

3.4.5

Site Number	5	Site Name	AL HUSHA		
Administrative Division	Sub-district : - District : Al Husha Governorate : Taizz				
No. of Villages	About 30	No. of Houses	Unknown	Present Population	13,000
Planned Area	120 km ²	Population Density		108 persons/km ²	
Income Sources	Rank 1: Agriculture (40%) Rank 2: Remittances (40%) Rank 3: Wages/Salaries (20%)	Average Monthly Income		YR1,600	
Medical Facilities	Hospitals /Clinics	PHC (1)	Educational Facilities	Primary School	13
	Medical Staff	Doctors (1) Nurses(3)		Intermedi-ate School	3
	No. of Beds	10		Secondary School	2
Shops/Restaurants	Several	Mosques		20	
Water Purchase Practice	Quantity	400 lit/ 5 days/15 persons: 5 lit/d/c			
	Price	YR400 - 600 /1,000 liters			
	Source	Wells in the nearby wadis			
Average Consumption		7.5 lit/day/capita			

(1) Water Practice and Existing Sources

The Project site covers an extensive area of the Al Husha district belonging to the Taizz governorate, comprising a large bulk of a mountainous body rising along the former eastern border with the southern part and a wadi lowland faced with the northern wall of the mountain. The low-lying wadi is 1,100 m above sea level, forming an upstream of the Wadi Tuban, which rises in the mountains in the Ibb governorate and flows southward as far as Aden. Called in this area by a name of the Wadi Yarakh, the wadi has a surface flow throughout the year, though varying with the seasons, which is utilized not only for irrigation and domestic water by the lowland's inhabitants but as the source of water for sales to those living on the mountain. The whole district comprises about 60 villages, among which the district's LCCD requires for the Project to cover some 30 villages scattered all over the mountainous area, with a hanging wall 600 to 1,200 m high on its northern side facing the wadi and a gently sloping zone on the southern side. The highest peak of this mountainous bulk is Mt. Al Husha (Jabar Al Husha) at an elevation of 2,400 m, and the center of the district, Zuran city, lies at 1,800 m above sea level in the midst of the rugged mountainous area.

In the harsh environment of the rugged mountain, there are no stable water sources. Within Zuran city, center of the district, are seven hand-dug wells of 22 to 23 m in depth installed in the lower sites of the city, all of them retaining stagnant turbid water merely 20 cm deep in the bottom, but gathering daily many girls and children who want to collect even a trickle of water. Yet the water levels are said to rise up a couple of meters during the wet seasons. According to the doctor assigned to the Primary Health Center (PHC) in Zuran, the use of such stagnant water is increasing casualties of bilharzia, not only in this city but all over Yemen. Meanwhile the drinking water transported to the mountain costs as much as YR400 to 600 per cubic meter.

In 1986, the LCCD installed two drilled wells as the public water sources at the junction of the Wadi Al Qula and the Wadi Yarakh in the northeastern part of the wadi lowland, one 165 m deep and the other 265 m located close to each other, both of which have since been left closed without any prospect of commencing a project to pump up water to the mountain because of its extensive scale.

On the other hand, the villages on the southern slope of the mountain have hand-dug wells along the wadis cutting down the mountainside. The condition of these wells grows better downstream the wadi, allowing pumping for limited periods even in the dry season. The main wadis on the southern slope are the Wadi Misma and the Wadi Sanat As Sanagir which forms the boundary with the neighboring district of Mawiya. Along the course of the latter until it is united with the former at the Suq Al Khamis village, 6 hand-dug wells have been installed to depths of 20 to 30 m, each one producing water for several hours even in dry seasons for the purpose of irrigation and

domestic use by nearby inhabitants.

Located at the junction of the wadis cutting down the southern slope, the area in and around Suq Al Khamis forms a low-lying flat land, where the *Southern Highland Development Authority* installed a public water source of hand-dug well with water supply facilities extending up the southern slope of the mountain. The entire system is composed of a water source at Suq Al Khamis (1,400 m in elevation), a pumping main to a booster pump station with a 180 m³ concrete reservoir at the Al Suhayy village (1,670 m), and another pumping main farther up to a 200 m³ reservoir built on a hill near the Al Midawwar village (1,940) located several km west of Zuran city. However, all the facilities including pumping mains over 5 km long have now been left idle, since the hand-dug well ran dry.

Within the boundary of the entire Al Husha district, the area badly in need of water is the upper part of the mountain, covering an extensive area of about 120 km², with the villages suffering most, according to the LCCD, scattered on the southeastern slope behind the highest peak of the mountain, Mt. Al Husha.

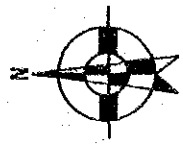
(2) Hydrogeological Features

The Project site comprises a gently undulating area in the upper part of the mountain rising to an elevation of 1,600 to 2,400 m south of the Wadi Al Qula, with its northern side showing a steep slope of 1/2.2 and its southern side, a contrasting gentle slope of 1/16, resulting in an extremely unsymmetrical profile. The wadis in this area are divided into the ones flowing northward and southward/southwestward; the former group has a short channel about 3 km long but slopes steeply in a gradient of 1/3 to 1/4, while the latter slopes down gently, with a long channel.

The region is composed of stratified volcanic rocks issued by the earlier activities of the *Yemen Volcanics*. The wadis are filled with alluvium, but its thickness is merely 4 m or less. Stratified volcanic rocks consist mainly of dark gray to black basalt lava, frequently displaced by rhyolite or andesite lava. They have interbeds of pyroclastic flows and green tuff, in places tinted with red brown color. Unconformity of small extent is widespread indicating the ancient volcanic activity ensued for quite a long period. The variation of facies is remarkable horizontally and vertically. The small mountains near the Wadi Al Qula, Mt. Yarakh and Mt. Al Hididah, are the remnants of volcanic cones composed of basalt.

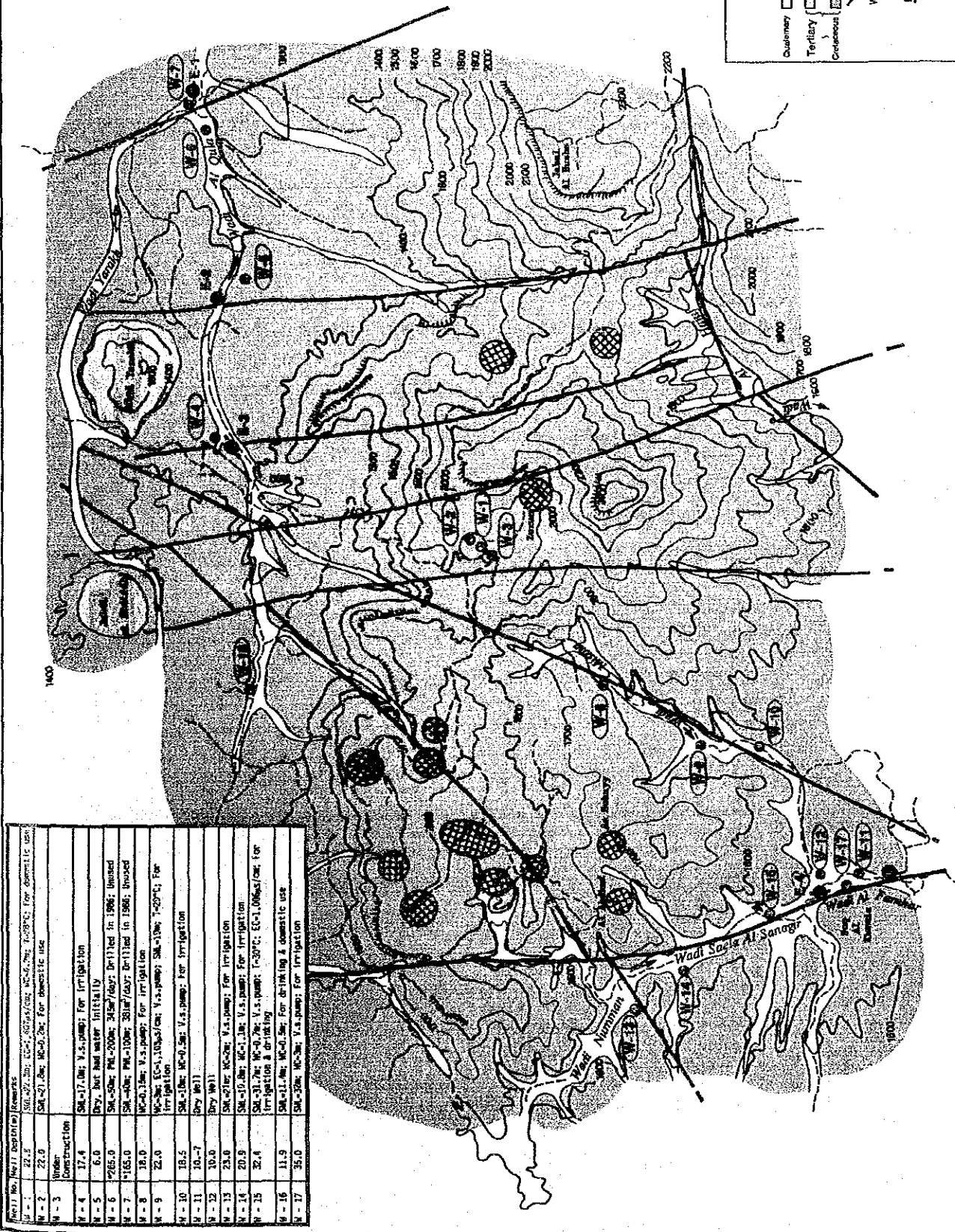
There occur in this area lineaments of the NS to NW10° and NE30° to 50° directions. The fractured zones of the latter are recognized to have already been plugged with clay, passing little water, while those of the former are rich in interstices, presenting a good passage of groundwater. The new sources, therefore are recommended to be located along the NS to NW10° lineaments.

No.5 Al Husha



LEGEND

- Quaternary
- Tertiary
- Cretaceous
- Alluvium
- Jabal Yarakah Rocks
- Volcanic Rocks
- Stratovolcanic Rocks
- Lineament
- Exist Well
- Proposed Well
- Geoelectric Prospecting Point
- Water Sampling Point
- Village



Well No.	Depth (m)	Remarks
W-1	22.5	SM-27.2m; EC-1, 602.6V/0m; MC-6.7m; EC-20V; For domestic use.
W-2	22.0	SM-21.0m; MC-0.0m; For domestic use.
W-3	Under construction	
W-4	17.4	SM-17.0m; V.S. pump; For irrigation. Dry, but had water initially.
W-5	6.0	SM-5.0m; PM-200m; 24.5m/day; Drilled in 1965; Unused.
W-6	205.0	SM-20.0m; PM-100m; 30m/day; Drilled in 1965; Unused.
W-7	18.0	MC-0.15m; V.S. pump; For irrigation.
W-8	22.0	MC-2m; EC-1, 103.0V/0m; V.S. pump; SM-1.0m; EC-1, 103.0V/0m; For irrigation.
W-9	18.5	SM-1.0m; MC-0.5m; V.S. pump; For irrigation.
W-10	10.7	Dry Well
W-11	30.0	Dry Well
W-12	23.0	SM-21.0m; MC-2m; V.S. pump; For irrigation.
W-13	20.9	SM-10.0m; MC-1.1m; V.S. pump; For irrigation.
W-14	20.9	SM-21.0m; MC-0.7m; V.S. pump; EC-1, 103.0V/0m; For irrigation & drinking.
W-15	32.4	SM-31.7m; MC-0.7m; V.S. pump; EC-1, 103.0V/0m; For irrigation & drinking.
W-16	11.9	SM-11.0m; MC-0.0m; For drinking & domestic use.
W-17	35.0	SM-3.0m; MC-3m; V.S. pump; For irrigation.

3.4.6

Site Number	6	Site Name	AL USFYN		
Administrative Division	Sub-district : Al Usfyn District : Al Qabaitah Governorate : Taizz				
No. of Villages	20 Total 30	No. of Houses	Unknown	Present Population	28,500
Planned Area	160 km ²	Population Density		178 persons/km ²	
Income Sources	Rank 1: Agriculture (40%) Rank 2: Wages/salaries (30%) Rank 3: Remittances (30%)	Average Monthly Income		YR1,750	
Medical Facilities	Hospitals /Clinics	Hospital (2) PHC (2)	Educational Facilities	Primary School	1
	Medical Staff	Doctors (3) Assistant (2) Nurse(3)		Inter-mediate School	1
	No. of Beds	30		Secondary School	1
Shops/Restaurants		several	Mosques		20
Water Purchase Practice	Quantity	100 lit/ 1 day / 7 persons: 14 lit/d/c			
	Price	YR 25/ 100 liters : YR250/m3			
	Source	Al Rahidah city and other sources			
Average Consumption		14 lit/day/capita			

(1) Water Practice and Existing Sources

The Project site covers an whole area of the Al Usfyn sub-district, belonging to the Al Qabaitah district of the Taizz governorate, involving 20 villages scattered on a vast mountainous area composed of the Precambrian rocks. Along the northern limit of the site runs a highway linking Taizz city to the former capital of the South, Aden, with stops such as Al Rahidah, a major city of the this area, and Ash Shraiij which was the former gateway of the North stationed with a customs office and a checkpoint (included in this Project as one of the villages for planning). The major planning area for the water supply stretches south of the highway, covering a vast mountainous area of the Precambrian rocks exceeding 150 km².

Along the wadis cutting down the mountains are numerous hand-dug wells being used by the inhabitants, but most of them tends to lose much water during the dry seasons. Worse than that, groundwater throughout the area has a high degree of salinity and fluoride, especially along the Wadi Hamid in the east and the Wadi Zawani in the north running northward or northeastward to the village of Ash Shraiij, where water of inferior quality is prevalent in not only the hand-dug wells but in the deep wells of the water supply systems constructed by the RWSD for a group of the villages in this area.

As a result of the field survey by the study team, there are apparently no appropriate locations within the Project site for the development of new sources to meet a large demand in this extensive area. The alternative site is outside the territory of the Project site, in the basin along the Wadi Warazan north of the highway, which is a major river in the region flowing eastward across the neighboring Dimmat Khadir district and farther down southerly toward Aden. A significant volume of water can be expected to be developed mainly through the wadi underflow there. However, this water source site poses a great difficulty for the water supply scheme to the Project site, since the distance between them is over 20 km, with the latter's mountainous area soaring to a level about 1,000 m higher than the former. In this view, the project for this site needs special attention and arrangement among the concerned parties for concluding the planning.

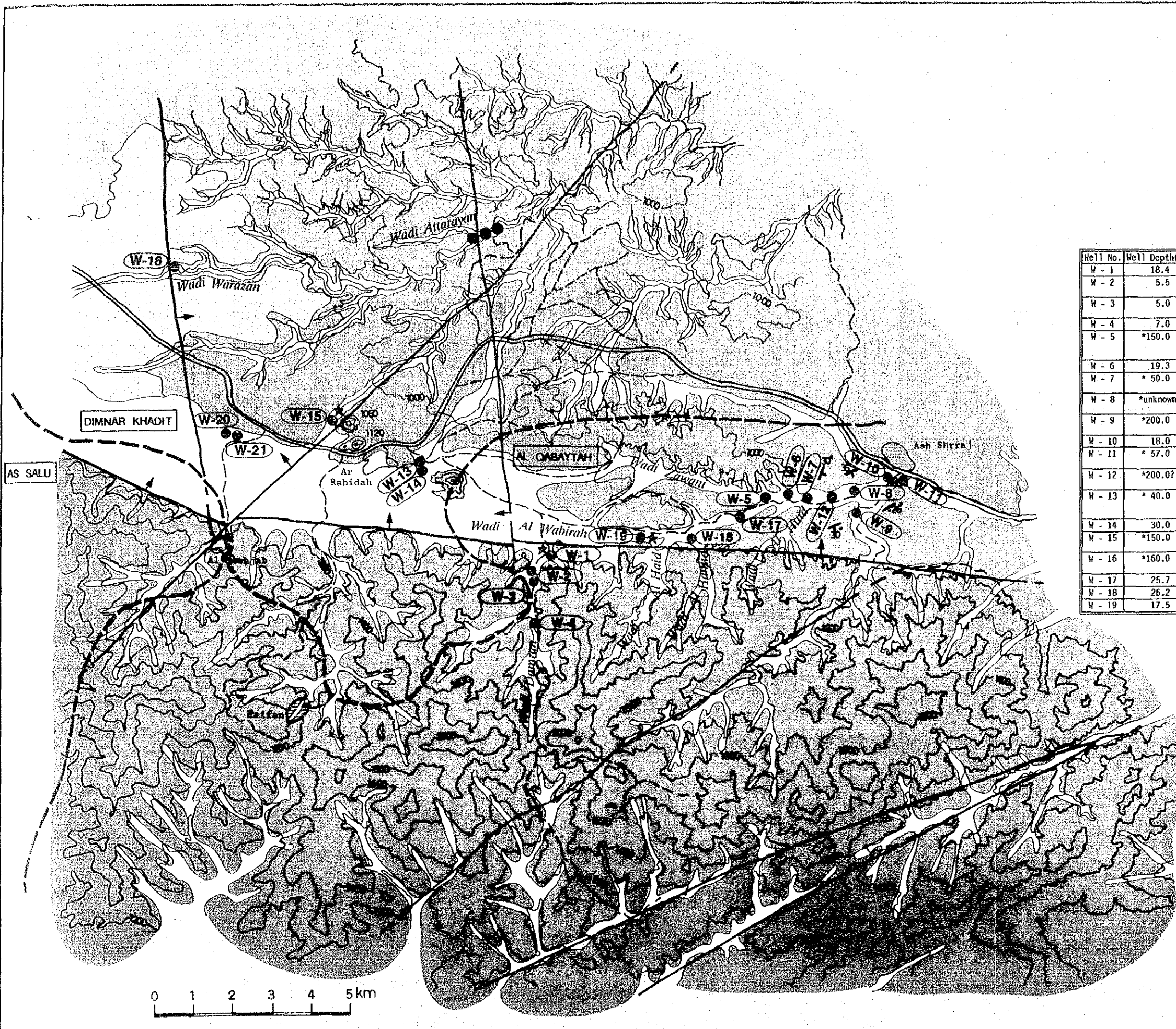
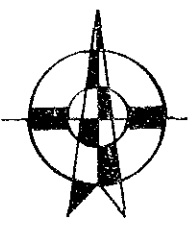
(2) Hydrogeological Features

The existing wells in this area are largely grouped into the hand-dug wells installed along the basins of dissected wadis cutting down the mountains composing the Project site and the hand-dug wells as well as the deep wells along the Wadi Zawani system fringing the northern limit of the site. The former wells are 6 to 19 m in depth, with

their bottoms reaching or partly penetrating the basement composed of granite. During the rainy season, the water table rises, allowing the inhabitants to use these wells for domestic water as well as for irrigation, while in the dry season most of them stand dry. During the field survey for the study in June 1991, a hand-dug well along the **Wadi Damran**, one of the valleys in the former group, was found to retain some quantity of water apparently due to rainfall on the previous day, with a gathering of the nearby inhabitants scrambling to collect it. Such a scene reveals there is little possibility of getting reliable sources in the dissected basin of the mountainous wadis.

On the other hand, the latter group along the Wadi Zawani and its tributaries includes not only the hand-dug wells through sand or sand and gravel of the wadi alluvium and reaching the underlying Yemen Volcanics but the deep wells drilled through the Yemen Volcanics. The hand-dug wells are 15 to 30 m in depth, and during the survey in June 1991 most of them were recognized to have water 0.5 to 1 m deep inside, rather sufficient in quantity in comparison with those in the former group. A problem is raised, however, concerning its quality, with the electrical conductivity ranging from 2,000 to 3,000 micro siemens/cm and chloride at a level exceeding 500 ppm. The deep wells are 50 to 200 m in depth, being operated with a submersible motor pump or a vertical shaft pump for irrigation as well as domestic use of the villagers in the surrounding areas. However, their water quality shows a similar tendency as that of hand-dug wells. Thus the hydrogeological conditions in the site seem unfavorable for the development of new water sources for the Project. The most promising site for the water source has been found outside the Project site, upstream the Wadi Warazan north of the area flowing eastward where an existing well shows a significant performance, with its daily operation continued for 10 hours, one hour for the public supply for the village and nine for irrigation, with a yield as much as 1,000 m³/day. The electrical conductivity remains at a level of 1,500 micro siemens/cm ($\mu\text{s/cm}$).

No.6 Al Usfyn



Well No.	Well Depth(m)	Remarks
W - 1	18.4	Dry, but water level rises in wet season
W - 2	5.5	A little water produced from rainfall; EC=718µs/cm; T=27°C
W - 3	5.0	A little water produced from rainfall; EC=1,532µs/cm; T=27°C
W - 4	7.0	Dry; Hard crackless granite gneiss
W - 5	*150.0	Generator/s.pump; T=32°C; For domestic use despite high EC of 3,292µs/cm; 570m ³ /d for 6 hrs./day operation
W - 6	19.3	A little water in bottom; EC=3,591µs/cm; T=31°C
W - 7	* 50.0	Closed with stones at 18m; Produced much water initially
W - 8	*unknown	Produces highly salty water; Operation suspended due to pump trouble
W - 9	*200.0	Drilled by Regional Development Authority; Abandoned due to little yield
W - 10	18.0	Abandoned due to little yield
W - 11	* 57.0	Dries in 30 min. with v.s.pump; 60m ³ /day; Initially produced more; EC=3,946µs/cm; T=32°C
W - 12	*200.0?	Is reported to have water; Now suspended due to pump trouble
W - 13	* 40.0	Source for Al Rahidah Hospital; Operated with s.pump for limited period due to fall of water level
W - 14	30.0	Source for Al Rahidah Hospital
W - 15	*150.0	Source for Al Rahidah city; Operated with generator/s.pump for 22 hrs./day
W - 16	*160.0	Deep well along Wadi Warazan; 1,000m ³ /day with v.s.pump; EC=1,500µs/cm
W - 17	25.7	SWL=23.4m; WC=2.3m
W - 18	26.2	Dry Well
W - 19	17.5	SWL=17m; WC=0.5m; T=27°C; EC=4,119µs/cm

LEGEND

- Quaternary
 - Holocene Alluvium
 - Pleistocene Alluvial Fan
- Tertiary Yemen Volcanics
- Cretaceous Granite Gneiss
- Pre-Cambrian Granite Gneiss
- Strike and Dip
- Lineament
- Existing Well
- Proposed Well
- Water Sampling Point

3.4.7

Site Number	7	Site Name	AL JABUB		
Administrative Division	Sub-district : Al Jabub District : Ar Radmah Governorate : Ibb				
No. of Villages	6	No. of Houses	210	Present Population	2,000
Planned Area	10 km ²	Population Density		200 persons/km ²	
Income Sources	Rank 1: Agriculture (60%) Rank 2: Wages/salaries (20%) Rank 3: Remittances (20%)	Average Monthly Income		YR3,000	
Medical Facilities	Hospitals /Clinics	PHC (1)	Educational Facilities	Primary School	1
	Medical Staff	Doctor (3) Nurse(3)		Intermedi-ate School	1
	No. of Beds	15		Secondary School	None
Shops/Restaurants		several	Mosques		6
Water Purchase Practice	Quantity				
	Price	YR 200 - 250/1,000 liters : YR250/m ³			
	Source	Deep well for the community			
Average Consumption		20 lit/day/capita			

(1) Water Practice and Existing Sources

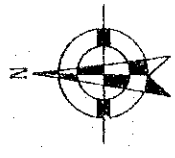
The Project site belongs to the Ar Radmah district, the center of which, Ar Radmah city, was among the sites in the previous loan project by the government of Japan. At a corner along the new highway passing through the wadi lowland of this area, which connects Sana'a and Aden, a public well 225 m deep was drilled 10 years ago by the LCCD, but had been left unused until last year when the land owner of this well site installed a vertical shaft pump in it. Currently this facility is run by his family for selling water to the mountain villages in the surrounding area. The inhabitants buy water transported by tanker up to the mountain. Women and children of families who cannot afford to buy water come down the mountain for 3 to 4 km on foot or on the back of donkeys, and get water in plastic containers from the tap at this pump station (this water is served free of charge). The private use of this public well by a villager is based upon the agreement among the villagers, and in case the public water facilities should be installed, the well is to be returned to the village (but the existing pump must be returned to the owner). The yield of this well is reported to have been about 350 liters/min, but now has decreased to no more than 100 liters/min. This well discharges hot water at a temperature of 37°C. This special feature of groundwater is also seen in the private well 330 m deep installed by the sheikh of the main village of Al Jabub, where the temperature rises to 44°C, and pumped water is temporarily kept in a pond near the well for use after cooling. Another deep well on the eastern side of the road at the base of the mountain displays the same characteristic and has a small tank for cooling pumped water. The heating of groundwater is caused by a broad belt of geothermal zone continuing from this area to the country's most famous hot spring area of Damt located down the highway south of this site. However, water quality falls within the criteria for drinking water.

(2) Hydrogeological Features

The Project site consists of the low-lying land of the Wadi Al Nasug and the mountainous areas rising on both sides of the wadi, composed of stratiform volcanic rocks of the *Yemen Volcanics*, with the wadi filled with alluvium. The Yemen Volcanics consist of basalt, andesite and rhyolite lavas and their pyroclastic rocks with a conspicuously stratified interbed of mudstone of volcanic ash origin. The facies frequently varies in the horizontal direction and has no characteristic bedding traceable as a key formation. The rocks generally strike in the NS to NE20° directions, dipping easterly at 10° to 20°, but these directions vary with blocs divided by the faults. The fresh and weathered beds are irregularly alternated, and in many places weathering have turned mudstone and pyroclastic rocks into soft materials.

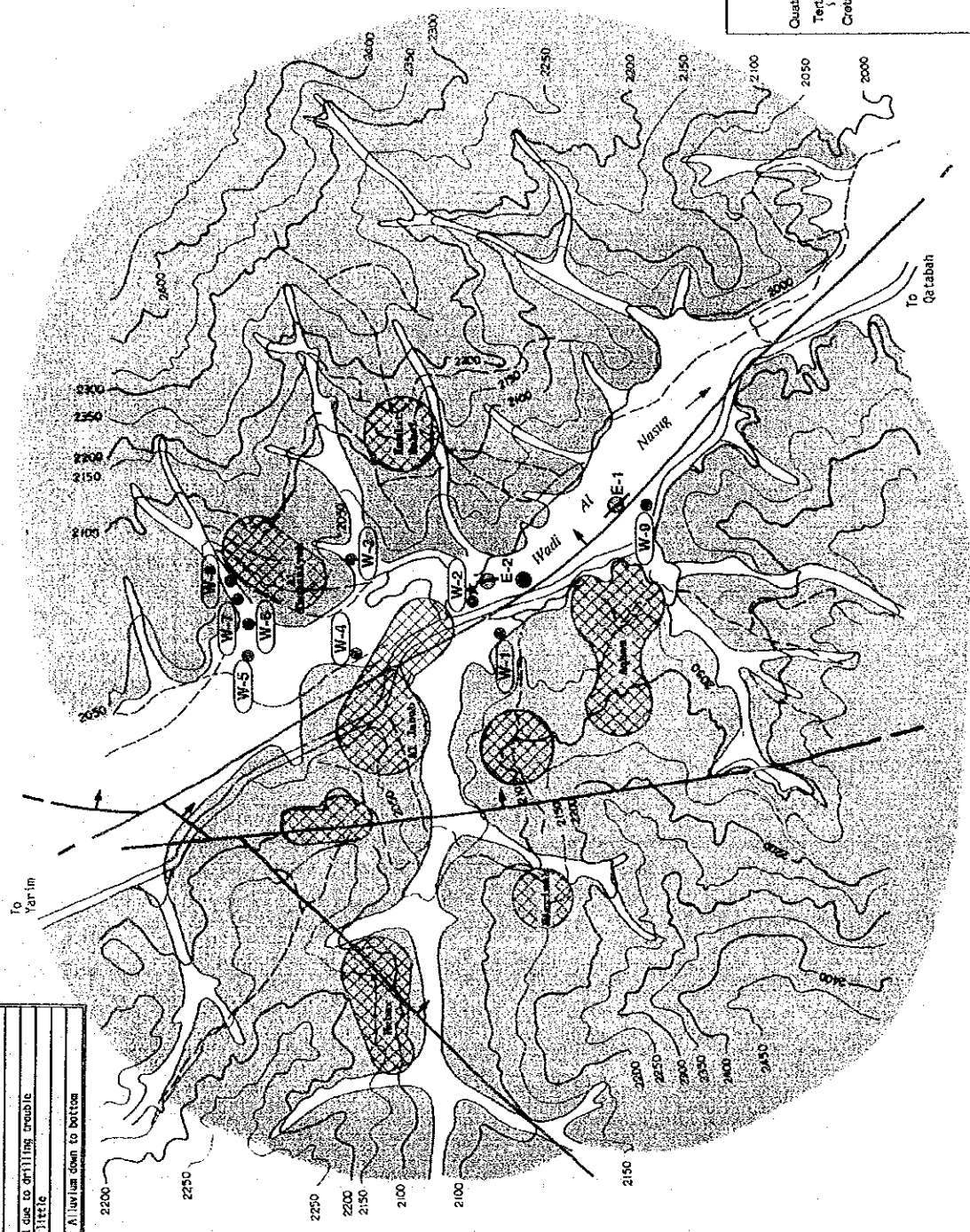
Lineaments run through the area in various directions of NS, NW20° to 30°, NW50° to 60° and NE30° to 40°, but the most significant ones are those of NW20° to 30° associated with permeable fractured zones. The one running through the Wadi Al Nasug forms an anomalous geothermal belt, linked to the hot spring zone of Damt southeast. The deep wells penetrating this lineament, therefore, produce hot water with its temperature ranging from 37° to 44°C, depending upon their depths from 200 to 300 m. On the other hand, the wadi lowland is mantled with alluvium, with its maximum thickness exceeding 24 m, and hand-dug wells installed there can supply adequate water to the inhabitants, although most of them run dry during the dry season.

No.7 Al Jabub



LEGEND

- Quaternary
- Tertiary
- Cretaceous
- Alluvium
- Yemen Volcanics
- Lineament
- Existing Well
- Project Well (Existing)
- Geoelectric Prospecting Point
- Proposed Well
- Water Sampling Point
- Village



Well No.	Depth (m)	Remarks
W-1	430	Private well; 30m/day of hot water at 144°C; (CO ₂) well; 1000 m/day of irrigation and drinking water; 1000 m/day of irrigation and drinking water; V.S. pump for irrigation and drinking water.
W-2	225	1000 well; 2000/day of hot water at 139°C; 60-80 m/day; Generator's pump for irrigation and water skilling.
W-3	175	1000 well; 2000/day of hot water at 139°C; 60-80 m/day; Generator's pump for irrigation and water skilling.
W-4	20	Dry Well
W-5	400	Dry Well
W-6	215	5m. Abandoned due to drilling trouble
W-7	270	Hot water; (cold little)
W-8	240	Dry Well
W-9	24	Under construction; Allowable down to bottom



3.4.8

Site Number	9	Site Name	AL GHUDU		
Administrative Division	Sub-district : Al Ghudu District : Sirwah Governorate : Marib				
No. of Villages	14	No. of Houses	200	Present Population	1,770
Planned Area	15 km ²	Population Density		118 persons/km ²	
Income Sources	Rank 1: Agriculture (50%) Rank 2: Remittances (30%) Rank 3: Wages/salaries (20%)	Average Monthly Income		YR3,300	
Medical Facilities	Hospitals /Clinics	None	Educational Facilities	Primary School	1
	Medical Staff	None		Intermedi-ate School	None
	No. of Beds	None		Secondary School	None
Shops/Restaurants		None	Mosques		5
Water Purchase Practice	Quantity	33 liters/day/capita			
	Price	YR 20 /m ³			
	Source	Deep well for the community			
Average Consumption		33 lit/day/capita			

(1) Water Practice and Existing Sources

The Project site belongs to the Sirwa district of the Marib governorate, reached by either a northern route taking a mountainous path southerly branched from the Sana'a-Marib highway, or a southern route along a road under construction from Sana'a via Jihana to Marib branched at Sirwa.

The site comprises 14 villages scattered over rather a flat terrain surrounded by small hills. Compared to other mountainous sites, the layout of the villages within the site is simple, and the water supply can be done with ease. Concerning the water source, the RWSD drilled a deep well of 200 m in depth in 1982 near the main village of Al Hazienn, and the yield is sufficient enough to meet the requirement of the Project. The inhabitants get water from this well operated with a vertical shaft pump or nearby hand-dug wells.

(2) Hydrogeological Features

The northern side of the site is limited by Mt. Marlud of 1,900 m in elevation composed of the Amran Series, while its southern side is fringed with a chain of Mt. Ad Darai of Quaternary volcanic rocks and separated basalt cinder cones running east to west. The Wadi Al Ghudu runs southeastward between these two ranges, forming an alluvial lowland 500 to 800 wide.

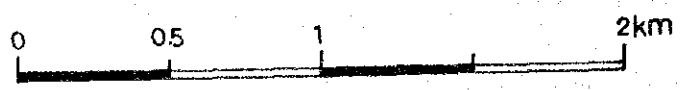
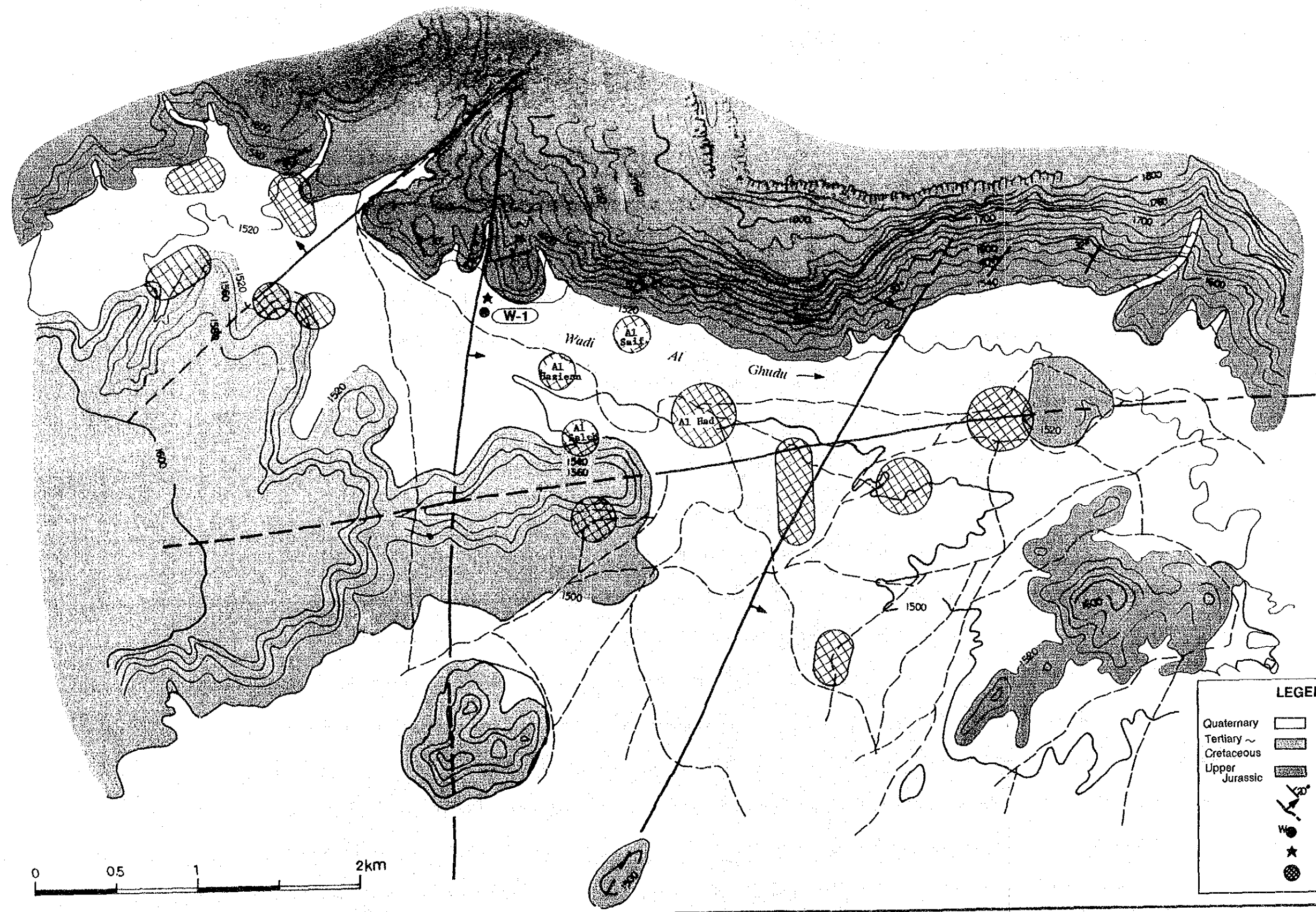
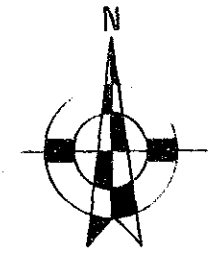
The Amran Series consists predominantly of limestone, through which the three lineaments run in the directions of NS and NE30° to 40°. The strikes and dips of layers vary with the blocks divided by these lineaments. The separated basalt cinder cones are aligned east to west. Probably a member of the group of the Quaternary aligned volcanoes broadly occurring around the Marib area, these cones maintain scarcely affected primary forms composed of basalt lava and scoria.

The Wadi Al Ghudu is filled with alluvium, extensively mantled with eolian sand, into which many hand-dug wells have been installed to a depth of about 10 m to serve water to the inhabitants. Most of them, however, go dry during the dry season.

This site has a public water source facility near the main village of Al Hazienn constructed in 1982 by the RWSD, composed of a deep well of 200 m and a vertical shaft pump, for supplying drinking water to the inhabitants. The location of the well was successfully aimed at the lineament in the NS direction, and resulted in the yield of about 720 m³ a day. This existing well can be employed as the water source of this Project.

No.9 Al Ghudu

Well No.	Well Depth(m)	Remarks
W - 1	*200	Drilled in 1982; 720m ³ /day; V.s.pump at 135m(1986)



LEGEND	
Quaternary	Alluvium
Tertiary ~ Cretaceous	Yemen Volcanics
Upper Jurassic	Amran Series
	Strike and Dip
	Lineament
	Project Well (Existing)
	Water Sampling Point
	Village

3.4.9

Site Number	11	Site Name	AFLAH AL YAMAN		
Administrative Division	Sub-district : - District : Aflah Al Yaman Governorate : Hajjah				
No. of Villages	22	No. of Houses	580	Present Population	4,500
Planned Area	7.5 km ²	Population Density		600 persons/km ²	
Income Sources	Rank 1: Agriculture (65%) Rank 2: Remittances (30%) Rank 3: Wages/salaries (5%)	Average Monthly Income		YR3,300	
Medical Facilities	Hospitals /Clinics	PHC (1)	Educational Facilities	Primary School	2
	Medical Staff	Nurse (1)		Intermedi-ate School	1
	No. of Beds	None		Secondary School	1
Shops/Restaurants		Several	Mosques		21
Water Purchase Practice	Quantity	2,000 liters/15 days/15 persons :8 lit/d/c			
	Price	YR 80 / 2,000 liters : YR40/m ³			
	Source	Sources in the nearby wadis			
Average Consumption		28 lit/day/capita			

(1) Water Practice and Existing Sources

The Project site covers a major part of the district of **Aflah Al Yaman** belonging to the Hajjah Governorate. The center of the district, **Bani Yus**, is about 20 km from a junction at **Shafar** along the highway across the **Tihama** plain, and with its location at 500 m above sea level, is governed by the coastal tropical weather with hot temperature and high humidity. The area around **Bani Yus** is hilly, surrounded by the two big channels of the **Wadi Unqan** and the **Wadi Al Jarah**, with the latter cutting down the steep mountainous area reaching **Al Mahabisha**, one of the main cities in the Central Mountains Zone with its elevation at 1,300 m. At the foot of the mountains the cultivation of *qat* is widespread to meet the demand in the coastal plain. Although the western limit of the district is in the mountainous area bordering **Al Mahabisha**, the area for the water supply under the Project have been decided through the discussions with the LCCD to be confined to the wadi lowland and the hilly zone where 22 villages are scattered.

The **Wadi Unqan** flows westerly, growingly widening its channel downstream, in places having surface runoff. The survey for *Hajja Province Integrated Rural Development* conducted by the government of Japan in 1978-1980 was mainly intended for the basin of this wadi including the area around **Bani Yus**.

(2) Hydrogeological Features

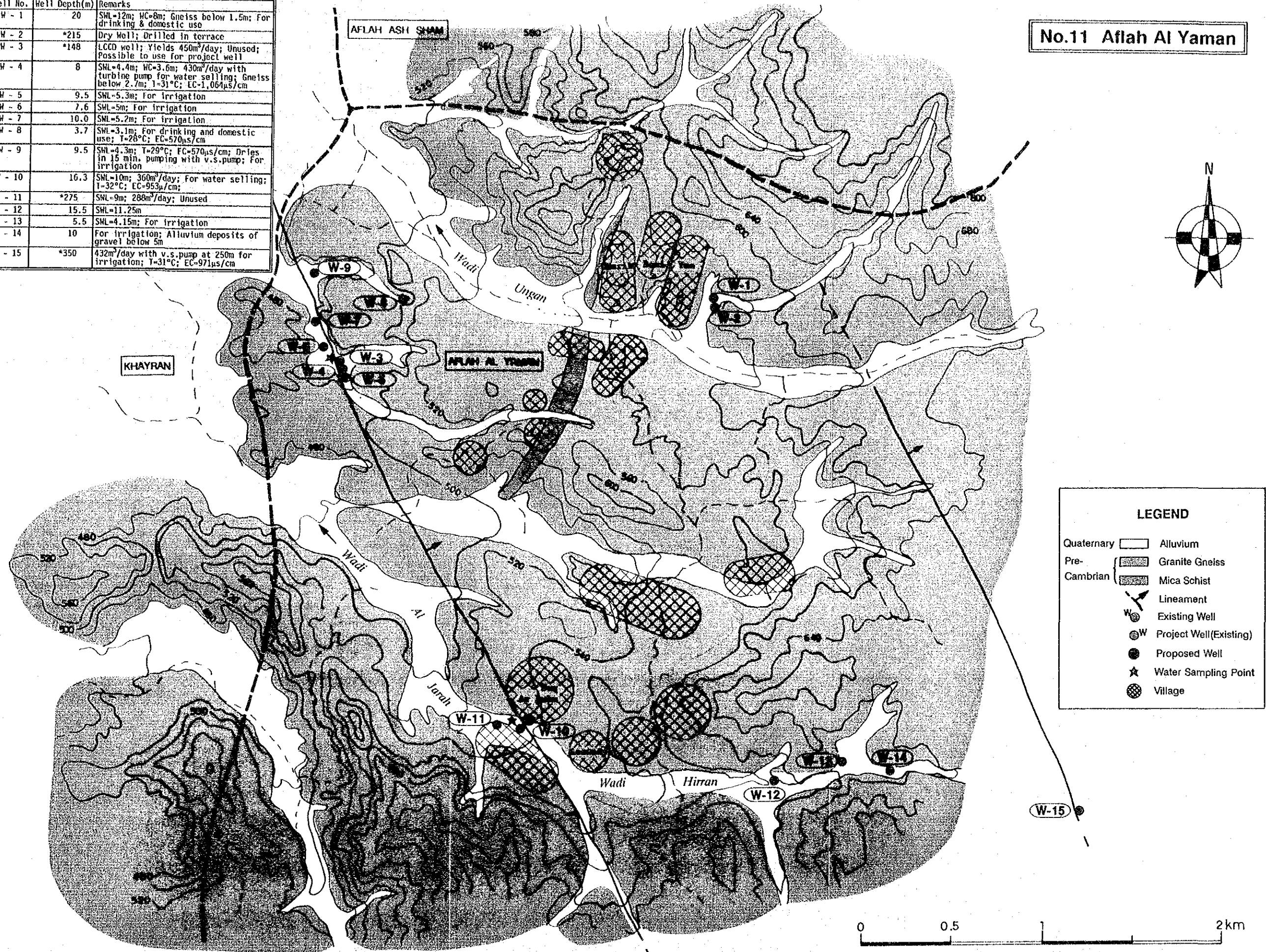
The Project site is an undulating hilly area composed of granite and gneiss of the Precambrian age, with the **Wadi Unqan** flowing westward on the northern side and the **Wadi Al Jarah** on the southern side. Both wadis have many tributaries in the NS direction. A pronounced layer of mica schist occurs near **Bani Yus** and a dike of the basic volcanic rocks about 20 to 30 m wide featuring onion-shaped joints is noticed near the western limit of the district.

Along the **Wadi Unqan** and the **Wadi Al Jarah** alluvial deposits of sand and gravel form a river terrace higher than 1.5 to 2 m than the present river bed, but its distribution is irregular and is no more than 2 to 3 m in thickness.

The distinct lineaments associated with fractured zones 5 to 10 m wide, occur in the direction of $NW10^\circ$ to 20° through the lines linking **Muharraq** to **Al Mizab** and **Ash Shibah** to **Al Qatibirah**. Among four deep wells installed in this area, those penetrating the lineaments hit groundwater, while others turned out dry. Groundwater in this area appears to occur exclusively through the $NW10^\circ$ to 20° lineaments with fracture zones. Meanwhile numerous hand-dug wells have been installed along the courses of the wadis, tapping the weathered zone of basement complex mainly consisting of gneiss. Most of them were found to have water during the field study in June 1991. The operation with a vertical shaft pump is quite popular, supplying domestic water and irrigation water to the inhabitants, although it gets limited during the dry seasons to one to two hours a day.

No.11 Aflah Al Yaman

Well No.	Well Depth(m)	Remarks
Wadi Urgan		
W - 1	20	SHL=12m; HC=8m; Gneiss below 1.5m; For drinking & domestic use
W - 2	*215	Dry Well; Drilled in terrace
W - 3	*148	LCCD well; Yields 450m ³ /day; Unused; Possible to use for project well
W - 4	8	SHL=4.4m; HC=3.6m; 430m ³ /day with turbine pump for water selling; Gneiss below 2.7m; T=31°C; EC=1,064µs/cm
W - 5	9.5	SHL=5.3m; For irrigation
W - 6	7.6	SHL=5m; For irrigation
W - 7	10.0	SHL=5.2m; For irrigation
W - 8	3.7	SHL=3.1m; For drinking and domestic use; T=28°C; EC=570µs/cm
W - 9	9.5	SHL=4.3m; T=29°C; EC=570µs/cm; Dries in 15 min. pumping with v.s.pump; For irrigation
Wadi Al Jarah		
W - 10	16.3	SHL=10m; 360m ³ /day; For water selling; T=32°C; EC=953µs/cm;
W - 11	*275	SHL=9m; 288m ³ /day; Unused
W - 12	15.5	SHL=11.25m
W - 13	5.5	SHL=4.15m; For irrigation
W - 14	10	For irrigation; Alluvium deposits of gravel below 5m
W - 15	*350	432m ³ /day with v.s.pump at 250m for irrigation; T=31°C; EC=971µs/cm



3.4.10

Site Number	12	Site Name	BAIT AL SULTAN		
Administrative Division	Sub-district : Bait Al Sultan District : Ar Rajam Governorate : Al Mahweet				
No. of Villages	11	No. of Houses	470	Present Population	3,600
Planned Area	14 km ²	Population Density		257 persons/km ²	
Income Sources	Rank 1: Agriculture (80%) Rank 2: Remittances (10%) Rank 3: Wages/salaries (10%)	Average Monthly Income		YR1,900	
Medical Facilities	Hospitals /Clinics	None	Educational Facilities	Primary School	1
	Medical Staff	None		Intermedi-ate School	None
	No. of Beds	None		Secondary School	None
Shops/Restaurants		None	Mosques		10
Water Purchase Practice	Quantity	800 liters/ 5 days/ 4 persons : 40 lit/d/c			
	Price	YR 160 / 800 liters : YR200/m ³			
	Source	Ar Rajam city			
Average Consumption		40 lit/day/capita			

(1) Water Practice and Existing Sources

The Project site is a sub-district (*Uzlah*) belonging to the Ar Rajam district where several independent water systems have previously been completed under Japan's grant aid for other sub-districts as well as for Ar Rajam city, the center of the district. The main village of Bait Al Sultan is located at 2,174 m above sea level in the western mountainous area. Meanwhile, a deep well of 102 m in depth has already been drilled by the RWSD as a public water source for Bait Al Sultan in a location within the city zone at 1,949 m above sea level. The distance from this source to Bait Al Sultan is as far as about 9 km, and the well remains yet to be tapped. The inhabitants have challenged twice to install wells near their dwelling places at the locations along small wadis in the mountain without successful results. They have so far no choice but to buy water carried up from the sources in Ar Rajam city. Prices of water vary with the sizes of water tanks the households own, ranging from YR130 to 200/m³.

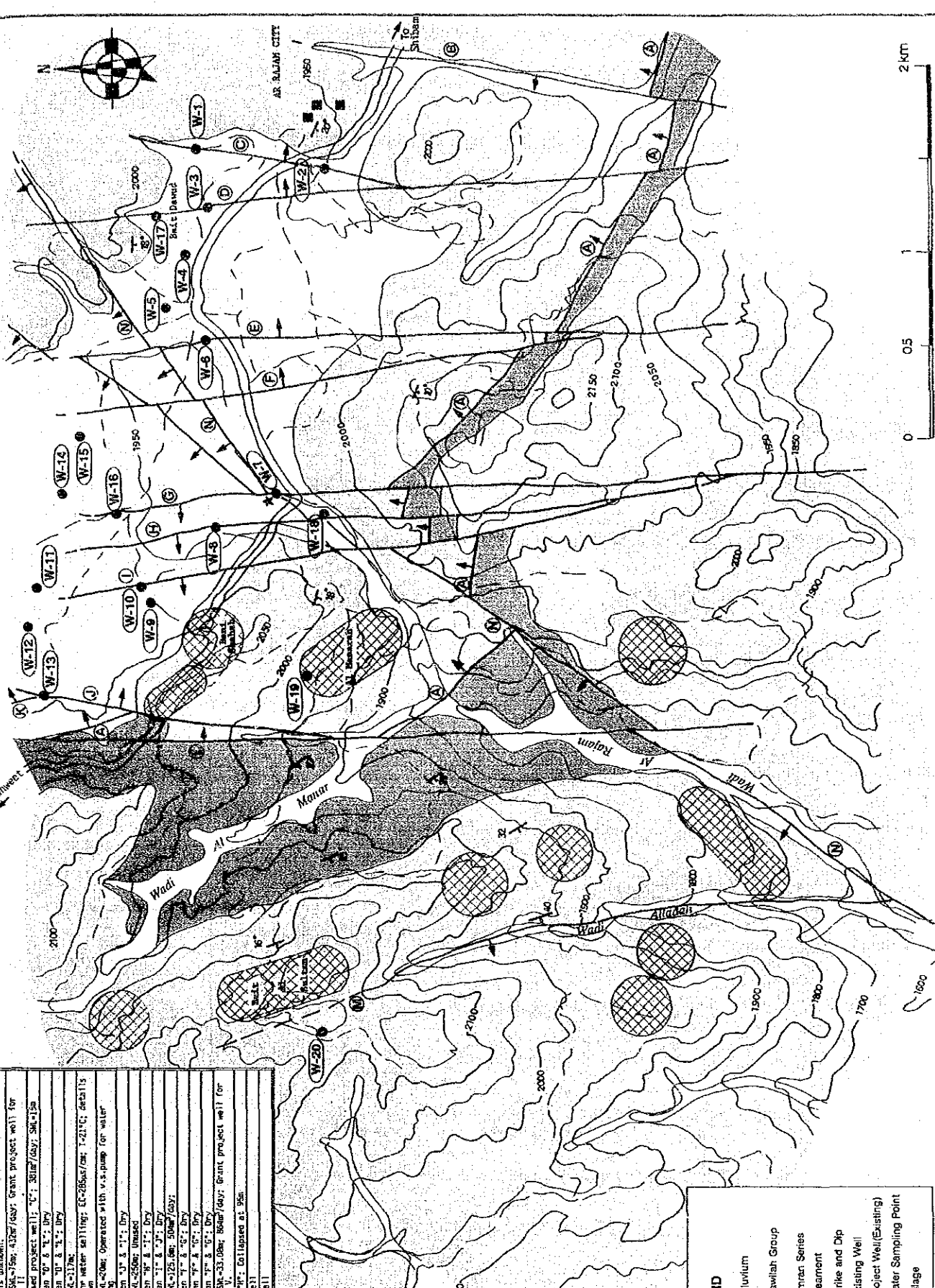
According to the past survey through the implementation of grant aid projects, it is now fairly clear that groundwater in this district occurs predominantly in the lineaments crossing the Ar Rajam basin surrounding the city. For this project, therefore, the existing well in that basin will have to be used as a sole source, although it is away from the supply area.

(2) Hydrogeological Features

The Project site is composed of the *Amran Series* and the unconformably overlying *Tawilah Group*, as is the Ar Rajam basin surrounding the center of the district, while belts of alluvium stretch along the wadis. The *Amran Series* consists mainly of black to gray colored limestone, with thin interbeds of mudstone. Its general strikes range from NW30° to NW50°, with its dips at 10° to 26° southwestward, showing slight changes in places. The *Tawilah Group* is prevalently tightly-cemented arkosic sandstone comprising medium to coarse particles, in places with interbeds of conglomerate containing round pebbles of 5 mm to 1 cm in size. Cross lamination (false bedding) is frequent, and trace fossils and ripple-marked ones are abundant. In places it contains interbeds of mudstone 1 to 2 m thick. Its layers generally strike in the directions of NW50° to 60°, dipping at 10° to 20° southwestward.

The Ar Rajam basin was initially formed through a depression on the eastern side of the fault in the NW50° direction (see Lineament "A" in Diagram), and later underwent frequent cuttings by blockfaulting to reach the complex geological structure it now presents. Under this complicated structure, groundwater occurs exclusively in the NW10° to NW20° lineaments penetrating the *Tawilah Group*. Furthermore, water comes only in those associated with fractured zones rich in permeability. Such a group of lineaments consists of the faults marked "B", "D", "E", "G", "H" and "K" in Diagram. Taking this situation into account, the development of groundwater in the entire area of this region is now quite limited, and the most suitable arrangements for this Project is considered to use the existing well for Bait Al Sultan, which hit the promising lineament in the Ar Rajam basin.

No. 12 Bait Al Sultan



No.	Depth (m)	Remarks
W-1	Unknown	1. Inactive. 2. Is reported to have water. Int. obs. 11
W-2	11.50	1. 54x15m; 43m/40m; Grant project well for obs. 11
W-3	10.2	Proposed project well; 1. 1. 30m/40m; 54x15m
W-4	1.80	Between 10' & 11'; Dry
W-5	1.30	Between 10' & 11'; Dry
W-6	1.52	1. 54x15m; 43m/40m; Grant project well for water sampling; 1. 21m/40m; details
W-7	1.50	1. 54x15m; 43m/40m; Grant project well for water sampling; 1. 21m/40m; details
W-8	1.67	1. 54x15m; 43m/40m; Grant project well for water sampling; 1. 21m/40m; details
W-9	1.80	Between 10' & 11'; Dry
W-10	1.30	1. 54x15m; 43m/40m; Grant project well for water sampling; 1. 21m/40m; details
W-11	1.278	Between 10' & 11'; Dry
W-12	1.306	Between 10' & 11'; Dry
W-13	1.217	1. 54x15m; 43m/40m; Grant project well for water sampling; 1. 21m/40m; details
W-14	1.280	Between 10' & 11'; Dry
W-15	1.300	Between 10' & 11'; Dry
W-16	1.580	Between 10' & 11'; Dry
W-17	1.114	1. 54x15m; 43m/40m; Grant project well for water sampling; 1. 21m/40m; details
W-18	1.05	Between 10' & 11'; Dry
W-19	1.355	1. 54x15m; 43m/40m; Grant project well for water sampling; 1. 21m/40m; details
W-20	1.39	1. 54x15m; 43m/40m; Grant project well for water sampling; 1. 21m/40m; details

LEGEND

- Quaternary
- Tertiary
- Cretaceous
- Upper Jurassic
- Aluvium
- Tawilah Group
- Amran Series
- Liamont
- Strike and Dip
- Existing Well
- Project Well (Existing)
- Water Sampling Point
- Village

3.4.11

Site Number	14	Site Name	AL MALLAHEETH		
Administrative Division	Sub-district : Al Mallaheeth District : Al Dhaher Governorate : Sa'dah				
No. of Villages	9	No. of Houses	415	Present Population	3,180
Planned Area	14 km ²	Population Density		227 persons/km ²	
Income Sources	Rank 1: Agriculture (40%) Rank 2: Wages/salaries (30%) Rank 3: Remittances (30%)	Average Monthly Income		YR2,500	
Medical Facilities	Hospitals /Clinics	PHC (1)	Educational Facilities	Primary School	1
	Medical Staff	Nurse (2)		Intermedi-ate School	1
	No. of Beds	None		Secondary School	1
Shops/Restaurants	Several	Mosques		3	
Water Purchase Practice	Quantity	2,000 liters/7 days/10 persons: 29 lit/d/c			
	Price	YR 200/2,000 liters : YR100/m ³			
	Source	Public well in Al Mallaheeth			
Average Consumption		29 lit/day/capita			

(1) Water Practice and Existing Sources

The northernmost border town, Harad, was among the sites in the phases I and V of Japan's past grant aid projects (The extension of distribution network was completed in the latter phase). Al Mallaheeth is 55 km northeast of Harad along a new road now under construction linking Harad to Sa'dah city across the rugged central mountains zone. The new road runs northward parallel to the border with Saudi Arabia, and one of Saudi Arabia's border army camps, Jabar Makbas, can be viewed from Al Mallaheeth, where a Yemeni border guard has been stationed to counterbalance the threat. Moreover, the site has such public facilities as schools, a dispensary, a telephone office and the LCCD office, developing a congested community over a flat land surrounded by the hills. Besides this community the LCCD plans to supply water to small settlements, which are 2 to 3 km away in all directions, involving 9 villages in total. The northern side of Al Mallaheeth is limited by the Wadi Kholab having a shallow flow throughout the year, which rises in the eastern Central Mountains Zone and eventually discharges into the Red Sea. Located at 460 m above sea level, the area is under the influence of the Tihama tropical weather, and according to the dispensary's staff, the residents have been threatened by the raging malaria as well as bilharzia.

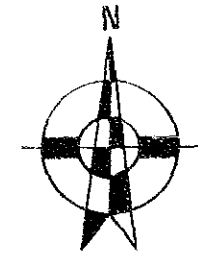
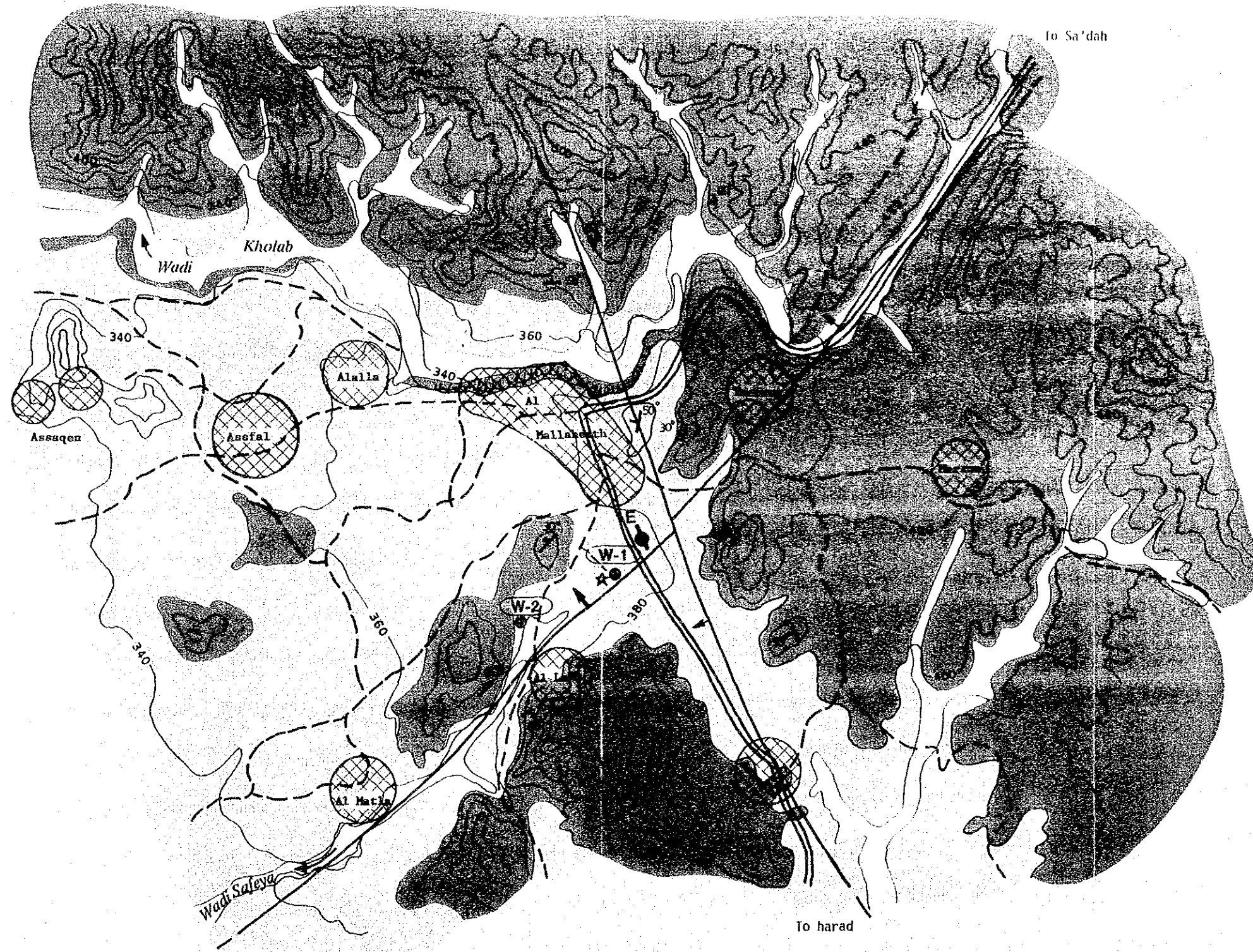
The community has an existing water source facility built seven years ago by the RWSD in the low-lying land of the Wadi Safeya. It consists of a drilled well 80 m deep, a belt-driven vertical shaft pump, and a pump station annexed with a 30 m³ water tank made of reinforced concrete. Water is sold here at the station, with the facility under the operation and control of a full-time operator employed by the LCCD from 6 o'clock in the morning to 2 o'clock in the afternoon. The yield from the well, however, is reported to have now decreased, compared to the initial rate. The operator has been engaged in all the work concerning the facility by himself, including operation, maintenance, repair and water selling. Instead he has been compensated by daily incomes from water selling for his labor. He charges YR60 for a 2 m³ tanker and sells water to about 10 tankers a day. However, the price of water transported in the tanker to the community rises to YR200 to YR300 a car, causing the same heavy burden on the consumers as in other Project sites. Yet water is said to be distributed free of charge to the public facilities in Al Mallaheeth.

(2) Hydrogeological Features

The Project site is based upon mica schist of the Precambrian age. Quartzite and pegmatite dikes are widespread and the orientation of schistosity frequently varies with places. Throughout the site, two lineaments occur, one in the NE50° direction along the Wadi Safeya and the other in the NW10° to 20° along the new road from the eastern edge of Al Mallaheeth. In the latter, a deep well was drilled to a depth of 80 m by the RWSD in 1984, and has been a sole water source for the area. When completed, it is reported to have produced about 550 m³/day, but the present yield has reduced to 210 m³/day.

Well No.	Well Depth(m)	Remarks
W - 1	75	558m ³ /day(initial), 210m ³ /day(now); Drilled by RWS in 1984; T=35°C; EC=1,148µs/cm
W - 2	150	Dry well

No.14 Al Mallaheeth



LEGEND	
Quaternary	[White box] Alluvium
	[Light gray box] Eolian Sand
Pre-Cambrian	[Dark gray box] Mica Schist
	[50° symbol] Strike and Dip
	[Lineament symbol] Lineament
	[W in circle symbol] Existing Well
	[W in circle with dot symbol] Project Well(Existing)
	[E in circle with dot symbol] Geoelectric Prospecting Point & Proposed Well
	[Star symbol] Water Sampling Point
	[Cross-hatched circle symbol] Village



CHAPTER IV

PROJECT PLANNING

CHAPTER IV. PROJECT PLANNING

4.1 OBJECTIVE OF THE PROJECT

The objective of the Project is to construct the water supply facilities pertinent to the specific conditions of the respective sites of eleven (11) located in the seven (7) governorates of the Republic of Yemen, based upon the request from its government to the government of Japan.

Inhabitants in these Project sites have their dwellings in the rugged mountainous and hilly areas where the installation of water facilities including the sources entails enormous difficulties. Without any stable and safe water supplies, they have currently been compelled to buy costly water for their essential needs such as drinking and cooking. Given the government's longstanding policy to promote the agricultural sector through its development planning, the installation of urgently-needed water facilities to those making their living mainly from farming is viewed as an undertaking having substantial effects on the stabilization and upgrading of the rural life as well as the improvement of sanitary environment in line with one of its top-priority strategies in the Five-Year Plan.

4.2 REVIEW OF THE REQUEST FOR THE PROJECT

4.2.1 Necessity of the Project

The country's rural water supply scheme intended for as many as over 80% of the entire population is one of the government's top-priority strategies while it is striving to consolidate the merger and to reform the economy. On June 16, 1990 just after the unity, the prime minister unveiled the new government's economic policy in which top-priority was given to the water resources development and water supplies in remote areas besides the agricultural development. The coverage of rural water supplies at present is put at around 50%, with a growing trend that areas disadvantaged in their natural and social conditions have been left behind with a widening gap from those developed. The ubiquitous presence of such undeveloped regions all