d.m.x.	Dug	36.7	31.6 Dyn	T. 33m	3.8	D 20 A 660	All.	3 Feb. '76	SC=610 @ 21.1°C DS: 12h/d.
281.	20m S of Beit Owda Village.	Haj Ahmed Saleh (Bir Al Jadidah)	v.old d.m.x.	Dug	43.7	35.2 Dyn	T. 40m	9.7	D 50 A 2200	All.	3 Feb. '76	SC=650 @ 21.7°C WS: ½h/d. DS: 16h/d.
282.	500m N of Beit Al Faqih Vill.	Ahmed Saleh Nagi (Bir Mudaid)	v.old d.m.x.	Dug	37.8*	-	T.	3.0	D 100 A 880	l.s.	2 Feb. '76	SC=580 @ 21.1°C DS: 12h/d.
283.	5m W of Beit Owda Village.	Haj Ahmed Saleh Saeed (Bir Owda)	v.old d.m.x.	Dug	43.2	27.6	T. 40m	3.4	D 30 A 220	All.	3 Feb. '76	SC=645 @ 21.1°C WS: 1h/d. DS: 12h/d.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
284.	800m N of Beit Al Faqih	Abdullah Moh'd Al Sufari (Bir Al Jabubah)	1960 d.m.x.	Dug	42.7	34.6 Dyn	T. 37.5m	11.3	D 100 A 3080	All.	2 Feb. '76	SC=660 @ 21.1°C WS: ½h/d. DS: 12-24h/d.
285.	Al Monsa'a, 4Km E of hwy, Km52.	Moh'd Saleh Sha'lal (Bir Sha'lal)	1966 d.10 x.	Dug	47.1	42.1	T. 41.25m	11.3	A 1320	Basalt & All.	27 Oct.'75	SC=690 @ 21.1°C WS: 6h/d,7d/w,3m/y. DS: 3h/d,7d/w,9m/y.
286.	Al Ashat, 2.3 Km E of hwy Km53.	Yahya Kaid Sawadah Al Warki (Bir Sawadah)	1974	Dug	61.8	60.3 Dyn	T.	3.4	A 1320	Basalt	26 Oct.'75	SC=652 @ 20.0°C DS: 12h/d,5d/w,6m/y.
287.	1Km NW of Amran.	Sinan Dawood (Bir Wahaish)	v.old d.m.x.	Dug	32.7	25.8	T. Not used	-	-	Basalt	25 Jan.'76	The well has not been used since 1974.
288.	1Km N of Amran City.	Hussein Herab (Bir Jaroosh Herab #1)	v.old d.m.x.	Dug	27.6	26.3	T.	-	D 20 A 44	All.& Basalt	20 Jan.'76	WS: n.p. DS: 1h/d.
289.	50m E of Bir Herab #1.	Haj Ahmed Herab (Bir Herab #2)	v.old d.m.x.	Dug	37.4	33.9 Dyn	T.	1.9	D 40 A 264	Basalt & All.	20 Jan.'76	SC=540 @ 21.1°C WS: ¼h/d. DS: 6h/d.
290.	4Km NW of Amran 1Km W of Beit Al Faqih.	Saleh Ali Hayder (Bir Hayder)	1970 d.m.x.	Dug	47.7	34.0	T. 46.25m	7.6	D 30 A 2200	All.	30 Dec.'75	SC=600 @ 20.5°C WS: ½h/d. DS: 12h/d.
291.	2Km NW of Amran 2Km W of Beit Al Faqih.	Ahmed Mokbil (Bir Al Kushah)	v.old d.m.x.	Dug	37.8	32.1 Dyn	T. 35m	6.2	D 400 A 1320	l.s. & All.	30 Dec.'75	SC=600 @ 20.5°C WS: ¼h/d. DS: 12h/d.
292.	6Km NW of Amran 2.5Km W of Beit Shubail	Mohsin Ali (Bir Al Hebaya)	1964 d.m.x.	Dug	50.1	41.2	T.	-	-	-	14 Jan.'76	The well has not been used since 1975 due to not enough water.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (1/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
293.	IKm NW of hwy, Km54.	Ahmed Nasir Al Agari (Bir Shuruh)	v.old d.m.x.	Dug	36.1	31.5 Dyn	T.	3.0	D A 660	All.	26 Jan.'76	SC=675 @ 21.1°C WS: n.p. DS: 12h/d.
294.	100m N of Bir Al Kizana, Jannat.	Ali Hussein Owda (Bir Al Haid)	v.old	Dug	15.0*	None	T. 14m	-	-	-	22 Jul.'75	The well is not used because no water.
295.	Gear al Jannat, S of Bir Adder.	Ali Jamil (Bir Mohmera)	v.old d.m.x.	Dug	41.6*	37.0* Dyn	T.	4.5	D 200 A 1320	-	21 Jul.'75	SC=620 @ 22.2°C P: 12-24h/d.
296.	1.5Km E of hwy, Km54.3	Shaikh Hussein Nasir (Bir Sowas #1)	1974	Drilled C.T.	112.0* Rpt	42.0* Rpt	T. 58 m	-	D 30 A 8800	All.& Basalt	26 Oct.'75	WS: 10h/d,4d/w,2m/y. DS: 20h/d,7d/w,4m/y. Drilled by Al Watary Co.
297.	1.5Km E of hwy, Km54.3	Sa'd Bin Sa'd Al Kohali (Bir Sowas #2)	1969	Dug	58.6	53.9 Dyn	T.	7.6	D A 1540	All.& Basalt	26 Oct.'75	SC=740 @ 21.1°C WS: ½h/d. DS: 12h/d.
298.	2Km E of hwy, Km54.3	Al Haj Hady (Bir Sellete)	1960 d.m.x.	Dug	54.6*	52.5* Dyn	T. 48.75m	9.7	D 500 A 1628	Basalt	26 Oct.'75	SC=685 @ 20.0°C WS: 12h/d,7d/w,6m/y. DS: 18h/d,7d/w,6m/y.
299.	Beit Badi, 7Km NW of Arman, 1Km S of Beit Rumyan.	Sheikh Hussein Ad dale (Bir Qa' Lughba)	1963	Dug	47.1	41.7	T. 38m Not used	-	-	-	18 Jan.'76	The well has not been used since 1974 due to broken pump and insufficient water quantity.
300.	5Km NW of Amran 2.5Km N of Beit Shobail Village	Abdulrahman Sa'ad Allah Al Tam (Bir Al Tam)	1968 d.m.x.	Dug	41.5	38.8 Dyn	T. 40m	3.8	D 35	All.	30 Dec.75	SC=600 @ 21.1°C WS: 3h/d. DS: 12h/d; but has reduced since 1974.
301.	6Km W of Amran 2.5Km W of Beit Shubail Village	Saleh Mohsid Shubail (Bir Herwa)	1965 d.m.x.	Dug	44.3	41.9 Dyn	T. 41.5m	6.8	D 150 A 2640	All.& l.s.	14 Jan.'76	SC=750 @ 21.1°C WS: 1h/d. DS: 18h/d.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
302.	Beit Badi, 2.5Km S of Beit Rumyan Village.	Abdu Omeri (Bir Al Faqi)	1956	Dug	43.3	36.9	T. Not used	-	-	-	18 Jan.'76	The well has not been used since 1974 due to insufficient quantity of water.
303.	7Km NW of Amran Beit Rumyan Village.	Saleh Mubarik Rumyan (Bir Rumyan)	v.old d.m.x.	Dug	21.1	9.6 Dyn	T.	8.5	D 70 A 1100	-	14 Jan.'76	SC=740 @ 21.1°C WS: Rpt. to be flowing DS: 3h/d.
304.	500m W of Beit Rumyan.	Murshed Al Agary (Bir Al Jaeidy)	1965	Dug	51.5	44.3	T. 48m Not used.	-	-	-	17 Jan.'76	The well has not been used since 1974.
305.	4Km NW of Amran 1Km W of Beit Al Faqih.	Al Haj Ahmed Al Sultan (Bir Al Sultan #1)	1973 d.s.x.	Dug/Drilled C.T.	Dug 0-53.0 Drilled 53.0-88.0 Rpt	-	T. 45m	13.6	A 3740	All.	31 Dec.'75	SC=650 @ 21.1°C WS: ½h/d,7d/w,4m/y. DS: 24h/d,7d/w,8m/y. Dug well deepened by Al Watary Co.
306.	4Km NW of Amran.	Haj Ahmed Al Sultan (Bir Al Sultan #2)	1955 d.m.x.	Dug	(42.2)*	(40.8)*	T.	4.3	D 50 A 880	All.	18 Jan.'76 (9 Jul.'75)	SC=650 @ 21.1°C WS: - DS: 12h/d.
307.	Jannat, 70m W of hwy, 100m S of Bir Hanabrah	Moh'd Sadabah (Bir Kharab)	1973	Dug	35.7*	34.3* Dyn	T.	7.6	D A 3080	All.	23 Jul.'75	SC=670 @ 17.8°C P: 12h/d.
308.	1.25Km W of hwy, Km50.5.	Mokbil Adlan (Bir Mohsin)	v.old d.m.x.	Dug	41.4	-	T. 34m	11.3	-	-	16 Feb.'76	SC=625 @ 22.2°C
309.	Jannat, 200m W of hwy, E side of Jannat Vill.	(Jannat #1) Min. of Agr.	Mar. '75	Drilled R	44.2	26.1*	None	-	-	All.	5 Mar. '76	Drilled by USAID/025 Water Sample - not in table 7.
310.	Jannat, 200m W of hwy, 30m from Well #1.	(Jannat #2) Min. of Agr.	Jun. '75	Drilled R	244.0	18.2*	None	-	-	All.	16 Jun.'76	Drilled with rotary rig by USAID/025.

TABLE 5.--Well inventory data, Aaran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (1/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
302.	Beit Badi, 2.5Km S of Beit Rumyan Village.	Abdu Omeri (Bir Al Faqi)	1956	Dug	43.3	36.9	T. Not used	-	-	-	18 Jan. '76	The well has not been used since 1974 due to insufficient quantity of water.
303.	7Km NW of Amran Beit Rumyan Village.	Saleh Mubarik Rumyan (Bir Rumyan)	v.old d.m.x.	Dug	21.1	9.6 Dyn	T.	8.5	D 70 A 1100	-	14 Jan. '76	SC=740 @ 21.1°C WS: Rpt. to be flowing DS: 3h/d.
304.	500m W of Beit Rumyan.	Murshed Al Agary (Bir Al Jaeidy)	1965	Dug	51.5	44.3	T. 48m Not used.	-	-	-	17 Jan. '76	The well has not been used since 1974.
305.	4Km NW of Amran 1Km W of Beit Al Faqih.	Al Haj Ahmed Al Sultan (Bir Al Sultan #1)	1973 d.s.x.	Dug/Drilled C.T.	Dug 0-53.0 Drilled 53.0-88.0 Rpt	-	T. 45m	13.6	A 3740	All.	31 Dec. '75	SC=650 @ 21.1°C WS: ½h/d, 7d/w, 4m/y. DS: 24h/d, 7d/w, 8m/y. Dug well deepened by Al Watary Co.
306.	4Km NW of Amran.	Haj Ahmed Al Sultan (Bir Al Sultan #2)	1955 d.m.x.	Dug	(42.2)*	(40.8)*	T.	4.3	D 50 A 880	All.	18 Jan. '76 9 Jul. '75)	SC=650 @ 21.1°C WS: - DS: 12h/d.
307.	Jannat, 70m W of hwy, 100m S of Bir Hanabrah	Moh'd Sadabah (Bir Kharab)	1973	Dug	35.7*	34.3* Dyn	T.	7.6	D A 3080	All.	23 Jul. '75	SC=670 @ 17.8°C P: 12h/d.
308.	1.25Km W of hwy, Km50.5.	Mokbil Adlan (Bir Mohsin)	v.old d.m.x.	Dug	41.4	-	T. 34m	11.3	-	-	16 Feb. '76	SC=625 @ 22.2°C
309.	Jannat, 200m W of hwy, E side of Jannat Vill.	(Jannat #1) Min. of Agr.	Mar. '75	Drilled R	44.2	26.1*	None	-	-	All.	5 Mar. '76	Drilled by USAID/025 Water Sample - not in table 7.
310.	Jannat, 200m W of hwy, 30m from Well #1.	(Jannat #2) Min. of Agr.	Jun. '75	Drilled R	244.0	18.2*	None	-	-	All.	16 Jun. '76	Drilled with rotary rig by USAID/025.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
311.	200m E of hwy Km51, 175m E of Bir Ali Zait	Hussein Dawood (Bir Al Kumel;)	v.old d.m.x.	Dug/Drilled C.T.	-	-	T. 45m	-	D 30 A 3520	-	25 Feb.'76	WS: n.p. DS: 24h/d. Dug well deepened by Al Watary Co.
312.	200m E of hwy, Km51, 150m E of Bir Ali Zait	Ahmed Bin Ahmed Al Bus-ely (Bir Red-wan).	-	Dug/Drilled C.T.	Dug 0-40.0 Drilled 40.0-90.0* Rpt	-	T. 39m	8.5	D 60 A 3520	Basalt	25 Feb.'76	SC=595 @ 22.8°C WS: n.p. DS: 24h/d. Dug well deepened by Al Watary Co.
313.	100m W of hwy, Km51.	Saleh Mohsin Sheban (Bir Al Saigha)	1973	Dug	36.9*	34.7* Dyn	T. 36m	8.5	A 3080 D	-	3 Feb. '76	SC=660 @ 21.1°C P: 12-24h/d. Water Sample 121913
314.	7Km NW of Amran 1.5Km W of Beit Rumyan Village	Munasir Derham (Bir Al Kerab)	1973 d.m.x.	Dug	79.2	46.3 Dyn	T. 55m	5.7	D 400 A 1760	All.& l.s.	17 Jan.'76	SC=500 @ 21.1°C WS: ½h/d. DS: 12h/d.
315.	5Km NW of Amran Beit Shubail, 2.5Km E of Beit Badi.	Hassan Rajeh Shubail (Bir Al Meshed)	1961 d.m.x.	Dug	50.7	41.0 Dyn	T. 48m	4.0	D 800 A 440	All.	14 Jan.'76	SC=625 @ 21.1°C WS:1½h/d. DS:12h/d.
316.	70m E of hwy Km50.5.	Hussein Yahya Dawood (Bir Rehaman)	v.old d.l x.	Dug/Drilled C.T.	Dug 0-50.0 Drilled 50.0-100.0* Rpt	-	T. 45m	8.5	D A 4400	Basalt	3 Aug. '75	SC=520 @ 21.7°C P: 24h/d. Dug well deepened by Al Watary Co.
317.	4Km NW of Amran 2Km W of Beit Al Faqih.	Saleh Al Ghadi (Bir Al Ghadi)	1970 d.m.x.	Dug	42.6	40.0 Dyn	T.	9.7	D 2 A 3080	All.	18 Jan.'76	SC=650 @ 21.1°C WS: ½h/d. DS: 12h/d.
318.	4Km NW of Amran 1.5Km W of Beit Al Faqih.	Moh'd Saleh Al Kushah (Bir Al Khazu)	old d.m.x.	Dug	42.4	-	T. 40m	8.5	A 3080	All.	18 Jan.'76	SC=660 @ 21.1°C WS: n.p. DS: 12h/d.
319.	700m W of Beit Al Faqih, 100m S of Bir Haider	Saleh Ali Haider (Bir Al Sanea)	1970 d.l x.	Dug	40.7	37.8 Dyn	T. 40m	7.6	D 60 A 3520	All.	30 Dec.'76	SC=580 @ 21.1°C WS: 1h/d,3d/w,4m/y. DS: 12h/d,7d/w,8m/y.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
320.	E side of Beit al Faqih Vill. 3Km N of Hajjah Road.	Saleh Modrik (Bir Shaider)	old d.m.x.	Dug	38.4	35.7 Dyn	T.	3.4	D 100 A 1760	All.	30 Dec.'75	SC=540 @ 21.1°C WS: 1-2h/d,7d/w,4m/y DS: 8h/d,7d/w,8m/y.
321.	Al Safyah, 5Km W of Amran,20m S of Hajjah Rd.	Hussein Shaider (Bir Shaider)	1972 d.3 x.	Dug	42.0	38.1 Dyn	T.	6.2	A 2200	All.	29 Dec.'75	SC=540 @ 21.1°C WS: 18h/d,6d/w,3m/y. DS: 20h/d,7d/w,9m/y.
322.	1Km N of USAID/025 wells, Al Jannat.	Saleh Bin Hussein Abdu (Bir Sha'a)	v.old d.m.x.	Dug	34.1	23.7	T. 32.5m	9.7	D 15 A 1320	-	28 Jan.'76	SC=630 @ 22.2°C WS: n.p. DS: 12h/d.
323.	1Km NW of Gesar Jannat.	Saleh Hussein Suhail (Bir Suhail)	1974 n.d.	Drilled C.T.	100.0* Rpt	43.5* Rpt	T. 51m	11.3	D 150 A 6600	l.s.	25 Jan.'76	SC=650 @ 22.2°C WS: occasionally DS: 12-24h/d. Drilled by Al Watary Co.
324.	250m S of Gesar Jannat.	Moh'd Saleh Al Borgholi (Bir Al Jamil)	v.old d.m.x.	Dug	(47.6)	(34.0)	T. 45m	7.6	D 800 A 2640	All.& l.s.	25 Jan.'76 (21Jul.'75)	SC=625 @ 21.1°C WS: ½h/d. DS: 12-24h/d.
325.	500m NW of hwy, Km54.	Moh'd Moaide (Bir Al Gassim)	v.old d.m.x.	Dug	22.3	19.9	T. 20m Not used	-	-	-	26 Jan.'76	The well has not been used since 1973 due to broken pump.
326.	3Km W of hwy, Km54.	Nasir Abdullah Al Mamar (Bir Al Soud)	1974 d.1 x.	Dug	48.0	45.5	T. 47.5m	-	D 25 A 440	All.& l.s.	1 Sep. '75	P: 3h/d,7d/w,12m/y.
327.	Qa'al Owhin, 600m W of hwy, Km54.	Saleh Saeed Al Doleri (Bir Al Danir)	1971 d.4 x.	Dug	54.4*	53.3*	T. 52.5m	4.0	-	All.	2 Sep. '75	SC=560 @ 21.1°C P: 4h/d,7d/w.
328.	1Km W of Amran.	Moh'd Yahya Al Omashi (Bir Sar Sar)	v.old	Dug	22.4	18.3	None	-	-	-	9 Mar. '76	Abandoned dug well.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
329.	1.5Km W of Amran, Beit Al Tabib.	Ali Moh'd Atabi (Bir Atabib)	v.old	Dug	27.7	22.5	T. 25m	8.5	D 20 A 2640	l.s.& Basalt	9 Mar. '76	SC=555 @ 21.1°C WS: ½h/d,7d/w. DS: 14h/d,7d/w.
330.	4Km E of hwy, Km52, Al Mansa'a area.	Hizam Al Sar (Bir Al Sar)	-	Dug	39.9*	35.1*	T.	-	-	-	17 Oct.'75	-
331.	500m W of hwy, Km54, Beit Shabban Village	A'id Senan (Bir Shabban)	v.old d.m.x.	Dug	36.0* Rpt	-	T.	5.2	D A 1760	All.	27 Jul.'75	SC=600 @ 23.3°C
332.	2Km W of hwy, Km54, Al Radin area.	Abdullah Mosleh Badiy (Bir Al Sabil)	old d.4 x.	Dug	51.6*	51.2*	T.	5.2	D A	All.& l.s.	3 Sep. '75	SC=550 @ 21.7°C P: 1h/d,7d/w,5m/y.
333.	Al Samrah, 500m S of hwy, Km54.	Saleh Jaher (Bir Al Samrah)	1962 d.12 x	Dug	73.3*	41.9*	T. 39m	-	A 440	All.	2 Sep. '75	P: 5h/d,7d/w,12m/y.
334.	Mogniah, 400m W of hwy, Km 54.	Senan Jamil (Bir Mogny)	1973 d.7 x.	Dug	51.9*	45.7*	T.	11.5	A 3080	Basalt	2 Sep. '75	SC=575 @ 21.7°C WS: 2h/d,7d/w,2m/y. DS: 16h/d,7d/w,10m/y
335.	Al Thuber, 100m N of Km55, 50m E of hwy.	Haj Moh'd Nagi Al Dobler (Bir Al Dobler)	v.old d.6 x.	Dug	39.5 Rpt	-	T. 40m	5.7	D 150 A 2200	All.	5 Aug. '75	SC=625 @ 22.2°C WS: 6h/d,7d/w,6m/y. DS: 24h/d,7d/w.
336.	Al Mahjar, W of hwy, Km56, 2Km S of Beit Al Haraq Village.	Saleh Said Al Yatim (Bir Al Mahjar)	1964 d.m.x.	Dug/Drilled C.T.	Dug 0-71.0 Drilled 71.0-111.0 Rpt	64.4	T. 90m	-	D A 528	All.	8 Mar. '76	WS: - DS: 4h/d,7d/w. Dug well deepened by Al Watary Co.
337.	Jannat Area	(Bir al Khuza)	-	Dug	48.3	-	T.	5.2	-	-	4 Mar. '75	P: 12-24h/d.
338.	Jannat, 100m SE of Bir Al Jadid.	(Bir Al Raymani)	old	Dug	27.7	21.9	T.	-	-	-	2 Jul. '75	P: 8h/d.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
339.	700m W of USAID/ 025 Jannat wells	Moh'd Eref (Bir Eref)	old	Dug	35.2	–	T.	6.8	–	All.	19 Mar. '75	SC=649 @ 23.3°C P: 12h/d.
340.	2.5Km E of hwy, Km 50.5.	Ahmed Al Bowmy (Bir Al Bir)	1971	Dug	–	66.8*	T.	–	D	–	6 Apr. '75	P: 1½h/d. Well was in the process of being deepened at time of inventory.
341.	1Km N of Amran, near Hajjah Rd.	Yahya Saleh Rasum (Bir Al Karab)	old	Dug	30.0*	27.3*	T.	–	–	Basalt	24 Sep. '77	SC=775 @ 18°C Well is abandoned. Water Sample 121907
342.	250m E of hwy, Km53.	Sa'ad Bin Sa'ad Al Gari (Bir al Wosta)	v.old n.d.	Dug	–	–	T. 32m	–	D 100 A 2200	Loam	11 Oct. '77	SC=700 @ 24°C P: 12h/d, 7d/w.
343.	1Km N of Bir Utair, Amran.	Mussein Moh'd al Hadheq (Bir Haidh)	1972 d.1 x.	Dug	42.0 Rpt	–	T. 42m	3.4	–	Loam	2 Jul. '75	SC=550 @ 21.7°C P: 12-24h/d.
344.	1Km NW of Bir Dhaifan, 500m N of Hajz vill.	Saleh Nasir Al Utair (Bir al Utair)	1973	Dug	39.2	–	T. 37.5m	6.2	–	Loam & All.	2 Jul. '75	SC=530 @ 21.1°C P: 12-24h/d.
345.	Amran City.	Cooperative	Old	Dug	–	–	T.	–	D 2000	–	24 Sep. '77	SC=600 @ 19°C Water Sample 121909
346.	400m S of Bir Al Makhazi, 3Km SW of Amran.	Ahmed Ali Dhaifani (Bir Al Rasim or Kinha).	1962 d.m.x.	Dug	45.8	29.8 Dyn	T. 45m	5.0	D 400 A 2200	Basalt	2 Jul. '75	SC=500 @ 73 P: 12-24h/d.
347.	350m SW of Bir Gazi #1, W of Amran.	Hazi Al Samri (Bir Al Samri)	old d.m.x.	Dug	23.5	–	T.	–	–	Basalt	1 Jul. '75	Reported that the well is dry during the dry season.
348.	350m SE of Bir Bakir, 1.5Km W of Amran.	(Bir Al Gazi #1) Moh'd Al Gazi	old d.m.x.	Dug	28.3*	23.5*	T. 27.5m	7.6	D 200 A 3080	Basalt	1 Jul. '75	SC=488 @ 21.1°C P: 12-24h/d.
349.	10m S of Bir Gazi #1.	(Bir Gazi #2)	old	Dug	–	–	No pump	–	–	–	1 Jul. '75	–

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
350.	Mosque of Ohoumey & Cooperative, Amran town.	Ohoumey & Cooperative	old	Dug	26.0	25.6	T.	-	-	Basalt	2 Jul. '75	-
351.	Inside walled city of Amran, near mosque Al Kabir.	Cooperative	old	Dug	28.3*	27.5*	T. 27.5m	-	-	-	1 Jul. '75	The well is not used due to insufficient water supply.
352.	Inside walled city of Amran, near Shaikh Yahya Mosque.	Cooperative	old	Dug	18.1*	15.7*	-	-	-	-	1 Jul. '75	The well is not used due to insufficient water/
353.	Amran, 200m W of Army Camp, & 350m S of hwy.	Beit Hizam Assab (Bir Al Warad) Sinan Moh'd Rajeh Al Sar	old	Dug	25.0*	12.7* Dyn	T.	4.0	D 1000 A 4400	All.	18 Aug.'75	SC=550 @ 26.1°C P: 12-24h/d.
354.	350m N of Bir Al Warad, 1Km W of Amran.	Mohsin Bakir (Bir Bakir #1)	v.old d.m.x.	Dug	23.7	18.0	T. 22.5m	-	D 50 A 3520	Basalt	1 Jul. '75	P: 1h @ 3h intervals per day, 6h/d.
355.	7m S of Bir Bakir #1, Amran.	(Bir Bakir #2) Sinan Al Shaikh Ali Al Barrde	v.old d.m.x.	Dug	25.9	19.9	T.	-	D 50 A 3520	Basalt	1 Jul. '75	P: 1h @ 1h intervals per day 12h/d.
356.	120m SE of Bir Marahaba Surebi.	Ali Mosead (Bir Al Makhazi)	1969 d.2 x.	Dug	43.6	34.9	T. 42m	-	-	All.	2 Jul. '75	P: 12-24h/d.
357.	W Amran 400m S of Bir Maidh	Mokbil Kassim (Bir Marahaba Surebi)	1973	Dug	38.0 Rpt	-	-	3.2	-	All.	2 Jul. '75	-
358.	Amran town, 350m NW of Kuwait School.	Government (Iraqi #2)	1971	Drilled C.T.	68.0* Rpt	-	None	-	-	-	1 Jul. '75	Drilled by Ministry of Public Works, Rural Water.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
359.	750m NW of Bir Al Samri, SW of Bir Bakir, Amran Town.	Hussein Ali (Bir Al Jadid)	1965	Dug	31.3 Rpt	28.3 Rpt	T.	-	-	Loam	2 Jul. '75	SC=520 @ 23.3°C P: 6h/d.
360.	35m E of hwy, Km50.5	Ali Zait (Bir Ali Zait)	old	Dug	-		-	-	-	-		
361.	Ash Shaub Dhaifan, Al Ghola, Beit Agebad Wa'ala.	Mohsin Saleh Ahmed	1971	Dug	37.7	31.1	T.	-	-	-	31 Oct.'74	P: 7h/d.
362.	Jannat, next to USAID/025 Jannat wells.	Government (Bir Iraqi-Jannat)	1972	Drilled C.T.								Drilled by Ministry of Public Works, Rural Water Dept.
363.	Al Makaser, 6Km S of Amran, Najer Village.	Kaid Al Haradi	1970 d.m.x.	Dug	-	-	T. 22.5m	-	D 200 A 3520	All.	1975	SC=780 @ 21.1°C DS: 23h/d,7d/w,3m/y. WS: 4h/d.
364.	2Km SW of Amran 20m N of Najer Village	Cooperative (Bir Azilatain)	v.old d.m.x.	Dug	29.8	21.9	T. 32.5m	13.6	D 500 A 220	-	7 Mar. '76	SC=520 @ 21.1°C WS: ½h/d,7d/w. DS: 2h/d,7d/w.
365.	Najer, S of Amran city.	Beit Abdullah Al Aswad (Bir Cerodah)	old d.1 x.	Dug	17.9	None	None	-	-	-	30 Jul.'75	The well has not been used since 1965, no water/
366.	Najer, 5Km S of Amran.	Beit Dahman (Bir Adar)	v.old d.m.x.	Dug	24.3	15.7 Dyn	T. 22m	7.6	D 500 A 4400	All.	7 Mar. '76	SC=440 @ 21.1°C P: 10h/d,7d/w.
367.	Najer, 2Km SW of Amran.	Cooperative (Bir Etaela)	v.old d.m.x.	Dug	32.3	28.7	T. 30m	13.6	D 1000	All.& Basalt	7 Mar. '76	SC=380 @ 21.1°C P: 6h/d,7d/w.
368.	Al Hawied, 500m S of Amran & 150m W of Army Camp.	Senan Moh'd Al Sar (Bir Al Ward)	v.old	Dug	14.0*	11.7*	-	-	-	-	18 Aug.'75	The well is not used very often because it dries during dry season, & only little water in wet season.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
369.	Najer.	Yahya Bin Hadi (Bir Aburah)	v.old d.1 x.	Dug	28.8*	13.6*	-	-	D 150	-	30 Jul.'75	-
370.	W of Najer, side of wadi.	Cooperative (Bir Al Gurshi)	v.old	Dug	13.6	9.1	None	-	D	-	3 Aug. '75	The well is used only occasionally.
371.	Najer, 100m SW of Bir al Gurshi, middle of Wadi.	Cooperative (Bir Salaam)	v.old d.1.x.	Dug	19.6	11.5 Dyn	T. 20m	6.8	D 500 A 1980	All.	3 Aug. '75	SC=500 @ 21.7°C P: 12-24h/d.
372.	3Km SW of Amran	Moh'd Ali Al Maghrabi (Bir Al Maghrabi)	1966 d.m.x.	Dug	41.6	32.6	T. 35m	6.2	D 100 A 2200	All.	9 Mar. '76	SC=520 @ 21.1°C WS: - DS: 12h/d,7d/w.
373.	Al Hjaz, 3Km SE of Amran.	Al Haj Moh'd Afeyah	1972 d.m.x.	Dug	41.9	35.0 Dyn	T.	3.0	D 200 A 440	All.	9 Mar. '76	SC=540 @ 22.2°C WS: - DS: 12h/d,7d/w.
374.	500m SE of Najer Village.	Abdullah Saeed Al Nagry (Bir Al Jebel)	old d.2 x.	Dug	19.5	12.8	T.	-	D 200 A 3080	All.	19 Aug.'75	WS: 12h/d,7d/w,3m/y. DS: 24h/d,7d/w,9m/y.
375.	W of Najer, 50m E of Bir Al Share.	(Bir Al Birain)	v.old n.d.	Dug	10.5	8.0	None	-	-	-	19 Aug.'75	The well is not used because it dries up in the dry season.
376.	3Km SW of Amran 2Km W of Wadi Najer.	Abdullah Bin Ahmed (Bir Asoda)	v.old d.m.x.	Dug	29.1	10.6	T. 17.5m	-	A 2640	All.& l.s.	22 Mar.'76	DS: 12h/d,7d/w.
377.	Al Hawied, 2Km S of Amran.	Saleh Senan Al Sa'ar (Bir Al Shawish)	old d.5 x.	Dug	23.6*	7.7*	T.	-	D 50 A 2200	All.	18 Oct.'75	WS: n.p. DS: 23h/d,7d/w,3m/y.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
378.	Al Hjaz, 6Km W of Amran, 250m N of Afia Village.	Al Haj Moh'd Afia (Bir Al Talha)	v.old	Dug	23.0*	21.5*	T. Not used	-	-	-	-	The well is not used
379.	W of Amran, N of Bir Al Kushan.	Ali Mokbil (Bir Mudad)	v.old	Dug	38.7*	34.5*	T. 36m	4.0	D A	All.& l.s.	13 Jul.'75	SC=490 @ 21.1°C P: 12-24h/d.
380.	Al Hjaz, 4Km W of Amran, 1Km E of Hjaz USAID well.	Haj Saleh Al Atir (Bir Al Atir).	1973 n.d.	Dug	40.0 Rpt	-	T. 34m	8.5	D 2000 A 3080	All.	21 Mar.'76	SC=490 @ 22.2°C WS: n.p. DS: 14h/d.
381.	3Km W of Amran 10m N of Hajjah Road.	Haj Moh'd Ja'dan (Bir Al Matar)	1963 d.m.x.	Dug	32.5	29.3	T. 31.75m	6.8	D 10 A 1320	All.& l.s.	29 Dec.'75	SC=480 @ 20.5°C WS: ½h/d. DS: 12h/d.
382.	350m NW of Iraqi well Amran town.	Shaikh Sinan Al Sa'ad (Bir Sa'ad)	v.old	Dug	43.7	41.6 Dyn	T.	-	-	All.& Calcrete	1 Jul. '75	P: 12-24h/d.
383.	7Km SW of Amran, N side of Al Hjaz Vill.	Cooperative (Bir Al Hjaz)	Oct. '76	Drilled R	221.1	(33.8)*	T. 50m	7.6	D 300	l.s.	27 Sep.'77 (3 Oct.'76)	Drilled by USAID/025 Pump installation by Rural Water Dept. Water Sample 121912
384.	SW side of Amran town.	Cooperative (Bir Amran)	Jan. '76	Drilled R	343.1	37.8*	T.	-	D	All.& l.s.	18 Jan.'76	Drilled by USAID/025 Pump installation by Rural Water Dept.
385.	Najer, S of Amran	Abdullah Jaharah	v.old d.3 x.	Dug	27.0*	15.9*	T.	-	D 150 A	All.	3 Aug. '75	P: 12-24h/d.
386.	Wadi Thaean, 400m SW of Bir Al Zafran, 10Km SE of Amran town.	Cooperative (Bir Bieda)	v.old d.1 x.	Dug	13.6	5.4	-	-	D	All.	29 Jul.'75	Used by a few people for drinking water only.

TABLE 5.--Well inventory data, Amran Valley, Yemen Arab Republic - Continued

WELL #	LOCATION	OWNER	APPROXIMATE AGE	TYPE	TOTAL DEPTH (METERS)	DEPTH TO WATER (METERS)	TYPE OF PUMP OR METHOD	YIELD (l/s)	USE	AQUIFER	DATE OF INVENTORY	REMARKS
387.	Wadi Thaean	Hussein Al Raseen (Bir Blaisenah)	v.old	Dug	11.2	-	T. 10m	6.8	D A 3080	All.	29 Jul.'75	SC=500 @ 21.1°C WS: 12-24h/d. DS: ½-24h/d.
388.	Wadi Thaean, 200m S of Bir Al Rakwah.	Ali Yahya Harir (Bir Za'fran)	v.old	Dug	10.8	3.5	T. 10m	-	D 1000 A	All.	29 Jul.'75	WS: 6h/d. DS: ½h/d.
389.	Wadi Thaean, 300m W of Thaean Village.	Cooperative (Chail Al Majik)	-	Spring,w/ developed catch basin	-	-	-	0.02	A	l.s.	30 Jul.'75	SC=320 @ 20.0°C Flow is seasonal.
390.	Wadi Thaean, Daiah village, Wadi Al Shogain.	Cooperative (Bir Al Shogain)	1965	Dug	18.0	Trace	None	-	-	l.s.	30 Jul.'75	Abandoned dug well.
391.	Wadi Thaean S of Amran	Shaikh Ali Hussein Sinah (Bir Ahwal)	v.old d.l.x.	Dug	18.0*	4.3*	T. 14m	-	D 1000 A 1100	All.	29 Jul.'75	SC=500 @ 18.9°C WS: 12h/d. DS: 3h/d.
392.	Wadi Thaean 100m E of Road, Beit Sinah	Haj Hussein Al Resin (Bir Al Rekwah)	v.old d.m.x.	Dug	24.4*	-	T. 24m	6.8	D A	-	29 Jul.'75	SC=500 @ 20.5°C WS: 12-24h/d. DS: ½h/d.
393.	Wadi Thaean, Beit al Haidain	Cooperative (Bir Al Haidain)	1972 n.d.	Dug	9.8	6.5	None	-	-	l.s.	30 Jul.'75	Reported not used because of collapsing at bottom.
394.	Wadi Thaean, Sufal al Wadi	Hussein Saleh Sinah (Bir Hewal)	v.old d.2 x.	Dug	19.0	5.6	T.	-	D 1000 A 3080	Fine Sand	27 Sep.'77	SC=580 @ 18.3°C P: 12h/d,7d/w. Water Sample 121911
395.	2Km S of Amran	Ali Mojeli (Bir Chulab)	v.old	Dug	27.0 Rpt	11.4 Dyn	T. 20m	13.6	A 2640	-	22 Mar.'76	SC=520 @ 21.1°C WS: n.p. DS: 10h/d.

EXPLANATION TO ACCOMPANY DRILLER'S LOGS, TABLE 6

The driller's logs which are included in this report are copies of logs on file with the Hydrology Section of the Mineral and Petroleum Authority in San'a'. The units of measurement for the wells are inches and feet, following the practice of the Drilling Section of the joint Yemen Arab Republic-USAID drilling project. When a measurement from a log is used in the text is is converted to its metric equivalent.

TABLE 6.--Driller's logs, Amran Valley, Yemen Arab Republic.

Al Hajz — About 7 Km SW of ʿAmrān city, at the village of Al Hajz, ʿAmrān Valley. — Sheet 1 of 1.

025

Rotary

Total Depth 725 Ft — Level 111.0 — Date 3 Oct'76 — Corrected to LSD

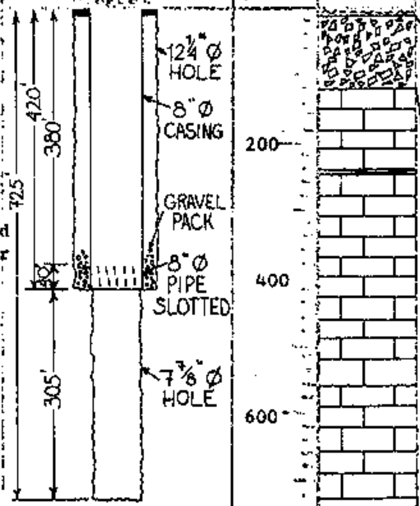
S.P.-Resistivity, Gamma-Natural — By G.C. Tibbitts & J.W. Aubel

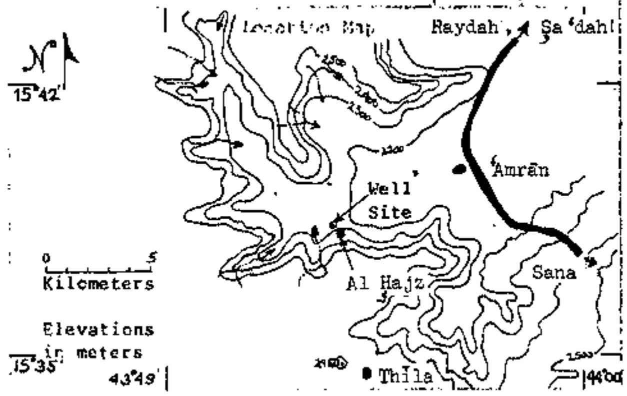
Driller H. Nagi — Rig No. 2 — Geophysical Log

Samples Described by Salah Wasse — Date Sept'76 — Other Data Hydrogeologic testhole — Production well.

Pumping Water Level

Other Data	Well Completion & Diagram	Depth (Feet)	Log	Lithologic Description
Airlift test by driller was a reported 94 GPM Well was screened and developed for production use. Water Sample:	See diagram	200 400 600 800	See diagram	0-10' Clayey loam, pale orange. 10-120' Limestone breccia, pale yellowish-brown to pale brown, granule size, subrounded to angular; composed of 60% limestone; 40% calcrete nodules, white; 55-90' coarse to very coarse size. 120-725' Limestone, pale yellowish-brown to pale brown; 265-270' pale brown; 290-295', 320-325', 355-360', 370-375', 425-475' medium gray; 475-500', 610-725' pale yellowish-brown; 500-610' medium gray. (240-245' Sample missing)





Clayey loam — Limestone — Breccia — Sample missing

TABLE 6.--Driller's logs, Amran Valley, Yemen Arab Republic - Continued

Site: Al Jubi (Km 58) Sheet 1 of 1

Location: About 1 Km east of Km 58 marker on the Sana-Ṣaʻdah highway, ʻAmrān Valley

Project: 025 Field No.:

Office No.: Drilling Method: Rotary Begun: 4 May'75 Completed: 4 June'75

Total Depth: 340' Ft. Static Water Level: 149.61' Ft. Date: 17 Dec'75 Measuring Pt.: Corrected to L.S.D. Ft. Above/Below L.S.D. Elev. Ground: Ft. Yield: Drawdown:

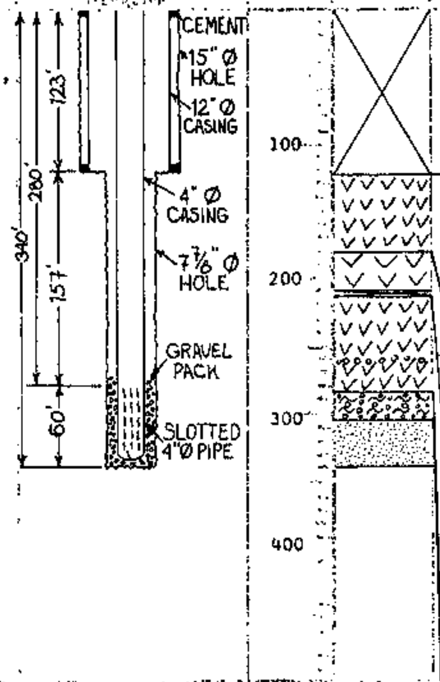
Driller: H. Nagi Rig No: 2 Geophysical Log: By:

Samples Described By: Salah Wasse Date: Sept'76 Other Data: Hydrogeologic testhole

Pump Intake Depth: Ft. Specific Capacity: @ Ft. Pumping Water Level: Ft.

Driller's Log:
0-175' Topsoil.
175-305' Basalt, hard.
305-340' Sand.

Driller reports yield of 50 GPM during airline development at 315' w/2" pipe.



Lithologic Description

125-180' Basalt, light olive-grey; crushed to very fine to fine fragments; 170-175' w/ 5% scoriaceous basalt, greyish-red to blackish-red; 175-180' w/20-25% scoriaceous basalt.

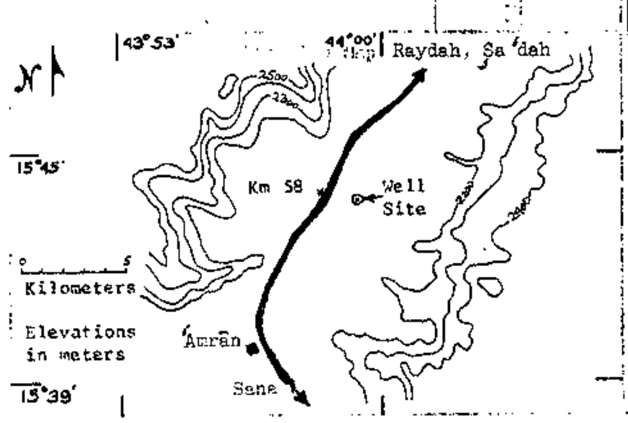
180-215' Scoriaceous basalt, greyish-red to blackish-red; w/15-20% gravel, varied colored, very coarse to small pebbles, fairly well sorted, angular to well rounded; composed of volcanics; 190-210' w/no gravel.

215-285' Basalt, dark grey to greyish-black; w/5% scoriaceous basalt; 220-305' medium dark grey to medium grey; 260-265' w/40% gravel, varied colored, very fine to small pebbles, angular to subrounded; composed of 30% weathered basalt, dusky-red; 5% limestone, pale yellow; 265-275' w/80% weathered basalt; 10% limestone; 275-285' w/85% weathered basalt; 5% limestone; 280-285' w/5% loam, pale red.

285-305' Loam, very pale orange to pale yellowish-orange; w/20% gravel, varied colored, very fine to small pebbles, angular to subrounded; composed of volcanics; 295-305' gravel is very fine to granule size.

305-340' Sand, moderate yellowish-brown, well sorted.

(0-125', 210-215' Sample missing)



Loam w/gravel — Scoriaceous basalt — Sample missing — Sand — Basalt

TABLE 6.--Driller's logs, Amran Valley, Yemen Arab Republic - Continued

LOG OF WELL

Site Amrān city   Sheet 1 of 1

Project 025   Location The well is located on the west side of Amrān city, about 45 Km from Sana'ā'   Field No. ____

Office No. ____   Drlg Method Rotary   Begun 20 Oct'75 Completed Jan'76

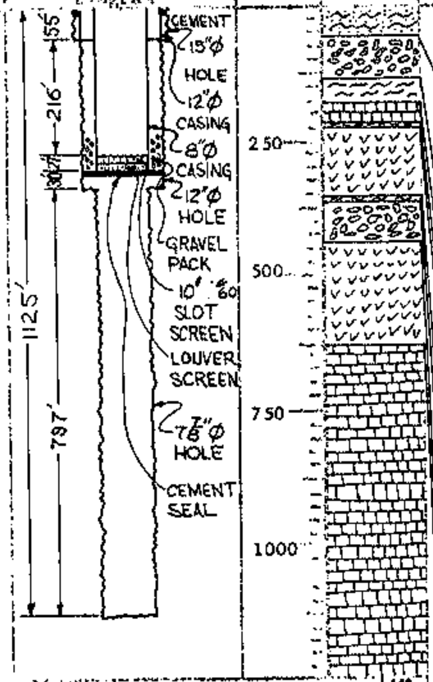
Total Depth 1125' Ft   Static W Level 124' Ft   Date 18 Jan'76 Meas. Ft. Corrected to L.S.D. M. above Ft. below L.S.D., Elev. Ground ____ M. Ft. Yield ____ Drawdown ____

Driller E. Osman   Rig No. 5   Geophysical Log Natural Gamma, S.P. & Resistivity, Density   By G.C.Tibbitts & J. Aubel

Samples Described By Adel Saeed   Date July'76   Other Data Hydrogeologic testhole - Production Well.

Pump Data: Depth ____ M. Ft. Rated Capacity 0 M. Ft. Pumping Water Level ____ M. Ft.

Drlg. Data Pump Tests &c	Well Completion & Diagram	Depth (Feet)	Log	Lithologic Description



0-50' Sandy loam, yellow-brown; medium to very coarse; w/few gravel; quartz; basalt; few limestone.

50-130' Gravel, varied colored, granule, angular; basalt; few limestone; 55-60' few quartz; 65-70' granule to pebble, subrounded to subangular; 95-100' limestone decreases; 120-125' very coarse to granule, rounded to angular; 125-130' pebble; basalt w/some loam.

130-175' Loam, grey; w/few gravel.

175-210' Limestone, buff to dark; w/few quartz & basalt; 190-195' basalt increases.

210-220' Clay, pale grey.

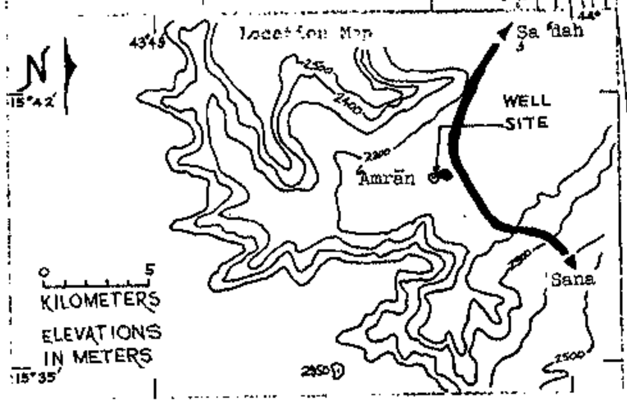
220-355' Basalt, dark; vesicular; w/limestone & sandstone; 225-230' w/clay; 235-255' dense basalt; 250-255' w/few limestone; 305-310' weathered basalt; w/gravel; few calcite amygdules; 335-340' w/few calcite crystals.

355-360' Loam, pale red; w/vesicular basalt.

360-435' Gravel, varied colored, pebble to granule; basalt w/loam; 370-375' w/few calcite crystals; 375-425' sand, varied colored, coarse to very coarse, rounded to subrounded; quartz w/few basalt; 425-435' granule size.

435-625' Basalt, black; w/few intermediate volcanics & limestone; 535-540' w/few quartz & clay.

625-1125' Limestone, pale yellow to dark; w/few basalt fragments.



Key: Sandy loam, Loam, Clay, Gravel, Limestone, Basalt, Sand

Site Al Jannat #1

025 Town of Al Jannāt, ʿAmrān Valley

Rotary Feb '75 March '75

82.66 Corrected to

145 5 Mar'76

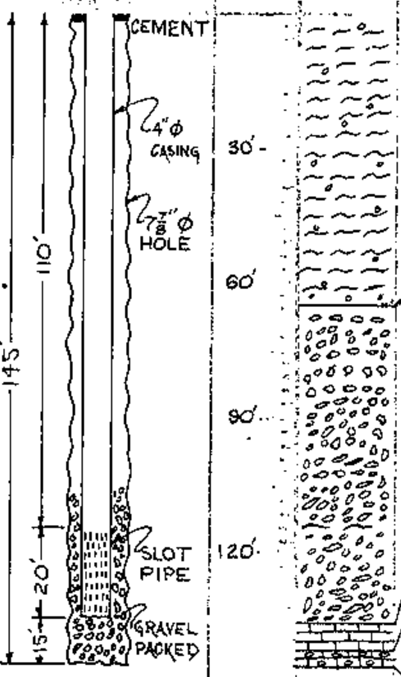
LSD Ft. Yield

F. Osman 5 Geophysical Log none

M.L. Eryani Date Oct'76 Other Data Hydrogeologic testhole

(Feet) Log

On 4 Mar'75 a preliminary pump test was conducted with air pumping: 1 inch airline set to 100 ft. and pumped for about 10 hrs. at an average discharge of 8.87 GPM. Total drawdown about 3.30 ft. Specific Capacity = 2.69 gallons/ ft./drawdown
Water sample analyzed:
Specific Conductance=700mmhos/ cubic cm.
Total dissolved solids=500ppm
Alkalinity=170 ppm
Total hardness = 3,0ppm

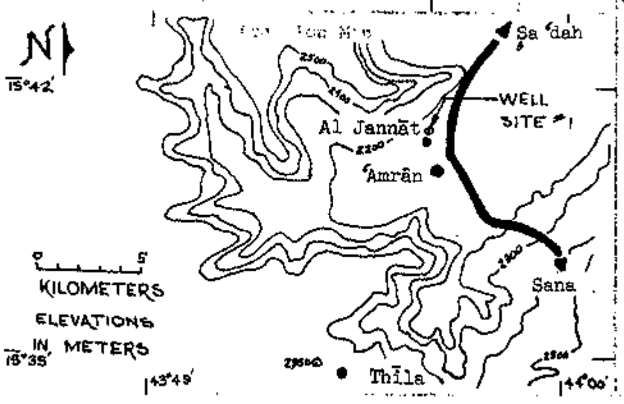


0'-65' Loam, pale yellow brown, calcareous; 25-30% gravel, varied colored, sand to pebble, angular to rounded; 15% volcanics; 15% limestone; 50-60' pale yellow orange; 10% gravel, sand to granule.

65-135' Gravel, varied colored, very fine to pebble, subangular to rounded, limestone, quartz, volcanics; 110-115' granule to pebble, angular to rounded, limestone, volcanics, quartz; 115-135' fine to pebble, angular to rounded.

135-142' Limestone, light brown

142-145' Gravel, varied colored, coarse to pebble, angular to subrounded; 95% limestone, 5% quartz and calcrete.



Loam Limestone

Gravel

TABLE 6.--Driller's logs, Amran Valley, Yemen Arab Republic - Continued

Site Al Jannat #2 — Sheet 1 of 1

Location: About 2 Km north of ʿAmrān town, and about 0.2 Km west of Sana-Saʿdah hwy on the eastern side of Al Jannāt village

No. .025 — Field No. ____

Drlg Method: Rotary 67'00' — Begun 19Mar'75, 17 May'75 — Completed 16 Jun'75

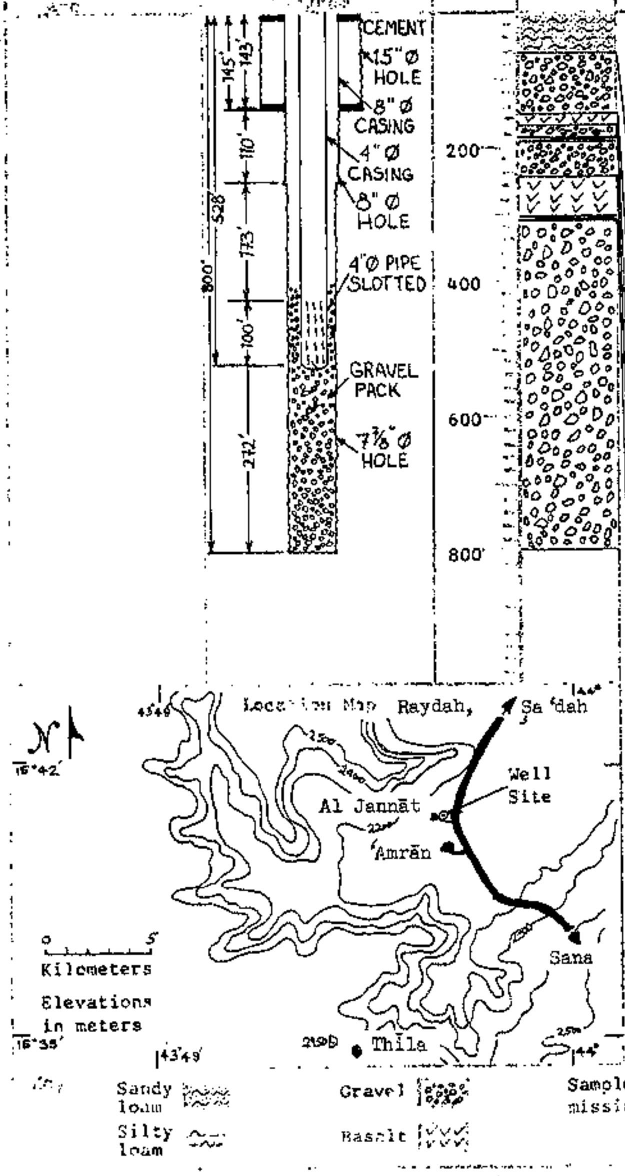
Total Depth 800' Ft. — Static W Level 59.75' Ft. above to L.S.D. — Date 16 Jun'76 — Meas. Pt. Corrected — Ft. below L.S.D. — Elev. Ground ____ Ft. — Yield ____ — Drawdown ____

Driller F. Osman — Rig No. 5 — Geophysical Log none — By ____

Samples Described By M.L. Eryani — Date Oct'76 — Other Data Hydrogeologic testhole

Pump Data: Depth ____ M. Ft. — Rated Capacity ____ @ ____ M. Ft. — Pumping Water Level ____ M. Ft.

Log Date / Pump Tests — Well Completion & Casing — Depth (Feet) — Log



Lithologic Description

0-60' Sandy loam,pale yellow-brown;calcareous;w/5% gravel, varied colored,very fine to granule,angular to subrounded; limestone and calcite;20-25' silty loam,pale yellow-orange; 25-50' pale yellow-orange.

60-150' Gravel,pale yellow-brown and black,coarse to granule,fairly well sorted,angular torounded;95% limestone,5% quartz; 105-145' very fine to very coarse;145-150' varied colored, mainly pebble size;90% limestone, 5% quartz,5% basalt.

150-170' Basalt,medium dark-grey;contaminated w/5% limestone,few quartz and calcite; 155-165' olive-black to brownish-black;no contamination.

170-245' Gravel,varied colored, mainly pebble size,subrounded to subangular;limestone;175-180' very fine to granule;w/20% loam, deep brown;180-245' coarse to granule,fairly well sorted,angular to rounded;95% limestone, 5% quartz;225-245' fine to granule.

245-310' Weathered basalt,light-grey;w/10% limestone and calcite; 250-255' less contamination;255-275',285-295' no contamination; 275-285' w/few ferruginous nodules.

310-800' Gravel,varied colored, very fine-granule,angular-rounded; 90% basalt,10% limestone,calcite, & quartz;330-340' very fine-pebble; 425-535',540-565',700-800' 60% limestone,40% basalt,quartz;535-540' coarse-pebble,angular-subrounded;80% limestone,20% basalt, calcrete,& quartz;565-580' 50% basalt,50% limestone;580-700' mainly basalt w/few limestone;625-700' medium to pebble size. (185-190',305-310' Sample missing)

LOG OF WELL

Sheet 1 of 1

Site Warehouse #1

Location: About 1.5 Km E of Km 64 marker, Sana-Sa'dah hwy, 'Amrān Valley

Well No. 025

Drilling Method Rotary — Begun 27Mar'76 — Completed Jun'76

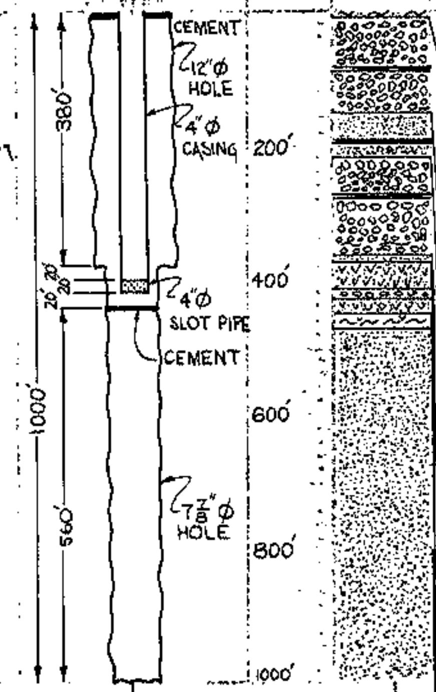
Depth 1000 Ft — Static W Level 91.99' Ft — Date 10 Jul '77 — Corrected to L.S.D. (M above / M below L.S.D.) — Elev. Ground Ft — Yield

Driller R. Banasijan — Rig No. 5 — Geophysical Log Resistivity, S.P., Gamma, Density — By J. Aubel & J. Ahmed

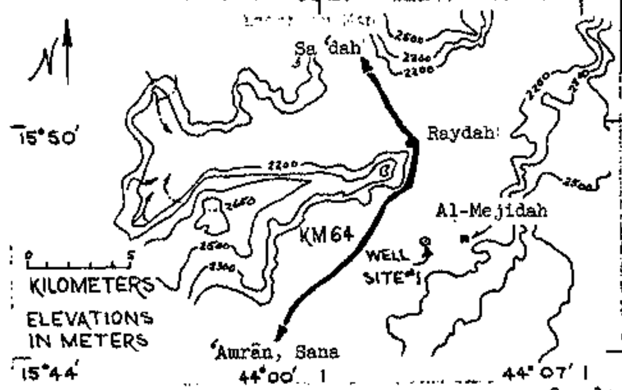
Samples Examined by M.S. Selui — Date Sep'76 — Other Data Hydrogeologic testhole

Pump Set at Depth Ft — Rated Capacity — Pumping Water Level Ft

Pertinent Data / Formations: Observation well for aquifer test, 10-13 July, 1977.



Depth (Feet)	Lithologic Description
	0-5' Loam. sandy, pale gray, some limestone.
	5-150' Gravel. varied colored, 1/8-16mm., rounded to subrounded, 40% limestone, 30% basalt, 30% sand. 30-150' subrounded to angular, 60% sand, 20% limestone, 20% basalt.
	150-220' Sand, colorless to yellow, 1/8-2.0mm., rounded to angular. Contains some limestone, basalt.
	220-365' Gravel, varied colored, 1/8-16.0mm., rounded to angular, volcanic origin, containing much limestone and sand. 285-325' 355-360' loam present. 325-355' composed primarily of limestone with basalt, sand.
	365-375' Sand, colorless to yellow-brown, 1/4-1.0mm., rounded to subrounded, with basalt, limestone.
	375-415' Basalt, dark brown, with much sand, limestone.
	415-430' Gravel, varied colored, 1/8-16.0mm., rounded to subrounded, volcanic origin with abundant sand, some limestone.
	430-450' Basalt, dark brown, with some sand and limestone.
	450-470' Loam, pale gray, with basalt.
	470-1000' Sand, colorless to yellow brown, 1/8-2.0mm., rounded to angular, poorly sorted, with some loam, clay, basalt and limestone pebbles. (85-90', 190-195', 275-280', samples missing.)



Loam — Gravel — Sample Missing

Sand — Basalt

Warehouse #2 — Sheet 1 of 1

025 — About 1.5 Km east of Km 64 marker, Sana-Sa'dah hwy, Amrān Valley and 100' west of #1.

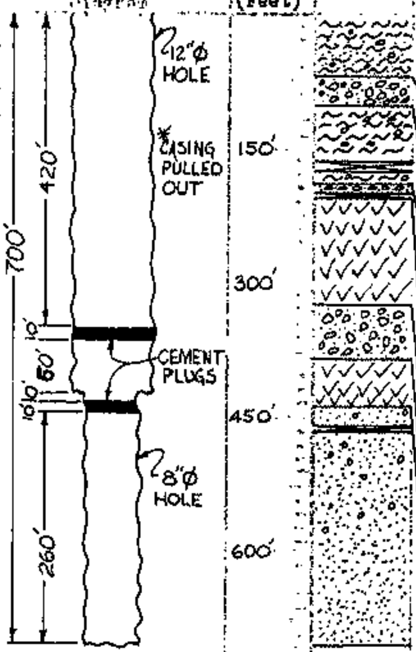
Rotary — Jun'76 — Completed Mar'77

700 Ft.

R. Banasijan — No. 5 — Geophysical Log: Gamma, Density, Resistivity, SP, Caliper — By J. Zaifallah

E. Schlueter — Date July'77 — Other Data: Abandoned testhole

Driller reports development with airlift= 10 GPM



Lithologic Description

0-70' Loam, yellow-brown; w/ much gravel of limestone and volcanic origin; some sand.

70-100' Gravel, varied colored, 1/16-16 mm., angular to subrounded; limestone and volcanic.

100-195' Loam, yellow-brown; w/ some gravel of limestone and volcanic origin.

195-205' Gravel, tan and light grey to black, 1/4-160 mm., subangular to subrounded; of volcanic and limestone origin.

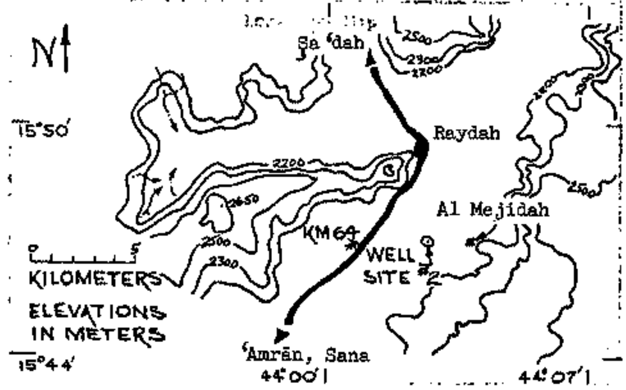
205-325' Basalt, dark grey; w/ some well rounded, frosted quartz grains.

325-385' Gravel, varied colored, 1/8-20 mm., angular to rounded; of volcanic, limestone, and sand.

385-440' Basalt, dark grey; w/ some sand and gravel contamination.

440-700' Sand, tan, 1/8-1 mm., subrounded to well-rounded; w/ much basalt contamination which lessens with depth.

(165-175', 190-195', 460-465' Samples missing)



Loam — Gravel — Sample Missing

Sand — Basalt

TABLE 6.--Driller's logs, Amran Valley, Yemen Arab Republic - Continued

LOG OF Well

Sheet 1 of 1

Warehouse #3

Project .025 Location About 1.5 Km east of Km 64 marker, Sana-Sa'dah hwy, 'Amrān Valley and 100' south of #1 Field No.

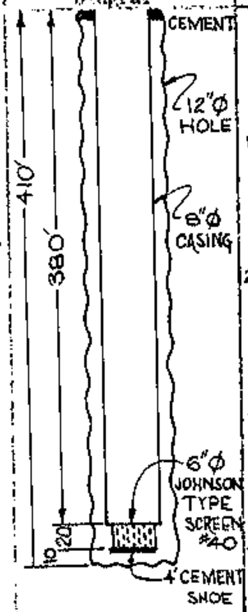
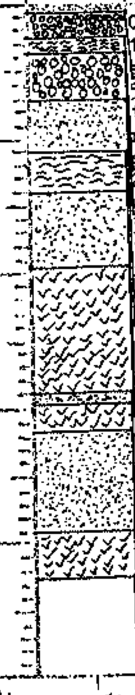
Office No. Drig Method Rotary Begun Mar'77 Completed Apr'77

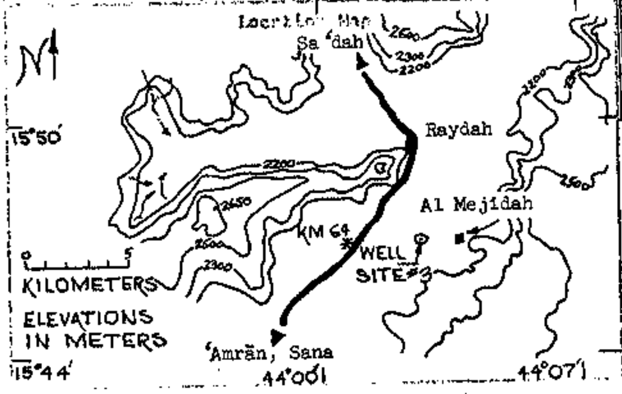
Total Depth 410 Ft. Static W Level Ft. Date Meas. Pt. M. above Ft below L.S.D., Elev. Ground Ft. Yield Drawdown

Driller R. Banasijan Rig No. 5 Geophysical Log Resistivity, S.P., Gamma, Density, Caliper By Odiani, Al Thari Aubel, Schlueter

Samples Described By Date Other Data

Pump Data: Depth M. Ft. Rated Capacity @ M. Ft. Pumping Water Level M. Ft.

Drig Data Pump Tests	Well Completion & Diagram	Depth (Feet)	Log	Lithologic Description
Driller reports with airlift development 70 GPM Aquifer test: 10-13 July 1977, Showed a T≅ 6,000 gpd/ft. and an S≅ 1x10⁻³ With a mean pumping rate of 130 gpm		100', 200', 300', 400'		0-5' Sand, pale yellow brown, 1/6-1/4mm., subrounded to rounded, with gravel and loam. 5-25' Gravel, varied colored, 16.0-1/16mm., angular to subrounded, composed of caliche, sand, volcanics, loam. 25-35' Loam, black to gray black, with sand. 35-70' Gravel, varied colored, 1/16-8.0mm., subangular to well-rounded, volcanic origin with much caliche and limestone, some sand and loam. 70-110' Sand, pale yellow, 1/16-16.0mm., subangular to well-rounded, with gravel of limestone and volcanic origin, some sand. 110-140' Loam, dark yellow brown, with sand and some gravel. 140-195' Sand, pale yellow brown, 1/16-1.0mm., angular to subrounded, with gravel of limestone and volcanic origin. 195-290' Basalt, dark gray, with gravel of limestone origin. 290-295' Sand, pale yellow, 1/16-1.0mm., angular to well-rounded, with gravel of volcanic origin. 295-315' Basalt, very dark gray. 315-390' Sand, pale yellow, 1/16-1.0mm., with gravel of volcanic origin. 390-425' Basalt, dark gray, with some sand.



Sand | Loam | Gravel | Basalt

TABLE 6.--Driller's logs, Amran Valley, Yemen Arab Republic - Continued

Site Raydah South #1 LOG OF WELL Sheet 1 of 1

025 About 2 Km southeast of Raydah, Ámrān Valley Field #

Drilling Method Rotary Began Jan'76 Completed Feb'76

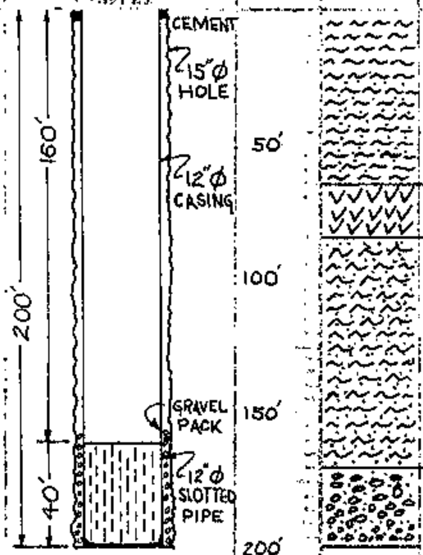
Total Depth 200' Ft Static W. Level 98.50 Ft Date 11May'77 Meas. Pt Corrected to L.S.D. M above Below L.S.D. Elev Ground Ft. Yield Drawdown

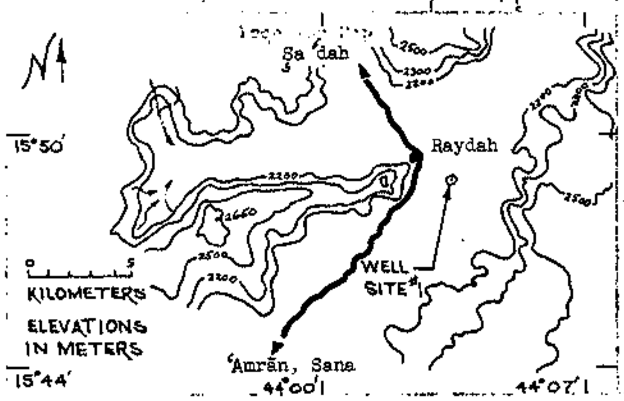
Driller R.Banasijan Rig No. 5 Geophysical Log none By

Samples Described By Date Other Data

Pump Depth M Ft Rated Capacity Pumping Water Level M Ft.

Notes on Test Data	Well Completion Diagram	Depth (Feet)	Log	Lithologic Description
Driller reports with air 120GPM Observation well for aquifer test, 22-25, Aug '77.				0-65' Loam,yellow-brown; composed of sand & volcanics, 1/8-7 mm,rounded to subrounded.
				65-85' Basalt,dark brown;w/ contamination of sand & gravel.
				85-170' Sandy loam,yellow-brown;composed of 75% sand & 10% volcanics,1/16-10 mm, rounded to subrounded;becomes less clayey from 165-170'.
				170-200' Gravel,varied colored, 1/8-70 mm,rounded to subrounded;composed of volcanics and sand;195-200' grain size is less than 20 mm.





Loam Gravel
Sandy loam Basalt

Site Raydah South #2 — Log Of Well — Sheet 1 of 1

About 2 Km southeast of Raydah, ʿAmrān Valley and 100' south of well site #1

Proj. No. 025

Log Method Rotary — Began Mar'76 — Completed Mar'76

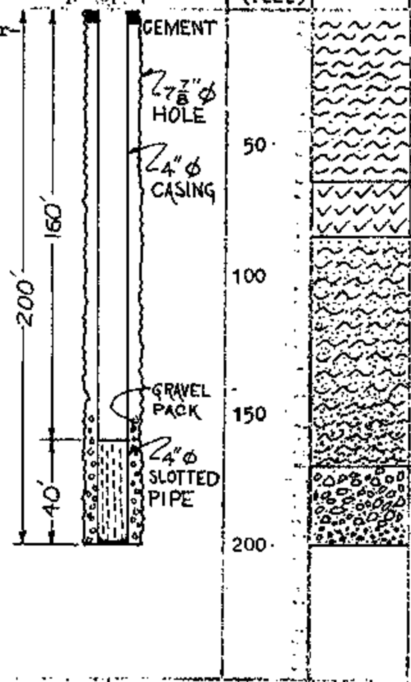
Total Depth 200 Ft. — Static W. Level 98.00 — Date 24Jan'77 — Meas. Pt. Corrected to L.S.D.

Driller R. Banasijan — No. 5 — Geophysical Log none

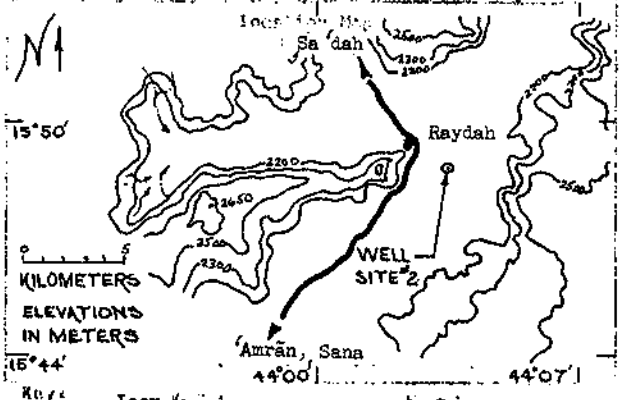
Sample Described By M.L. Eryani — Date Nov'76 — Other Data Hydrogeologic testhole

Pump — Rated Capacity 0

Drlg. Data / Pump Tests / etc.	Well Completion & Diagram	Depth (Feet)	Log	Lithologic Description
This is a 4" observation well.				0-65' Loam, yellow-brown; composed of sand and volcanics, 1/8-7 mm, rounded to subrounded.
				65-85' Basalt, dark brown; w/ contamination of sand & gravel.
				85-170' Sandy loam, yellow-brown; composed of 75% sand & 10% volcanics, 1/16-10 mm, rounded to subrounded; becomes less clayey from 165-170'.
				170-200' Gravel, varied colored, 1/8-70 mm, rounded to subrounded; composed of volcanics and sand; 195-200' grain size is less than 20 mm.



Location Map



Key: Loam — Gravel — Sandy loam — Basalt

LOG OF WELL

Site Raydah South #3 — About 2 Km southeast of Raydah, ʿAmrān Valley and about 100' east of well sites #1 and 2 — Sheet 1 of 1

Pt. No. 025 — Field No.

Office — Drilling Method Rotary — Began 26 July'77 Completed 14 Aug'77

Total Depth 200 Ft. Static W. Level Ft. Date — Meas. Pt.

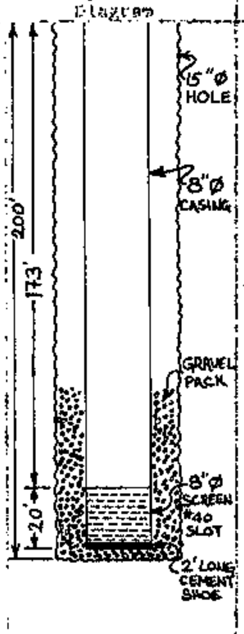
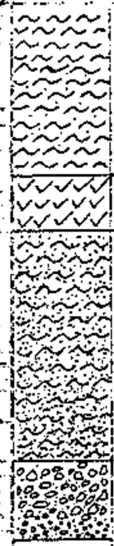
M. above — M.

Ft. below L.S.D. Elev. Ground Ft. Yield — Drawdown

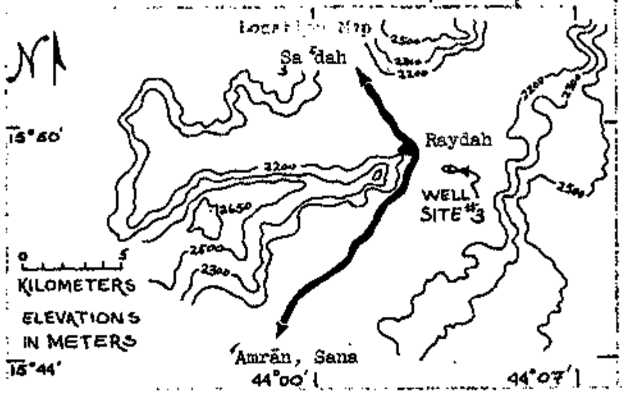
Driller Bannistijan Rig No. 5 Geophysical Log S.P.-Resistivity By J. Aubel

Samples Described By Saleh & Taj Date July'77 Other Data Production testhole

Pump Intake Depth M. Ft. Rated Capacity — Ft. Pumping Water Level M. Ft.

Rig Data / Pump Tests	Well Completion & Diagram	Depth (Feet)	Log	Lithologic Description
		50 100 150 200		0-65' Loam, yellow-brown; composed of sand and volcanics, 1/8-7 mm, rounded to subrounded. 65-85' Basalt, dark brown; w/ contamination of sand & gravel. 85-170' Sandy loam, yellow-brown; composed of 75% sand & 10% volcanics, 1/16-10 mm, rounded to subrounded; becomes less clayey from 165-170'. 170-200' Gravel, varied colored, 1/8-70 mm, rounded to subrounded; composed of volcanics and sand; 195-200' grain size is less than 20 mm.

Location Map



Key: Loam — Gravel — Sandy loam — Basalt

Raydah Middle #1

Project 025 — About 1 Km E of Km 66 marker, Sana-Sa'dah hwy, Amran Valley

Office No — Drlg Method: Rotary — Feb'76 — May'76

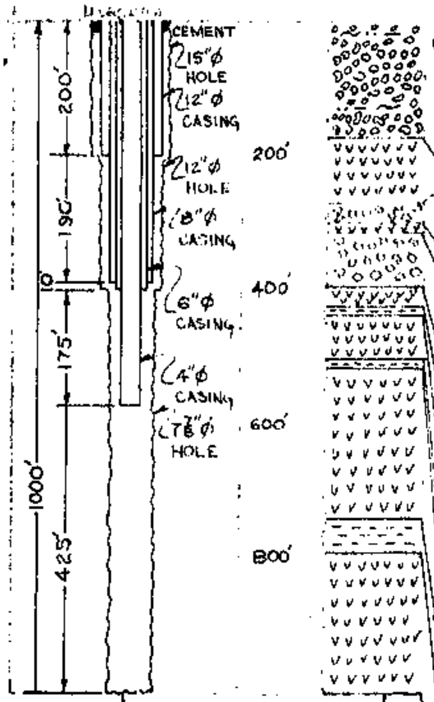
Total Depth 1000 Ft — 107.96 — 6 Feb'78 — Corrected to

L.S.D.

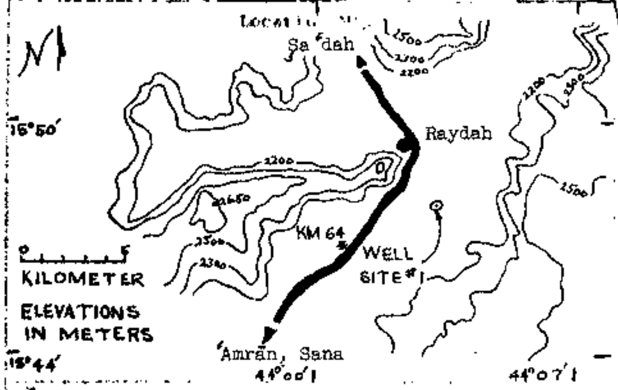
Driller Bannastijan, Rig No 2 — S.P. & Resistivity, Caliper, Natural Gamma, Density. — J.Aubel, J.Zaifullah

Samples Described By, Seluwi — Aug'76 — Hydrogeologic testhole

Pump Data: Depth — Level

Drlg. Data, Pump Tests etc.	Completion Diagram		Description
Observation well for aquifer test, 6-11, Feb '78			0-175' Gravel, varied colored, 1/16-40 mm, rounded to subrounded; 40% limestone; 30% sand; 30% basalt; 0-25', 115-140' silty loam, pale grey; w/some basalt, dark brown. 175-275' Basalt, dark brown. 275-300' Gravel, varied colored, ½-30 mm, rounded to subrounded; 50% basalt; 40% sand; 10% limestone. 300-315' Basalt, dark brown. 315-395' Gravel, varied colored, ½-30 mm, rounded to subrounded; 40% basalt; 35% sand; 25% limestone; 360-395' 1/16-4 mm. 395-425' Basalt, dark brown; w/ sand; 400-410', 420-425' w/some limestone; 410-425' w/out sand. 425-435' Clay, pale red-brown; w/few basalt fragments. 435-500' Basalt, dark brown; w/ some clay, red-brown; 455-500' w/sand. 500-515' Clay, pale red-brown; w/some basalt fragments; w/few sand. 515-735' Basalt, dark brown; w/ some sand. 735-785' Clay, pale red-brown; w/some limestone fragments; 745-750', 760-775' grey clay; 775-785' dark brown clay. 785-1000' Basalt, dark brown; w/abundant sand.

Location Map



Key: Silty loam — Gravel — Clay — Basalt

Site **Raydah Middle #2** — About 1 Km E of Km 66, Sana-Sa'dah hwy., Amrān Valley, 100' W. of well #1

Project **025**

Office No. — Rotary — May'76 — Nov'76

Total Depth 580 Ft

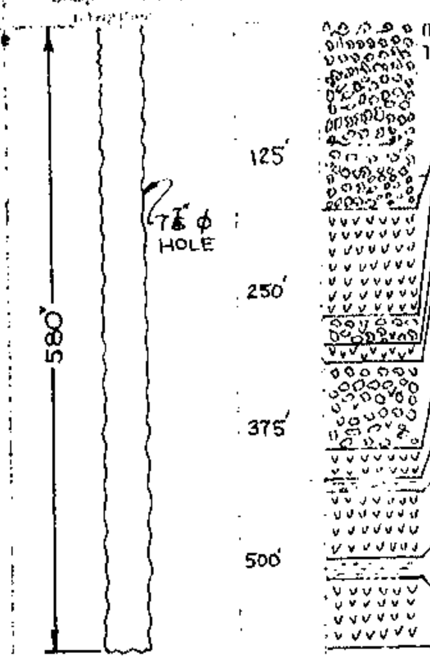
Driller **Bannastijan** Rig No 2 — Density, Natural Gamma, Res.-S.P., Caliper — J. Zaifullah

Samples Described By Seluwi — July'77 — Hydrologic testhole

Pump Data: Depth

Drlg. Data, Pump Tests etc.

Abandoned because of drilling problems.



0-175' Gravel, varied colored, 1/16-40 mm, rounded to subrounded; 40% limestone; 30% sand; 30% basalt; 0-25', 115-140' silty loam, pale grey; w/some basalt, dark brown.

175-275' Basalt, dark brown.

275-300' Gravel, varied colored, ½-30 mm, rounded to subrounded; 50% basalt; 40% sand; 10% limestone.

300-315' Basalt, dark brown.

315-395' Gravel, varied colored, ½-30 mm, rounded to subrounded; 40% basalt; 35% sand; 25% limestone; 360-395' 1/16-4 mm.

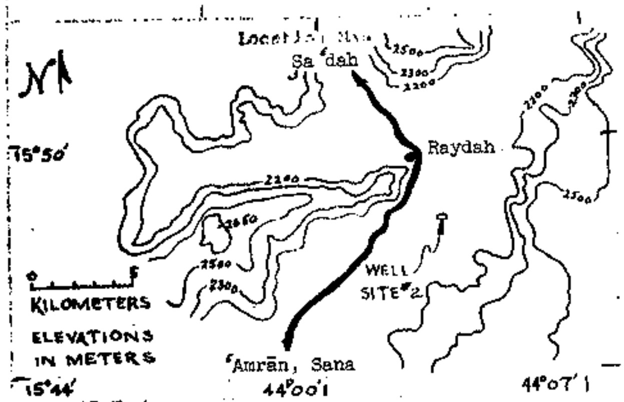
395-425' Basalt, dark brown; w/sand; 400-410', 420-425' w/some limestone; 410-425' w/out sand.

425-435' Clay, pale red-brown; w/few basalt fragments.

435-500' Basalt, dark brown; w/some clay, red-brown; 455-500' w/sand.

500-515' Clay, pale red-brown; w/some basalt fragments; w/few sand.

515-580' Basalt, dark brown; w/some sand.



Key: Silty loam — Clay — Gravel — Basalt

TABLE 6.--Driller's logs, Amran Valley, Yemen Arab Republic - Continued

Site Raydah Middle #3

Project 025 — About 1 Km east of Km marker, Sana- Ṣa'dah hwy, 'Amrān Valley, and 100' south of #1

Office No. — Rotary — Apr'77 — Jun'77

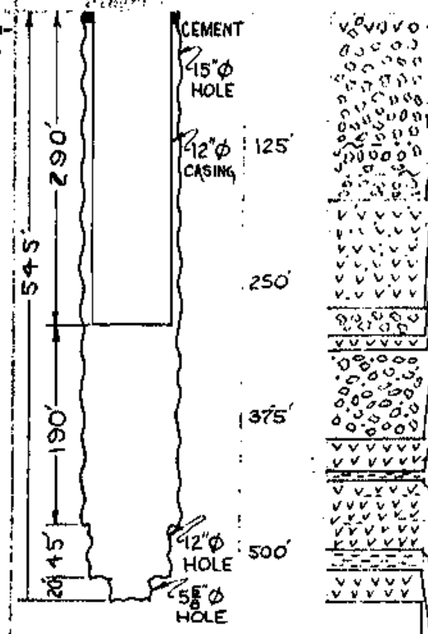
Total Depth 545

Drillers Banasijun — Gamma, Density, Resistivity, S.P., Caliper — Odaini, Aubel, Athary

Samples Described By — Hydrologic testhole

Pump Data: Depth

Drlg. Data Pump Tests etc.	Well Completion Diagram	Log
Borehole abandoned due to drilling problems.		



0-175' Gravel, varied colored, 1/16-40 mm, rounded to subrounded; 40% limestone; 30% quartz sand; 30% basalt; 0-25', 115-140' silty loam, pale grey; w/some basalt, dark brown.

175-275' Basalt, dark brown.

275-300' Gravel, varied colored, ½-30 mm, rounded to subrounded; 50% basalt; 40% sand; 10% limestone.

300-315' Basalt, dark brown.

315-395' Gravel, varied colored, ½-30 mm, rounded to subrounded; 40% basalt; 35% sand; 25% limestone; 360-395', 1/16-4 mm.

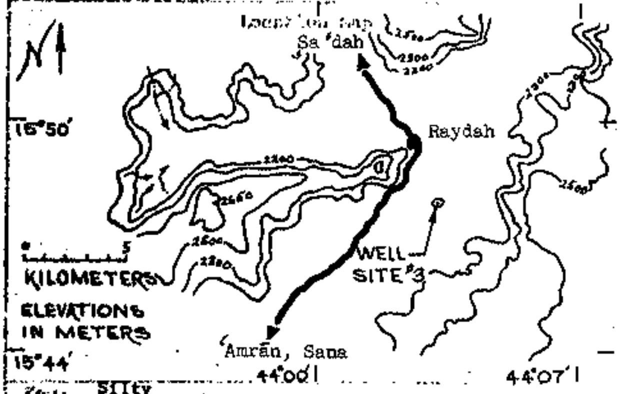
395-425' Basalt, dark brown; w/sand; 400-410', 420-425' w/some limestone; 410-425' w/out sand.

425-435' Clay, pale red-brown; w/few basalt fragments.

435-500' Basalt, dark brown; w/some clay, red-brown; 455-500' w/sand.

500-515' Clay, pale red-brown; w/some basalt fragments; w/few sand.

515-545' Basalt, dark brown; w/some sand.



Key: Silty loam — Gravel — Clay — Basalt

Site Raydah Middle 4

Project 025 — About 1 Km E of hwy, Km 66 marker, Sana-Sa'dah hwy, 'Amrān Valley, 100' NW of well #1

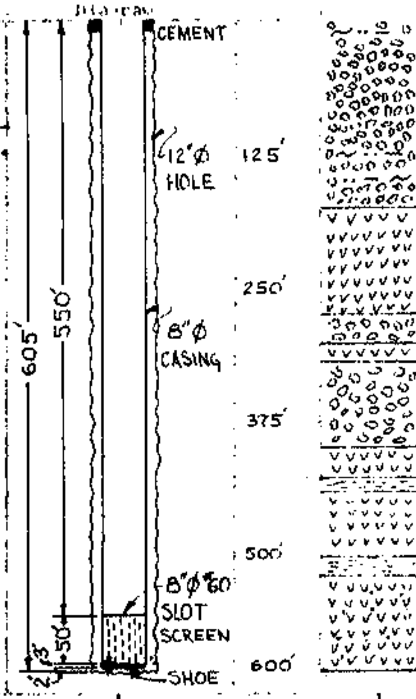
Office No. — Rotary — Sep '77 — Feb'78

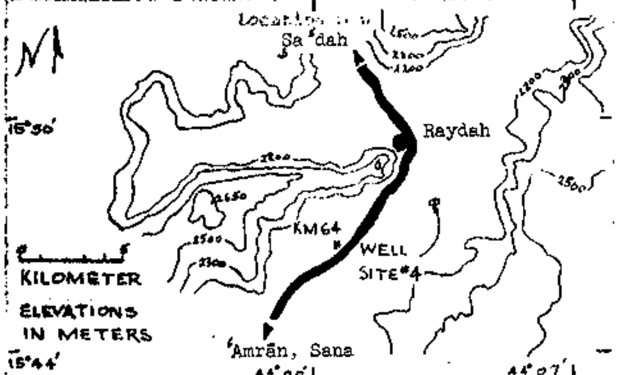
Total Depth 605 — 107.75 — 11 Feb'78 — corrected to L.S.D.

Driller H. Nagi — Rig No. 5 — Resistivity, caliper J.Ahmed

Samples Described By Al Thary — Feb '78 — Hydrologic testhole

Pump Data: Depth

Drlg. Data Pump Tests etc.	Completion Diagram	Lithologic Description
Aquifer Test: Pumped for 64 hours @ 154 GPM (9.7 l/s), w/ a total drawdown of 7.05 ft. (2.15m), pumping water level= 117.23 ft. (35.74m). Specific Capacity= 21.8 gallons/ft. dd., (4.5 l/s per m of drawdown).		0-175' Gravel, varied colored, 1/16-40 mm, rounded to subrounded; 40% limestone; 30% sand; 30% basalt; 0-25', 115-140' silty loam, pale grey; w/some basalt fragments, dark brown. 175-275' Basalt, dark brown. 275-300' Gravel, varied colored, ½-30 mm, rounded to subrounded; 50% basalt; 40% sand; 10% limestone. 300-315' Basalt, dark brown. 315-395' Gravel, varied colored, ½-30 mm, rounded to subrounded; 40% basalt; 35% sand; 25% limestone; 360-395', 1/16-4 mm. 395-425' Basalt, dark brown; w/ sand; 400-410', 420-425', w/some limestone; 410-425' w/out sand. 425-435' Clay, pale red-brown; w/few basalt fragments. 435-500' Basalt, dark brown; w/ some clay, red-brown; 455-500' w/sand. 500-515' Clay, pale red-brown; w/some basalt fragments; w/few sand. 515-605' Basalt, dark brown; w/ some sand.



Key: Silty loam; Gravel; Clay; Basalt

LOG OF ...

Sheet 1 of 1

Site Menjidah #1

Location: About 4 Km east of Km 64 marker, Sana-Sa'dah hwy, and about 0.5 Km south of Al Menjidah, Amrān Valley

Project 025

Method Rotary

Began 18 Jun'75 Completed 25 Jun'75

Total Depth 265 Ft

Static W Level Dry

Yield dry

Driller F. Osman

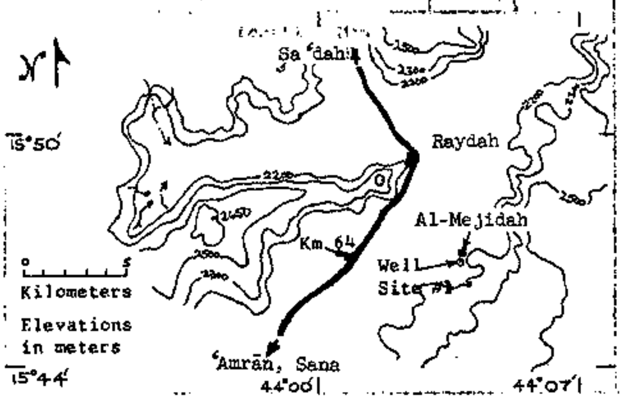
Rig No. 5

Geophysical Log - none

Samples Described By Adel Kaid, Date Sep'76

Other Data Hydrogeological testhole

Drlg Data Pump Tests etc	Well Completion & Diagram	Depth (Feet)	Log	Lithologic Description
Driller reports no traces of water found. 254-265' Limestone, very hard; used hard formation bit with 500 lbs. hydraulic pulldown, the speed was 1 foot per 37 minutes. No casing was installed.	265' 7 7/8" Ø HOLE	100 200 300		0-265' Limestone, buff to yellowish-grey; contaminated with some loam; 140-265' yellowish-buff to greyish-black, limestone.



Limestone

LOG OF WELL

Site Menjidah #2 — Location: About 4 Km east of Km 64 marker, Sana-Sa'dah hwy, about 0.5 Km south of Al Menjidah, and about 100 M west of Menjidah #1, Amrān Valley. — Sheet 1 of 1

Proj. 025

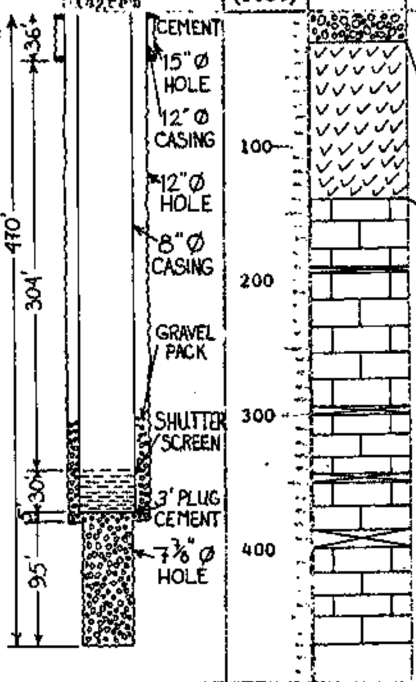
Drilling Method: Rotary — Begun 29 Jun'75 — Completed 10 Oct'75

Total Depth 470 Ft — Static W. Level 152.29 Ft (M. above to L.S.D.) — Date 1 Sept'76 — Corrected

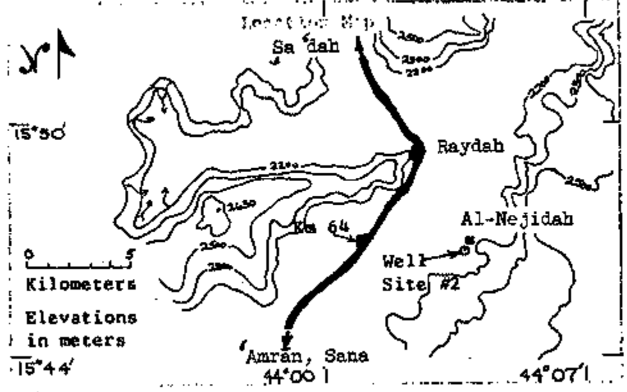
Driller F. Osman — Rig No. 5 — Geophysical Log: none

Samples Described By Saif Ali — Date Sept'76 — Other Data: Hydrologic testhole

Rated Capacity ____ @ ____ Ft. Pumping Water Level ____ Ft.

Drilling Data / Pump Tests	Well Completion & Diagram	Depth (Feet)	Log	Lithologic Description
Driller's report: Water first found at 190' increased with depth. Airlift tests: @ 275' was about 120 GPM. @ 400' was about 230 GPM. Well was screened and developed for use as a production well.				0-25' Gravel, pale yellowish-brown and black, fine to pebble size, rounded to angular; composed of limestone. 25-140' Vesicular basalt, dark brown; contaminated w/some limestone, pale yellowish; 35-40', 85-95' w/out limestone; 125-140' limestone is red. 140-470' Limestone, light red to pale yellowish-brown; w/ vesicular basalt; 140-160' all light red; 160-165', 180-185', 230-235', 250-255' w/out vesicular basalt; 305-325', 350-360', 370-385', 410-415', 425-430' w/ black limestone. (190-195', 295-300', 345-350', 385-400' Sample missing.)

Location Map



Gravel — Limestone — Basalt — Sample missing

TABLE 6.--Driller's logs, Amran Valley, Yemen Arab Republic - Continued

LOG OF WELL

Kharif #1,#2,#3,#4,#7 — Sheet 1 of 1

022 — About 4 Km northeast of Raydah, ʿAmrān Valley

Drilling Method: Rotary — Begun: Jun'74 — Completed: Oct'74

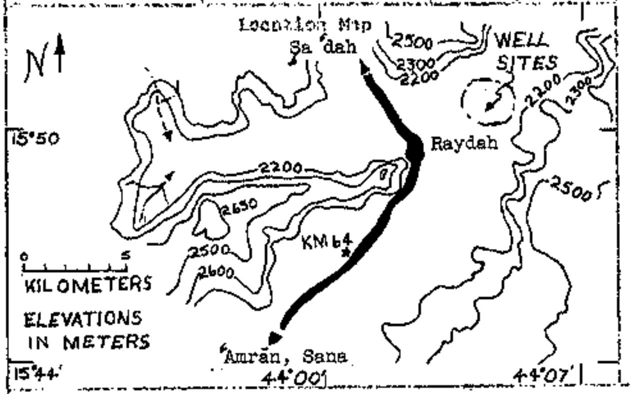
Total Depth ... M. Ft. Static W. Level ... M. Ft. Date ... Meas. Pt. ... M. above ... Ft. below L.S.D., Elev. Ground ... Ft. Yield ... Drawdown ...

Driller: Bourgoin Godshall — Rig No. – — Geophysical Log: none — By: –

Samples Described By: – — Date: – — Other Data: Boreholes abandoned

Pump Data: Depth ... M. Ft. Rated Capacity ... @ ... M. Ft. Pumping Water Level ... M. Ft.

Drlg. Data Pump Tests etc.	Well Completion & Diagram	Depth	Log	Lithologic Description
All wells were dry, drilled completely in basalt. #3 reached a possible TD of 281'. Tools were lost in hole #7.				Samples not available, inaccurate driller's Log.



Key:

Site Kharif #5 LOG OF WELL Sheet 1 of 1

Project 022-025 Location About 4 Km northeast of Raydah, ʿAmrān Valley Field No. ______

Office No. ______ Drlg Method Rotary ______ Begun Jun'74 Completed ______

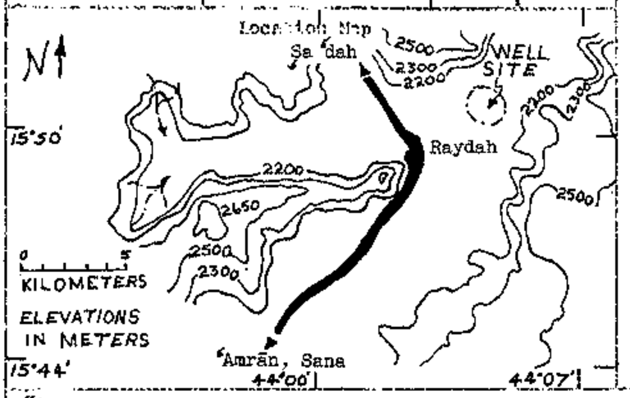
Total Depth 555 Ft. Static W. Level 342 Ft. Date 12Aug'74 Meas. Pt. –
M. above M.
______ Ft. below L.S.D., Elev.Ground ______ Ft. Yield ______ Drawdown ______

Driller Bourgoin Rig No. ______ Geophysical Log none ______ By ______

Samples Described By ______ Date ______ Other Data Borehole abandoned.

Pump Data: Depth ______ M. Ft. Rated Capacity ______ M. Ft. Pumping Water Level ______ M. Ft.

Drlg. Data Pump Tests etc.	Well Completion & Diagram	Depth	Log	Lithologic Description
Small amount of water hit on 17Jun'74, but not sufficient for development. Hole reopened on 12Aug '74. Hole had caved to 422' and had a SWL of 342'	None			Driller's Logs 0-555 ft. Basalt Samples not available



Key:

Site Kharif #6 — LOG OF WELL — Sheet 1 of 1

Project 025 Location About 2 Km northeast of Raydah, ʻAmrān Valley Field No. ______

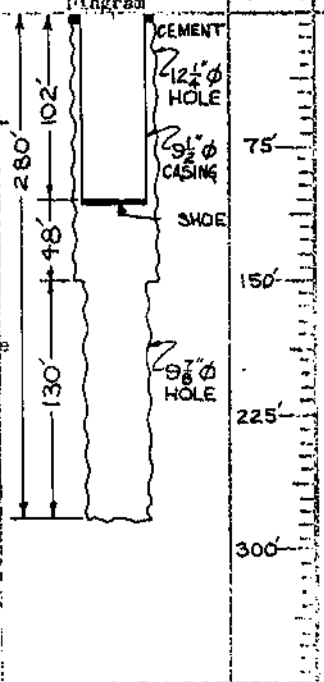
Office No. ______ Drlg.Method Rotary ______ Begun Sep'74 Completed Oct'74

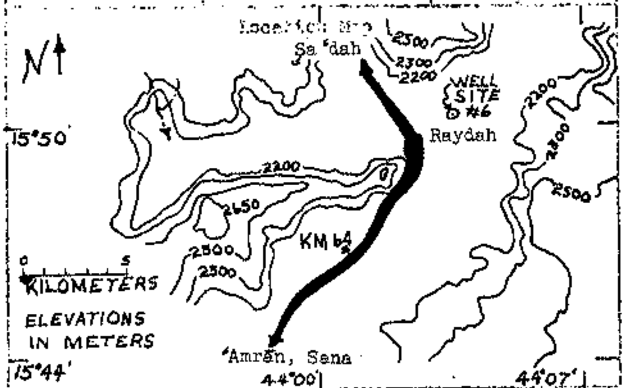
Total Depth 276 Ft. Static W. Level 109.9 Ft. Date 26Jul'75 Meas. Pt. Corrected to L.S.D. Ft. M. above below L.S.D., Elev.Ground ______ Ft. M. Yield ______ Drawdown ______

Driller R. Bourgoin Rig No. 1 Geophysical Log none ______ By —

Samples Described By ______ Date ______ Other Data Production well

Pump Data: Depth ______ Ft. M. Rated Capacity ______ Q ______ Ft. M. Pumping Water Level ______ Ft. M.

Drlg. Data Pump Tests etc.	Well Completion & Diagram	Depth (Feet)	Log	Lithologic Description
Driller reports 40 GPM by air-lift. Drawdown and recovery measurements could not be taken. It is assumed that the well could produce much more than 40 GPM because of fast recovery and surging of water outside the eductor pipe.				Samples not available, inaccurate driller's log.



Key:

LOG OF WELL

Site Al Sheikh (Km. 72) Sheet 1 of 1

Project 025 Location About 3 Km west of Km 72 marker on the Sana-Sa'dah hwy, Amrān Valley Field No.

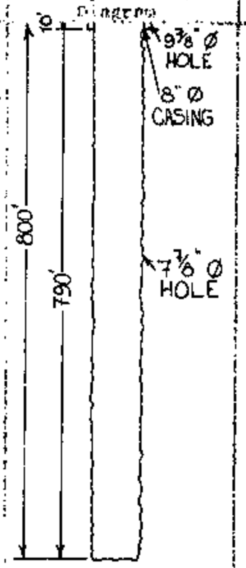
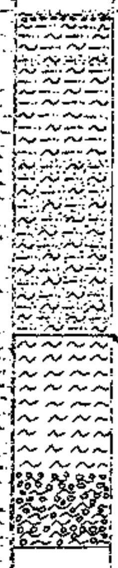
Office No. Drlg Method Rotary Begun 4Jun'75 Completed 28Jun'75

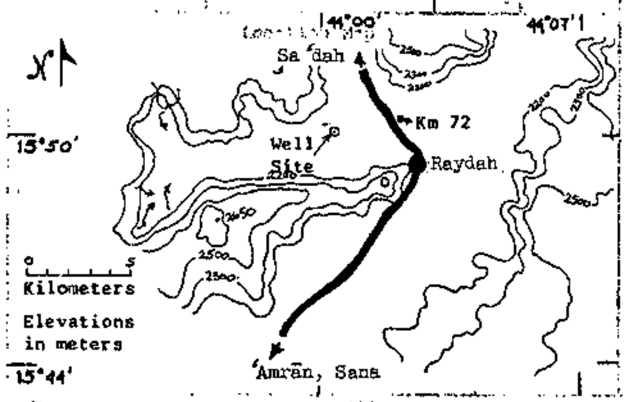
Total Depth 800 Ft Static W Level Dry Ft Date Meas Pt. M. above Ft below L.S.D., Elev Ground Ft Yield Drawdown

Driller H. Nagi Rig No. 2 Geophysical Log By

Samples Described By M.L. Eryani Date Oct '76 Other Data Hydrogeologic testhole.

Pump Data: Depth M. Ft Rated Capacity @ M. Ft Pumping Water Level M. Ft

Drlg. Data Pump Tests etc	Well Completion & Diagram	Depth (Feet)	Log	Lithologic Description
Driller reports slight trace of water, not measurable. Borehole was not developed.		200, 400, 600, 800		0-485' Silty loam, pale yellowish-orange; calcareous; 5-10' gravel, varied colored, pebble size, angular to rounded, poorly sorted; 90% limestone; 10% clay; calcareous; 15-20' w/few rounded to subrounded limestone grains; 20-25' dark-brown; 75-85', 230-245', 250-470' w/very few fine to very fine limestone grains; 165-175', 210-215', 220-225' white, highly calcareous; 175-180', 215-220', 225-230' moderately calcareous; 445-455', 470-485' w/clay, brownish-black. 485-800' Loam, pale yellowish-brown, calcareous; w/15-20% gravel, varied colored, very fine to granule, angular to subrounded; composed of limestone; 625-650' w/10% gravel; 680-690' w/10% gravel, 3% calcrete; 690'-730' w/40-50% gravel, 5% calcrete; 730-800' w/40-50% gravel, no calcrete.



Loam | Silty loam | Sandy loam | Gravel

Al Gusair #1 (Al Chola #1)

025

North of Km 76, Sana-Sa'dah hwy in the wadi below the village of Al Gusair, Amran Valley

Sheet 1 of 1

Rotary

Feb'75

410

Yield none

F. Osman

5

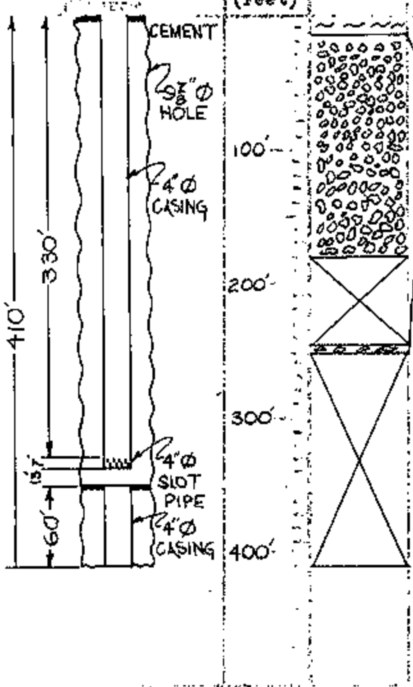
Geophysical Log none

Saif Ali

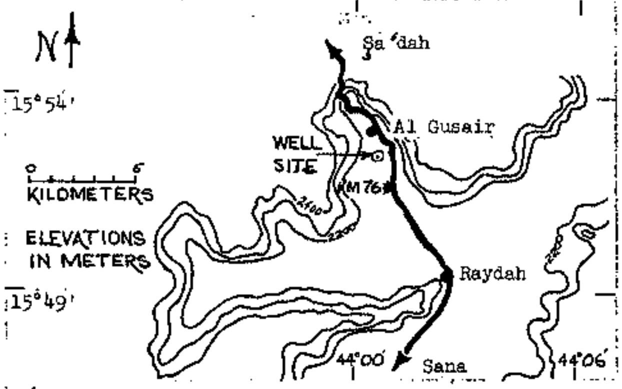
Date Oct'76

Other Data Hydrogeologic testhole - Abandoned.

Well abandoned because of technical problems.



Depth (Feet)	Lithologic Description
0-15'	Loam, silty, pale yellow orange.
15-250'	Gravel, pale yellow, brown and black, 2.0-4.0mm, angular to subrounded, limestone origin.
	(180-245', 250-410' samples missing.)



Silty loam

Gravel

Sample Missing

TABLE 6.--Driller's logs, Amran Valley, Yemen Arab Republic - Continued

Site Km. 76 (Al Jaola #2) LOG OF WELL Sheet 1 of 1

Project 025 Location North of Km 76, Sana-Sa'dah hwy, at the base of the limestone cliff, Al Gusair, Field No. Km. 76 Amran Valley

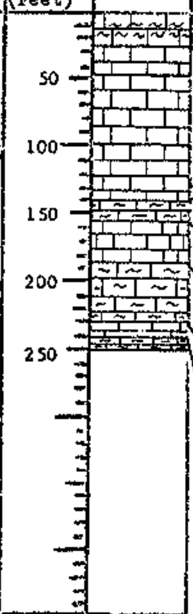
Office No. ___ Drlg. Method Rotary Begun 30Jun75 Completed 6July75

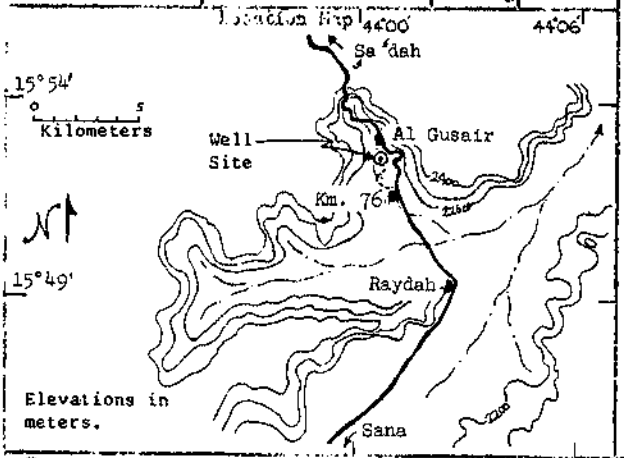
Total Depth 250 Ft Static W. Level None Ft Date 6July75 Meas. Pt. - above/below L.S.D., Elev. Ground ___ Yield - Drawdown -

Driller H. Stovall Rig No. 2 Geophysical Log - By -

Samples Described by Salah Wasse Date Aug76 Other Data Hydrogeologic testhole.

Drlg. Data Pump Tests etc.	Well Completion & Diagram	Depth (Feet)	Log	Lithologic Description
Penetration rate from 247 Ft. to 248 ft. was 9 min. at 75 rpm and a 2500 hydraulic pulldown pressure 850 psi torque. No traces of water.	250'; 7 7/8" Ø hole; No casing	50, 100, 150, 200, 250		0-140 Limestone, greyish-white; 5-10 with quartz, subrounded; 15-20 with loam, pale orange. 140-155 Argillaceous limestone, pale grey. 155-185 Limestone, greyish-white. 185-230 Argillaceous limestone, pale grey; 220-225 w/ large amount of calcite. 230-240 Limestone, greyish-white. 240-250 Argillaceous limestone, greyish-white.





Key: Loam; Argillaceous limestone; Limestone

Site Al Gusair #3(Al Ghola #3) Log of [illegible] Sheet 1 of 1

Project 025 Location North of Km 76, Sana-Sa'dah hwy, in the wadi below the village of Al Gusair, Amrān Valley Field No. ____

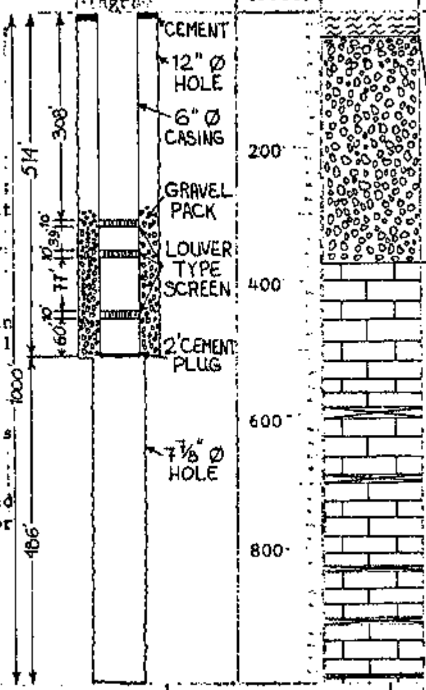
Office No. ____ Drig Method Rotary Begun 7 Jul'75 Completed 17 Nov'75

Total Depth 1000' Ft. Static Water Level 259'00" / 262.72' Ft. Date 17 Dec'75 / 16 May'76 Meas. Pt. Corrected to L.S.D. M. above Datum L.S.D., Alt. Ground ____ Ft. Yield ____ Drawdown ____

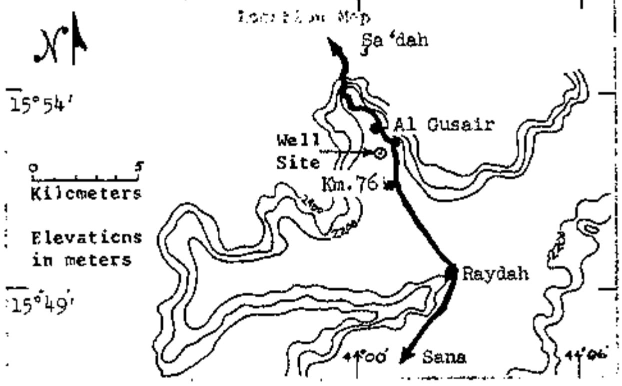
Driller H. Nagi Rig No. 2 Geophysical Log ____ By ____

Samples Described By Taj Yahya Date Oct'76 Other Data Hydrogeologic testhole - Production well.

Pump Intake Depth ____ M. Ft. Rated Capacity ____ @ ____ Ft. Pumping Water Level ____ M. Ft.

Drilling Data / Pump Tests	Well Completion & Diagram	Depth (Feet)	Log	Lithologic Description
Driller's Report: @425' limestone with some water. @870' loss of about 1,400 gallons of mud. Penetration rate; w/ 7 7/8" soft bit @494-500' slow, @876-879'=5 min/ft.@200 lbs pull-down, @920-921'=6.5 min/ft.@200 lbs pull-back. Airlift test: @600' for 3 hours =about 65 GPM. Well was screened and developed for production use.		200 400 600 800		0-40' Loam,dark brown;5-20', 35-40' w/abundant limestone fragments,pale grey;20-35' loam is silty;w/some limestone fragments. 40-375' Gravel,pale grey,angular to subangular;98% limestone,2% loam;50-55' loam increases;170-200',205-375' w/some black limestone;280-375' w/out loam. 375-1000' Limestone,pale grey; 400-570',625-785' w/25% black limestone;780-1000' w/90% black limestone. (590-605',690-700',825-830', 900-905',985-990' Sample missing)

Location Map



Loam ≈≈ Limestone ┼┼ Gravel Sample missing ⨯

CHEMICAL ANALYSES OF GROUND WATER, TABLE 7

All analyses were performed by the U.S. Geological Survey's Central Laboratory, Atlanta, Georgia.

Lab ID number is shown in the remarks column of well inventory table 5. Well numbers of table 5 are given here in the sample location entry.

TABLE 7.--Chemical analyses of ground water in Amran Valley, Yemen Arab Republic

WATER QUALITY ANALYSIS
LAB ID # 121901 RECORD # 6841

SAMPLE LOCATION: #142 MENJIDAH USAID WELL #2
STATION ID: 99999999 LAT.LONG.SEQ.: * NONE GIVEN *
DATE OF COLLECTION: BEGIN--750924 END-- TIME--0001
COUNTY CODE: PROJECT IDENTIFICATION:
DATA TYPE: 2 SOURCE: GROUND WATER GEOLOGIC UNIT: LIMESTONE
COMMENTS:

ALK,TOT (AS CACO3)	MG/L	110	POTASSIUM DISS	MG/L	2.3
BICARBONATE	MG/L	130	RESIDUE DIS CALC SUM	MG/L	256
BORON DISSOLVED	UG/L	70	RESIDUE DIS TON/AFT		0.37
CALCIUM DISS	MG/L	33	RESIDUE DIS 180C	MG/L	270
CHLORIDE DISS	MG/L	21	SAR		0.6
HARDNESS NONCARB	MG/L	58	SILICA DISSOLVED	MG/L	38
HARDNESS TOTAL	MG/L	160	SODIUM DISS	MG/L	18
MAGNESIUM DISS	MG/L	20	SODIUM PERCENT		19
NO2+NO3 AS N DISS	MG/L	4.4	SP. CONDUCTANCE LAB		377
PH LAB		8.0	SULFATE DISS	MG/L	40

CATIONS	(MG/L)	(MEQ/L)	ANIONS	(MG/L)	(MEQ/L)
CALCIUM DISS	33	1.647	BICARBONATE	130	2.131
MAGNESIUM DISS	20	1.646	CHLORIDE DISS	21	0.593
POTASSIUM DISS	2.3	0.059	SULFATE DISS	40	0.833
SODIUM DISS	18	0.783	NO2+NO3 AS N D	4.4	0.315
	TOTAL	4.134		TOTAL	3.870

PERCENT DIFFERENCE = 3.29

TABLE 7.--Chemical analyses of ground water in Amran Valley, Yemen Arab Republic - continued

WATER QUALITY ANALYSIS
LAB ID # 121902 RECORD # 6843

SAMPLE LOCATION: #195 BIR SHEBARI
STATION ID: 99999999 LAT.LONG.SEQ.: * NONE GIVEN *
DATE OF COLLECTION: BEGIN--770904 END-- TIME--0001
COUNTY CODE: PROJECT IDENTIFICATION:
DATA TYPE: 2 SOURCE: GROUND WATER GEOLOGIC UNIT: BASALT
COMMENTS:

ALK.TOT (AS CACO3)	MG/L	150	RESIDUE DIS CALC SUM	MG/L	313
BICARBONATE	MG/L	180	RESIDUE DIS TON/AFT		0.53
CALCIUM DISS	MG/L	43	RESIDUE DIS 180C	MG/L	388
CHLORIDE DISS	MG/L	28	SAR		0.8
HARDNESS NONCARB	MG/L	42	SILICA DISSOLVED	MG/L	34
HARDNESS TOTAL	MG/L	190	SODIUM DISS	MG/L	26
MAGNESIUM DISS	MG/L	20	SODIUM PERCENT		23
NO2+NO3 AS N DISS	MG/L	6.2	SP. CONDUCTANCE FLD		500
PH LAB		8.3	SP. CONDUCTANCE LAB		496
POTASSIUM DISS	MG/L	2.6	SULFATE DISS	MG/L	43

CATIONS	(MG/L)	(MEQ/L)	ANIONS	(MG/L)	(MEQ/L)
CALCIUM DISS	43	2.146	BICARBONATE	180	2.951
MAGNESIUM DISS	20	1.646	CHLORIDE DISS	28	0.790
POTASSIUM DISS	2.6	0.067	SULFATE DISS	43	0.896
SODIUM DISS	26	1.131	NO2+NO3 AS N D	6.2	0.443
TOTAL		4.988	TOTAL		5.078

PERCENT DIFFERENCE = -0.89

TABLE 7.--Chemical analyses of ground water in Amran Valley, Yemen Arab Republic - Continued

WATER QUALITY ANALYSIS
LAB ID.# 121903 RECORD # 6845

SAMPLE LOCATION: #207 RAYDAH SOUTH COMPLEX WELL #3 YEMEN
STATION ID: 99999999 LAT.LONG.SEQ.: * NONE GIVEN *
DATE OF COLLECTION: BEGIN--770823 END-- TIME--0001
COUNTY CODE: PROJECT IDENTIFICATION:
DATA TYPE: 2 SOURCE: GROUND WATER GEOLOGIC UNIT: ALLUVIUM
COMMENTS:

ALK.TOT (AS CACO3)	MG/L	30	POTASSIUM DISS	MG/L	2.0
BICARBONATE	MG/L	60	RESIDUE DIS CALC SUM	MG/L	261
BORON DISSOLVED	UG/L	60	RESIDUE DIS TON/AFT		0.36
CALCIUM DISS	MG/L	37	RESIDUE DIS 180C	MG/L	265
CHLORIDE DISS	MG/L	23	SAR		0.8
HARDNESS NONCARB	MG/L	31	SILICA DISSOLVED	MG/L	30
HARDNESS TOTAL	MG/L	160	SODIUM DISS	MG/L	22
MAGNESIUM DISS	MG/L	17	SODIUM PERCENT		23
NO2+NO3 AS N DISS	MG/L	4.4	SP. CONDUCTANCE FLD		425
PH LAB		8.5	SP. CONDUCTANCE LAB		413
			SULFATE DISS	MG/L	32

CATIONS	(MG/L)	(MEQ/L)	ANIONS	(MG/L)	(MEQ/L)
CALCIUM DISS	37	1.847	BICARBONATE	160	2.623
MAGNESIUM DISS	17	1.399	CHLORIDE DISS	23	0.649
POTASSIUM DISS	2.0	0.052	SULFATE DISS	32	0.667
SODIUM DISS	22	0.957	NO2+NO3 AS N D	4.4	0.315
	TOTAL	4.253		TOTAL	4.252

PERCENT DIFFERENCE = 0.01

TABLE 7.--Chemical analyses of ground water in Amran Valley, Yemen Arab Republic - Continued

WATER QUALITY ANALYSIS
LAB ID # 121904 RECORD # 6847

SAMPLE LOCATION: #276 BIR AL-SHAHDI #1
STATION ID: 99999999 LAT.LONG.SEQ.: * NONE GIVEN *
DATE OF COLLECTION: BEGIN--770925 END-- TIME--0001
COUNTY CODE: PROJECT IDENTIFICATION:
DATA TYPE: 2 SOURCE: GROUND WATER GEOLOGIC UNIT: ALLUVIUM
COMMENTS:

ALK,TOT (AS CACO3)	MG/L	190	RESIDUE DIS CALC SUM	MG/L	426
BICARBONATE	MG/L	230	RESIDUE DIS TON/AFT		0.66
CALCIUM DISS	MG/L	84	RESIDUE DIS 180C	MG/L	486
CHLORIDE DISS	MG/L	43	SAR		0.6
HARDNESS NONCARB	MG/L	130	SILICA DISSOLVED	MG/L	21
HARDNESS TOTAL	MG/L	320	SODIUM DISS	MG/L	25
MAGNESIUM DISS	MG/L	27	SODIUM PERCENT		14
PH LAB		7.7	SP. CONDUCTANCE FLD		670
POTASSIUM DISS	MG/L	2.5	SP. CONDUCTANCE LAB		742
			SULFATE DISS	MG/L	110

CATIONS	(MG/L)	(MEQ/L)	ANIONS	(MG/L)	(MEQ/L)
CALCIUM DISS	84	4.192	BICARBONATE	230	3.770
MAGNESIUM DISS	27	2.222	CHLORIDE DISS	43	1.214
POTASSIUM DISS	2.5	0.064	SULFATE DISS	110	2.291
SODIUM DISS	25	1.088			
	TOTAL	7.564		TOTAL	7.273

PERCENT DIFFERENCE = 1.96

TABLE 7.--Chemical analyses of ground water in Amran Valley, Yemen Arab Republic - Continued

WATER QUALITY ANALYSIS
LAB ID # 121905 RECORD # 6849

SAMPLE LOCATION: #186 BIR MAKIR NAJI AIASH
STATION ID: 99999999 LAT.LONG.SEQ.: * NONE GIVEN *
DATE OF COLLECTION: BEGIN--770925 END-- TIME--0001
COUNTY CODE: PROJECT IDENTIFICATION:
DATA TYPE: 2 SOURCE: GROUND WATER GEOLOGIC UNIT: ALLUVIUM
COMMENTS:

ALK.TOT (AS CACO3)	MG/L	110	RESIDUE DIS CALC SUM	MG/L	265
BICARBONATE	MG/L	140	RESIDUE DIS TON/AFT		0.39
CALCIUM DISS	MG/L	35	RESIDUE DIS 180C	MG/L	286
CHLORIDE DISS	MG/L	29	SAR		0.7
HARDNESS NONCARB	MG/L	51	SILICA DISSOLVED	MG/L	22
HARDNESS TOTAL	MG/L	170	SODIUM DISS	MG/L	22
MAGNESIUM DISS	MG/L	19	SODIUM PERCENT		22
NO2+NO3 AS N DISS	MG/L	5.6	SP. CONDUCTANCE FLD		490
PH LAB		8.0	SP. CONDUCTANCE LAB		437
POTASSIUM DISS	MG/L	2.8	SULFATE DISS	MG/L	41

CATIONS	(MG/L)	(MEQ/L)	ANIONS	(MG/L)	(MEQ/L)
CALCIUM DISS	35	1.747	BICARBONATE	140	2.295
MAGNESIUM DISS	19	1.563	CHLORIDE DISS	29	0.819
POTASSIUM DISS	2.8	0.072	SULFATE DISS	41	0.854
SODIUM DISS	22	0.957	NO2+NO3 AS N D	5.6	0.400
	TOTAL	4.338		TOTAL	4.366

PERCENT DIFFERENCE = -0.32

TABLE 7.--Chemical analyses of ground water in Amran Valley, Yemen Arab Republic - Continued

WATER QUALITY ANALYSIS
LAB ID # 121906 RECORD # 6851

SAMPLE LOCATION: #200 BIR BADAH
STATION ID: 99999999 LAT.LONG.SEQ : * NONE GIVEN *
DATE OF COLLECTION: BEGIN--770925 END-- TIME--0001
COUNTY CODE: PROJECT IDENTIFICATION:
DATA TYPE: 2 SOURCE: GROUND WATER GEOLOGIC UNIT: ALLUVIUM
COMMENTS:

ALK.TOT (AS CACO3)	MG/L	160	RESIDUE DIS CALC SUM	MG/L	369
BICARBONATE	MG/L	200	RESIDUE DIS TON/AFT		0.57
CALCIUM DISS	MG/L	68	RESIDUE DIS 180C	MG/L	421
CHLORIDE DISS	MG/L	42	SAR		0.7
HARDNESS NONCARB	MG/L	96	SILICA DISSOLVED	MG/L	26
HARDNESS TOTAL	MG/L	260	SODIUM DISS	MG/L	26
MAGNESIUM DISS	MG/L	22	SODIUM PERCENT		18
PH LAB		8.0	SP. CONDUCTANCE FLD		610
POTASSIUM DISS	MG/L	2.5	SP. CONDUCTANCE LAB		641
			SULFATE DISS	MG/L	84

CATIONS	(MG/L)	(MEQ/L)	ANIONS	(MG/L)	(MEQ/L)
CALCIUM DISS	68	3.394	BICARBONATE	200	3.278
MAGNESIUM DISS	22	1.810	CHLORIDE DISS	42	1.185
POTASSIUM DISS	2.5	0.064	SULFATE DISS	84	1.749
SODIUM DISS	26	1.131			
	TOTAL	6.398		TOTAL	6.212

PERCENT DIFFERENCE = 1.48

TABLE 7.--Chemical analyses of ground water in Amran Valley, Yemen Arab Republic - Continued

WATER QUALITY ANALYSIS
LAB ID # 121907 RECORD # 6853

SAMPLE LOCATION: #341 BIR AL-KARAB
STATION ID: 99999999 LAT.LONG.SEQ.: * NONE GIVEN *
DATE OF COLLECTION: BEGIN--770924 END-- TIME--0001
COUNTY CODE: PROJECT IDENTIFICATION:
DATA TYPE: 2 SOURCE: GROUND WATER GEOLOGIC UNIT: BASALT
COMMENTS:

ALK.TOT (AS CACO3)	MG/L	210	RESIDUE DIS CALC SUM	MG/L	554
BICARBONATE	MG/L	260	RESIDUE DIS TON/AFT		0.88
CALCIUM DISS	MG/L	100	RESIDUE DIS 180C	MG/L	648
CHLORIDE DISS	MG/L	39	SAR		0.7
HARDNESS NONCARB	MG/L	180	SILICA DISSOLVED	MG/L	16
HARDNESS TOTAL	MG/L	400	SODIUM DISS	MG/L	31
MAGNESIUM DISS	MG/L	36	SODIUM PERCENT		14
PH LAB		8.0	SP. CONDUCTANCE LAB		888
POTASSIUM DISS	MG/L	3.7	SULFATE DISS	MG/L	200

CATIONS	(MG/L)	(MEQ/L)	ANIONS	(MG/L)	(MEQ/L)
CALCIUM DISS	100	4.990	BICARBONATE	260	4.262
MAGNESIUM DISS	36	2.962	CHLORIDE DISS	39	1.101
POTASSIUM DISS	3.7	0.095	SULFATE DISS	200	4.164
SODIUM DISS	31	1.349			
TOTAL		9.394	TOTAL		9.526

PERCENT DIFFERENCE = -0.69

TABLE 7.--Chemical analyses of ground water in Amran Valley, Yemen Arab Republic - Continued

WATER QUALITY ANALYSIS
LAB ID # 121908 RECORD # 6855

SAMPLE LOCATION: #209 WAREHOUSE PUMP TEST
STATION ID: 99999999 LAT.LONG.SEQ.: * NONE GIVEN *
DATE OF COLLECTION: BEGIN--770711 END-- TIME--0001
COUNTY CODE: PROJECT IDENTIFICATION:
DATA TYPE: 2 SOURCE: GROUND WATER GEOLOGIC UNIT: ALLUVIUM AND BASALT
COMMENTS:

ALK.TOT (AS CACO3)	MG/L	120	POTASSIUM DISS	MG/L	2.2
BICARBONATE	MG/L	150	RESIDUE DIS CALC SUM	MG/L	300
BORON DISSOLVED	UG/L	70	RESIDUE DIS TON/AFT		0.37
CALCIUM DISS	MG/L	40	RESIDUE DIS 180C	MG/L	274
CHLORIDE DISS	MG/L	23	SAR		1.2
HARDNESS NONCARB	MG/L	26	SILICA DISSOLVED	MG/L	19
HARDNESS TOTAL	MG/L	150	SODIUM DISS	MG/L	33
MAGNESIUM DISS	MG/L	12	SODIUM PERCENT		32
NO2+NO3 AS N DISS	MG/L	12	SP. CONDUCTANCE FLD		440
PH LAB		8.0	SP. CONDUCTANCE LAB		441
			SULFATE DISS	MG/L	44

CATIONS	(MG/L)	(MEQ/L)	ANIONS	(MG/L)	(MEQ/L)
CALCIUM DISS	40	1.996	BICARBONATE	150	2.459
MAGNESIUM DISS	12	0.988	CHLORIDE DISS	23	0.649
POTASSIUM DISS	2.2	0.057	SULFATE DISS	44	0.917
SODIUM DISS	33	1.436	NO2+NO3 AS N D	12	0.857
TOTAL		4.475	TOTAL		4.880

PERCENT DIFFERENCE = -4.33

TABLE 7.--Chemical analyses of ground water in Amran Valley, Yemen Arab Republic - Continued

WATER QUALITY ANALYSIS
LAB ID # 121909 RECORD # 6857

SAMPLE LOCATION: #345 AMRAN CITY DUG WELL
STATION ID: 99999999 LAT.LONG.SEQ.: * NONE GIVEN *
DATE OF COLLECTION: BEGIN--770924 END-- TIME--0001
COUNTY CODE: PROJECT IDENTIFICATION:
DATA TYPE: 2 SOURCE: GROUND WATER GEOLOGIC UNIT: NOT DETERMINED
COMMENTS:

ALK.TOT (AS CACO3)	MG/L	180	RESIDUE DIS CALC SUM	MG/L	295
BICARBONATE	MG/L	220	RESIDUE DIS TON/AFT		0.47
CALCIUM DISS	MG/L	56	RESIDUE DIS 180C	MG/L	347
CHLORIDE DISS	MG/L	32	SAR		0.5
HARDNESS NONCARB	MG/L	50	SILICA DISSOLVED	MG/L	19
HARDNESS TOTAL	MG/L	230	SODIUM DISS	MG/L	16
MAGNESIUM DISS	MG/L	22	SODIUM PERCENT		13
PH LAB		7.7	SP. CONDUCTANCE FLD		600
POTASSIUM DISS	MG/L	2.4	SP. CONDUCTANCE LAB		546
			SULFATE DISS	MG/L	39

CATIONS	(MG/L)	(MEQ/L)	ANIONS	(MG/L)	(MEQ/L)
CALCIUM DISS	56	2.795	BICARBONATE	220	3.606
MAGNESIUM DISS	22	1.810	CHLORIDE DISS	32	0.903
POTASSIUM DISS	2.4	0.062	SULFATE DISS	39	0.812
SODIUM DISS	16	0.696			
TOTAL		5.361	TOTAL		5.320

PERCENT DIFFERENCE = 0.38

TABLE 7.--Chemical analyses of ground water in Amran Valley, Yemen Arab Republic - Continued

WATER QUALITY ANALYSIS
LAB ID # 121910 RECORD # 6859

SAMPLE LOCATION: #204 RAYDAH MIDDLE
STATION ID: 99999999 LAT.LONG.SEQ.: * NONE GIVEN *
DATE OF COLLECTION: BEGIN--780207 END-- TIME--0001
COUNTY CODE: PROJECT IDENTIFICATION:
DATA TYPE: 2 SOURCE: GROUND WATER GEOLOGIC UNIT: BASALT
COMMENTS:

ALK.TOT (AS CACO3)	MG/L	130	RESIDUE DIS CALC SUM	MG/L	251
BICARBONATE	MG/L	160	RESIDUE DIS TON/AFT		0.38
BORON DISSOLVED	UG/L	50	RESIDUE DIS 180C	MG/L	283
CALCIUM DISS	MG/L	39	SAR		0.8
CHLORIDE DISS	MG/L	26	SILICA DISSOLVED	MG/L	27
HARDNESS NONCARB	MG/L	32	SODIUM DISS	MG/L	24
HARDNESS TOTAL	MG/L	160	SODIUM PERCENT		24
MAGNESIUM DISS	MG/L	16	SP. CONDUCTANCE FLD		413
PH LAB		8.3	SP. CONDUCTANCE LAB		433
POTASSIUM DISS	MG/L	2.1	SULFATE DISS	MG/L	38

CATIONS	(MG/L)	(MEQ/L)	ANIONS	(MG/L)	(MEQ/L)
CALCIUM DISS	39	1.947	BICARBONATE	160	2.623
MAGNESIUM DISS	16	1.317	CHLORIDE DISS	26	0.734
POTASSIUM DISS	2.1	0.054	SULFATE DISS	38	0.792
SODIUM DISS	24	1.044			
TOTAL		4.360	TOTAL		4.147

PERCENT DIFFERENCE = 2.50

TABLE 7.--Chemical analyses of ground water in Amran Valley, Yemen Arab Republic - Continued

WATER QUALITY ANALYSIS
LAB ID # 121911 RECORD # 6861

SAMPLE LOCATION: #394 BIR HEWAL
STATION ID: 99999999 LAT.LONG.SEQ.: * NONE GIVEN *
DATE OF COLLECTION: BEGIN--770927 END-- TIME--0001
COUNTY CODE: PROJECT IDENTIFICATION:
DATA TYPE: 2 SOURCE: GROUND WATER GEOLOGIC UNIT: FINE SAND
COMMENTS:

ALK.TOT (AS CACO3)	MG/L	250	RESIDUE DIS CALC SUM	MG/L	330
BICARBONATE	MG/L	300	RESIDUE DIS TON/AFT		0.
CALCIUM DISS	MG/L	68	RESIDUE DIS 180C	MG/L	358
CHLORIDE DISS	MG/L	23	SAR		0.
HARDNESS NONCARB	MG/L	2	SILICA DISSOLVED	MG/L	23
HARDNESS TOTAL	MG/L	250	SODIUM DISS	MG/L	22
MAGNESIUM DISS	MG/L	19	SODIUM PERCENT		16
PH LAB		7.4	SP. CONDUCTANCE FLD		580
POTASSIUM DISS	MG/L	1.9	SP. CONDUCTANCE LAB		591
			SULFATE DISS	MG/L	25

CATIONS	(MG/L)	(MEQ/L)	ANIONS	(MG/L)	(MEQ/L)
CALCIUM DISS	68	3.394	BICARBONATE	300	4.917
MAGNESIUM DISS	19	1.563	CHLORIDE DISS	23	0.649
POTASSIUM DISS	1.9	0.049	SULFATE DISS	25	0.521
SODIUM DISS	22	0.957			
TOTAL		5.962	TOTAL		6.086

PERCENT DIFFERENCE = -1.03

TABLE 7.--Chemical analyses of ground water in Amran Valley, Yemen Arab Republic - Continued

WATER QUALITY ANALYSIS
LAB ID # 121912 RECORD # 6863

SAMPLE LOCATION: #383 AL-HJAZ USAID WELL
STATION ID: 99999999 LAT.LONG.SEQ.: * NONE GIVEN *
DATE OF COLLECTION: BEGIN--770927 END-- TIME--0001
COUNTY CODE: PROJECT IDENTIFICATION:
DATA TYPE: 2 SOURCE: GROUND WATER GEOLOGIC UNIT: LIMESTONE
COMMENTS:

ALK.TOT (AS CACO3)	MG/L	170	RESIDUE DIS CALC SUM	MG/L	1420
BICARBONATE	MG/L	210	RESIDUE DIS TON/AFT		2.16
BORON DISSOLVED	UG/L	160	RESIDUE DIS 180C	MG/L	1590
CALCIUM DISS	MG/L	270	SAR		0.7
CHLORIDE DISS	MG/L	34	SILICA DISSOLVED	MG/L	13
HARDNESS NONCARB	MG/L	850	SODIUM DISS	MG/L	55
HARDNESS TOTAL	MG/L	1000	SODIUM PERCENT		10
MAGNESIUM DISS	MG/L	85	SP. CONDUCTANCE FLD		1700
PH LAB		7.5	SP. CONDUCTANCE LAB		1810
POTASSIUM DISS	MG/L	6.0	SULFATE DISS	MG/L	850

CATIONS	(MG/L)	(MEQ/L)	ANIONS	(MG/L)	(MEQ/L)
CALCIUM DISS	270	13.473	BICARBONATE	210	3.442
MAGNESIUM DISS	85	6.993	CHLORIDE DISS	34	0.960
POTASSIUM DISS	6.0	0.154	SULFATE DISS	850	17.697
SODIUM DISS	55	2.393			
	TOTAL	23.011		TOTAL	22.098

PERCENT DIFFERENCE = 2.02

TABLE 7.--Chemical analyses of ground water in Amran Valley, Yemen Arab Republic - Continued

WATER QUALITY ANALYSIS
LAB ID # 121913 RECORD # 6865

SAMPLE LOCATION: #313 BIR AL-SAIGHA
STATION ID: 99999999 LAT.LONG.SEQ.: * NONE GIVEN *
DATE OF COLLECTION: BEGIN--770925 END-- TIME--0001
COUNTY CODE: PROJECT IDENTIFICATION:
DATA TYPE: 2 SOURCE: GROUND WATER GEOLOGIC UNIT: NOT DETERMINED
COMMENTS:

ALK.TOT (AS CACO3)	MG/L	200	RESIDUE DIS CALC SUM	MG/L	452
BICARBONATE	MG/L	240	RESIDUE DIS TON/AFT		0.68
CALCIUM DISS	MG/L	89	RESIDUE DIS 180C	MG/L	503
CHLORIDE DISS	MG/L	48	SAR		0.6
HARDNESS NONCARB	MG/L	140	SILICA DISSOLVED	MG/L	21
HARDNESS TOTAL	MG/L	340	SODIUM DISS	MG/L	25
MAGNESIUM DISS	MG/L	28	SODIUM PERCENT		14
PH LAB		7.8	SP. CONDUCTANCE FLD		710
POTASSIUM DISS	MG/L	2.4	SP. CONDUCTANCE LAB		759
			SULFATE DISS	MG/L	120

CATIONS	(MG/L)	(MEQ/L)	ANIONS	(MG/L)	(MEQ/L)
CALCIUM DISS	89	4.442	BICARBONATE	240	3.934
MAGNESIUM DISS	28	2.304	CHLORIDE DISS	48	1.355
POTASSIUM DISS	2.4	0.062	SULFATE DISS	120	2.499
SODIUM DISS	25	1.088			
TOTAL		7.893	TOTAL		7.786

PERCENT DIFFERENCE = 0.68

TABLE 7.--Chemical analyses of ground water in Amran Valley, Yemen Arab Republic - Continued

WATER QUALITY ANALYSIS
LAB ID # 121914 RECORD # 6867

SAMPLE LOCATION: #198 BIR AL-QA
STATION ID: 99999999 LAT.LONG.SEQ.: * NONE GIVEN *
DATE OF COLLECTION: BEGIN--771003 END-- TIME--0001
COUNTY CODE: PROJECT IDENTIFICATION:
DATA TYPE: 2 SOURCE: GROUND WATER GEOLOGIC UNIT: ALLUVIUM
COMMENTS:

ALK,TOT (AS CACO3)	MG/L	130	RESIDUE DIS CALC SUM	MG/L	334
BICARBONATE	MG/L	160	RESIDUE DIS TON/AFT		0.52
CALCIUM DISS	MG/L	57	RESIDUE DIS 180C	MG/L	379
CHLORIDE DISS	MG/L	46	SAR		0.7
HARDNESS NONCARB	MG/L	98	SILICA DISSOLVED	MG/L	25
HARDNESS TOTAL	MG/L	230	SODIUM DISS	MG/L	26
MAGNESIUM DISS	MG/L	21	SODIUM PERCENT		20
PH LAB		8.0	SP. CONDUCTANCE FLD		560
POTASSIUM DISS	MG/L	2.2	SP. CONDUCTANCE LAB		577
			SULFATE DISS	MG/L	78

CATIONS	(MG/L)	(MEQ/L)	ANIONS	(MG/L)	(MEQ/L)
CALCIUM DISS	57	2.845	BICARBONATE	160	2.623
MAGNESIUM DISS	21	1.728	CHLORIDE DISS	46	1.298
POTASSIUM DISS	2.2	0.057	SULFATE DISS	78	1.624
SODIUM DISS	26	1.131			
	TOTAL	5.759		TOTAL	5.544

PERCENT DIFFERENCE = 1.90

TABLE 7.--Chemical analyses of ground water in Amran Valley, Yemen Arab Republic - Continued

WATER QUALITY ANALYSIS
LAB ID # 121915 RECORD # 6869

SAMPLE LOCATION: #69 AL GUSAIR #3 USAID
STATION ID: 99999999 LAT.LONG.SEQ.: * NONE GIVEN *
DATE OF COLLECTION: BEGIN--771003 END-- TIME--0001
COUNTY CODE: PROJECT IDENTIFICATION:
DATA TYPE: 2 SOURCE: GROUND WATER GEOLOGIC UNIT: ALLUVIUM AND LIMESTONE
COMMENTS:

ALK,TOT (AS CACO3)	MG/L	200	RESIDUE DIS CALC SUM	MG/L	326
BICARBONATE	MG/L	240	RESIDUE DIS TON/AFT		0.51
BORON DISSOLVED	UG/L	100	RESIDUE DIS 180C	MG/L	376
CALCIUM DISS	MG/L	63	SAR		0.7
CHLORIDE DISS	MG/L	29	SILICA DISSOLVED	MG/L	20
HARDNESS NONCARB	MG/L	47	SODIUM DISS	MG/L	24
HARDNESS TOTAL	MG/L	240	SODIUM PERCENT		18
MAGNESIUM DISS	MG/L	21	SP. CONDUCTANCE FLD		542
PH LAB		8.0	SP. CONDUCTANCE LAB		599
POTASSIUM DISS	MG/L	2.1	SULFATE DISS	MG/L	48

CATIONS	(MG/L)	(MEQ/L)	ANIONS	(MG/L)	(MEQ/L)
CALCIUM DISS	63	3.144	BICARBONATE	240	3.934
MAGNESIUM DISS	21	1.728	CHLORIDE DISS	29	0.819
POTASSIUM DISS	2.1	0.054	SULFATE DISS	48	1.000
SODIUM DISS	24	1.044			
TOTAL		5.969	TOTAL		5.751

PERCENT DIFFERENCE = 1.86

TABLE 7.--Chemical analyses of ground water in Amran Valley, Yemen Arab Republic - Continued

WATER QUALITY ANALYSIS
LAB ID # 121916 RECORD # 6871

SAMPLE LOCATION: #8 MOBKHAT SALEH AL BRARI
STATION ID: 99999999 LAT.LONG.SEQ.: * NONE GIVEN *
DATE OF COLLECTION: BEGIN--770925 END-- TIME--0001
COUNTY CODE: PROJECT IDENTIFICATION:
DATA TYPE: 2 SOURCE: GROUND WATER GEOLOGIC UNIT: ALLUVIUM
COMMENTS:

ALK.TOT (AS CACO3)	MG/L	98	POTASSIUM DISS	MG/L	2.2
BICARBONATE	MG/L	120	RESIDUE DIS CALC SUM	MG/L	277
CALCIUM DISS	MG/L	31	RESIDUE DIS TON/AFT		0.40
CHLORIDE DISS	MG/L	30	RESIDUE DIS 180C	MG/L	297
HARDNESS NONCARB	MG/L	41	SAR		1.4
HARDNESS TOTAL	MG/L	140	SILICA DISSOLVED	MG/L	20
MAGNESIUM DISS	MG/L	15	SODIUM DISS	MG/L	37
NO2+NO3 AS N DISS	MG/L	12	SODIUM PERCENT		36
PH LAB		8.3	SP. CONDUCTANCE LAB		437
			SULFATE DISS	MG/L	30

CATIONS	(MG/L)	(MEQ/L)	ANIONS	(MG/L)	(MEQ/L)
CALCIUM DISS	31	1.547	BICARBONATE	120	1.967
MAGNESIUM DISS	15	1.234	CHLORIDE DISS	30	0.847
POTASSIUM DISS	2.2	0.057	SULFATE DISS	30	0.625
SODIUM DISS	37	1.610	NO2+NO3 AS N D	12	0.857
TOTAL		4.447	TOTAL		4.294

PERCENT DIFFERENCE = 1.74

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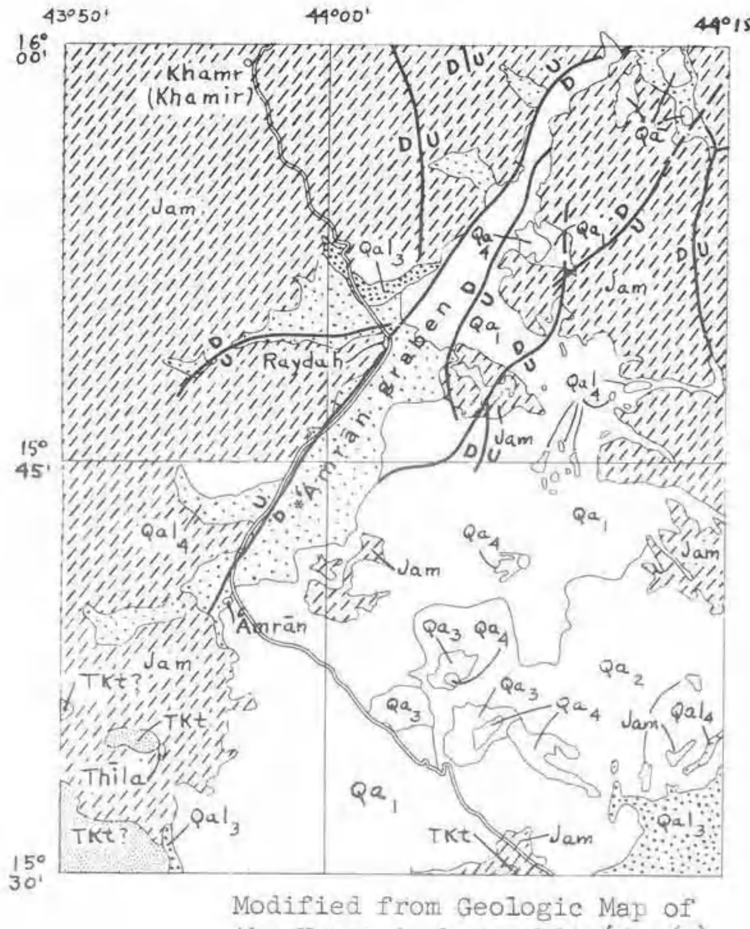
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
YEMEN ARAB REPUBLIC
UNDER THE AUSPICES OF THE
U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

OPEN-FILE REPORT 80-774
PLATE 1



Modified from Geologic Map of the Yemen Arab Republic(San'ā), U.S. Geological Survey, 1978, Scale 1:500 000

A-Index map of geology and structure of the 'Amrān Valley

EXPLANATION

Qal4 — TKt

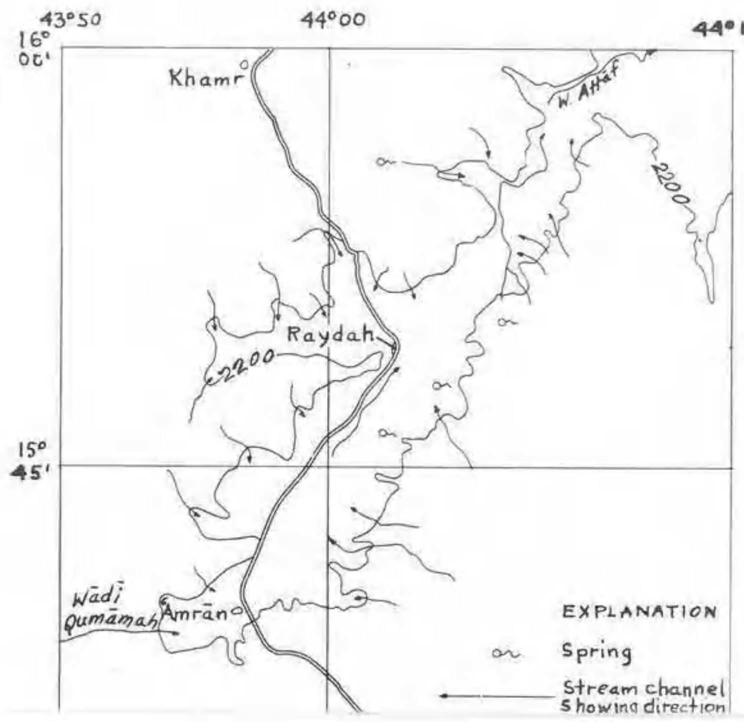
Qal3 — Jam

Qa4-1

Contact

Fault, dashed where approximately located. U upthrown side; D downthrown side

For geologic explanation, refer to Plate 1



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10 0 10 MILES
SCALE 1:250 000

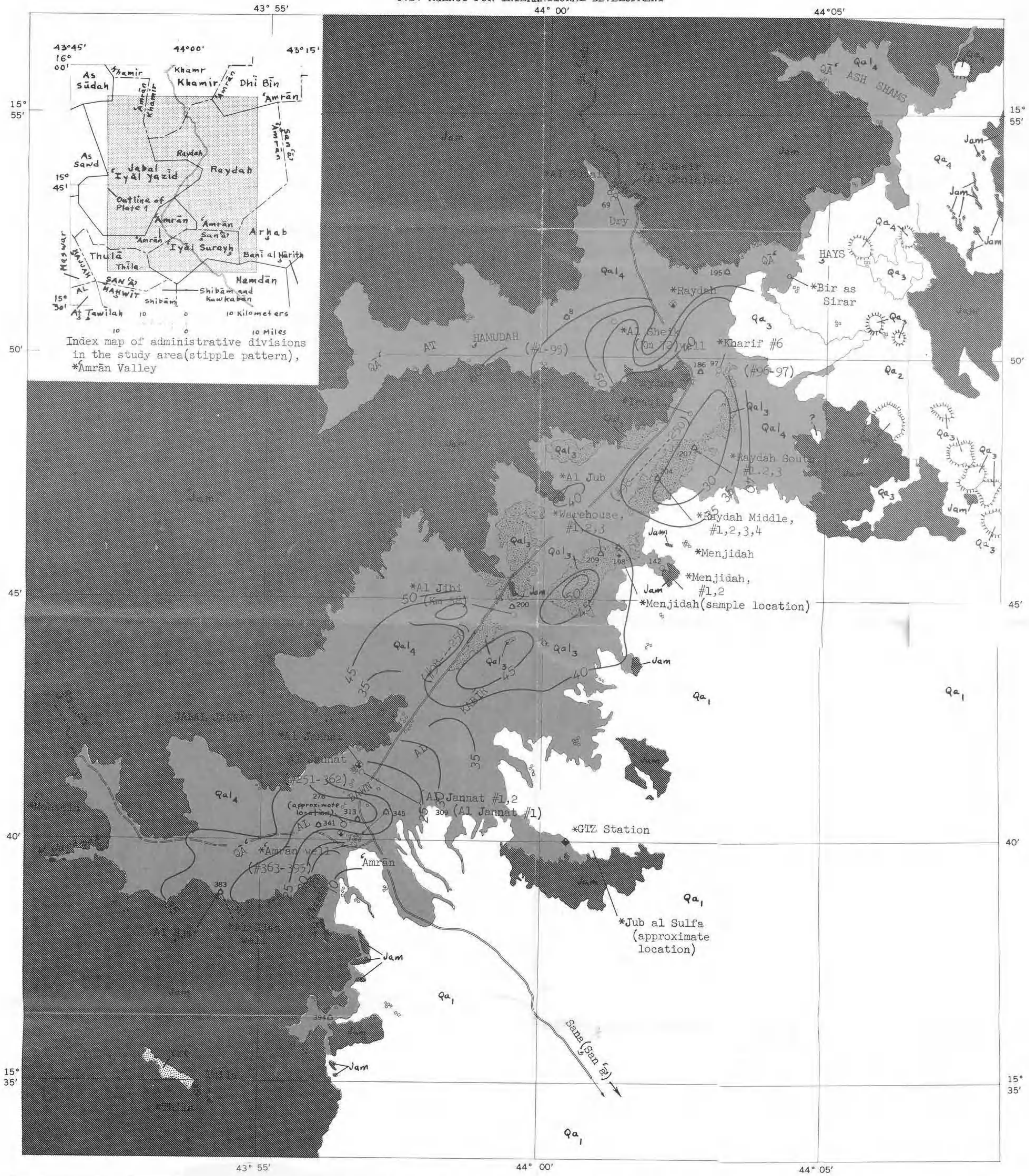

PLATE 1--MAP SHOWING WELL LOCATIONS, GROUND WATER CONTOURS, AND GEOLOGY IN THE 'AMRĀN BASIN, YEMEN ARAB REPUBLIC.

1 0 1 2 3 4 5 6 7 8 9 10 KILOMETERS
1 0 1 2 3 4 5 6 7 8 9 10 MILES
SCALE 1:100 000

EXPLANATION*

QUATERNARY

Qal4 — Alluvial gravel, silts, clays, loess, deposits, may include colluvium, cultivated

Qal3 — Alluvial gravel, very sandy, possibly older than Qal4, not cultivated

Qa — Basalt flows and dikes; numerous scattered cones and craters; at places covered with tuff and volcanic bombs. Divided regionally into four sub-units
Qa4, very dark basaltic lobate flows, extruded in historical times
Qa3, dark basaltic flows
Qa2, thin basalt flows, discontinuous over older rocks; appear lighter-grey
Qa1, basalt flows forming a continuous mantle over older rocks
Contact uncertain between Qa2 and Qa1 in the area of 15°46'-44°08'

TERTIARY AND CRETACEOUS

TKt — Tawilah Group and Medj-zir Series, undivided--Continental type coarse crossbedded sandstone with lenses of conglomerate and gravel; interbedded shale and sandstone in lower parts; overlies rocks of Jurassic age

JURASSIC

Jam — Amran Series--Limestone, marl, and shale; lower part locally includes detrital beds. The series is overlain by a less wide Upper Jurassic transition zone of gypsum, clay, marl, shale, sandstone and some limestone of Callovian and Kimmeridgian age

Geologic contact

142 *Menjidah, #1,2 — Well with name and number. *Menjidah #1,2- well name, or name with number, inventoried for the Al Baun Project. 142- well identification number referred to in well tables

142 *Menjidah, #1,2 — Water sample, with number of sample. Number referred to in well tables

—60— Depth to water, in meters(m). Contours generalized. Contour interval 5m

(#1-95) — Approximate locations of well inventory. Number referred to in well tables

198 *Menjidah — Rain gage, with name and number (well identification number). Number referred to in well tables

Volcanic cone

Raydah — Populated area, village, with name

Road, all weather, hard surface

Road, all weather, loose surface

*Geologic explanation adapted from "Preliminary geologic map of North Yemen," Grolier and Overstreet, U.S.G.S. Open File Report 76-741

Names preceded with asterisk(*) are not verified names of the U.S. Board on Geographic Names