

## CHAPTER 3 CONSIDERATIONS

### 3-1 Hydrological Condition

#### 3-1-1 Water Balance

##### (1) Wadi al Hawasinah River

The conceptional map of water balance in the Ghuzayn District is shown in Figure II-3-1. Input data for the water balance is used hydrological and meteorological data obtained by the hydrological investigation.

Formula of water balance based on the conception is shown in Formula - 4.

$$R = E + S + U + G$$

Formula - 4

$$E = Ev1 + Ev2$$

$$S = So1 - Si + Sgw$$

$$U = So2 - Ds$$

$$G = Go - Gi$$

R : Precipitation	(m <sup>3</sup> /year)
E : Volume of evapotranspiration	(m <sup>3</sup> /year)
S : Outflow of surface water	(m <sup>3</sup> /year)
U : Volume of water use	(m <sup>3</sup> /year)
G : Volume of infiltration	(m <sup>3</sup> /year)
Ev1 : Evapotranspiration from earth surface	(m <sup>3</sup> /year)
Ev2 : Evaporation from river, channel, etc.	(m <sup>3</sup> /year)
So1 : Outflow by rivers	(m <sup>3</sup> /year)
Si : Inflow of surface water	(m <sup>3</sup> /year)
Sgw : Inflow to rivers by groundwater	(m <sup>3</sup> /year)
So2 : Outflow by irrigation channel	(m <sup>3</sup> /year)
Ds : Drainage (waste water)	(m <sup>3</sup> /year)
Go : Outflow of groundwater	(m <sup>3</sup> /year)
Gi : Inflow by groundwater	(m <sup>3</sup> /year)

Concerning the hydrological parameters as mentioned above, precipitation in the district is mean value of precipitation between Sohar and Seeb Airport, and the evapotranspiration is assumed 80 % based on the result of the Follow-up Survey in the Rakah Area (MMAJ, 1997). But the volume of evaporation from rivers, inflow to rivers by groundwater and outflow of groundwater in the district are

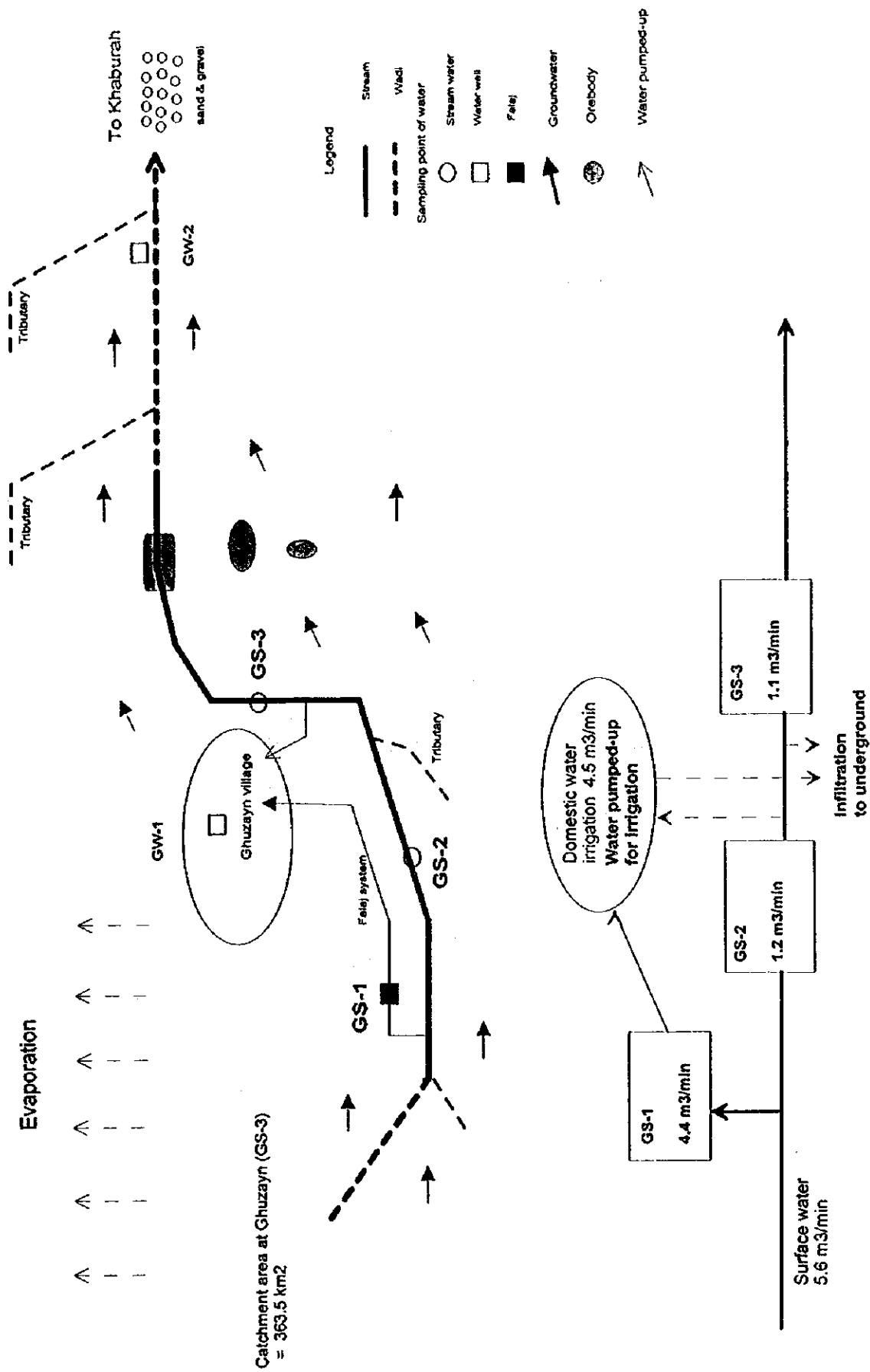


Figure II-3-1 Schematic Water Balance in the Ghuzayn District

excepted from the examination, because these data could not be obtained.

Each value of hydrological parameters at Ghuzayn Village (GS-3) is shown as below.

R	=	37,985,750	(m <sup>3</sup> /year)	: Precipitation : 104.5 mm/year
E	=	34,187,175	(m <sup>3</sup> /year)	
S	=	578,160	(m <sup>3</sup> /year)	
		So1	: 578,160	(m <sup>3</sup> /year)
		Si	: 0	(m <sup>3</sup> /year)
		Sgw	: -	(m <sup>3</sup> /year)
		So2	: 0	(m <sup>3</sup> /year)
U	=	2,312,640	(m <sup>3</sup> /year)	
		So2	: 2,312,640	(m <sup>3</sup> /year)
		Ds	: 0	(m <sup>3</sup> /year)
G	=	R - (E + S + U)		
	=	4,706,350	(m <sup>3</sup> /year)	
		Go	: 0	(m <sup>3</sup> /year)
		Gi	: 0	(m <sup>3</sup> /year)

The volume of groundwater at Ghuzayn Village (GS-3) is calculated to be 4,706,350 m<sup>3</sup>/year which corresponds to about two times of discharge of irrigation channel (Falaj system). The outflow of rivers at GS-3 is 578,160 m<sup>3</sup>/year and all of surface water of Wadi al Hawasinah River becomes to the river-bed water, so that the volume of groundwater around the No.3 Orebody is calculated to be 5,284,510 m<sup>3</sup>/year in total.

Based on the calculation of water balance in the district, it seems that the volume of groundwater around Ghuzayn Village, which is about two times of the volume of surface water, is relatively small quantity. And the potential of groundwater around Ghuzayn Village also supports to be relatively small quantity, because water level of Wadi al Hawasinah River is quite unstable and wadi sediments around Ghuzayn Village is relatively small volume of wadi sediments along the river.

## (2) Ghuzayn Village

The water balance around Ghuzayn Village is shown in Figure II-3-2.

Outflow of river as surface water at the upper stream of GS-1 is 5.6 m<sup>3</sup>/min.

4.4 m<sup>3</sup>/min of river water is taken by irrigation channel (Falaj system), and the water is used for living and agriculture.

The volume of surface water at GS-2 decreases to 1.2 m<sup>3</sup>/min by the intake of irrigation channel, and then the surface water at GS-2 decreases again to 1.1 m<sup>3</sup>/min at GS-3.

The living and agricultural water for Ghuzayn Village is mostly supplied by Falaj system, and there is only one water well in the village.

All of drainage in Ghuzayn Village is seeped to the ground.

### **3 - 1 - 2 Groundwater**

#### **(1) Topography**

The topographic map around the investigation area of bore holes in the district is shown in Figure II-3-2.

The river condition of Wadi al Hawasinah River from about 3.5 km upper stream from Ghuzayn Village to the village forms narrow and deep U-shaped valley, and is thought to be relatively thin river sediments. Therefore, river-bed water flows out and several points of small scale of surface water reveals in the river (Figure II-1-1).

Especially, the width of river around Ghuzayn Village becomes narrow (about 100 m) and the water level of the river in 1998 largely changes from the condition in 1997, so that the baseflow showing recharging volume from groundwater is assumed to be relatively small quantity.

Wadi al Hawasinah River, which bents flow to the west at Ghuzayn Village, is bifurcated to the northwest (main stream) and to the north-northeast (tributary). It seems that the division of two flowing courses at Ghuzayn Village is affected by hilly topography including gossan zone.

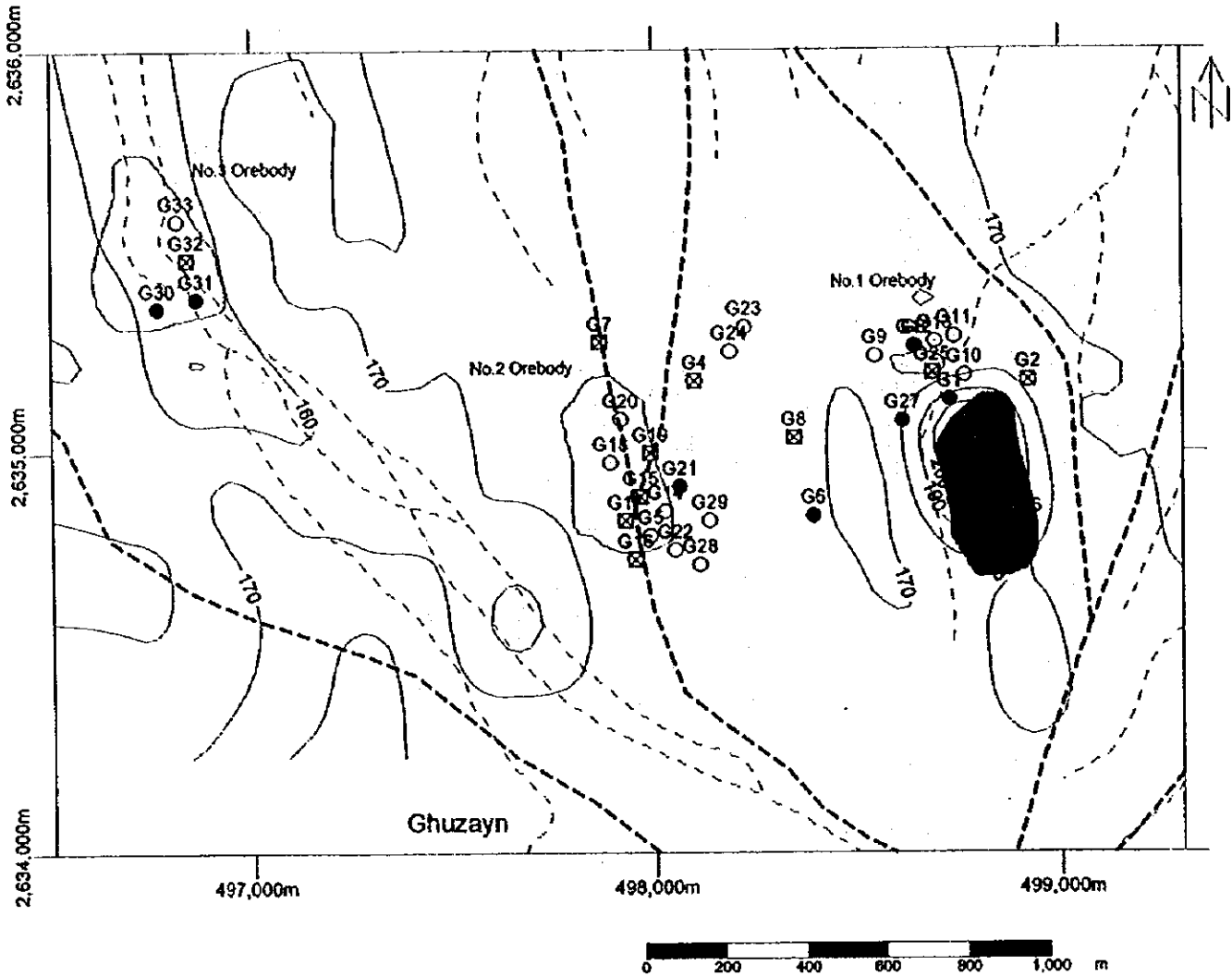
The lower terrace is widespread in the central and northern parts of the district and the main stream and tributaries of Wadi al Hawasinah River erode its surface. Wadi al Hawasinah River flows to the northeast and the drainage system shows parallel drainage pattern.

#### **(2) Geological feature and aquifers**

##### **① Geological feature**

The geologic section and geological feature of each bore holes are shown in Figure II-3-4 and Table II-3-1, respectively.

The River Sediments (Qtgz), ranging in thickness from 6.90 to 15.10 m,



**Legend**

Existing bore holes

- Investigation of groundwater
- ⊕ Investigation of groundwater, recovery test
- Closed
- - - Wadi
- Road
- 170 Contour (m)

Figure II-3-2 Topographic Map in the Ghuzayn District



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Table II-3-1 Geological Feature of the Existing Bore Holes

Bore holes (No.)	Depth of lithofacies boundary *1 (m)												Number of orebody
	Qtgz		Ggx				SVI-2		Ore zone		SVI-1		
			unconsolidated		consolidated								
	from	to	from	to	from	to	from	to	from	to			
MJOB-G1	-	-	0.00	3.40	-	-	34.00	42.60	-	-	42.60	186.50	No. 1
MJOB-G2	-	-	0.00	3.60	-	-	3.60	42.60	-	-	42.60	305.40	-
MJOB-G3	-	-	0.00	6.10	-	-	6.10	115.15	115.15	288.20	288.20	300.40	No.1
MJOB-G4	-	-	0.00	5.30	5.30	10.90	10.90	290.30	-	-	290.30	300.50	No.1
MJOB-G5	-	-	0.00	10.10	10.10	23.10	23.10	134.00	134.00	170.60	170.60	300.20	No.1
MJOB-G6	-	-	0.00	11.80	-	-	11.80	73.10	-	-	73.10	300.30	-
MJOB-G7	-	-	0.00	11.00	11.00	28.95	28.95	300.15	-	-	-	-	-
MJOB-G8	-	-	0.00	4.90	4.90	19.80	19.80	191.55	-	-	191.55	200.25	-
MJOB-G9	-	-	0.00	7.35	7.35	17.80	17.80	200.20	-	-	-	-	-
MJOB-G10	-	-	0.00	5.80	-	-	5.80	84.70	-	-	84.70	200.10	-
MJOB-G11	-	-	0.00	4.60	-	-	4.60	162.85	162.85	165.25	165.25	200.20	No.1
MJOB-G12	-	-	0.00	4.80	4.80	6.50	6.50	156.50	-	-	156.50	200.30	-
MJOB-G13	-	-	0.00	4.70	-	-	4.70	152.80	152.80	154.40	154.40	200.10	No.1
MJOB-G14	-	-	0.00	2.80	2.80	18.60	18.60	119.60	119.80	230.50	230.50	250.10	No.2
MJOB-G15	-	-	0.00	3.50	3.50	18.60	18.60	178.85	178.85	212.30	212.30	250.15	No.2
MJOB-G16	-	-	0.00	4.80	4.80	20.25	20.25	186.30	186.30	189.90	189.90	201.85	No.2
MJOB-G17	-	-	0.00	6.70	6.70	18.25	18.25	215.90	215.90	222.80	222.80	250.25	No.2
MJOB-G18	-	-	0.00	10.00	10.00	19.35	19.35	251.80	251.80	267.00	267.00	300.25	No.2
MJOB-G19	-	-	0.00	3.60	3.60	24.80	24.80	194.10	194.10	227.50	227.50	300.40	No.2
MJOB-G20	-	-	0.00	7.75	7.75	16.00	16.00	273.90	273.90	279.30	279.30	300.45	No.2
MJOB-G21	-	-	0.00	8.90	-	-	8.90	126.10	126.10	138.75	138.74	250.25	No.2
MJOB-G22	-	-	0.00	8.70	-	-	8.70	90.50	90.50	127.85	127.85	200.60	No.2
MJOB-G23	-	-	0.00	3.15	3.15	12.10	12.10	350.20	-	-	-	-	-
MJOB-G24	-	-	0.00	7.80	7.80	12.10	12.10	331.60	-	-	331.60	350.25	-
MJOB-G25	-	-	0.00	4.05	4.05	13.00	13.00	115.60	115.60	123.05	123.05	200.10	No.2
MJOB-G26	-	-	-	-	-	-	0.00	37.55	80.05	86.80	37.55	200.15	No.2
MJOB-G27	-	-	0.00	4.55	4.55	13.60	13.60	101.25	-	-	101.25	201.05	-
MJOB-G28	-	-	0.00	7.50	-	-	7.50	80.75	-	-	80.75	150.20	-
MJOB-G29	-	-	0.00	3.30	3.30	15.15	15.15	116.05	132.75	142.85	116.05	200.15	No.2
MJOB-G30	0.00	14.95	-	-	-	-	14.95	110.40	110.40	201.80	201.80	250.20	No.3
MJOB-G31	0.00	15.10	-	-	-	-	15.10	109.30	109.30	181.30	181.30	235.45	No.3
MJOB-G32	-	-	-	-	0.00	18.60	18.60	169.35	169.35	209.00	209.00	250.50	No.3
MJOB-G33	-	-	-	-	0.00	7.30	7.30	223.20	223.20	247.40	247.40	300.00	No.3
MJOB-G34	-	-	0.00	4.30	-	-	4.30	210.65	210.65	250.40	-	-	No.3
MJOB-G35	0.00	6.90	-	-	-	-	6.90	127.25	127.25	133.35	127.25	200.10	No.3
MJOB-G36	0.00	13.15	-	-	-	-	13.15	177.00	177.00	231.25	177.00	251.00	No.3
MJOB-G37	0.00	12.50	-	-	-	-	12.50	255.05	255.05	259.15	259.15	270.15	No.3

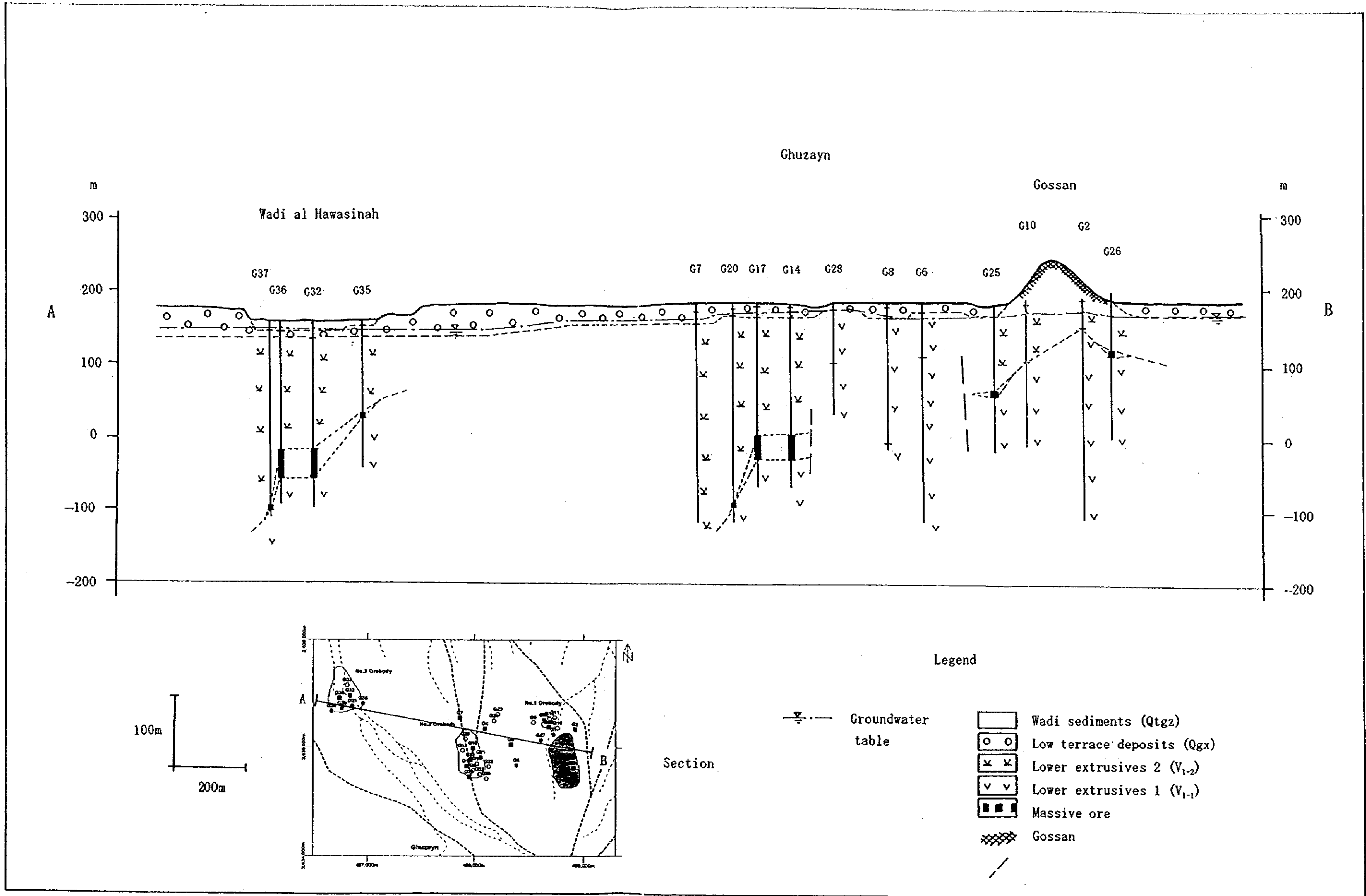
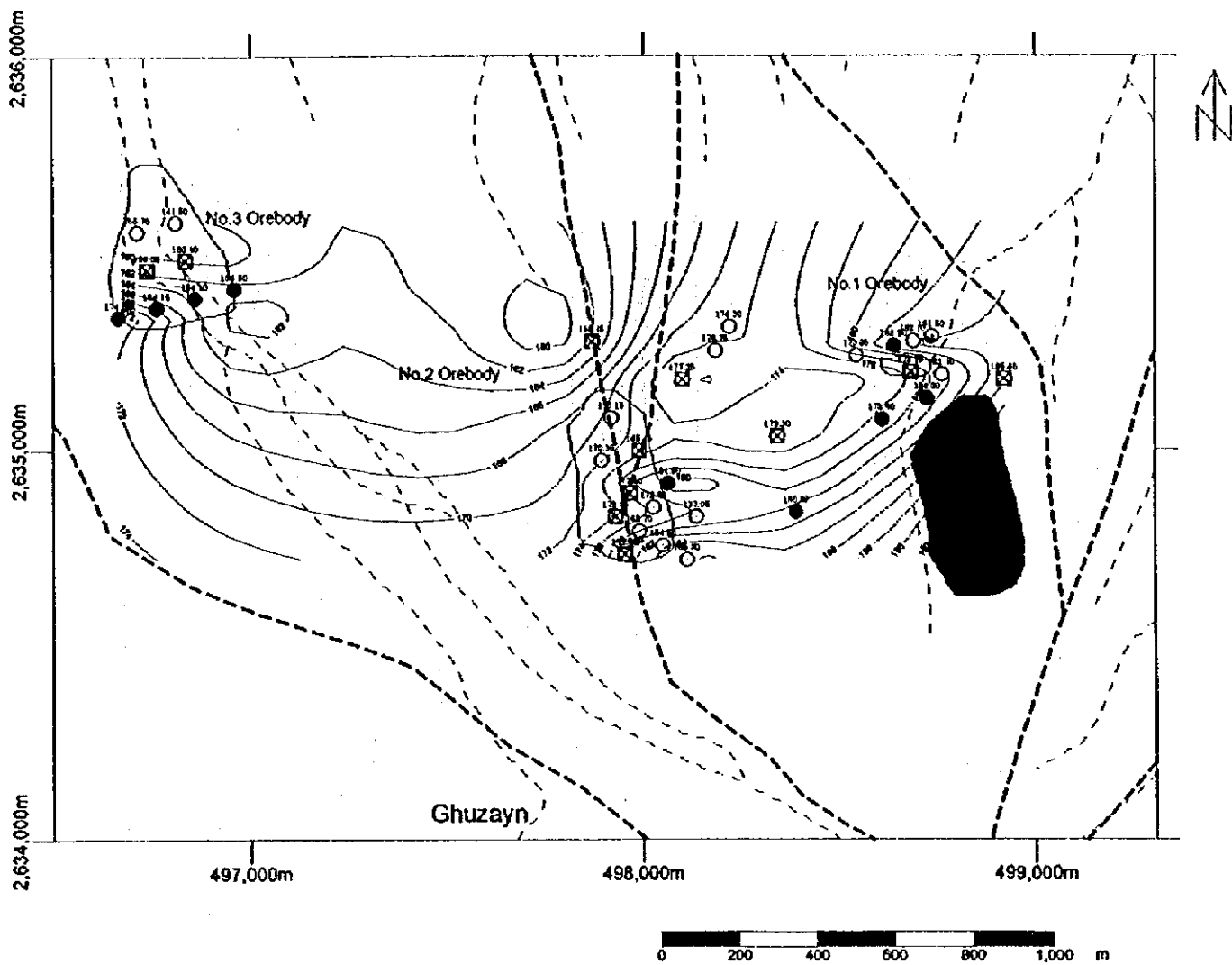


Figure II-3-3 Geologic Section in the Survey Area





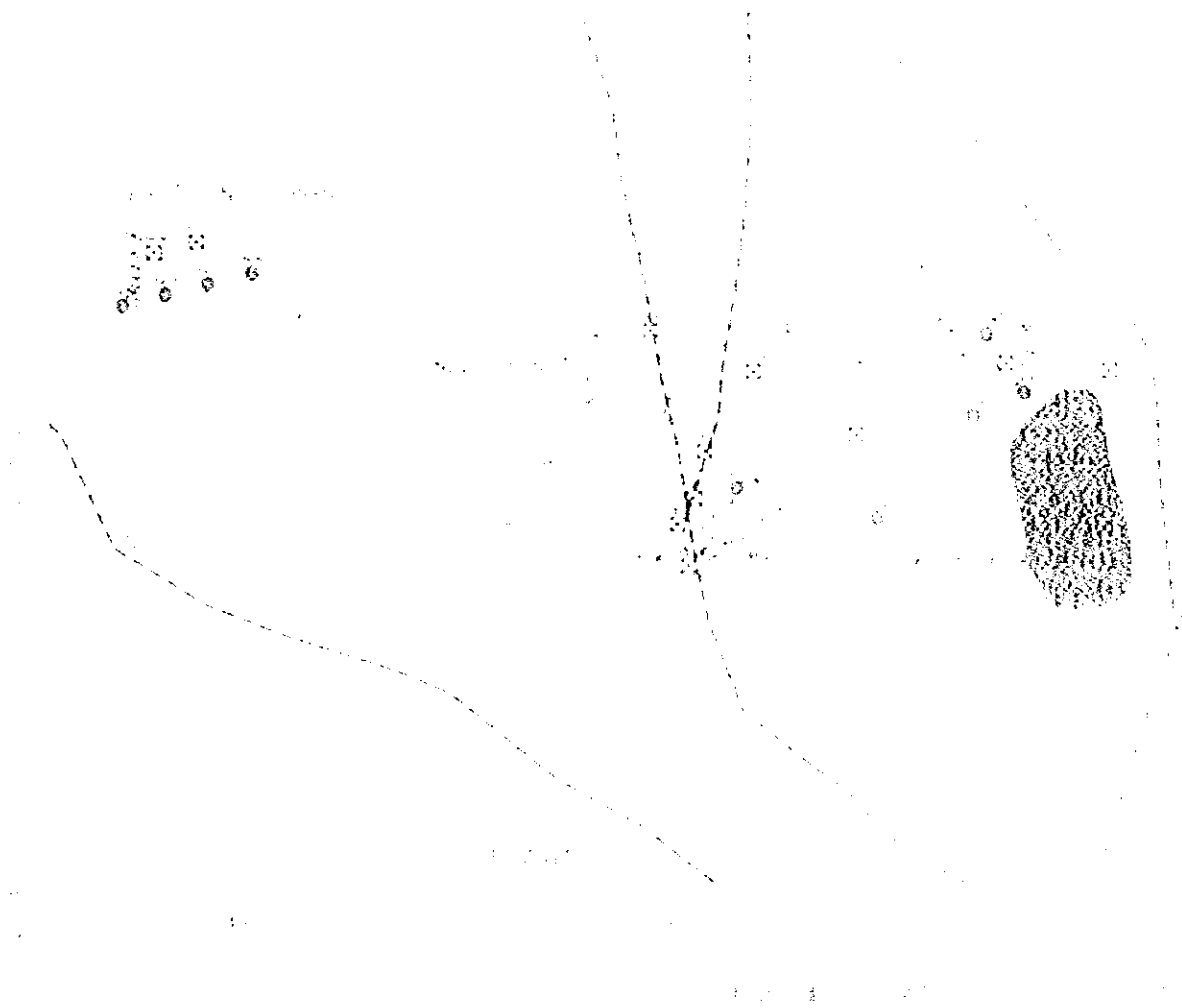


**Legend**

Existing bore holes

- Investigation of groundwater
- ⊗ Investigation of groundwater, recovery test
- Closed
- - - Wadi
- Road
- 7.0 Contour of level of basement

Figure II-3-4 Contour map of the basement



Legend:

Legend:

- ⊠ (shaded rectangle) - Shaded area
- ⊠ (unshaded rectangle) - Unshaded area
- (circle) - Point
- (solid line) - Road
- - - (dashed line) - Boundary

Table II-3-2 Hydrological Condition of Existing Bore Holes in the Ghuzyn District

Bore holes (No.)	Ground level (m)	Depth of groundwater (m)	Groundwater level (m)	Thickness of Qtgz & Qgx *1 (m)	Bottom level of Qtgz & Qgx (m)	Thickness *2 of groundwater in Qtgz & Qgx (m)
MJOB-G1	187.40	-	-	3.40	184.00	-
MJOB-G2	189.25	-20.24	169.01	3.60	185.65	16.64
MJOB-G3	190.00	-	-	6.10	183.90	-
MJOB-G4	188.15	-17.88	170.27	10.90	177.25	6.98
MJOB-G5	191.80	-15.11	176.69	23.10	168.70	(7.99)
MJOB-G6	192.40	-	-	11.80	180.60	-
MJOB-G7	187.40	-21.63	165.77	28.95	158.45	(7.32)
MJOB-G8	192.10	-20.94	171.16	19.80	172.30	1.14
MJOB-G9	191.20	-22.86	168.34	17.60	173.60	5.26
MJOB-G10	187.90	-18.04	169.86	5.80	182.10	12.24
MJOB-G11	186.10	-19.97	166.13	4.60	181.50	15.37
MJOB-G12	190.00	-23.96	166.04	6.50	183.50	17.46
MJOB-G13	188.80	-20.03	168.77	4.70	182.10	15.33
MJOB-G14	191.45	-16.00	175.45	18.60	172.85	(2.60)
MJOB-G15	191.10	-14.39	176.71	18.60	172.50	(4.21)
MJOB-G16	192.90	-16.00	176.90	20.25	172.65	(4.25)
MJOB-G17	191.20	-14.62	176.58	18.25	172.95	(3.63)
MJOB-G18	189.70	-14.83	174.87	19.35	170.35	(4.52)
MJOB-G19	190.25	-15.41	174.84	24.80	165.45	(9.39)
MJOB-G20	189.15	-15.26	173.89	16.00	173.15	(0.74)
MJOB-G21	190.80	-	-	8.90	181.90	-
MJOB-G22	193.20	-15.75	177.45	8.70	184.50	7.05
MJOB-G23	188.40	-18.30	170.10	12.10	176.30	6.20
MJOB-G24	187.85	-19.10	168.75	12.10	175.75	7.00
MJOB-G25	188.10	-20.51	165.59	13.00	173.10	7.51
MJOB-G26	198.70	-32.67	166.03	0.00	198.70	32.67
MJOB-G27	189.20	-	-	13.60	175.60	-
MJOB-G28	194.40	-18	176.40	7.50	186.90	10.50
MJOB-G29	192.20	-	-	15.15	177.05	-
MJOB-G30	169.10	-	-	14.95	154.15	-
MJOB-G31	169.20	-	-	15.10	154.10	-
MJOB-G32	169.00	-13.65	155.35	18.60	150.40	(4.95)
MJOB-G33	168.80	-12.39	156.41	7.30	161.50	5.09
MJOB-G34	179.10	-	-	4.30	174.80	-
MJOB-G35	170.50	-	-	6.90	163.60	-
MJOB-G36	169.20	-9.40	159.80	13.15	156.05	(3.75)
MJOB-G37	168.20	-	-	12.50	155.70	-

\*1 Qtgz : Wadi sediments

\*2 ( ): Groundwater table in the SV1

Qgx : Lower terrace deposits

are found along Wadi al Hawasinah River in the western part of the district. In the section among bore holes MJOB-G30, G31 and G32, its thickness is almost stable between 12.50 and 14.95 m. It becomes thinner in the lower stream of the river.

The Lower Terrace Deposits (Qgx) are widespread in the district and range in thickness from 7.30 to 28.97 m. Qgx around the gossan zone and No. 1 Orebody is thin layer ranging from 3.40 to 6.50 m. Qgx at MJOB-G9 hole is 17.60 m thick and forms steep slope. And Qgx around No. 2 Orebody ranges in thickness from 7.50 to 28.95 m, and their thickness remarkably varies and wholly increases. The base of Qgx shows unevenness and forms small valley extending from the north of gossan zone to the west (Figure II-3-4).

## ② Aquifers

The main aquifers of groundwater in the district are thought to be composed of unconsolidated sand and gravel of the River Sediments (Qtgz) and the Lower Terrace Deposits (Qgx).

Although the lower part of Qgx becomes calcrete layer filled by carbonate minerals, a part of calcrete layer seems to be remained permeability due to loose texture, fractures, etc. And top of the groundwater in the bore holes is mostly changed to fresh water which is not contaminated by the drill mud, so that the groundwater seems to seep from Qgx.

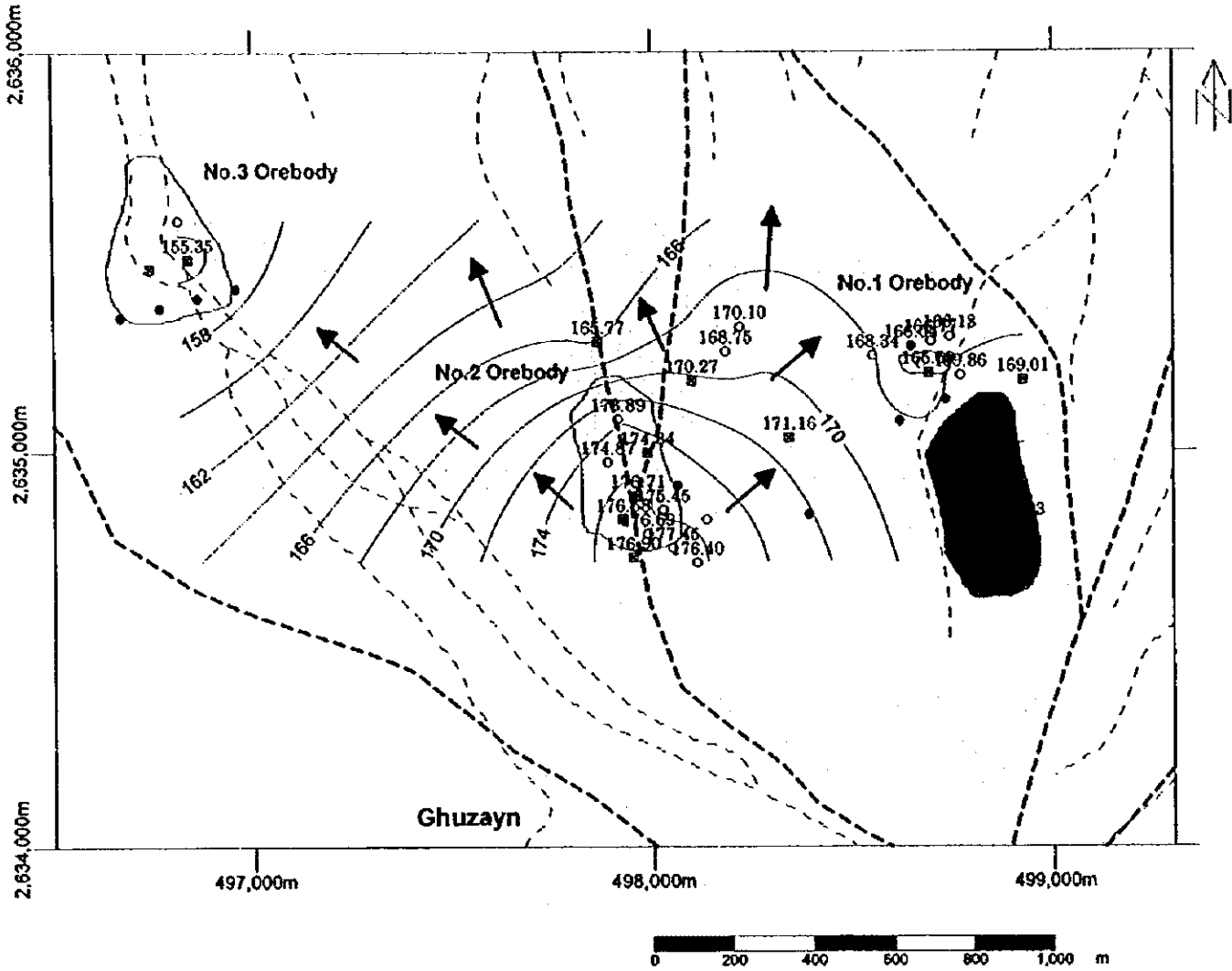
The basement consisting mainly of pillow lava is thought to be relatively good permeability due to the fractures developed by weathering and alteration, but its sphere is limited only upper part of the basement.

Incidentally, the water spring in the bore hole during drilled work at the No. 2 Orebody was recorded, therefore it assumes there are limited aquifers in the basement and the confined groundwater is flowing.

## (3) Water table

The profile and plan of water table in the district are shown in Figure II-3-3 and Figure II-3-5, respectively.

Groundwater table in the district forms almost flat, but about 2 km distance from southeast (175 m in elevation) to northwest (155 m in elevation) of the district shows very gentle slope ( $0.6^\circ$ ). The feature of water table in the district is mostly concordant with topography of the district. And the groundwater table at the water wells (GW-1 and GW-2) in the district also exists



**Legend**

**Existing bore holes**

- Investigation of groundwater
- ⊗ Investigation of groundwater, recovery test
- Closed
- - - Wadi
- Road
- 170 Contour of groundwater level (m)
- ➔ Inferred flow direction of groundwater

Figure II-3-5 Water Table in the Survey Area

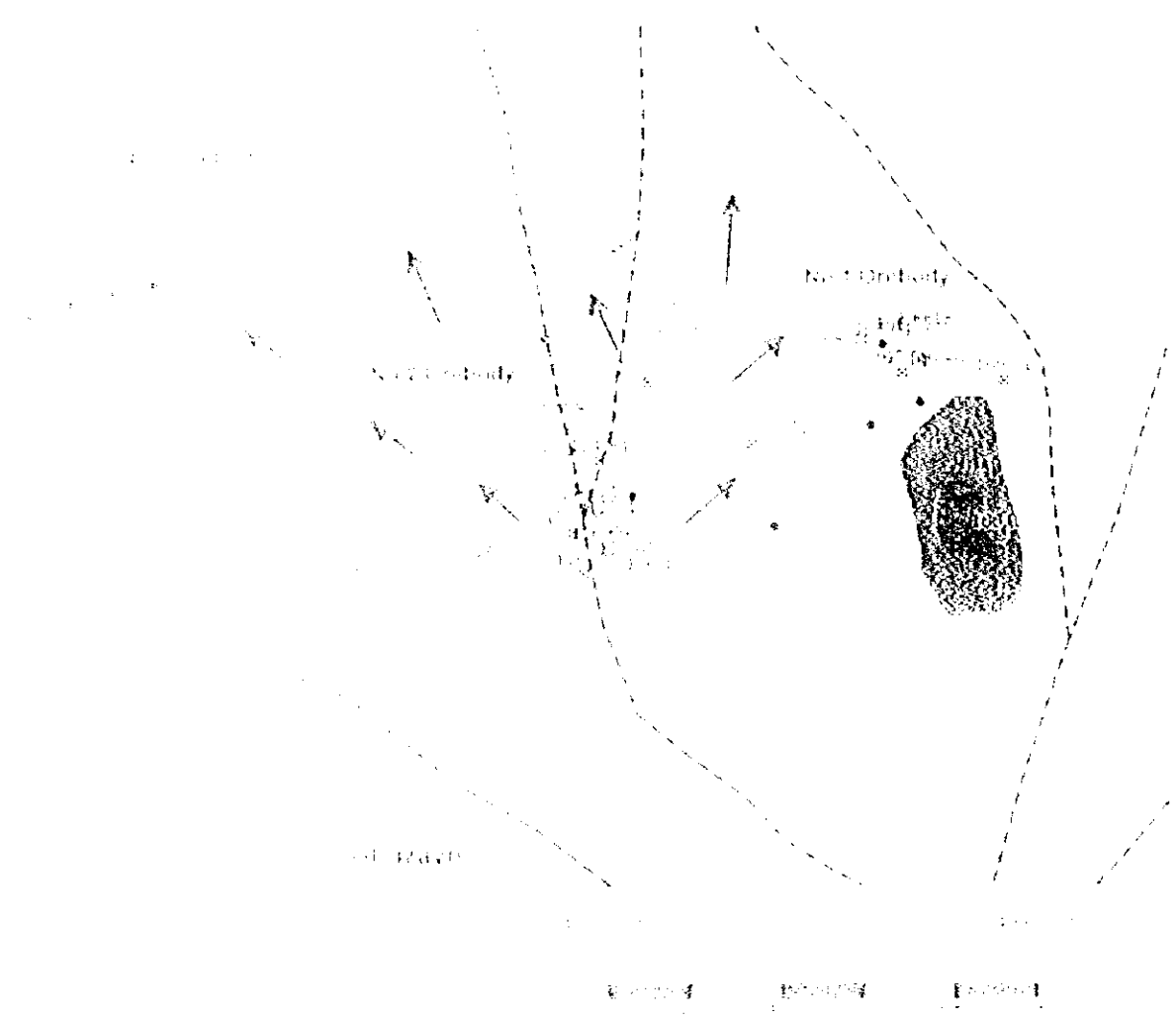


Figure 1. Inferred flow direction of groundwater

Figure 1. Inferred flow direction of groundwater

(b) inferred flow direction of groundwater

in the Qgx.

The groundwater table around bore holes of MJOB-G5, G16, G22 and G28 is 176 m and shows a convex shape, which is about 5 to 10 m higher than that of other bore holes. The convex shape of groundwater around the No. 2 Orebody corresponds to the confined groundwater in the basement mentioned as before.

The drilling mud (EG-mud) is thought to be still remained in the bore holes, so that the drilling mud gives critical influence to the recovery test.

#### (4) Flow direction of groundwater

##### ① Flow direction

The flow direction of groundwater in the district shows radial shape at the center of No. 2 Orebody (Figure II-3-5).

##### ② Permeability coefficient

The permeability coefficient in the district ranges from  $10^{-4}$  to  $10^{-7}$  cm/s. That of MJOB-G36 is  $10^{-4}$  cm/s and shows to be relatively good aquifer, because of the sand and gravel of the River Sediments (Qtgz).

The permeability coefficient of other bore holes ranges from  $10^{-5}$  to  $10^{-7}$  cm/s, and it is thought that the drilling mud gives critical influence to the recovery test.

### 3-2 Water Quality

#### 3-2-1 Hexadiagram and Key Diagram

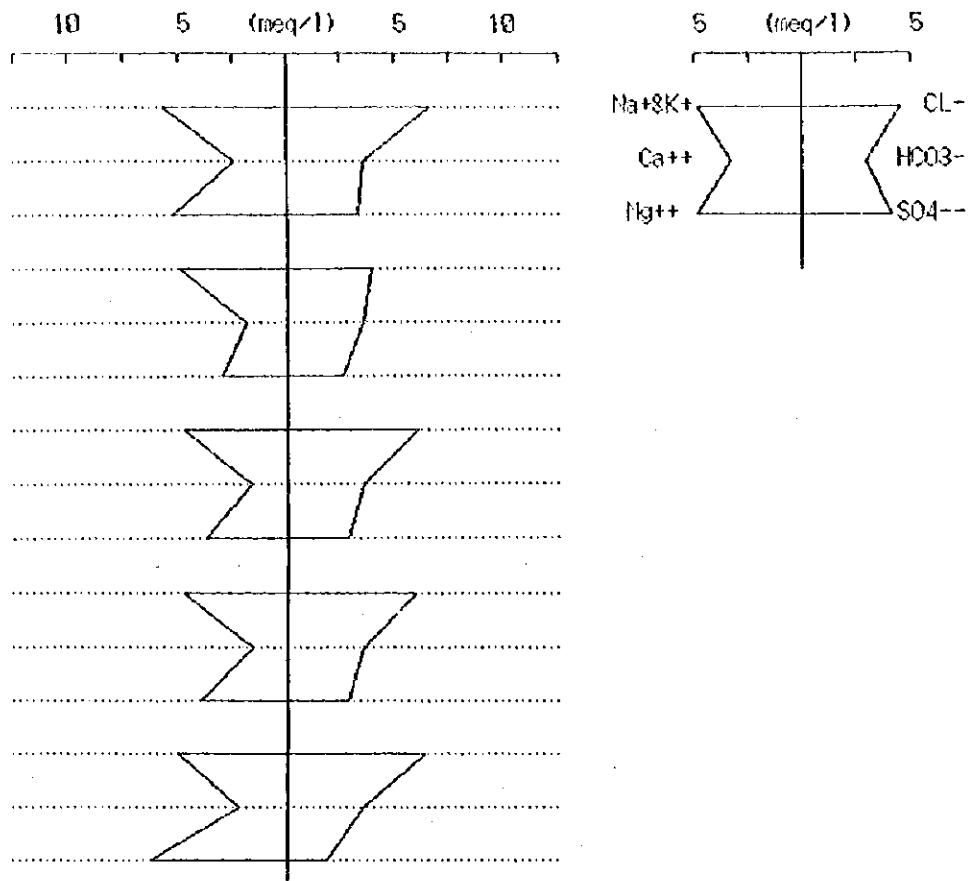
The water quality diagram of river and well water is shown in Figure II-3-6. But the concentration of  $\text{HCO}_3$  was not available, so that the water quality data ( $\text{HCO}_3$  : 219 mg/l) of well water (Hayl as Safil) in the Rakah area is used as reference.

Surface water (GS-2) shows very similar to the irrigated water (GS-1). Surface water in Ghuzayn Village (GS-3) slightly increases dissolved substance more than GS-2, especially Mg ion remarkably increased.

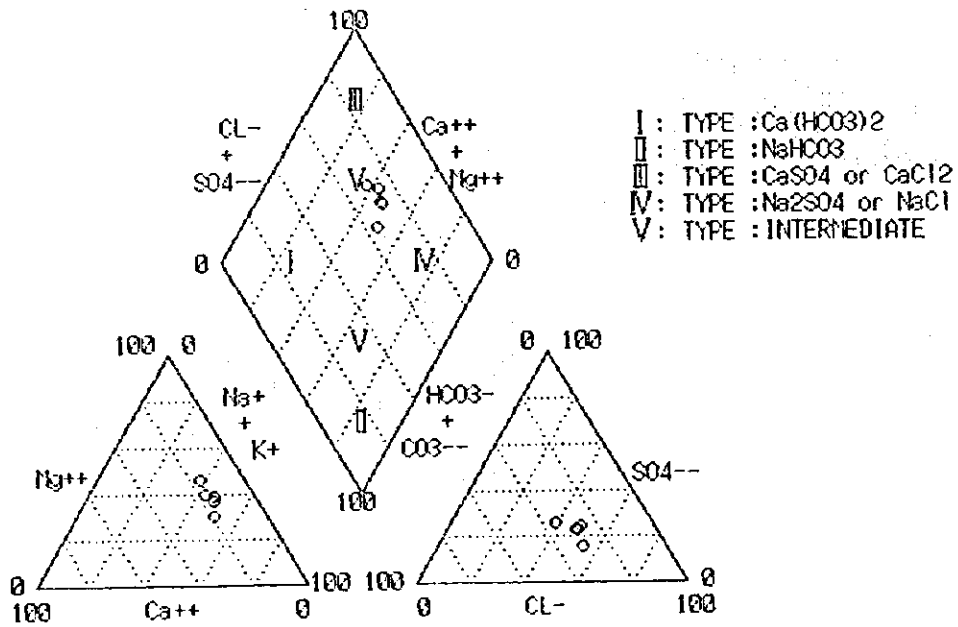
Well water (GW-2) is the lowest water of dissolved substance in the district.

River water and well water show almost same feature of water quality, especially the well water of Ghuzayn Village (GW-1) and river water of Wadi al Hawasinah River at Ghuzayn Village (GS-3) show same group.





(1) Hexa Diagram



(2) Key Diagram

Figure II-3-6 Hexadiagram and Key Diagram of Water Quality in the Ghuzayn District

### 3-2-2 Water Quality of Groundwater in the Bore Holes

The water quality of the bore holes shows that pH ranges from 7.08 to 11.28. Groundwater of G16, G17 and G25 shows alkali ranging from pH 9 to 11, because of the influence of cementing during drilling work.

The electric conductivity ranges from 20.5 to >1999  $\mu\text{S}/\text{cm}$ . Especially, the electric conductivity of MJOB-G8, G12, G32 and G36 shows more than 1000  $\mu\text{S}/\text{cm}$ . Although the major reason of high electric conductivity is not clear because of any data of main components of water, it is assumed to be affected by drilling mud.

Water temperature ranges from 28.7 to 35.3  $^{\circ}\text{C}$ , and the water temperature is higher than that of surface water (27.1~29.0 $^{\circ}\text{C}$ ).

The concentration of As and Hg is less than minimum limit of determination.

The concentration of Cr ranges from <0.02 to 0.13 mg/l. The groundwater of MJOB-G15, G16, G17 and G22 shows relatively high concentration of Cr.

The concentration of Cu ranges from 0.02 to 0.46 mg/l. The groundwater of MJOB-G22 shows relatively high concentration of Cu (0.45~0.46 mg/l). The concentration of Cu can not recognize clear difference between surface and deep groundwater. It is thought that the drilling mud gives critical influence to the water quality.

The concentration of Fe ranges from 0.93 to 32.90 mg/l. The surface and deep groundwater of MJOB-G8, G13, G18, G22 and G36 shows relatively high concentration of Fe (13.60~32.90 mg/l). And it is not recognized to be clear difference between surface and deep groundwater.

The concentration of Mn ranges from 0.05 to 0.84 mg/l. The deep groundwater of MJOB-G8, G18, G22, G26, G32 and G36 shows high concentration of Mn (0.32~0.84 mg/l). The concentration of Mn of deep groundwater indicates higher than that of surface groundwater.

The concentration of Zn ranges from 0.02 to 7.00 mg/l. The groundwater of MJOB-G8, G13 and G17 shows high concentration of Zn (3.65~7.00 mg/l).

The concentration of  $\text{SO}_4$  ranges from 110 to 1230 mg/l. The deep groundwater of MJOB-G8, G12 and G26 shows high concentration of  $\text{SO}_4$ .

Relatively high concentration of heavy metals concerning the groundwater in the bore holes is recognized in the holes of MJOB-G8, G13, G18, G22 and G26. Well water (GW-2) in the lower stream of the river is the lowest water of dissolved substance in the district. These holes are located around orebodies.

As a whole, the drilling mud is thought to give strict influence to the water quality and flow of the groundwater in the bore holes.

### 3-3 Water Quality around Orebodies

Although the relationship between ore deposit and water quality could not be sufficiently clarified, the remarkable influence of ore deposit to the surrounding, especially heavy metals and  $SO_4$ , is not recognized.

PART III CONCLUSIONS AND RECOMMENDATIONS

1994-1995

## CHAPTER 1 CONCLUSIONS

The conclusions of the study are as follows:

### (Hydrological Investigation)

- River in the Ghuzayn District belongs to the drainage system of Wadi al Hawasinah River.
- Sampling points of water for the hydrological investigation consist of 5 points, 3 points of river survey (GS-1, GS-2 and GS-3) and 2 points of well survey (GW-1 and GW-2).
- Discharge of GS-1 (Falaj) is 4.432 m<sup>3</sup>/min, GS-2 (upper stream) is 1.119 m<sup>3</sup>/min, and GS-3 (lower stream) is 1.213 m<sup>3</sup>/min.
- Water wells (GW-1 and GW-2) in the district are shallow well for living and irrigation. Depth of groundwater table is about -7 m and water quality shows almost similar.
- Approximately two times of volume of surface water is assumed to supply to the groundwater by rain-fall in the Ghuzayn District. River water of 4.4 m<sup>3</sup>/min is taken for the irrigation to Ghuzayn Village by Falaj system and water is used for living and agriculture.
- The water quality of river water and well water show almost similar, especially the well water of Ghuzayn Village (GW-1) is similar to that of Wadi al Hawasinah River at Ghuzayn Village (GS-3).
- River water and well water show that pH ranges from 7.63 to 8.46, electric conductivity ranges from 104.9 to 139.0  $\mu$ S/cm.
- The concentration of heavy metals of river water and well water shows to be almost same group that Cu ranges in concentration from 0.03 to 0.04 mg/l, Fe ranges in concentration from 0.14 to 0.32 mg/l, and Mn ranges in concentration from <0.01 to 0.01 mg/l.
- The concentration of light metals of river water and well water shows to be almost same group that Ca ranges in concentration from 31.5 to 48.0 mg/l, K ranges in concentration from 3.34 to 4.65 mg/l, Mg ranges in concentration from 36.3 to 76.1 mg/l, and Na ranges in concentration from 107 to 129 mg/l.
- The concentration of anion of river water and well water shows to be almost same group that Cl ranges in concentration from 140 to 236 mg/l, NO<sub>3</sub> ranges in concentration from 0.83 to 4.69 mg/l, and SO<sub>4</sub> ranges in concentration from 31.5 to 48.0 mg/l.

- The technical transfers for the establishment of organization for the periodical hydrological investigation was carried out.

(Water Investigation of Bore Holes)

- 13 bore holes, including MJOB-G2, G4, G7, G8, G15, G16, G17, G19, G25, G26, G28, G32 and G36 were selected for the recovery test.
- The permeability coefficient in the district ranges from  $10^{-4}$  to  $10^{-7}$  cm/s, and that of MJOB-G36 is  $10^{-4}$  cm/s and shows to be relatively good aquifer.
- River Sediments, which are found along the Wadi al Hawasinah River in the western part of the district, range in thickness from 6.90 to 15.10 m.
- The Lower Terrace Deposits, which widespread in the district, range in thickness from 7.30 to 28.97 m.
- Major aquifer in the district is assumed to be unconsolidated River Sediments, Lower Terrace Deposits, and cracky zone of basement (basalts).
- Groundwater table in the district forms very gentle slope ( $0.6^\circ$ ) from southeast (175 m in elevation) to northwest (155 m in elevation).
- The groundwater level around bore holes of MJOB-G5, G16, G22 and G28 is 176 m, which is about 5 to 10 m higher than that of other bore holes.
- The flow direction of groundwater in the district shows radial shape at the center of No. 2 Orebody.
- The drilling mud (EG-mud) is thought to be still remained in the bore holes, so that the drilling mud gives critical influence to the recovery test.
- The water quality of the bore hoes shows that pH ranges from 7.08 to 11.28. Groundwater of MJOB-G16, G17 and G25 shows alkali ranging from pH 9 to 11, because of the influence of cementing during drilling work.
- The Electric Conductivity ranges from 20.5 to  $>1999 \mu\text{S/cm}$ . Water temperature ranges from 28.7 to 35.3  $^\circ\text{C}$ .
- The concentration of heavy metals shows that Cu ranges in concentration from 0.02 to 0.46 mg/l, Fe ranges in concentration from 0.93 to 32.90 mg/l, Mn ranges in concentration from 0.05 to 0.84 mg/l, Zn ranges in concentration from 0.02 to 7.00 mg/l.
- The difference between shallow groundwater and deep groundwater in the bore holes can not be recognized except Mn. Mn concentration of deep groundwater of MJOB-G8, G18, G22, G26, G32 and G36 is higher than that of surface groundwater.
- The drilling mud is thought to gives serious influence to the water quality of the groundwater of the bore holes.

## CHAPTER 2 RECOMMENDATIONS

The recommendations of the study are as follows:

- It is necessary to settle bore holes in the upper and lower parts of the orebodies for monitoring of groundwater, because the existing bore holes are influenced by drilling mud.
- It is necessary to carry out the more detailed environmental study in the Ghuzayn District for the conceptional design of the mine development.
- The items of environmental investigation consist of air quality, water quality, groundwater, soil, noise and vibration, and social environment.
- It is desirable to continue the monitoring work of water after the project.



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## APPENDICES

1. Measurement Card for Discharge
2. Investigation Card of Bore Holes
3. Meteorological Data

1. Measurement Card for Discharge

Measurement of Discharge (GS-1)

(December 7, 1998)

1. Location : Falaj system, Ghuzayn
2. Number of measurement point : GS-1
3. Measurement of stream bed

	1	2	3	4	
Length	<u>0</u>	<u>20</u>	<u>40</u>	<u>62.2</u>	(cm)
width		<u>20</u>	<u>20</u>	<u>22.2</u>	(cm)
Depth	<u>11</u>	<u>13.5</u>	<u>13.5</u>	<u>12.5</u>	(cm)
NOR <sup>1</sup> (60%)		<u>6.62</u>	<u>6.17</u>	<u>5.85</u>	(r/s)

4. Calculation

$$V = 0.132 \times N + 0.004 \quad (\text{m/s})$$

V : Flow speed (m/s)

N : Number of rotation

	1	2	3	
FS <sup>2</sup>	<u>0.88</u>	<u>0.82</u>	<u>0.78</u>	(m/s)
Area	0.0245	0.0363	0.0289	(m <sup>2</sup> )

$$V_o = (0.0245 \times 0.88) + (0.0363 \times 0.82) + (0.0289 \times 0.78)$$

$$= \underline{0.074} \quad (\text{m}^3/\text{s})$$

$$= \underline{4.432} \quad (\text{m}^3/\text{min})$$

<sup>1</sup> NOR : Number of rotation

<sup>2</sup> FS : Flow speed (m/s)

Measurement of Discharge (GS-2)

(December 7, 1998)

1. Location : Upper stream of Wadi Hawasina, Ghuzayn
2. Number of measurement point : GS-2
4. Measurement of stream bed

	1	2	3	4	
Length	<u>0</u>	<u>30</u>	<u>50</u>	<u>77</u>	(cm)
width	<u>30</u>	<u>20</u>	<u>27</u>		(cm)
Depth	<u>9</u>	<u>10.8</u>	<u>11.1</u>	<u>8.7</u>	(cm)
NOR <sup>3</sup> (60%)	<u>1.43</u>	<u>1.66</u>	<u>2.26</u>		(r/s)

4. Calculation

$$V = 0.132 \times N + 0.004 \quad (\text{m/s})$$

V : Flow speed (m/s)

N : Number of rotation

	1	2	3	
FS <sup>4</sup>	<u>0.19</u>	<u>0.22</u>	<u>0.30</u>	(m/s)
Area	0.0297	0.0219	0.0267	(m <sup>2</sup> )

$$V_0 = (0.0297 \times 0.19) + (0.0219 \times 0.30) + (0.0267 \times 0.30)$$

$$= \underline{0.020} \quad (\text{m}^3/\text{s})$$

$$= \underline{1.213} \quad (\text{m}^3/\text{min})$$

<sup>3</sup> NOR : Number of rotation

<sup>4</sup> FS : Flow speed (m/s)

Measurement of Discharge (GS-3)

(December 7, 1998)

1. Location : Lower stream of Wadi Hawasina, Ghuzayn  
 (In front of Ghuzayn Elementary School.)
2. Number of measurement point : GS-3
5. Measurement of stream bed

	1	2	3	4	
Length	<u>0</u>	<u>20</u>	<u>40</u>	<u>64</u>	(cm)
width		<u>20</u>	<u>20</u>	<u>24</u>	(cm)
Depth	<u>4.6</u>	<u>9.8</u>	<u>9.9</u>	<u>6.1</u>	(cm)
NOR <sup>5</sup>					
(60%)	<u>2.63</u>	<u>2.65</u>	<u>2.62</u>		(r/s)

4. Calculation

$$V = 0.132 \times N + 0.004 \quad (\text{m/s})$$

V : Flow speed (m/s)

N : Number of rotation

	1	2	3	
FS <sup>6</sup>	<u>0.35</u>	<u>0.35</u>	<u>0.35</u>	(m/s)
Area	0.0144	0.0197	0.0192	(m <sup>2</sup> )

$$V_o = (0.0144 \times 0.35) + (0.0197 \times 0.35) + (0.0192 \times 0.35)$$

$$= \underline{0.019} \quad (\text{m}^3/\text{s})$$

$$= \underline{1.119} \quad (\text{m}^3/\text{min})$$

<sup>5</sup> NOR : Number of rotation

<sup>6</sup> FS : Flow speed (m/s)

2. Investigation Card of Bore Holes





Investigation Card (No. G2)

(Date : 6/12/1998)

1. Purpose of investigation : (1) (2) (3) Groundwater in bore hole											
2. Name of Location		: Ghuzayn									
Location number		: MJOB-G2									
Number of water sample		: GD-21 : surface (of groundwater)									
3. Content of investigation											
3-1. Surface water (S)											
pH		: _____									
EC		: _____ $\mu$ S/cm									
Temperature		: _____									
Discharge		: _____ $m^3/min$									
3-2. Water well (W)											
pH		: _____									
EC		: _____ $\mu$ S/cm									
Temperature		: _____									
Groundwater level		: _____ m (Depth from GL : - m)									
Ground level		: _____ m									
3-3. Bore hole (D) (Surface of groundwater)											
pH		: 7.28									
EC		: 174.2 $\mu$ S/cm									
Temperature		: 33.2									
Groundwater level		: _____ m (Depth from GL : -20.24m)									
Ground level		: _____ m									
Recovery test		: Initial water level : -20.26m from GL Lifted water volume : 33.2 $\ell$ (25 min) Fallen water level : -22.74m from GL									
Remarks		:									
Time (min) and depth of groundwater from GL (- m)											
1	22.52	2	22.24	3	22.03	4	21.82	5	21.72	6	21.64
7	21.52	8	21.41	9	21.28	10	21.22	15	20.88	20	20.61
30	20.38	40	20.32	50	20.28	60	20.27	75	20.27	90	20.27
105	20.27	120	20.27	150	20.27	180	20.26	210	20.26	240	20.26
270	-	300	-	360	-	420	-	480	-	540	-
600	-	660	-	720	-	780	-	840	-	900	-
960	-	1020	-	1080	-	1140	-	1200	-	1260	-
1320	-	1380	-	1440	-						
				2850	20.27						



## Investigation Card (No. G4)

(Date : 4/12/1998)

1. Purpose of investigation : (1) (2) (3) Groundwater in bore hole											
2. Name of Location : <u>Ghuzayn</u> Location number : <u>MJOB-G4</u> Number of water sample : <u>GD-41</u> : surface											
3. Content of investigation											
3-1. Surface water (S)											
pH : _____											
EC : _____ $\mu$ S/cm											
Temperature : _____											
Discharge : _____ $m^3/min$											
3-2. Water well (W)											
pH : _____											
EC : _____ $\mu$ S/cm											
Temperature : _____											
Groundwater level: _____ m (Depth from GL : - _____ m)											
Ground level : _____ m											
3-3. Bore hole (D) (Surface of groundwater)											
pH : <u>8.08</u>											
EC : <u>76.1</u> $\mu$ S/cm											
Temperature : <u>33.4</u>											
Groundwater level: <u>170.26</u> m (Depth from GL : -17.88m)											
Ground level : <u>188.15</u> m											
Recovery test : Initial water level : -17.89m from GL											
Lifted water volume : 24.9 $\ell$ (20 min)											
Fallen water level : -23.55m from GL											
Remarks : Bore hole is still affected by drilling mud.											
Time (min) and depth of groundwater from GL (- m)											
1	23.35	2	23.15	3	22.85	4	22.80	5	22.73	6	22.69
7	22.64	8	22.60	9	22.57	10	22.53	15	22.42	20	22.33
30	21.90	40	21.60	50	21.33	60	21.07	75	20.76	90	20.54
105	20.32	120	20.15	150	19.85	180	19.75	210	19.65	240	19.56
270	19.50	300	19.47	360	19.385	420	19.30	480	19.21	540	-
600	-	660	-	720	-	780	-	840	-	900	-
960	-	1020	-	1080	-	1140	-	1200	-	1260	-
1320	-	1380	-	1440	-						
				1500	18.66						







Investigation Card (No. G8)

(Date : 4/12/1998)

1. Purpose of investigation : (1) (2) (3) Groundwater in bore hole											
2. Name of Location : <u>Ghuzayn</u> Location number : <u>MJOB-G8</u> Number of water sample : <u>GD-81</u> : surface, <u>GD-82</u> : -100.00m deep											
3. Content of investigation											
3-1. Surface water (S)											
pH : _____											
EC : _____ $\mu$ S/cm											
Temperature : _____											
Discharge : _____ $m^3/min$											
3-2. Water well (W)											
pH : _____											
EC : _____ $\mu$ S/cm											
Temperature : _____											
Groundwater level : _____ m (Depth from GL : - _____ m)											
Ground level : _____ m											
3-3. Bore hole (D) (Surface of GW) (-100.00m deep)											
pH : <u>8.14</u> <u>8.65</u>											
EC : <u>1049</u> <u>1122</u> $\mu$ S/cm											
Temperature : <u>33.3</u> <u>33.4</u> °											
Groundwater level : _____ m (Depth from GL : -20.94m)											
Ground level : _____ m											
Recovery test : Initial water level : -20.96m from GL Lifted water volume : 19.9 $\ell$ (10 min) Fallen water level : -21.51m from GL											
Remarks : Bore hole is slightly affected by drilling mud.											
Time (min) and depth of groundwater from GL (- m)											
1	21.46	2	21.41	3	21.39	4	21.37	5	21.35	6	21.34
7	21.34	8	21.33	9	21.33	10	21.325	15	21.325	20	21.325
30	21.325	40	21.32	50	21.32	60	21.32	75	21.32	90	21.32
105	21.32	120	21.32	150	21.32	180	21.32	210	21.31	240	21.31
270	21.31	300	21.31	360	21.31	420		480		540	
600		660		720		780		840		900	
960		1020		1080		1140		1200		1260	
1320		1380		1440							











## Investigation Card (No. G13)

(Date : 5/12/1998)

1. Purpose of investigation : (1) (2) (3) Groundwater in bore hole										
2. Name of Location : Ghuzayn Location number : MJOB-G13 Number of water sample : GD-131 : surface										
3. Content of investigation										
3-1. Surface water (S)										
pH : _____										
EC : _____ $\mu$ S/cm										
Temperature : _____										
Discharge : _____ $m^3/min$										
3-2. Water well (W)										
pH : _____										
EC : _____ $\mu$ S/cm										
Temperature : _____										
Groundwater level : _____ m (Depth from GL : - _____ m)										
Ground level : _____ m										
3-3. Bore hole (D) (Surface of groundwater)										
pH : <u>7.92</u>										
EC : <u>172.6</u> $\mu$ S/cm										
Temperature : <u>33.5</u>										
Groundwater level : _____ m (Depth from GL : -20.03m)										
Ground level : _____ m										
Remarks : _____										
Time (min) and depth of groundwater from GL (- m)										
1		2		3		4		5		6
7		8		9		10		15		20
30		40		50		60		75		90
105		120		150		180		210		240
270		300		360		420		480		540
600		660		720		780		840		900
960		1020		1080		1140		1200		1260
1320		1380		1440						













Investigation Card (No. G19)

(Date : 5/12/1998)

1. Purpose of investigation : (1) (2) (3) Groundwater in bore hole											
2. Name of Location : Ghuzayn Location number : MJOB-G19 Number of water sample : GD-191 : surface											
3. Content of investigation											
3-1. Surface water (S)											
pH : _____											
EC : _____ $\mu$ S/cm											
Temperature : _____											
Discharge : _____ $m^3/min$											
3-2. Water well (W)											
pH : _____											
EC : _____ $\mu$ S/cm											
Temperature : _____											
Groundwater level: _____ m (Depth from GL : -            m)											
Ground level : _____ m											
3-3. Bore hole (D) (Surface of groundwater)											
pH : 7.88											
EC : 129.6 $\mu$ S/cm											
Temperature : 33.1 °											
Groundwater level: _____ m (Depth from GL : -15.41m)											
Ground level : _____ m											
Recovery test : Initial water level : -15.47m from GL Lifted water volume : 23.3 $\ell$ (10 min) Fallen water level : -18.39m from GL											
Remarks : Bore hole is weekly affected by drilling mud.											
Time (min) and depth of groundwater from GL (- m)											
1	18.37	2	18.33	3	18.30	4	18.28	5	18.24	6	18.19
7	18.13	8	18.08	9	18.04	10	18.01	15	17.76	20	17.53
30	17.21	40	16.91	50	16.64	60	16.46	75	16.19	90	16.07
105	15.95	120	15.81	150	15.68	180	15.53	210	15.50	240	15.47
270	15.46	300	15.45	360	15.45	420	15.45	480	15.45	540	-
600	-	660	-	720	-	780	-	840	-	900	-
960	-	1020	-	1080	-	1140	-	1200	-	1260	-
1320	-	1380	-	1440	15.45						









Investigation Card (No. G24)

(Date :5/12/1998)

1. Purpose of investigation : (1)  
 (2)  
 (3) Groundwater in bore hole

2. Name of Location : Ghuzayn  
 Location number : MJOB-G24  
 Number of water sample :

3. Content of investigation  
 3-1. Surface water (S)  
 pH : \_\_\_\_\_  
 EC : \_\_\_\_\_  $\mu$  S/cm  
 Temperature : \_\_\_\_\_  
 Discharge : \_\_\_\_\_  $m^3/min$

3-2. Water well (W)  
 pH : \_\_\_\_\_  
 EC : \_\_\_\_\_  $\mu$  S/cm  
 Temperature : \_\_\_\_\_  
 Groundwater level: \_\_\_\_\_ m (Depth from GL : - \_\_\_\_\_ m)  
 Ground level : \_\_\_\_\_ m

3-3. Bore hole (D)  
 pH : \_\_\_\_\_  
 EC : \_\_\_\_\_  $\mu$  S/cm  
 Temperature : \_\_\_\_\_  
 Groundwater level: \_\_\_\_\_ m (Depth from GL : -19.10m)  
 Ground level : \_\_\_\_\_ m  
 Remarks : Groundwater of the hole is strongly suffered by the drilling mud.

Time (min) and depth of groundwater from GL (- m)

1	2	3	4	5	6
7	8	9	10	15	20
30	40	50	60	75	90
105	120	150	180	210	240
270	300	360	420	480	540
600	660	720	780	840	900
960	1020	1080	1140	1200	1260
1320	1380	1440			

## Investigation Card (No. G25)

(Date : 5/12/1998)

1. Purpose of investigation : (1) (2) (3) Groundwater in bore hole											
2. Name of Location : Ghuzayn Location number : MJOB-G25 Number of water sample : GD-251 : surface, GD-252 : -55.30m deep											
3. Content of investigation											
3-1. Surface water (S)											
pH : _____											
EC : _____ $\mu$ S/cm											
Temperature : _____											
Discharge : _____ $m^3/min$											
3-2. Water well (W)											
pH : _____											
EC : _____ $\mu$ S/cm											
Temperature : _____											
Groundwater level: _____ m (Depth from GL : - _____ m)											
Ground level : _____ m											
3-3. Bore hole (D) (Surface of GW) (-55.30m deep)											
pH : 10.49 8.99											
EC : 100.1 246 $\mu$ S/cm											
Temperature : 33.5 32.0 °											
Groundwater level: _____ m (Depth from GL : -20.51m)											
Ground level : _____ m											
Recovery test : Initial water level : -20.70m from GL Lifted water volume : 8.426.6 $\ell$ (15 min) Fallen water level : -26.59m from GL											
Remarks : Bore hole is slightly affected by drilling mud.											
Time (min) and depth of groundwater from GL (- m)											
1	26.55	2	26.53	3	26.51	4	26.49	5	26.47	6	26.45
7	26.44	8	26.43	9	26.42	10	26.40	15	26.37	20	26.34
30	26.32	40	26.29	50	26.25	60	26.21	75	26.15	90	26.09
105	26.05	120	26.00	150	25.89	180	25.79	210	-	240	-
270	-	300	-	360	-	420	-	480	-	540	-
600	-	660	-	720	-	780	-	840	-	900	-
960	-	1020	-	1080	-	1140	-	1200	-	1260	-
1320	-	1380	-	1440	-						
				2730	20.82						



Investigation Card (No. G26)

(Date : 6/12/1998)

1. Purpose of investigation : (1) (2) (3) Groundwater in bore hole											
2. Name of Location : Ghuzayn											
Location number : MJOB-G26											
Number of water sample : GD-261 : surface, GD-262 : -41.60m deep											
3. Content of investigation											
3-1. Surface water (S)											
pH : _____											
EC : _____ $\mu$ S/cm											
Temperature : _____											
Discharge : _____ $m^3/min$											
3-2. Water well (W)											
pH : _____											
EC : _____ $\mu$ S/cm											
Temperature : _____											
Groundwater level: _____ m (Depth from GL : - _____ m)											
Ground level : _____ m											
3-3. Bore hole (D) (Surface of GW) (-41.80m deep)											
pH : 7.51 7.51											
EC : 389 432 $\mu$ S/cm											
Temperature : 33.4 32.7 °											
Groundwater level: _____ m (Depth from GL : -32.67m)											
Ground level : _____ m											
Recovery test : Initial water level : -32.69m from GL											
Lifted water volume : 19.9 $\ell$ (25 min)											
Fallen water level : -34.97m from GL											
Remarks :											
Time (min) and depth of groundwater from GL (- m)											
1	34.67	2	34.45	3	34.18	4	34.01	5	33.97	6	33.66
7	33.56	8	33.46	9	33.37	10	33.29	15	33.17	20	33.03
30	32.92	40	32.87	50	32.85	60	32.83	75	32.82	90	32.81
105	32.80	120	32.795	150	32.78	180	32.77	210	32.76	240	32.76
270	32.76	300	32.76	360	-	420	-	480	-	540	-
600	-	660	-	720	-	780	-	840	-	900	-
960	-	1020	-	1080	-	1140	-	1200	-	1260	-
1320	-	1380	-	1440	-						
				2990	32.70						





Investigation Card (No. G29)

(Date : 5/12/1998)

1. Purpose of investigation : (1) (2) (3) Groundwater in bore hole										
2. Name of Location : <u>Chuzayn</u> Location number : <u>MJOB-G29</u> Number of water sample :										
3. Content of investigation 3-1. Surface water (S) pH : _____ EC : _____ $\mu$ S/cm Temperature : _____ Discharge : _____ $m^3/min$  3-2. Water well (W) pH : _____ EC : _____ $\mu$ S/cm Temperature : _____ Groundwater level : _____ m (Depth from GL : - _____ m) Ground level : _____ m  3-3. Bore hole (D) pH : _____ EC : _____ $\mu$ S/cm Temperature : _____ Groundwater level : _____ m (Depth from GL : - _____ m) Ground level : _____ m Remarks : The bore hole is closed by sand and gravel at the depth of -13.40m.										
Time (min) and depth of groundwater from GL (- m)										
1		2		3		4		5		6
7		8		9		10		15		20
30		40		50		60		75		90
105		120		150		180		210		240
270		300		360		420		480		540
600		660		720		780		840		900
960		1020		1080		1140		1200		1260
1320		1380		1440						

Investigation Card (No. G30)

(Date : 5/12/1998)

1. Purpose of investigation : (1) (2) (3) Groundwater in bore hole											
2. Name of Location : <u>Ghuzayn</u> Location number : <u>MJOB-G30</u> Number of water sample :											
3. Content of investigation											
3-1. Surface water (S)											
pH : _____											
EC : _____ $\mu$ S/cm											
Temperature : _____											
Discharge : _____ $m^3/min$											
3-2. Water well (W)											
pH : _____											
EC : _____ $\mu$ S/cm											
Temperature : _____											
Groundwater level : _____ m (Depth from GL : - _____ m)											
Ground level : _____ m											
3-3. Bore hole (D)											
pH : _____											
EC : _____ $\mu$ S/cm											
Temperature : _____											
Groundwater level : _____ m (Depth from GL : - _____ m)											
Ground level : _____ m											
Remarks : The bore hole is closed by sand and gravel at the depth of -4.30m.											
Time (min) and depth of groundwater from GL (- m)											
1		2		3		4		5		6	
7		8		9		10		15		20	
30		40		50		60		75		90	
105		120		150		180		210		240	
270		300		360		420		480		540	
600		660		720		780		840		900	
960		1020		1080		1140		1200		1260	
1320		1380		1440							









Investigation Card (No. G34)

(Date : 6/12/1998)

1. Purpose of investigation : (1)  
 (2)  
 (3) Groundwater in bore hole

2. Name of Location : Ghuzayn  
 Location number : MJOB-G34  
 Number of water sample :

3. Content of investigation

3-1. Surface water (S)

pH : \_\_\_\_\_  
 EC : \_\_\_\_\_  $\mu$  S/cm  
 Temperature : \_\_\_\_\_  
 Discharge : \_\_\_\_\_ m<sup>3</sup>/min

3-2. Water well (W)

pH : \_\_\_\_\_  
 EC : \_\_\_\_\_  $\mu$  S/cm  
 Temperature : \_\_\_\_\_  
 Groundwater level: \_\_\_\_\_ m (Depth from GL : - m)  
 Ground level : \_\_\_\_\_ m

3-3. Bore hole (D)

pH : \_\_\_\_\_  
 EC : \_\_\_\_\_  $\mu$  S/cm  
 Temperature : \_\_\_\_\_  
 Groundwater level: \_\_\_\_\_ m (Depth from GL : - m)  
 Ground level : \_\_\_\_\_ m  
 Remarks : The bore hole is closed by sand and gravel  
 at the depth of -5.46m.

Time (min) and depth of groundwater from GL (- m)

1		2		3		4		5		6	
7		8		9		10		15		20	
30		40		50		60		75		90	
105		120		150		180		210		240	
270		300		360		420		480		540	
600		660		720		780		840		900	
960		1020		1080		1140		1200		1260	
1320		1380		1440							









Investigation Card (No. GS-2)

(Date : 6/12/1998)

1. Purpose of investigation : (1) Surface water (2) (3)											
2. Name of Location : <u>Ghuzayn, Wadi Hawasina</u> Location number : <u>GS-2</u> Number of water sample : <u>GS-2</u>											
3. Content of investigation											
3-1. Surface water (S)											
pH : <u>8.46</u>											
EC : <u>115.7</u> $\mu$ S/cm											
Temperature : <u>29.0</u> °											
Discharge : <u>1.213</u> m <sup>3</sup> /min											
Remarks : The stream water is almost ////////////// Water of Wadi Hawasina.											
3-2. Water well (W)											
pH : _____											
EC : _____ $\mu$ S/cm											
Temperature : _____											
Groundwater level: _____ m (Depth from GL : -            m)											
Ground level : _____ m											
3-3. Bore hole (Ø)											
pH : _____											
EC : _____ $\mu$ S/cm											
Temperature : _____											
Groundwater level: _____ m (Depth from GL : -            m)											
Ground level : _____ m											
Time (min) and depth of groundwater from GL (- m)											
1		2		3		4		5		6	
7		8		9		10		15		20	
30		40		50		60		75		90	
105		120		150		180		210		240	
270		300		360		420		480		540	
600		660		720		780		840		900	
960		1020		1080		1140		1200		1260	
1320		1380		1440							

Investigation Card (No. GS-3)

(Date : 6/12/1998)

1. Purpose of investigation : (1) Surface water (2) (3)										
2. Name of Location : <u>Ghuzayn, Wadi Hawasina</u> Location number : <u>GS-3</u> Number of water sample : <u>GS-3</u>										
3. Content of investigation										
3-1. Surface water (S)										
pH : <u>7.87</u>										
EC : <u>133.3</u> $\mu$ S/cm										
Temperature : <u>28.6</u> °										
Discharge : <u>1.119</u> m <sup>3</sup> /min										
Remarks : The stream water is almost <u>////////</u> water of Wadi Hawasina.										
3-2. Water well (W)										
pH : _____										
EC : _____ $\mu$ S/cm										
Temperature : _____										
Groundwater level: _____ m (Depth from GL : - _____ m)										
Ground level : _____ m										
3-3. Bore hole (D)										
pH : _____										
EC : _____ $\mu$ S/cm										
Temperature : _____										
Groundwater level: _____ m (Depth from GL : - _____ m)										
Ground level : _____ m										
Time (min) and depth of groundwater from GL (- m)										
1		2		3		4		5		6
7		8		9		10		15		20
30		40		50		60		75		90
105		120		150		180		210		240
270		300		360		420		480		540
600		660		720		780		840		900
960		1020		1080		1140		1200		1260
1320		1380		1440						







### 3. Meteorological Data

Sultanate of Oman  
 Ministry of Communications  
 Directorate General of Civil Aviation & Meteorology  
 Department of Meteorology

Station :Seeb Air port  
 Parameter :Surface Wind (speed in knots) # Prevailing direction with mean speed

Year	Month												annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1980	22505	04510	04510	22507	36010	04509	04510	04511	04509	04509	04512	22505	
81	22505	04510	36009	04510	04509	36009	04509	04511	04509	04511	36010	04511	
82	22508	27009	36009	36009	36009	04510	04511	04510	04508	04509	04510	22505	
83	22506	27008	04510	36009	22512	04508	04508	04510	04507	36008	04507	36007	
84	24005	06005	06005	24005	06006	03004	06005	06005	06006	03004	06004	06005	
85	06004	24005	24005	27006	06005	06005	06006	06005	06005	06005	24005	24005	
86	21005	06006	06006	06005	06007	06005	06006	06005	06005	24005	06005	06006	
87	21004	06005	06005	33004	06006	06005	06006	06005	06005	03004	03004	03004	
88	21005	24006	06006	06005	06005	06006	06006	06005	06005	36004	06004	21004	
89	24005	03005	06005	06005	06005	03004	06006	03004	09004	27005	06004	30005	
1990	24004	24005	09005	09005	09004	09006	09006	09006	09004	06004	03004	06004	
91	06005	06005	06005	27005	06004	06005	06005	06005	06004	06004	06004	24004	
92	27005	27006	30004	03004	03005	03005	06005	06006	06005	06005	03005	03005	
93	24005	27005	06006	06005	21006	06006	06005	06005	06005	21004	06004	21004	
94	06005	12004	33005	06006	06004	06006	09006	06006	06004	06004	03004	21004	
95	03003	27005	27005	06005	27006	06005	06006	06007	06005	06005	21005	06005	
96	21005	06004	06005	27005	21006	06007	06005	06005	06005	06004	06004	21003	
97	21004	33004	06005	06006	21006	06006	06005	06006	06005	06005	06005	21004	

SULTANATE OF OMAN  
 MINISTRY OF COMMUNICATIONS  
 DIRECTORATE GENERAL OF CIVIL AVIATION & METEOROLOGY  
 DEPARTMENT OF METEOROLOGY

Station :MAJIS(Sohar)

Parameter :Air temperature (oC)

*\*Monthly mean*

Year	Month												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1980	17.5	19.0	22.4	28.5	32.7	32.5	33.7	31.5	30.1	28.1	23.3	19.9	26.6
81	19.7	19.6	22.5	28.1	29.8	32.3	33.5	32.9	29.9	26.1	22.0	20.1	26.4
82	19.1	18.4	21.2	25.7	30.4	32.4	32.3	31.8	30.2	27.7	22.7	19.1	25.9
83	18.4	18.5	20.6	24.5	31.9	33.9	33.2	31.8	30.7	26.9	22.9	19.9	26.1
84	18.9	18.7	23.3	28.3	31.9	32.4	32.7	31.7	30.7	25.7	22.6	20.4	26.4
85	19.7	19.9	23.0	26.9	30.4	32.4	32.2	31.3	29.7	27.4	24.0	20.8	26.5
86	18.8	19.7	22.2	26.7	31.4	32.3	33.1	30.7	30.5	28.7	24.7	20.0	26.6
87	19.2	20.4	23.1	26.0	31.1	32.7	33.7	32.4	30.8	27.6	23.6	19.9	26.7
88	18.9	19.9	23.0	27.3	31.1	33.3	32.5	31.6	30.2	27.6	24.7	21.6	26.8
89	18.5	19.6	22.2	25.5	29.9	32.2	32.5	30.6	29.7	27.7	25.3	21.3	26.3
1990	19.6	20.4	22.4	27.7	30.8	33.1	34.0	31.1	30.3	28.1	24.5	21.8	27.0
91	20.6	20.2	22.1	27.1	29.1	31.3	32.1	30.0	29.4	26.5	23.6	21.4	26.1
92	18.6	19.0	20.4	24.4	31.1	33.0	32.7	31.7	29.7	27.6	23.7	21.9	26.2
93	19.8	21.2	22.8	26.5	31.1	32.9	33.4	32.3	30.5	26.9	24.4	21.8	26.9
94	20.2	20.1	23.3	27.3	31.4	33.3	33.0	31.8	30.1	27.7	25.4	21.1	27.0
95	20.3	20.9	22.1	25.7	30.2	32.4	32.7	32.6	30.7	28.7	24.0	21.6	26.8
96	19.5	20.9	23.1	27.2	31.1	33.3	34.0	32.3	30.0	26.7	22.8	19.7	26.7
97	18.5	20.7	21.9	25.2	30.4	32.4	33.4	32.0	31.5	28.9	24.5	21.6	26.8

SULTANATE OF OMAN  
 MINISTRY OF COMMUNICATIONS  
 DIRECTORATE GENERAL OF CIVIL AVIATION & METEOROLOGY  
 DEPARTMENT OF METEOROLOGY

STATION :MAJIS(Sohar)  
 PARAMETER :Air temperature [oC]

\*Monthly Absolute maximum

year	Month												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1980	27.9	30.0	34.8	44.5	44.2	47.2	46.9	43.8	40.0	41.8	33.7	30.6	47.2
81	32.5	30.0	36.5	44.0	43.0	48.5	44.4	43.8	43.0	39.2	33.8	30.6	48.5
82	27.9	29.7	29.7	38.6	43.7	45.3	43.9	42.6	42.4	42.4	34.3	33.9	45.3
83	31.0	29.4	30.7	41.6	46.8	42.8	43.1	42.5	43.2	39.7	32.8	29.2	46.8
84	29.7	32.1	37.4	43.3	45.0	43.4	44.6	45.0	42.7	37.7	35.6	30.0	45.0
85	30.7	31.5	35.6	40.9	42.3	44.0	43.5	41.0	35.3	36.2	31.4	31.8	44.0
86	25.7	29.2	32.4	36.8	46.9	36.3	40.7	39.4	41.1	38.0	36.6	29.0	46.9
87	27.3	28.4	32.1	41.0	45.8	47.5	50.0	41.6	39.3	42.1	31.8	28.0	50.0
88	27.5	28.8	34.4	39.4	44.2	47.7	37.6	38.4	39.1	37.6	34.1	31.4	47.7
89	28.7	32.0	32.0	40.5	45.2	46.1	40.4	34.7	39.0	35.4	37.7	28.4	46.1
1990	28.0	29.8	33.5	42.4	40.4	45.8	48.2	35.7	35.0	36.0	32.4	29.6	48.2
91	28.8	32.0	31.4	40.4	46.7	37.4	38.0	33.9	35.4	35.0	32.0	28.6	46.7
92	26.8	26.3	32.4	36.1	46.0	45.5	40.6	40.2	37.0	35.0	31.7	29.8	46.0
93	26.8	34.0	33.0	36.9	47.0	40.0	41.2	41.2	35.6	36.2	32.6	28.9	47.0
94	28.6	31.6	33.3	39.0	44.4	44.9	39.2	38.4	36.7	34.3	32.6	31.0	44.9
95	29.0	27.6	35.0	39.0	43.4	41.6	40.7	42.4	37.3	37.1	32.8	28.0	43.4
96	27.2	26.8	33.2	41.6	45.6	47.5	44.3	41.6	34.8	34.5	33.5	27.0	47.5
97	26.3	30.2	32.3	39.9	46.0	42.4	43.0	43.2	37.6	37.7	31.5	29.9	46.0
maximum	32.5	34.0	37.4	44.5	47.0	48.5	50.0	45.0	43.2	42.4	37.7	33.9	50.0

SULTANATE OF OMAN  
 MINISTRY OF COMMUNICATIONS  
 DIRECTORATE GENERAL OF CIVIL AVIATION & METEOROLOGY  
 DEPARTMENT OF METEOROLOGY

STATION :MAJIS(Sohar)

PARAMETER :Air temperature [oC] \*Monthly Absolute minimum

year	Month												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1980	6.5	7.0	8.4	15.0	17.8	21.0	23.6	21.7	21.5	17.6	12.3	8.7	6.5
81	9.0	8.5	10.2	12.2	17.7	19.7	23.3	23.7	17.4	12.0	8.0	9.8	8.0
82	8.4	7.0	10.8	13.0	19.8	21.8	23.4	23.7	18.7	17.2	9.0	8.6	7.0
83	5.7	5.8	6.8	11.2	17.8	22.0	26.0	25.1	19.8	16.3	13.3	7.8	5.7
84	6.9	7.7	9.9	17.0	19.2	20.4	23.7	22.9	20.3	13.0	10.3	10.7	6.9
85	10.5	7.7	11.0	12.0	16.0	21.0	22.4	21.4	20.8	15.6	13.8	7.4	7.4
86	7.8	10.2	10.4	14.9	16.6	25.5	27.1	25.4	21.9	19.2	14.3	12.1	7.8
87	8.9	11.0	12.7	14.3	20.5	21.2	25.4	26.0	21.4	14.8	13.7	11.2	8.9
88	7.5	9.4	12.0	18.5	21.9	23.7	28.0	23.6	18.5	15.1	14.7	10.0	7.5
89	7.9	10.0	11.2	13.5	16.0	25.4	26.3	24.9	19.6	17.5	17.0	13.0	7.9
1990	10.8	11.3	11.1	16.2	19.0	23.3	24.7	25.6	24.5	18.1	14.5	10.6	10.6
91	10.9	7.4	10.8	17.5	18.7	22.5	25.2	25.8	21.5	14.6	13.8	11.0	7.4
92	7.8	8.3	8.8	14.3	21.4	23.6	25.8	23.2	19.9	17.1	14.0	12.4	7.8
93	5.8	12.1	11.0	14.4	17.4	24.0	26.2	24.8	20.0	14.5	12.6	11.0	5.8
94	11.6	9.3	12.9	17.6	20.6	24.0	27.5	27.3	18.5	17.7	16.6	11.5	9.3
95	10.6	10.2	12.8	13.0	20.0	23.4	26.4	28.0	22.1	15.4	14.8	15.6	10.2
96	12.0	11.3	13.3	16.0	21.0	25.5	23.8	26.4	20.7	11.5	12.2	10.0	10.0
97	6.8	8.5	8.6	13.8	18.2	25.3	25.8	26.2	23.0	20.4	16.0	11.0	6.8

Minimum	05.7	05.8	06.8	11.2	16.0	19.7	22.4	21.4	17.4	11.5	08.0	07.4	05.7
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SULTANATE OF OMAN  
 MINISTRY OF COMMUNICATIONS  
 DIRECTORATE GENERAL OF CIVIL AVIATION & METEOROLOGY  
 DEPARTMENT OF METEOROLOGY

Station :MAJIS(Sohar)

Parameter :Rainfall[mm]

*\*Monthly total*

Year	Month												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1980	1.5	2.5	3.9	0.0	Tr	0.0	0.0	Tr	0.0	0.0	0.0	0.0	7.9
81	4.7	0.0	1.3	17.1	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.1
82	0.0	135.3	57.3	2.1	0.0	0.0	0.0	0.0	0.0	0.0	13.8	9.1	217.6
83	0.4	59.9	37.7	24.4	0.0	Tr	0.0	0.0	Tr	0.0	0.0	Tr	122.4
84	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	0.0	0.0	9.7	14.7
85	0.0	0.0	Tr	0.0	0.0	0.0	0.0	Tr	0.0	0.0	0.0	0.0	Tr
86	21.9	11.8	7.3	3.1	0.0	0.0	0.0	0.0	0.0	0.0	24.7	26.4	95.2
87	0.0	64.6	45.5	13.9	14.9	0.0	0.0	0.0	0.0	0.0	0.0	3.6	142.5
88	0.0	235.3	0.0	22.3	0.0	0.0	0.2	0.0	0.0	0.0	0.0	2.7	260.5
89	0.0	13.6	17.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0	2.9	107.5	143.0
1990	23.3	95.2	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	120.6
91	0.0	15.7	49.4	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.2	10.2	76.5
92	45.7	24.9	3.2	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1	102.9
93	2.2	19.2	11.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.5	53.3
94	40.0	0.0	30.6	0.0	0.0	0.0	0.0	4.5	0.0	Tr	1.2	0.0	76.3
95	0.0	5.3	46.2	Tr	0.0	0.0	45.3	0.9	0.0	12.2	8.8	187.4	306.1
96	82.3	25.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Tr	0.0	131.1
97	24.7	0.0	74.8	13.5	0.0	0.0	0.0	0.0	0.0	127.2	12.2	8.6	261.0

SULTANATE OF OMAN  
 MINISTRY OF COMMUNICATIONS  
 DIRECTORATE GENERAL OF CIVIL AVIATION & METEOROLOGY  
 DEPARTMENT OF METEOROLOGY

STATION : MAJIS (Sohar)

PARAMETER : Surface wind

\* Monthly prevailing direction with mean speed (knots)

Year	Month												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1984	03003	06002	03002	03003	03003	03002	03003	03003	06003	06002	03002	03002	03003
85	06002	06007	03006	09007	12005	06005	12006	12005	09004	09005	24005	24006	09005
86	24006	24006	06006	09005	06005	09006	09005	12005	09005	09004	24006	24006	09005
87	24005	24005	09006	36005	09005	09005	09005	09005	09005	24005	24005	24005	09005
88	24006	24005	09005	36005	06004	09006	12006	12006	09004	09004	24005	24006	09005
89	24006	30006	06006	06006	09005	09006	12006	12006	09005	24004	24005	24006	09006
1990	24004	30005	09005	09005	09004	09005	09005	12006	09005	09004	24004	21004	09005
91	21006	24005	03004	27005	09004	06004	09004	09005	09005	21004	21004	21005	06005
92	21006	27006	06005	06004	06004	03004	09005	09005	06004	06004	24005	09006	09005
93	30007	33008	27006	06006	06007	09005	09005	09005	09006	09004	24005	09006	09006
94	24006	30007	06006	09006	09006	09006	09006	12006	09005	06005	24005	24005	09006
95	24006	27006	27006	06005	09007	12004	12005	12005	09004	09004	27005	27005	12005
96	24005	27005	03005	09005	09004	12005	12005	12005	12005	24005	24005	27005	12005
97	24005	30005	30005	09005	09005	12004	12005	12005	12004	12004	27004	24005	



SULTANATE OF OMAN  
 MINISTRY OF COMMUNICATIONS  
 DIRECTORATE GENERAL OF CIVIL AVIATION & METEOROLOGY  
 DEPARTMENT OF METEOROLOGY

STATION :MAJIS (Sohar)

PARAMETER : :Surface wind [speed in knots]

# Monthly maximum gust with direction

year	MONTH												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1980	20014	25020	33030	31018	31021	08014	09012	04012	02012	09015	36014	33018	33030
81	01015	28022	36022	36025	33040	15015	08012	15012	24015	06013	06012	36010	33040
82	32011	31014	34015	28015	36011	04013	01012	30013	04011	23011	33020	33015	33020
83	11013	11016	11022	35025	31018	09010	06013	06015	11011	36011	04010	24015	35025
84	28019	29011	20018	28016	-	-	-	-	-	-	-	-	-
85	11014	35033	34028	34044	03021	02026	30024	09019	09016	03017	33021	24031	34044
86	33034	28027	35027	02039	34030	36030	11023	13030	36027	08022	31034	36034	02039
87	34026	34029	33065	33033	33045	01040	09023	08019	10018	10021	06021	10021	33065
88	35027	23061	29033	02033	30042	31033	11041	04018	12018	11017	10017	34029	23061
89	29037	33031	33029	22036	01028	35027	10019	10019	10021	32019	35024	02032	29037
1990	35024	36060	30029	33033	35034	13020	29017	09015	08021	10018	09019	34029	36060
91	33032	30025	27032	33030	05021	33017	06019	08016	07019	09023	04026	36037	36037
92	30045	33033	33029	34034	12030	34026	27020	08019	04018	12018	33021	01026	30045
93	32031	20034	27033	29037	33038	33025	06022	11020	06023	03022	09018	34026	33038
94	06033	29034	33033	34029	33033	35028	12024	14026	09017	10020	35020	30027	29034
95	23028	33035	35031	31030	32029	-	-	-	11017	06022	32027	06041	06041
96	14027	02028	03030	01029	09025	12028	12026	-	-	14022	13022	05027	03030
97	33026	01029	36038	36035	03031	17022	01018	16018	12015	03044	05029	34021	03044

Sultanate of Oman  
Ministry of Communications  
Directorate General of Civil Aviation & Meteorology  
Department of Meteorology

Station :Seeb Airport

Parameter :Air temperature Data [C]

\*Monthly mean

Year	Month												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1974	20.6	20.5	25.6	28.0	32.5	34.3	36.0	32.6	31.4	28.1	24.6	23.0	28.1
75	21.3	21.0	24.5	28.3	33.9	34.3	32.3	31.4	31.1	28.7	24.8	21.0	27.7
76	21.1	21.7	24.2	28.0	35.0	35.1	34.1	33.1	31.7	30.6	25.2	23.0	28.6
77	21.0	22.3	27.2	30.7	35.9	35.9	33.9	32.7	32.5	31.3	26.9	24.5	29.6
78	22.4	23.2	25.6	31.5	34.6	35.7	35.3	32.6	30.2	28.9	26.7	23.0	29.1
79	21.6	23.0	24.1	29.5	32.7	34.9	34.2	32.0	30.7	29.7	24.4	22.2	28.3
1980	20.8	22.6	25.5	32.7	35.4	34.8	34.0	31.2	30.9	30.2	25.6	22.4	28.8
81	22.0	22.5	25.7	31.3	33.1	35.9	35.0	33.9	31.4	28.9	24.9	22.8	28.9
82	21.6	21.3	24.2	28.9	33.6	35.5	33.8	32.3	31.8	31.0	24.9	21.3	28.3
83	21.0	21.0	22.7	27.3	35.3	36.3	33.1	32.0	31.7	29.7	25.1	22.3	28.1
84	21.3	20.9	26.8	31.9	34.1	34.6	33.2	31.7	32.6	28.4	25.6	22.9	28.7
85	22.3	22.3	26.1	29.6	33.8	35.5	33.6	31.8	30.6	29.3	25.9	22.7	28.6
86	20.7	21.3	24.6	30.1	36.3	33.8	34.4	31.4	32.8	31.4	26.4	22.0	28.8
87	21.4	22.5	25.8	29.1	34.5	35.2	36.3	32.5	32.1	29.5	25.5	21.5	28.8
88	20.8	22.0	26.2	30.9	34.6	36.1	33.0	31.9	31.7	29.8	26.4	23.6	28.9
89	20.7	21.5	24.3	28.3	33.3	34.3	33.7	29.9	30.9	29.9	27.1	22.9	28.1
1990	21.4	22.2	24.8	31.1	33.3	36.4	36.8	30.4	30.5	29.8	26.1	23.5	28.9
91	22.4	22.4	24.6	30.2	31.7	34.3	33.9	29.8	30.7	28.6	25.6	23.4	28.1
92	20.0	20.8	22.9	26.8	35.5	37.6	34.0	32.6	31.3	28.6	24.7	23.3	28.2
93	21.3	23.1	24.4	28.8	34.1	35.9	35.1	32.8	31.0	28.5	25.8	23.1	28.7
94	21.6	22.0	25.1	29.7	33.9	35.7	33.1	30.9	30.9	28.9	26.5	22.7	28.4
95	21.4	22.4	23.2	27.7	32.9	34.0	32.8	32.8	31.3	29.7	24.7	22.5	28.0
96	20.4	21.7	24.4	28.8	34.1	34.4	34.6	31.2	29.7	27.5	23.6	20.6	27.6
97	20.1	21.9	23.0	26.5	32.2	33.2	33.5	31.5	31.1	29.6	24.9	22.3	27.5
average	21.2	21.9	24.8	29.4	34.0	35.2	34.2	31.9	31.3	29.4	25.5	22.6	28.4

Sultanate of Oman  
Ministry of Communications  
Directorate General of Civil Aviation & Meteorology  
Department of Meteorology

Station :Seeb Air port  
Parameter :Air temperature (C) \*Monthly absolute maximum

Year	Month												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1974	30.0	30.0	37.0	41.0	43.0	45.0	46.0	41.0	39.0	37.0	35.0	30.5	46.0
75	30.4	31.8	34.0	39.5	47.0	47.8	40.0	40.3	39.8	39.8	33.5	30.2	47.8
76	29.3	31.2	35.7	38.0	45.5	45.2	45.0	44.4	41.2	38.8	33.0	31.3	45.5
77	34.2	33.0	41.2	42.3	45.0	47.0	44.0	46.8	43.5	40.8	37.0	33.0	47.0
78	31.0	33.0	38.8	44.0	46.2	47.5	48.2	42.0	42.3	39.8	37.8	31.0	48.2
79	31.7	37.0	35.0	42.0	46.0	48.3	45.4	43.4	41.5	39.9	33.0	31.4	48.3
1980	28.3	35.8	36.0	43.6	44.8	45.4	45.5	43.4	40.6	40.9	33.7	28.3	45.5
81	32.5	34.8	37.2	42.2	45.7	46.6	44.8	44.6	42.4	38.7	34.0	30.7	46.6
82	30.5	30.0	38.2	40.4	43.0	45.2	43.0	42.6	42.0	41.5	34.5	32.5	45.2
83	29.5	34.1	32.0	41.5	44.8	47.1	44.6	44.1	42.3	40.0	33.3	28.8	47.1
84	29.0	31.0	38.2	42.8	43.0	45.1	45.5	42.2	40.5	38.4	36.0	32.5	45.5
85	31.2	30.2	41.4	40.5	44.5	47.2	45.2	43.0	40.3	39.2	32.8	30.1	47.2
86	29.0	28.5	39.2	40.0	46.6	41.7	45.9	41.2	42.5	42.0	36.0	31.0	46.6
87	29.9	30.4	38.9	42.2	44.4	46.7	47.0	45.5	43.2	40.7	33.2	29.8	47.0
88	29.5	30.2	40.0	40.7	45.6	47.2	43.2	44.0	42.2	39.6	35.0	30.6	47.2
89	30.0	35.6	35.4	39.2	45.3	47.0	45.2	39.7	43.6	41.0	37.0	32.2	47.0
1990	28.6	30.1	34.9	42.7	45.0	46.0	49.2	39.4	37.8	41.5	35.3	30.5	49.2
91	33.2	32.0	35.8	42.0	46.8	44.6	47.0	36.4	44.5	39.3	35.3	31.0	47.0
92	28.3	31.1	34.0	39.6	46.7	48.0	46.2	43.0	42.2	37.8	33.5	30.5	48.0
93	30.4	34.4	37.5	42.4	47.0	47.2	44.6	45.6	41.0	41.0	35.2	30.0	47.2
94	32.5	28.5	35.0	42.0	44.2	48.5	42.6	43.3	43.0	40.0	33.0	33.0	48.5
95	28.5	31.2	32.0	40.4	44.6	46.9	45.4	45.4	43.0	39.4	33.9	29.4	46.9
96	28.5	29.1	36.5	41.5	45.2	47.8	44.1	42.1	39.8	37.5	32.3	28.4	47.8
97	28.8	31.8	33.9	38.0	44.4	46.6	46.7	39.0	42.2	38.6	31.3	29.4	46.7

Sultanate of Oman  
Ministry of Communications  
Directorate General of Civil Aviation & Meteorology  
Department of Meteorology

Station :Seeb Air port

Parameter :Air temperature Data (C)

*\*Monthly absolute minimum*

Year	Month												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1974	13.0	13.0	17.6	20.0	24.0	27.0	27.0	25.0	25.0	18.3	15.9	14.9	13.0
75	13.5	13.0	16.0	19.0	26.0	26.0	26.4	27.0	25.0	17.5	18.0	16.2	13.0
76	14.5	16.0	18.0	20.0	24.0	28.5	26.6	25.0	25.0	23.0	15.8	21.1	14.5
77	13.0	14.2	15.7	19.4	26.8	26.0	28.0	26.0	24.8	23.2	17.3	17.3	13.0
78	15.0	16.0	16.7	19.8	25.0	28.7	27.5	24.5	23.8	20.4	14.6	15.4	14.6
79	11.5	13.2	15.6	19.2	21.4	27.0	25.0	25.0	23.0	22.8	14.3	15.6	11.5
1980	14.0	13.6	15.3	23.5	26.0	27.5	25.7	24.7	24.7	23.2	18.5	14.5	13.6
81	14.5	14.0	18.6	20.4	19.6	27.2	29.4	25.5	25.0	20.7	16.3	16.2	14.0
82	14.7	14.5	14.4	19.7	24.9	27.6	27.2	24.7	23.5	23.1	15.4	15.4	14.4
83	14.6	14.4	15.5	19.4	24.0	27.0	26.8	24.5	25.3	20.5	17.7	15.7	14.4
84	15.2	13.1	16.4	21.9	23.6	27.5	25.5	26.4	25.2	18.0	17.3	15.0	13.1
85	15.8	12.5	17.0	20.3	25.0	26.3	26.4	25.9	24.6	22.3	19.2	14.9	14.9
86	13.8	15.6	19.0	20.9	25.6	27.2	27.8	23.3	24.5	23.3	19.4	15.7	13.8
87	12.5	15.0	16.4	17.5	25.2	24.5	29.5	27.0	25.8	20.3	17.2	14.4	12.5
88	14.6	15.5	18.3	22.1	24.1	28.5	27.8	24.0	24.3	22.5	19.0	16.4	14.6
89	13.2	13.9	15.6	18.4	22.4	27.3	26.4	24.5	24.2	20.1	20.3	16.0	13.2
1990	15.7	16.4	16.0	22.4	25.8	28.2	29.0	25.5	26.0	21.0	17.5	14.5	14.5
91	12.4	10.0	16.6	21.2	23.1	27.4	27.5	25.5	24.6	21.6	18.2	16.4	10.0
92	13.4	14.5	15.6	18.5	27.5	29.7	27.8	27.2	22.2	20.5	15.0	15.4	13.4
93	12.6	16.0	15.6	18.8	24.3	27.0	28.0	25.3	24.2	19.2	16.5	13.9	12.6
94	14.0	14.0	17.0	20.0	23.7	25.2	26.0	26.0	22.5	20.3	18.5	13.8	13.8
95	12.0	16.0	15.3	17.5	23.5	26.1	25.8	26.7	24.3	18.5	15.6	15.6	12.0
96	12.8	14.1	15.4	19.2	22.4	27.1	27.3	25.3	22.2	16.6	12.8	10.9	10.9
97	12.6	14.9	15.4	17.7	21.0	26.1	28.0	27.1	23.8	22.6	17.8	15.2	12.6

Sultanate of Oman  
Ministry of Communications  
Directorate General of Civil Aviation & Meteorology  
Department of Meteorology

Statio :Seeb Air port  
Parameter :Rainfall [mm]

*\*Monthly total rainfall*

Year	Month												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1974													
75	6.0	47.8	0.0	Tr	0.0	0.0	0.0	2.5	0.0	0.0	0.0	20.3	76.6
76	16.0	42.5	57.0	30.3	0.0	0.0	2.4	0.0	0.0	Tr	0.0	4.1	152.3
77	50.5	27.0	4.6	14.0	0.9	9.9	Tr	Tr	0.0	0.0	75.7	Tr	182.6
78	10.7	11.4	12.8	Tr	Tr	0.0	Tr	0.0	0.0	0.0	7.0	Tr	41.9
79	8.3	2.2	Tr	Tr	Tr	Tr	0.0	0.0	0.0	0.5	0.0	8.5	19.5
1980	1.5	2.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	Tr	Tr	Tr	3.7
81	17.0	Tr	23.5	Tr	69.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	109.7
82	2.9	59.6	35.1	0.9	0.0	0.0	0.0	Tr	0.0	0.0	4.5	29.5	132.5
83	Tr	25.6	4.5	46.7	Tr	0.0	Tr	0.9	Tr	0.0	0.0	2.6	80.3
84	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	Tr	0.0	1.7	2.4
85	Tr	0.0	1.3	0.0	Tr	0.0	Tr	0.0	0.0	0.0	0.0	Tr	1.3
86	8.9	52.4	2.8	5.8	0.0	3.5	0.0	6.3	0.0	0.0	0.0	14.7	94.4
87	0.0	32.7	67.9	67.3	Tr	0.0	0.0	Tr	0.0	13.0	0.0	13.4	194.3
88	0.9	25.6	0.0	7.2	0.0	0.0	Tr	0.0	0.0	0.0	Tr	28.8	62.5
89	Tr	5.2	13.0	16.0	Tr	0.0	0.0	0.0	0.0	0.0	Tr	35.7	69.9
1990	43.4	33.5	Tr	TR	0.0	0.0	0.0	0.1	0.0	0.0	1.1	0.7	78.8
91	1.3	22.4	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Tr	20.0	44.8
92	28.0	33.5	8.9	29.0	0.0	0.0	0.0	1.1	0.0	Tr	0.0	Tr	100.5
93	24.4	0.5	0.6	5.2	Tr	0.0	Tr	0.0	0.0	0.0	Tr	0.0	30.7
94	9.4	0.0	0.0	1.0	0.0	0.0	3.6	26.6	0.0	0.0	0.0	3.7	44.3
95	0.3	22.3	11.5	4.3	0.0	0.0	68.3	0.0	0.0	0.0	0.0	112.3	219.0
96	16.7	19.7	24.9	Tr	0.0	0.0	0.0	Tr	0.0	0.0	0.0	0.2	61.5
97	19.5	0.0	145.4	35.4	0.0	0.0	0.0	0.0	0.0	7.0	24.4	5.4	237.1

Sultanate of Oman  
 Ministry of Communications  
 Directorate General of Civil Aviation & Meteorology  
 Department of Meteorology

Station :Seeb Air port  
 Parameter :Surface Wind (speed in knots) # Prevailing direction with mean speed

Year	Month												annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1980	22505	04510	04510	22509	36010	04509	04510	04511	04509	04509	04512	22505	
81	22505	04510	36009	04510	04509	36009	04509	04511	04509	04511	36010	04511	
82	22508	27009	36009	36009	36009	04510	04511	04510	04508	04509	04510	22505	
83	22506	27008	04510	36009	22512	04508	04508	04510	04507	36008	04507	36007	
84	24005	06005	06005	24005	06006	03004	06005	06005	06006	03004	06004	06005	
85	06004	24005	24005	27006	06005	06005	06006	06005	06005	06005	24005	24005	
86	21005	06006	06006	06005	06007	06005	06006	06005	06005	24005	06005	06006	
87	21004	06005	06005	03004	06006	06005	06006	06005	06005	03004	03004	03004	
88	21005	24006	06006	06005	06005	06006	06006	06005	06005	36004	06004	21004	
89	24005	03005	06005	06005	06005	03004	06006	03004	09004	27005	06004	30005	
1990	24004	24005	09005	09005	09004	09006	09006	09005	09004	06004	03004	06004	
91	06005	06005	06005	27005	06004	06005	06005	06005	06004	06004	06004	24004	
92	27005	27006	30004	03004	03005	03005	06005	06005	06005	06005	03005	03005	
93	24005	27005	06006	06005	21006	06006	06005	06005	06005	21004	06004	21004	
94	06005	12004	33005	06006	06004	06006	09006	06006	06004	06004	03004	21004	
95	03003	27005	27005	06005	27006	06005	06006	06007	06005	06005	21005	06005	
96	21005	06004	06005	27005	21006	06007	06005	06005	06005	06004	06004	21003	
97	21004	33004	06005	06006	21006	06006	06005	06006	06005	06005	06005	21004	



Sultanate of Oman  
Ministry of Communications  
Directorate General of Civil Aviation & Meteorology  
Department of Meteorology

Station : **Seeb Air port**

Parameter : **Surface Wind (speed in knots)**

*# monthly maximum gust with direction*

Year	Month												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1977	04030	26025	24020	33026	12030	09040	21020	20050	07030	06018	33020	34018	20050
78	34016	36022	27029	27032	30026	06030	23026	24025	05022	21022	20025	06023	27032
79	21028	23030	21033	18042	21030	03030	05025	06025	05023	05028	04024	20048	20048
1980	33025	20039	32053	22044	20037	20029	21036	05028	02027	17027	03025	06028	32053
81	25034	32040	19031	18055	28066	21040	19026	05036	05025	20025	04022	05025	28066
82	20035	23036	20043	05032	21030	20034	05027	04028	20028	06025	06027	06022	20043
83	28035	22030	31034	27037	20036	04030	09027	06038	04020	04018	05019	34020	06038
84	21022	06022	20030	21030	21027	29022	07029	06016	17025	06017	06020	06019	20030
85	07019	34019	21030	31031	21020	21020	21021	05018	34014	34017	05016	32019	31031
86	06020	21026	20029	26025	21030	06027	21025	07028	21024	06019	34016	06021	31031
87	34018	01030	20046	30034	06032	21036	21029	05021	02024	20029	04019	04021	20046
88	27025	32027	21035	22037	33037	28027	21029	06021	06023	19020	06019	25025	22037
89	31026	32024	20029	33038	07031	01023	23030	04022	23024	35023	09026	36031	33038
1990	30024	29035	01023	36029	33029	22029	27040	09025	10020	10026	09020	07026	27040
91	22043	25031	25031	24033	21028	21027	21030	07029	28024	06025	07019	31023	22043
92	33025	30027	23032	19027	17026	25026	20027	-	05022	08030	06019	20024	23032
93	09024	18034	21025	21029	-	05028	-	-	-	06024	-	-	-
94	34031	04032	21032	09031	27024	06030	09025	-	07021	06022	07025	22029	04032
95	33019	22027	22025	23026	-	-	07025	24034	07020	08024	08021	09026	24034
96	23030	07025	34026	35025	23028	22031	08024	10021	07024	08025	08025	07020	22031
97	22028	24026	-	25042	34031	33026	07024	07023	24025	06040	08022	09024	25042

- data not available







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