WATER ISSUES IN THE MIDDLE EAST

Yarmuk Basin

Jordan

Field Data

PHASE I

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Yarmuk Basin - Jordan

The Yarmuk catchment area in both Jordan and Syria is 6790 km^2. The catchment area in Jordan is 1160 km^2. The average annual precipitation is 280 mm ($\pm$ 80 mm standard deviation). In Mcm/yr this is 324 Mcm $\pm$ 93 Mcm.

Table: Monthly Average Precipitation (42 Years Average) (in mm)

Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
0	7	31	52	70	51	50	17	3	0	0	0

Surface Water Resources

Three gauging stations are available on the Yarmuk River:

	No.	Elevation	Drainage Area (km^2)
Maqarin	AD5	+12 m above sea level	5950
Hemmah	AD3	-175 m below sea level	6760
Adasiya	AD2	-212 m below sea level	6790

The annual average discharge:

		1954 -	1930 - 1953
AD5		251 Mcm	365 Mcm
AD3	no registration	-	-
AD2		318 Mcm	467 Mcm

The overall average for 1930 - 1977:

AD5	313 Mcm
AD2	391 Mcm

Table: Monthly Average Discharge (Mcm)

	1954-1977		1930-1953		1930-1977 (Avg.)	
	AD5	AD2	AD5	AD2	AD5	AD2
Oct	15.6	18.4	22.1	14.5	18.8	16.4
Nov	16.2	19.6	24.0	16.2	20.1	17.9
Dec	23.3	29.6	33.8	25.4	28.5	27.5
Jan	34.3	47.9	71.6	61.0	53.0	54.5
Feb	35.1	57.9	111.5	97.7	73.3	77.8
Mar	32.7	41.3	66.4	55.8	49.5	46.5
Apr	22.4	21.5	35.3	27.1	28.8	24.3
May	14.9	17.3	24.3	17.0	19.5	17.1
Jun	13.5	16.0	19.8	12.9	16.6	14.5
Jul	14.0	15.9	19.3	12.0	16.6	14.0
Aug	14.6	16.1	19.5	12.1	17.1	14.1
Sep	14.9	16.3	19.9	12.4	17.4	14.3

Table: Duration of the Discharge at Station AD5

Discharge m^3/sec.	68/69 days	69/70 days	70/71 days	71/72 days	74/75 days	75/76 days	76/77 days	77/78 days	78/79 days	79/80 days
18	60	12	14	3	-	5	2	7	-	42
17	63	13	15	3	-	5	3	7	-	45
16	68	14	17	4	-	5	3	8	-	65
15	76	14	17	4	-	7	5	9	-	69
14	83	15	17	5	-	7	6	10	-	74
13	99	16	19	5	-	8	6	12	-	78
12	106	19	21	5	1	11	7	14	-	81
11	112	19	24	7	1	16	10	22	-	91
10	124	26	25	8	5	23	15	33	-	95
9	140	47	27	10	13	29	18	59	1	111
8	148	59	33	10	19	38	37	79	5	131
7	168	105	75	47	43	74	107	124	14	138
6	206	170	100	145	106	148	151	156	63	161
5	292	231	155	162	149	184	182	211	140	193
4	364	364	358	360	330	316	326	301	202	355
3	364	364	365	366	365	366	365	364	362	365
2	364	364	365	366	365	366	365	365	364	365

Table: Historic Discharge (in Mcm)

Year	AD5	AD2	Year	AD5	AD2	Year	AD5	AD2
1930	306	402	1946	245	353	1962	245	389
1931	460	572	1947	219	315	1963	221	327
1932	277	377	1948	305	420	1964	252	412
1933	156	248	1949	354	476	1965	289	447
1934	257	354	1950	291	404	1966	189	258
1935	464	577	1951	283	387	1967	421	613
1936	217	319	1952	542	652	1968	203	138
1937	352	458	1953	496	615	1969	532	123
1938	427	544	1954	348	664	1970	224	76
1939	311	436	1955	190	289	1971	269	92
1940	338	451	1956	282	457	1972	182	280
1941	315	426	1957	266	360	1973	-	244
1942	367	477	1958	240	373	1974	-	-
1943	478	599	1959	201	302	1975	156	298
1944	366	490	1960	205	244	1976	131	-
1945	550	670	1961	232	289			

Table: Measured Streamflow (in Mcm)
Gauging Station - AD5 Y. Maqarin

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Wet	Dry	Total
50/51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51/52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
52/53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
53/54	15.0	16.0	19.0	55.0	110.0	33.0	25.0	15.0	14.0	15.0	15.0	16.0	258.0	90.0	348.0
54/55	19.0	20.0	22.0	21.0	15.0	16.0	14.0	13.0	11.0	12.0	13.0	14.0	108.0	82.0	190.0
55/56	15.0	24.0	31.0	42.0	31.0	26.0	21.0	18.0	17.0	19.0	19.0	19.0	175.0	107.0	282.0
56/57	19.0	19.0	23.0	23.0	30.0	41.0	20.0	18.0	17.0	19.0	19.0	18.0	156.0	110.0	266.0
57/58	19.0	20.0	24.0	31.0	23.0	20.0	18.0	16.0	16.0	18.0	18.0	17.0	136.0	104.0	240.0
58/59	17.0	16.0	17.0	17.0	16.0	19.0	16.0	17.0	16.0	16.0	17.0	17.0	101.0	100.0	201.0
59/60	17.0	16.0	17.0	18.0	17.0	18.0	18.0	18.0	17.0	16.0	17.0	16.0	104.0	101.0	205.0
60/61	17.0	18.0	19.0	23.0	27.0	23.0	19.0	20.0	17.0	16.0	16.0	17.0	129.0	103.0	232.0
61/62	19.3	18.9	86.4	27.6	31.0	20.6	14.3	14.5	13.7	14.5	16.1	18.1	148.8	96.2	245.0
62/63	20.3	11.5	21.5	21.4	26.2	25.8	17.1	16.3	13.9	14.4	16.2	17.2	123.5	98.3	221.8
63/64	17.4	17.1	22.1	19.7	45.9	34.8	17.9	16.1	14.7	14.4	16.0	16.6	157.5	95.2	252.7
64/65	16.1	17.2	28.1	58.5	51.1	22.3	18.6	15.9	14.5	15.5	15.8	15.5	195.8	93.3	289.1
65/66	16.9	15.8	17.7	17.2	17.8	24.2	15.1	12.0	11.9	12.4	13.0	14.8	107.8	81.0	188.8
66/67	20.4	18.8	41.8	34.2	62.3	98.6	31.3	19.6	20.4	22.7	25.4	25.4	287.0	133.9	420.9
67/68	7.8	9.2	11.7	69.4	37.8	9.0	8.1	8.5	9.8	9.3	10.6	11.7	145.2	57.8	203.0
68/69	16.6	17.2	61.9	142.0	81.8	113.0	31.0	17.0	12.4	12.8	13.4	13.2	446.9	85.4	532.3
69/70	16.7	19.6	17.5	27.3	21.5	44.2	15.4	13.9	11.8	12.2	12.2	11.8	145.5	78.6	224.1
70/71	12.2	11.8	12.2	20.3	22.8	24.6	103.0	14.9	11.9	11.4	11.9	11.6	194.7	73.9	268.6
71/72	12.2	11.8	13.2	19.7	24.7	18.8	18.1	17.2	12.0	10.8	11.8	11.6	106.3	75.6	181.9
72/73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
73/74	-	-	-	53.3	71.2	62.4	-	13.9	11.7	11.2	11.7	12.1	-	60.6	-
74/75	-	8.0	17.2	15.4	21.8	24.1	11.3	11.3	11.5	13.0	10.7	11.3	97.8	57.8	155.6
75/76	12.9	14.0	16.7	17.1	22.5	29.9	18.0	0.0	0.0	0.0	0.0	0.0	118.2	12.9	131.1
Averages															
	15.6	16.2	23.3	34.3	35.1	32.7	22.4	14.9	13.5	14.0	14.6	14.9	163.9	87.5	251.4

Table: Measured Streamflow (in Mcm)
Gauging Station - A3 Jord Wahadneh

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Wet	Dry	Total
50/51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51/52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
52/53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
53/54	-	-	-	-	380.0	240.0	160.0	130.0	80.0	68.0	67.0	66.0	-	411.0	-
54/55	84.0	74.0	96.0	66.0*	32.0	44.0*	-	-	-	-	-	-	-	-	-
55/56	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
56/57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
57/58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
58/59	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
59/60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
60/61	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
61/62	-	-	-	157.0	180.0	58.9	22.5	21.7	18.6	21.7	22.4	27.3	-	111.7	-
62/63	40.0*	75.3	55.1	64.4	116.0	124.0	50.6	69.1	26.3	19.4	13.5	17.5	485.4	185.8	671.2
63/64	26.4	45.3	179.0	61.0	239.0	216.0	96.4	49.4	21.5	16.0	16.3	15.6	836.7	145.2	981.9
64/65	21.1	102.0	148.0	224.0	239.0	47.7	34.8	17.3	19.7	14.5	12.2	16.0	795.5	100.8	896.3
65/66	27.4	25.1	33.6	41.6	57.4	47.4	23.3	12.4	12.0	9.9	10.3	13.4	228.4	85.4	313.8
66/67	23.3	21.5	76.1	100.0	162.0	332.0	146.0	36.4	16.2	13.0	10.4	13.7	837.6	113.0	950.6
67/68	18.1	24.1	99.1	361.0	-	-	-	-	-	-	-	-	-	-	-
68/69	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
69/70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
70/71	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
71/72	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
72/73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
73/74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
74/75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75/76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Averages															
	27.6	53.8	98.4	98.2	162.7	153.4	70.2	36.9	19.1	14.6	12.5	15.2	636.7	126.0	762.8

* The figures are estimated for only a few days

(Station was closed after war 1967)

Water Quality - Yarmuk River

During flood flows the total dissolved solids (TDS) content ranges from 260 mg/l up to 900 mg/l. The base flow has a TDS of 420 up to 490 mg/l. Representative analysis can be seen from the attached tables. Trace metals have also very low concentration. From the chemical point of view Yarmuk River water is suitable for domestic and irrigational purpose.

Table: Chemical Composition of the Yarmuk River Water

Sample Number		Yarmuk River	Wach-Maddana	Wadi Ehrer	Yarmuk River	Yarmuk River	Yarmuk River	Yarmuk River	Yarmuk River	Spring No. 3	Spring No. 3
Date		3/8/80	16/8/80	1/10/80	16/8/80	12/3/81	22/4/81	9/12/80	25/5/81	4/8/80	22/4/81
Source Type		River	River	River	River	River	River	River	River	Spring	Spring
Temperature °C		24.5	25.0	23.0	26.0	-	-	-	-	27.0	-
pH		6.5	6.8	6.8	6.8	6.8	-	6.5	9.0	6.8	6.8
Ca^{++}	mg/l	30.06	46.09	50.10	32.06	30.60	28.06	26.05	38.08	62.12	38.08
	m eq/l	1.50	2.30	2.50	1.60	1.50	1.40	1.30	1.90	3.10	1.90
	m eq%	18.87	26.41	30.53	21.53	30.86	20.12	27.96	24.87	36.91	32.93
Mg^{++}	mg/l	32.83	30.40	25.54	24.32	13.38	26.75	19.46	24.36	17.02	18.24
	m eq/l	2.70	2.50	2.10	2.00	1.10	2.20	1.66	2.00	1.40	1.50
	m eq%	33.96	28.70	25.64	26.92	22.63	31.61	34.41	26.18	16.67	26.00
Na^{+}	mg/l	83.83	87.36	80.47	86.44	49.40	75.87	39.08	83.55	85.06	52.88
	m eq/l	3.65	3.80	3.50	3.76	2.15	3.30	1.70	3.63	3.70	2.30
	m eq%	45.91	43.63	42.74	50.61	44.24	47.41	36.56	47.51	44.05	39.86
K^{+}	mg/l	3.96	4.30	3.52	2.74	4.82	2.35	1.96	4.09	7.82	2.74
	m eq/l	0.10	0.11	0.09	0.07	0.11	0.06	0.05	0.11	0.20	0.07
	m eq%	1.26	1.26	1.10	0.94	2.26	0.86	1.08	1.44	2.38	1.21
Total cations (m eq/l)		7.95	8.71	8.19	7.43	4.86	6.96	4.65	7.64	8.40	5.77

Table continued

Sample Number		Yarmuk River	Wach-Maddana	Wadi Ehrer	Yarmuk River	Yarmuk River	Yarmuk River	Yarmuk River	Yarmuk River	Spring No. 3	Spring No. 3
CO_3^{--}	mg/l	24.01	18.02	18.02	12.00	0.00	12.00	0.00	24.01	0.00	0.00
	m eq/l	0.80	0.60	0.60	0.40	0.00	0.40	0.00	0.80	0.00	0.00
	m eq%	9.49	7.02	7.59	5.26	0.00	0.40	0.00	9.70	0.00	0.00
HCO_3^-	mg/l	207.47	207.47	195.26	189.19	158.65	176.96	152.55	175.96	256.28	195.24
	m eq/l	3.40	3.40	3.20	2.10	2.60	2.90	2.40	2.90	4.20	3.20
	m eq%	40.33	39.77	40.46	40.74	51.08	40.79	47.34	35.15	49.41	53.33
OH^-	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl^-	mg/l	88.67	80.42	80.42	82.48	54.46	75.25	57.33	86.14	85.57	55.45
	m eq/l	2.50	2.27	2.27	2.23	1.54	2.12	1.63	2.43	2.41	1.56
	m eq%	29.66	26.55	28.70	29.30	30.26	29.82	32.15	24.46	28.35	26.00
NO_3^-	mg/l	14.55	12.91	15.62	16.81	11.10	14.52	13.10	16.58	11.88	10.57
	m eq/l	0.24	0.21	0.25	0.27	0.18	0.23	0.21	0.27	0.19	0.17
	m eq%	2.85	2.56	3.16	3.55	3.54	3.24	4.14	3.27	2.24	2.83
SO_4^{--}	mg/l	71.43	99.42	76.19	77.40	36.73	70.27	39.87	88.77	81.75	51.27
	m eq/l	1.49	2.07	1.59	1.61	0.77	1.46	0.83	1.85	1.70	1.07
	m eq%	17.68	24.21	20.10	21.16	15.13	20.54	16.37	22.42	20.00	17.83
Total anions (m eq/l)		8.43	8.55	7.91	7.61	5.09	7.11	5.07	8.25	8.50	6.00
T.D.S. (mg/l)		* figures missing from copy *						273.53	454.06	479.36	326.85

Table: Trace Metal Composition Yarmuk River Water

Location	Date	pH	T.D.S. p.p.m.	Cu p.p.b.	Mn p.p.b.	Cr p.p.b.	Ni p.p.b.	Zn p.p.m.	Pb p.p.b.	Fe p.p.m.	Co p.p.b.	Cd p.p.b.	Mo p.p.b.
Yarmuk R.	3/8/80	6.5	421.11	7.23	4.93	11.35	11.32	0.05	19.63	0.194	5.17	N.D.	N.D.
Yarmuk R.	16/8/80	6.8	482.66	7.24	12.14	18.55	13.06	0.02	20.22	0.170	15.58	1.22	18.21
Yarmuk R.	16/8/80	6.8	447.51	5.86	7.55	10.18	11.29	0.22	21.29	0.178	14.16	N.D.	N.D.
Yarmuk R.	16/8/80	6.8	-	4.18	5.93	10.91	9.88	0.41	21.29	0.213	9.91	N.D.	N.D.
Yarmuk R.	1/10/80	6.8	428.85	6.91	8.72	12.22	16.56	5.25	46.89	0.305	N.D.	1.65	8.38
Yarmuk R.		6.5	-	3.95	5.23	9.70	14.87	0.02	N.D.	0.039	13.29	N.D.	N.D.
Yarmuk R.		6.8	-	3.46	2.91	12.58	13.18	0.02	11.98	0.052	N.D.	N.D.	N.D.
Yarmuk R.	9/12/80	6.5	273.53	11.63	13.63	29.12	18.27	0.02	21.14	0.497	12.39	N.D.	14.72
Yarmuk R.	12/3/81	6.8	279.76	7.55	2.04	11.80	15.29	0.02	N.D.	0.147	10.84	N.D.	15.46
Yarmuk R.	22/4/81	-	393.55	6.58	4.97	17.42	14.04	0.05	20.15	0.151	14.03	1.64	12.63
Yarmuk R.	25/5/81	9.0	454.06	2.75	6.56	20.99	6.83	0.01	12.48	0.297	17.92	1.81	15.05
Yarmuk R.	23/6/81	6.8	468.09	7.71	6.56	18.78	6.41	0.02	18.15	0.204	11.69	2.89	N.D.

N.D. = not detected

Sediment Load

No significant sediment transport is found during the dry season. By volume the amount of sediment load is estimated to be 0.3% of the annual flood volume. By discharge average of 319 Mcm/yr for Maqarin there is a sediment load of about:

0.3% x 319 = 0.96 Mcm of sediments

or about 2 million tons of solid and suspended loads. For Adasiya by an average discharge of 391 Mcm/yr it equals:

0.3% x 391 = 1.17 Mcm of sediment load

or about 2.3 million tons.

Pollution

As can be seen from the major water constituents as well as trace metal contents the Yarmuk River water is chemically not polluted. The physical parameters are also very suitable for domestic and irrigational uses. Care must be taken by chlorinating this water after long exposures to light, where the organic carbon contents increase due to the activities of micro-organisms and [chloroforum?] and [brownoforum?] are then produced by adding chlorine to disinfect the water.

Soils

The catchment area is covered by calcereous-siliceous rocks in the western catchment and by basalts in the eastern part. The weathering of these two rock types resulted, under the prevailing climate, in the formation of two soil types.

a. Yellow Mediterranean Soils

They are related to the Brown Soils and differ from them by their extremely high calcereous content. They develop over basalt rocks (including lava) and have in some parts a dense cover of basalt boulders. In the Jordanian part of the Yarmuk catchment they occupy the area to the east of NS-line (36° 07').

b. Red Mediterranean Soils

They develop from calcereous and siliceous sediments. They differ from the typical Red Med. Soils by their high $CaCO_3$ content and by their base saturation of clay complex. This type of soil present in the area develop as a subgroup of typical Red Med. Soils in areas receiveing lower amounts of precipitation. In our area they occupy the highlands to the west of 36° 07' NS westward to the slopes over the Jordan Valley.

The amount of precipitation and the topography allows only for certain land uses, mainly dry farming. Average altitude, basin climate index, soil classification, average precipitation allow to calculate a Landuse Factor of 0.8-0.85 with an average Runoff-precipitation Factor as follows.

	Precipitation	Avg. Altitude	Runoff coefficient % Flood	Base	Total
Adasiya	592 mm	900 m	14.1%	9.9%	24.0%
Maqarin	326 mm	700 m	5.5%	6.9%	12.4%

(National Water Master Plan / Jordan 1977)

Table: Chemical Composition of the Spring Water

These springs issue from B4,5 and their overlying recent rocks of basalts and soils. (Lower Tertiary and pleistocene). It includes Lower chalky unit, chalky unit, upper chalky unit. Basalts and Soils. Compare columnar section.

Sample Number		Spring No. 4	Spring No. 9	Spring No. 2	Ein el Quseir	Ein Ghazala	Ein el Mardash	Ain Quelba	Ain Quelba	Ain Quelba	Ain Quelba
Date		4/8/80	4/8/80	4/8/80	24/9/80	24/9/80	9/8/80	8/3/72	14/12/77	7/5/80	10/11/80
Source Type		Spring	Spring	Spring	Spring	Spring	Spring	Spring	Spring	Spring	Spring
Temperature °C		34.5	32.0	32.0	20.5	20.5	23.0	-	-	-	-
pH		6.9	6.8	6.8	8.5	6.8	6.8	-	-	-	-
Ca^{++}	mg/l	88.18	72.14	90.18	78.16	20.04	94.19	70.54	68.14	70.54	68.14
	m eq/l	4.40	3.60	4.50	3.90	1.00	4.70	3.52	3.40	3.52	3.40
	m eq%	34.06	35.33	50.28	39.80	4.45	30.92	80.09	71.88	77.88	72.03
Mg^{++}	mg/l	52.29	42.56	30.40	25.54	15.81	71.74	4.38	6.06	4.74	7.30
	m eq/l	4.30	3.50	2.50	2.10	1.30	5.90	0.36	0.50	0.39	0.60
	m eq%	33.28	34.35	27.93	21.43	29.35	38.82	8.24	10.57	8.63	12.71
Na^{+}	mg/l	91.96	66.90	41.38	85.06	46.91	103.46	10.35	18.39	13.79	15.17
	m eq/l	4.00	2.91	1.80	3.70	2.05	4.50	0.45	0.80	0.60	0.66
	m eq%	30.95	28.56	20.11	37.76	46.05	29.61	10.30	16.91	13.27	13.98
K^{+}	mg/l	4.69	7.84	5.87	3.91	5.46	3.91	2.35	1.17	0.39	2.35
	m eq/l	0.12	0.18	0.15	0.10	0.09	0.10	0.06	0.03	0.01	0.06
	m eq%	0.93	1.77	1.68	1.02	2.03	0.66	1.37	0.63	0.22	1.27
Total cations (m eq/l)		12.82	10.19	8.95	9.80	4.43	15.20	4.37	4.73	4.52	4.72

Table continued

Sample Number		Spring No. 4	Spring No. 9	Spring No. 2	Ein el Quseir	Ein Ghazala	Ein el Mardash	Ain Quelba	Ain Quelba	Ain Quelba	Ain Quelba
	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO_3^{--}	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	mg/l	427.14	488.16	366.12	213.57	152.55	390.53	211.13	211.13	205.03	207.47
HCO_3^-	m eq/l	7.00	7.80	6.00	3.50	2.21	6.40	3.46	3.46	3.36	3.40
	m eq%	48.54	68.24	64.87	35.90	48.15	44.57	77.75	80.65	72.41	77.63
	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OH^-	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	mg/l	177.33	96.91	64.95	113.41	44.33	165.99	20.56	28.01	21.99	22.68
Cl^-	m eq/l	5.00	2.73	1.83	3.20	1.25	4.68	0.58	0.79	0.62	0.64
	m eq%	34.67	23.89	19.46	32.82	27.23	32.59	13.03	18.42	13.36	14.61
	mg/l	1.07	0.64	0.60	136.19	18.71	24.16	0.00	0.00	33.49	24.90
NO_3^-	m eq/l	0.02	0.01	0.00	2.20	0.30	0.41	0.00	0.00	0.54	0.04
	m eq%	0.14	0.09	0.00	22.56	6.54	2.86	0.00	0.00	11.64	0.91
	mg/l	117.46	42.75	68.25	40.80	16.20	*131.?5*	19.69	1.92	5.76	14.40
SO_4^{--}	m eq/l	1.49	0.89	1.42	0.85	0.34	* 2.07*	0.41	0.04	0.12	0.30
	m eq%	10.33	7.79	15.35	8.72	7.41	* 19.73*	9.21	0.93	2.59	6.85
Total anions (m eq/l)			*****	copy of table cut off			*****				
T.D.S. (mg/l)			*****	copy of table cut off			*****				

Table continued

Sample Number		Ain et Trab	Ain Shalaq	Ain-Shalaq	Ain-Um Jrain		Spring No. 7	Ain-Ba'boul	Ain-Sombal
Date		9/9/80	21/7/79	20/7/80	21/7/79	20/7/80	6/9/80	6/9/80	6/9/80
Source Type		Spring	Spring	Spring	Spring	Spring	Spring	Spring	Spring
Temperature °C		24.0	-	-	-	-	22.50	23.00	23.00
pH		6.8	-	-	-	-	6.80	6.80	6.80
Ca^{++}	mg/l	68.14	60.92	66.13	52.10	63.73	104.21	128.26	110.22
	m eq/l	3.40	3.04	3.30	2.60	3.18	5.20	6.40	5.50
	m eq%	67.73	52.96	-	-	-	-	-	-
Mg^{++}	mg/l	7.30	11.68	14.59	10.46	13.62	23.10	41.34	20.67
	m eq/l	0.60	0.96	1.20	0.86	1.12	1.90	3.40	1.70
	m eq%	11.95	16.73	-	-	-	-	-	-
Na^{+}	mg/l	22.99	39.08	42.76	57.48	62.99	22.99	41.38	22.07
	m eq/l	1.00	1.70	1.86	2.50	2.74	1.00	1.80	0.96
	m eq%	5.02	29.62	-	-	-	-	-	-
K^{+}	mg/l	0.78	1.56	3.13	1.56	3.91	2.74	2.35	3.13
	m eq/l	0.02	0.04	0.08	0.04	0.10	0.07	0.06	0.08
	m eq%	0.40	0.70	-	-	-	-	-	-
Total cations (m eq/l)		5.02	5.74	-	6.00	7.14	8.17	11.66	8.24

Table continued

Sample Number		Ain et Trab	Ain Shalaq	Ain-Shalaq	Ain-Um Jrain		Spring No. 7	Ain-Ba'boul	Ain-Sombal
	mg/l	0.00	10.20	0.00	2.40	0.00	0.00	0.00	0.00
CO_3^{--}	m eq/l	0.00	0.84	0.00	0.08	0.00	0.00	0.00	0.00
	m eq%	0.00	5.87	0.00	1.37	0.00	0.00	0.00	0.00
	mg/l	225.77	183.06	223.33	147.67	237.98	378.32	390.53	372.22
HCO_3^-	m eq/l	3.70	3.00	3.66	2.42	3.90	6.30	6.40	6.10
	m eq%	76.61	51.81	-	41.44	52.07	-	-	-
	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OH^-	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	mg/l	22.68	54.25	61.35	81.56	82.98	39.18	79.39	61.86
Cl^-	m eq/l	0.64	1.53	1.73	2.30	2.34	1.11	2.24	1.75
	m eq%	13.25	26.43	-	39.39	31.24	-	-	-
	mg/l	22.30	32.34	46.51	39.69	56.43	6.69	6.40	11.46
NO_3^-	m eq/l	0.36	0.52	0.75	0.64	0.91	0.18	0.10	0.19
	m eq%	7.45	8.98	-	10.96	12.15	-	-	-
	mg/l	6.45	19.21	16.33	31.70	5.76	62.69	111.91	28.82
SO_4^{--}	m eq/l	0.13	0.40	0.34	0.66	0.12	1.31	2.33	0.60
	m eq%	2.69	6.91	*****	copy cut off		*****		

Total anions (m eq/l)	**********	copy cut off	**********
T.D.S. (mg/l)	**********	copy cut off	**********

Table: Trace Metal Composition of the Springs Water

Location	pH	T.D.S. p.p.m.	Cu p.p.b.	Mn p.p.b.	Cr p.p.b.	Ni p.p.b.	Zn p.p.m.	Pb p.p.b.	Fe p.p.m.	Co p.p.b.	Cd p.p.b.	Mo p.p.b.
Spring No. 4	6.9	746.55	5.32	17.81	7.22	15.65	0.01	18.60	0.063	9.60	2.34	N.D.
Spring No. 9	6.8	573.02	5.53	6.30	3.44	12.99	0.02	21.70	0.123	13.29	1.64	N.D.
Spring No. 2	6.8	484.69	4.68	20.27	3.44	13.65	0.02	N.D.	0.076	5.91	2.44	N.D.
Spring No. 3	6.8	479.36	5.96	5.21	7.22	10.99	0.03	14.03	0.116	6.65	N.D.	N.D.
Spring No. 3	6.8	326.85	3.39	7.22	15.57	8.97	0.03	12.31	0.396	10.13	1.55	N.D.
Quseir	8.5	589.86	13.65	25.02	3.09	15.55	0.09	23.81	0.371	N.D.	1.51	N.D.
Ghazabah	6.8	247.74	2.58	4.83	7.20	8.11	0.02	15.87	0.180	N.D.	1.00	*8.??*
Spring No. 7	6.8	450.76	6.46	3.78	6.18	29.65	0.03	19.16	0.086	9.94	1.79	N.D.
Ba'boul	6.8	606.40	8.07	25.08	19.27	7.41	0.02	27.67	0.196	N.D.	1.79	20.89
Sombal	6.8	444.34	6.68	4.85	4.00	31.17	0.04	17.03	0.080	N.D.	2.93	*8.8?*
El-Trab	6.8	502.86	6.93	5.12	2.74	12.17	0.02	12.27	0.052	5.94	0.97	N.D.
Quelba	6.8	258.68	8.89	9.01	4.31	19.61	1.59	55.91	0.122	12.46	2.17	N.D.
Murdahia	6.8	796.57	8.67	20.23	12.00	19.77	0.03	24.48	0.266	18.41	2.28	N.D.

N.D. = not detected

Table: Location of Sampling Sites Not Plotted on the Map

Sampling Site	Coordinates N	E
Spring No. 4	237,799.2	232,676.9
Ain El Merdashia	236,451.49	233,397.96
Spring No. 7		
Ain Ba'bul	234,380.0	233,402.2
Ain Sombal	235,118.8	233,229.0
Ain et Trab	229.900	226.900
Ain el Quseir	Springs issue from the basalts in the Syrian side.	
NRA-Saham Exp. 234.000	234.000	222.000
Travertine Zone Seepage	236,981.7	232.739,96
Ain Quelbe	231.600	231.000
Ain Shelaq	221.000	238.400
Ain Um Jrain	221.200	240.100

Table: Chemical Composition of High pH Water
Upper Portion of B-3/Bituminous Marl Formation (compare columnar section)

Sample Number		FS-1	Travertine Zone	AFS-2	A-1	A-4	W.S. seepage	W.S. seepage	W.S. seepage	W.S. seepage
Date		5/8/80	16/8/80	5/8/80	5/9/77	6/9/77	5/8/80	1/81	12/3/81	22/4/81
Source Type		Seepage	Seepage	Seepage	Seepage	Seepage	Seepage	Seepage	Seepage	Seepage
Temperature °C		24.5	-	24.5	-	-	29.0	-	-	-
pH		12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Ca^{++}	mg/l	923.84	735.47	679.36	710.10	310.62	815.63	545.29	456.91	454.91
	m eq/l	46.10	36.70	33.90	35.43	15.50	40.70	27.21	22.80	22.70
	m eq%	94.82	83.33	92.55	91.81	79.61	94.78	91.90	89.59	91.72
Mg^{++}	mg/l	0.00	6.08	3.65	0.00	7.30	0.00	0.00	1.22	0.00
	m eq/l	0.00	0.50	0.30	0.00	0.60	0.00	0.00	0.10	0.00
	m eq%	0.00	1.14	0.82	0.00	3.08	0.00	0.00	0.39	0.00
Na^{+}	mg/l	45.98	124.15	50.58	59.77	68.97	39.08	45.98	48.28	39.08
	m eq/l	2.00	5.40	2.20	2.60	3.00	1.70	2.00	2.10	1.70
	m eq%	4.11	-	6.01	6.74	15.41	3.96	6.76	8.25	6.87
K^{+}	mg/l	20.33	75.85	20.72	21.90	14.47	21.11	15.69	17.60	13.69
	m eq/l	0.52	1.94	0.53	0.56	0.37	0.54	0.40	0.45	0.35
	m eq%	1.07	12.26	1.45	1.45	1.90	1.26	1.35	1.77	1.41
Total cations (m eq/l)		48.62	44.04	36.63	38.59	19.47	42.94	29.61	25.45	24.75

Table continued

Sample Number		FS-1	Travertine Zone	AFS-2	A-1	A-4	W.S. seepage	W.S. seepage	W.S. seepage	W.S. seepage
CO_3^{--}	mg/l	36.01	162.05	60.02	42.33	18.31	108.04	30.01	66.02	36.01
	m eq/l	1.20	5.46	2.00	1.41	0.61	3.60	1.00	2.20	1.20
	m eq%	2.47	12.58	5.50	3.33	3.09	8.55	3.28	8.71	4.83
HCO_3^-	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OH^-	mg/l	682.10	435.46	474.58	523.06	175.88	523.91	365.72	243.24	284.41
	m eq/l	40.10	25.60	27.90	30.75	10.34	30.80	21.50	14.30	16.70
	m eq%	82.44	59.62	76.69	72.51	52.51	73.18	70.58	56.63	67.20
Cl^-	mg/l	101.04	253.63	74.23	95.74	92.91	91.76	90.23	87.13	69.71
	m eq/l	2.85	7.15	2.09	2.70	2.62	2.59	2.55	2.46	1.96
	m eq%	5.86	16.65	5.75	6.37	13.25	6.15	8.37	9.74	7.89
NO_3^-	mg/l	2.25	32.94	8.18	7.75	2.86	8.86	10.65	10.75	6.66
	m eq/l	0.04	0.53	0.13	0.13	0.05	0.14	0.17	0.17	0.11
	m eq%	0.08	1.23	0.36	0.31	0.25	0.33	0.56	0.67	0.44
SO_4^{--}	mg/l	223.34	204.61	204.61	356.38	286.26	238.23	260.30	293.94	321.39
	m eq/l	4.65	4.26	4.26	7.42	5.96	4.96	5.42	6.12	4.88
	m eq%	9.56	8.78	11.71	17.50	30.15	11.78	17.79	24.24	19.64
Total anions (m eq/l)		48.64	42.94	36.38	42.41	19.77	42.09	30.64	25.25	24.85
T.D.S.(mg/l)		2068.17	2030.00	1575.93	1774.70	977.58	1866.94	1363.84	1225.08	1110.89

Table continued

Sample Number		W.S. seepage	W.S. seepage
Date		23/6/81	14/2/77
Source Type		seepage	seepage
Temperature °C		-	-
pH		12.5	12.5
Ca^{++}	mg/l	795.59	611.22
	m eq/l	39.70	30.50
	m eq%	39.63	89.13
Mg^{++}	mg/l	0.00	7.30
	m eq/l	0.00	0.60
	m eq%	0.00	1.75
Na^{+}	mg/l	47.46	59.77
	m eq/l	2.07	2.60
	m eq%	4.88	7.60
K^{+}	mg/l	24.53	20.33
	m eq/l	0.63	0.52
	m eq%	1.49	1.52
Total cations (m eq/l)		42.40	34.2

Table continued

Sample Number		W.S. seepage	W.S. seepage
CO_3^{--}	mg/l	24.01	15.61
	m eq/l	0.80	0.52
	m eq%	1.93	1.44
HCO_3^-	mg/l	0.00	0.00
	m eq/l	0.00	0.00
	m eq%	0.00	0.00
OH^-	mg/l	534.11	395.31
	m eq/l	31.40	23.24
	m eq%	75.74	64.16
Cl^-	mg/l	93.07	108.51
	m eq/l	2.63	3.06
	m eq%	6.34	8.45
NO_3^-	mg/l	7.44	0.00
	m eq/l	0.12	0.00
	m eq%	0.29	0.00
SO_4^{--}	mg/l	321.43	451.48
	m eq/l	6.69	9.40
	m eq%	16.14	25.95
Total anions (m eq/l)		41.46	36.22
T.D.S.(mg/l)		1847.64	1668.53

Table: Trace Metal Composition of High pH Water

Location	Date	pH	T.D.S. p.p.m.	Cu p.p.b.	Mn p.p.b.	Cr p.p.b.	Ni p.p.b.	Zn p.p.m.	Pb p.p.b.	Fe p.p.m.	Co p.p.b.	Cd p.p.b.	Mo p.p.b.
Adits for	10/1/81	12.5	-	11.97	8.90	415.82	39.88	0.03	49.09	0.085	24.37	5.04	42.69
construct.	10/1/81	12.5	1289.62	5.51	7.83	467.81	27.61	0.08	47.32	0.184	38.20	6.54	32.30
of Maqarin	12/3/81	12.5	1175.97	5.58	4.33	425.12	22.21	0.03	31.02	0.056	37.94	5.96	32.39
Dam, left	22/4/81	12.5	1226.06	6.18	7.38	437.35	25.62	0.05	55.97	0.120	33.51	5.89	28.42
side of	25/5/81	12.5	1285.02	8.62	6.21	419.48	20.07	0.02	38.56	0.133	38.96	6.93	28.42
Yarmuk R.	23/6/81	12.5	1127.87	6.79	2.76	400.70	18.79	0.02	41.97	0.125	47.53	6.35	27.63
W.S.-	5/8/80	12.5	1866.94	17.54	6.38	523.32	67.41	0.10	95.79	0.081	39.65	9.76	49.62
seepages	10/1/81	12.5	1363.86	-	7.99	466.05	31.43	0.11	59.40	0.139	41.52	7.46	44.17
	12/3/81	12.5	1225.08	8.37	5.39	348.76	24.64	3.06	48.13	0.113	36.39	5.97	39.02
	22/4/81	12.5	1140.89	8.17	8.18	383.98	21.35	0.02	43.85	0.090	31.74	6.54	26.50
	23/6/81	12.5	1847.46	7.52	10.01	635.78	29.47	0.05	73.72	0.125	52.21	10.06	26.84
Tr. Zone	16/8/80	12.5	2030.24	33.13	14.02	422.74	66.00	0.13	81.96	0.113	38.94	8.54	38.07
FS-1	5/8/80	12.5	2868.94	16.71	19.42	161.08	75.53	0.10	81.15	0.161	50.22	9.91	80.77
Adit-AFS	25/8/80	12.5	1575.93	14.48	16.18	265.46	59.65	0.10	69.19	0.096	36.81	9.76	46.35

Table: Chemical Composition of Amman Formation Waters

Sample Number		FS-36	FS-36	FS-36	FS-36	FS-52	FS-52	Borehole FS-35	Borehole FS-35	Borehole FS-35
Date		9/12/80	22/4/81	25/5/81	23/6/81	4/8/80	22/4/81	9/9/80	12/3/81	22/4/81
Source Type		G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.
Temperature °C		-	-	-	-	26.5	-	30.0	-	-
pH		6.80	-	7.20	7.10	6.50	-	7.10	6.80	-
Ca^{++}	mg/l	96.19	86.17	92.18	90.18	76.15	52.10	33.06	58.12	50.10
	m eq/l	4.80	4.30	4.60	4.50	3.80	2.60	1.60	2.90	2.50
	m eq%	48.39	43.66	46.23	45.32	35.58	35.23	32.85	33.68	34.82
Mg^{++}	mg/l	27.97	34.05	30.40	32.82	40.13	24.36	3.65	35.26	32.26
	m eq/l	2.30	2.50	2.50	2.70	3.30	2.00	0.30	2.90	2.70
	m eq%	23.19	28.43	25.13	27.19	30.90	*27.1?*	6.16	33.68	37.60
Na^{+}	mg/l	63.91	62.07	63.28	60.81	75.87	62.07	64.37	62.07	43.91
	m eq/l	2.78	2.70	2.75	2.65	3.30	2.70	2.80	2.70	1.91
	m eq%	28.02	27.41	27.64	26.69	30.90	36.59	57.50	31.36	26.60
K^{+}	mg/l	1.56	1.96	3.83	3.07	10.95	3.13	6.65	4.30	2.74
	m eq/l	0.04	0.08	0.10	0.08	0.28	0.08	0.17	0.11	0.07
	m eq%	0.40	0.81	1.01	0.81	2.62	1.08	3.49	1.28	0.98
Total cations (m eq/l)		9.92	9.85	9.95	9.93	10.68	7.38	4.87	8.61	7.18

Table continued

Sample Number		FS-36	FS-36	FS-36	FS-36	FS-52	FS-52	Borehole FS-35	Borehole FS-35	Borehole FS-35
CO_3^{--}	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	36.01	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	1.20	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	25.32	0.00	0.00
HCO_3^-	mg/l	402.73	390.53	378.53	409.33	256.28	250.18	67.12	305.10	323.41
	m eq/l	6.60	6.40	6.20	6.60	4.20	4.10	1.10	5.00	5.30
	m eq%	67.76	65.11	63.46	62.44	41.26	54.16	23.21	59.45	78.99
OH^-	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl^-	mg/l	79.39	76.24	79.21	80.20	109.29	74.26	80.42	77.33	40.59
	m eq/l	2.24	2.15	2.23	2.26	3.08	2.09	2.27	2.18	1.15
	m eq%	23.00	21.87	22.83	21.38	30.26	27.61	47.89	25.92	17.14
NO_3^-	mg/l	1.00	0.20	0.00	0.00	0.75	2.22	2.18	0.90	0.11
	m eq/l	0.20	0.00	0.00	0.00	0.01	0.04	0.04	0.02	0.00
	m eq%	0.21	0.00	0.00	0.00	0.10	0.53	0.84	0.24	0.00
SO_4^{--}	mg/l	42.48	61.62	64.12	82.14	138.09	64.20	6.45	58.12	12.50
	m eq/l	0.88	1.20	1.34	1.71	2.89	1.34	0.13	1.21	0.26
	m eq%	9.04	12.21	13.72	16.18	28.39	17.70	2.70	14.39	3.88
Total anions (m eq/l)		9.74	9.83	9.77	10.57	10.18	7.57	4.70	8.41	6.71
T.D.S.(mg/l)		512.31	517.54	522.18	553.90	580.17	407.43	256.45	448.65	349.49

Table continued

Sample Number		Well NRA-W.S.	Well NRA-W.S.	Well NRA-W.S.	FS-74	HV-11	HV-11	FS-4	FS-4	FS-34
Date		7/9/80	12/3/81	25/5/81	24/9/80	10/9/80	12/3/81	10/8/80	12/3/81	9/9/80
Source Type		G.W.	G.W.	G.W.	-	G.W.	G.W.	G.W.	G.W.	G.W.
Temperature °C		26.0	-	-	-	29.0	-	29.0	-	26.5
pH		6.8	6.8	7.4	6.9	7.0	7.3	6.8	6.8	12.0
Ca^{++}	mg/l	106.21	70.14	96.17	24.05	14.03	8.02	90.18	66.13	206.41
	m eq/l	5.30	3.40	4.80	1.20	0.70	0.40	3.90	3.30	10.30
	m eq%	41.31	29.80	39.15	15.06	11.09	8.55	43.67	51.40	43.22
Mg^{++}	mg/l	32.83	49.86	55.94	26.75	9.73	0.00	30.40	21.89	3.65
	m eq/l	4.10	4.60	4.10	2.20	0.80	0.00	2.50	1.80	0.30
	m eq%	31.96	40.32	33.44	-	12.68	0.00	28.00	28.03	1.26
Na^{+}	mg/l	71.27	69.86	69.21	91.96	105.29	24.81	41.38	28.44	108.05
	m eq/l	3.10	3.04	3.01	4.00	4.58	4.12	2.30	1.24	4.70
	m eq%	24.16	26.64	24.55	27.58	88.03	25.76	19.32	-	19.72
K^{+}	mg/l	2.90	14.86	13.80	22.25	7.42	6.26	5.87	3.11	333.52
	m eq/l	0.33	0.36	0.35	0.57	0.23	0.16	0.23	0.08	8.53
	m eq%	2.57	3.16	-	7.15	3.65	3.42	2.58	1.25	35.80
Total cations (m eq/l)		12.83	11.41	12.26	7.97	6.31	4.68	8.93	6.42	23.83

Table continued

Sample Number		Well NRA-W.S.	Well NRA-W.S.	Well NRA-W.S.	FS-74	HV-11	HV-11	FS-4	FS-4	FS-34
	mg/l	0.00	0.00	0.00	18.01	12.00	12.00	0.00	0.00	66.02
CO_3^{--}	m eq/l	0.00	0.00	0.00	0.60	0.40	0.40	0.00	0.00	2.20
	m eq%	0.00	0.00	0.00	-	6.53	8.49	0.00	0.00	9.37
	mg/l	292.90	280.69	280.69	201.37	42.71	24.41	366.14	274.59	0.00
HCO_3^-	m eq/l	4.80	4.60	4.60	3.30	0.70	0.40	6.00	4.60	0.00
	m eq%	39.80	39.76	39.18	-	11.42	8.49	65.95	61.07	0.00
	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.93
OH^-	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.70
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.50
	mg/l	143.31	144.56	133.66	118.57	168.03	137.62	64.95	45.36	90.73
Cl^-	m eq/l	4.04	4.56	3.77	3.34	4.74	3.88	1.85	1.23	2.56
	m eq%	33.50	39.41	32.11	40.19	77.33	82.38	20.33	19.22	10.91
	mg/l	2.46	1.80	1.35	4.50	2.60	1.85	0.60	1.45	10.97
NO_3^-	m eq/l	0.04	0.03	0.02	0.07	0.04	0.03	0.06	1.45	0.18
	m eq%	0.33	0.26	0.17	0.84	0.65	0.64	0.66	0.30	0.77
	mg/l	152.74	114.05	160.71	62.40	12.00	5.00	68.25	36.40	760.32
SO_4^{--}	m eq/l	3.18	2.38	3.35	1.30	0.25	0.10	1.19	0.76	15.83
	m eq%	26.37	20.57	28.55	15.64	4.08	2.12	13.08	11.41	67.54
Total anions (m eq/l)		12.06	11.57	11.74	8.31	6.13	4.71	9.10	6.66	23.47
T.D.S.(mg/l)		685.20	611.56	665.11	469.22	352.46	277.77	484.69	340.09	1625.50

Table continued

Sample Number		FS-34	FS-37	FS-17	FS-26	FS-63	FS-62	FS-32	Exp.	NRA-A(2)	FS-18
Date		9/12/80	1/81	4/8/80	8/9/80	9/9/80	9/9/80	2/10/80	9/9/80	7/9/80	9/9/80
Source Type		G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.
Temperature °C		-	-	26.5	27.0	25.0	26.0	24.5	25.0	25.5	28.0
pH		12.0	6.8	6.8	7.5	12.0	7.1	8.2	6.8	8.5	7.1
Ca^{++}	mg/l	96.19	90.18	104.21	68.14	44.09	42.08	22.04	60.12	44.09	49.09
	m eq/l	4.80	4.50	5.20	3.40	2.20	2.10	1.10	3.00	2.20	2.30
	m eq%	23.08	46.06	44.94	41.87	35.03	34.04	21.87	38.66	31.56	31.59
Mg^{++}	mg/l	18.24	35.26	37.70	6.08	3.65	9.73	10.94	36.48	3.65	25.04
	m eq/l	1.50	2.90	3.10	0.50	0.30	0.80	0.90	3.00	0.30	2.10
	m eq%	7.21	29.68	26.79	6.16	4.78	12.97	17.89	38.66	4.30	28.85
Na^{+}	mg/l	117.94	52.88	72.85	101.16	78.17	71.27	64.87	39.08	91.96	61.84
	m eq/l	5.13	2.30	3.17	4.04	3.40	3.10	2.82	1.70	4.00	2.69
	m eq%	24.66	23.54	27.40	49.75	54.14	50.24	56.06	21.91	57.39	36.95
K^{+}	mg/l	366.37	2.74	4.69	7.04	14.86	6.65	8.29	2.35	16.42	7.43
	m eq/l	9.37	0.07	3.71	0.18	0.38	0.17	0.21	0.06	0.47	0.19
	m eq%	45.05	0.72	0.86	2.22	6.05	2.76	4.18	0.77	6.74	2.61
Total cations (m eq/l)		20.80	9.77	11.57	8.12	6.28	6.17	5.03	7.76	6.97	7.28

Table continued

Sample Number		FS-34	FS-37	FS-17	FS-26	FS-63	FS-62	FS-32	Exp.	NRA-A(2)	FS-18
CO_3^{--}	mg/l	42.01	0.00	0.00	24.00	36.01	24.01	24.01	0.00	30.01	12.00
	m eq/l	1.40	0.00	0.00	0.80	1.20	0.80	0.80	0.00	1.00	0.10
	m eq%	6.27	0.00	0.00	10.30	19.14	13.84	17.06	0.00	13.95	1.45
HCO_3^-	mg/l	0.00	421.00	463.75	42.71	0.00	79.33	54.92	341.71	0.00	36.61
	m eq/l	0.00	6.90	7.60	0.70	0.00	1.30	0.40	5.60	0.00	4.70
	m eq%	0.00	68.66	66.55	9.01	0.00	22.49	19.19	77.56	0.00	68.12
OH^-	mg/l	69.01	0.00	0.00	0.00	8.51	0.00	0.00	0.00	1.70	0.00
	m eq/l	4.10	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.10	0.00
	m eq%	18.37	0.00	0.00	0.00	7.97	0.00	0.00	0.00	1.40	0.00
Cl^-	mg/l	84.54	77.33	86.60	113.41	113.41	79.39	59.80	39.18	117.53	68.05
	m eq/l	4.10	2.18	2.44	3.20	3.20	2.24	1.69	1.11	3.32	1.92
	m eq%	18.10	21.69	21.37	41.18	51.04	38.75	36.03	15.37	46.30	27.83
NO_3^-	mg/l	5.85	1.00	0.89	3.52	3.80	5.28	5.84	1.90	1.96	3.31
	m eq/l	0.09	0.02	0.01	0.06	0.06	0.09	0.09	0.03	0.02	0.05
	m eq%	0.40	0.20	0.09	0.77	0.96	1.56	1.92	0.42	0.28	0.73
SO_4^{--}	mg/l	606.62	45.59	65.87	144.57	84.60	69.00	58.20	22.80	130.95	6.24
	m eq/l	12.63	0.95	1.37	3.01	1.76	1.44	1.21	0.48	2.73	0.13
	m eq%	56.59	9.45	12.00	38.79	28.07	24.91	25.80	6.65	38.08	1.88
Total anions (m eq/l)		22.32	10.05	11.42	7.77	6.27	5.78	4.69	7.22	7.17	6.90
T.D.S.(mg/l)		1407.49	515.48	603.71	489.29	387.10	347.08	281.45	372.77	438.27	238.77

Table: Trace Metal Concentration of Amman Formation Waters

Location	Date	pH	T.D.S. p.p.m.	Cu p.p.b.	Mn p.p.b.	Cr p.p.b.	Ni p.p.b.	Zn p.p.m.	Pb p.p.b.	Fe p.p.m.	Co p.p.b.	Cd p.p.b.	Mo p.p.b.
FS-36	Aug 80	6.5	-	5.11	16.99	2.06	23.31	8.20	24.80	0.146	N.D.	1.95	N.D.
FS-36	Nov 80	6.8	-	4.20	20.92	10.78	25.35	8.29	21.96	0.613	14.12	2.43	6.10
FS-36	Jun 81	6.8	512.31	3.88	19.74	N.D.	16.57	4.14	16.10	0.682	13.29	1.76	7.36
FS-36	Apr 81	-	517.58	2.59	13.15	12.23	17.08	0.14	20.15	0.153	17.14	2.04	10.26
FS-36	May 81	7.2	522.18	2.39	29.82	187.46	83.27	0.24	32.51	0.835	21.82	3.19	15.79
FS-36	Jun 81	7.4	553.90	4.95	15.01	8.10	13.24	1.18	13.61	0.107	17.14	2.97	N.D.
FS-35	Sep 80	7.1	265.45	18.67	11.65	6.87	17.51	3.19	53.18	0.361	N.D.	1.77	19.86
FS-35	Dec 80	8.0	-	5.19	N.D.	2.87	9.80	0.23	16.97	0.047	N.D.	N.D.	20.57
FS-35	Mar 81	6.8	448.65	1.84	8.15	N.D.	14.44	2.81	32.22	0.111	8.52	N.D.	10.31
FS-35	Apr 81	-	349.49	1.79	7.22	N.D.	6.41	0.76	16.79	0.125	12.39	1.55	6.36
NRA-W.S.	Sep 80	6.8	685.20	9.70	22.75	6.51	21.51	1.11	54.67	0.316	13.45	1.86	14.07
NRA-W.S.	Mar 81	6.8	611.56	2.59	N.D.	N.D.	10.68	0.19	23.53	0.056	17.03	1.55	14.72
NRA-W.S.	May 81	7.4	665.11	2.75	21.74	19.15	17.51	0.29	43.66	0.271	8.57	3.03	10.26
HV-11	Sep 80	7.0	352.46	11.33	19.05	17.14	10.82	4.82	37.70	0.633	N.D.	3.43	11.43
HV-11	Mar 81	7.3	277.77	2.25	2.35	N.D.	9.79	1.91	N.D.	0.078	14.71	N.D.	6.63
HV-11	Apr 81	-	-	7.38	7.05	N.D.	8.97	1.26	42.54	0.304	13.16	1.47	N.D.
FS-37	Aug 80	6.8	-	6.38	13.48	5.46	24.71	3.70	24.04	0.147	11.82	2.60	9.23
FS-37	Jun 81	6.8	515.48	3.47	14.73	4.64	13.17	7.49	15.10	0.443	12.39	1.93	11.04
FS-37	Mar 81	6.8	-	4.69	14.57	N.D.	4.67	11.38	20.13	0.051	6.97	N.D.	11.04
FS-52	Aug 80	6.5	580.17	5.01	25.35	5.09	14.82	0.02	22.04	0.121	8.86	N.D.	N.D.
FS-52	Apr 81	-	407.43	3.59	14.11	9.64	13.24	0.06	19.25	0.137	19.35	1.88	N.D.
FS-74	Sep 80	6.9	469.22	8.50	20.05	3.59	18.59	1.16	22.96	0.196	N.D.	1.00	10.97
FS-74	Dec 80	6.8	-	18.52	9.59	3.59	17.58	0.54	52.91	0.100	12.46	N.D.	14.48
FS-74	Mar 81	6.8	391.82	14.08	6.42	10.32	16.72	1.14	N.D.	0.107	11.61	N.D.	11.04
FS-34		12.0	1625.60	13.60	11.65	8.31	48.51	5.87	527.73	0.268	34.18	22.98	40.55
FS-34		12.0	1407.49	23.46	6.68	7.19	45.30	0.83	534.09	0.032	36.54	3.04	54.10

Table continued

Location	Date	pH	T.D.S. p.p.m.	Cu p.p.b.	Mn p.p.b.	Cr p.p.b.	Ni p.p.b.	Zn p.p.m.	Pb p.p.b.	Fe p.p.m.	Co p.p.b.	Cd p.p.b.	Mo p.p.b.
FS-4	Aug 80	6.8	458.60	6.17	15.62	5.16	19.31	1.72	N.D.	0.199	13.29	2.44	36.00
FS-4	Mar 81	6.8	359.48	1.63	7.21	32.44	23.36	0.88	36.24	0.331	17.81	7.88	12.50
FS-17		6.8	603.70	6.60	34.25	5.85	17.31	4.31	14.47	0.529	5.91	2.73	N.D.
NRA-B		11.5	-	9.75	30.61	71.27	28.09	0.05	37.17	1.054	13.45	2.42	14.90
$NRA-A_2$		8.5	438.27	11.73	21.40	6.87	22.25	3.00	171.65	0.206	9.91	N.D.	N.D.
FS-26		7.5	489.29	16.27	87.95	7.95	22.61	6.06	162.91	0.613	N.D.	0.97	11.59
FS-25		9.5	-	20.27	9.75	9.76	25.17	1.00	59.04	0.261	N.D.	1.94	18.21
FS-10		6.8	-	10.40	7.04	7.59	18.61	4.04	44.83	0.610	10.62	2.26	14.07
FS-63		12.0	387.10	16.53	41.45	2.12	19.33	7.05	281.25	0.420	11.15	1.77	23.17
FS-62		7.0	347.08	13.60	5.96	1.45	16.78	3.80	43.98	0.233	N.D.	N.D.	10.76
FS-21		7.5	432.71	16.00	14.36	3.25	15.68	15.28	227.05	2.636	N.D.	3.22	N.D.
FS-18		7.1	238.81	21.07	17.92	4.80	29.07	6.15	150.34	0.527	N.D.	3.46	8.28
NRA-Saham Exp.		6.8	372.77	48.53	5.40	2.40	17.24	0.01	18.41	0.151	N.D.	N.D.	N.D.
FS-22		7.4	-	41.72	23.61	7.20	30.42	10.51	169.64	0.338	26.01	2.42	48.00
FS-32		8.2	281.45	21.48	6.97	4.67	24.00	2.55	125.79	0.160	N.D.	N.D.	10.67
$NRA-A_1$		6.8	-	25.34	32.24	8.68	21.89	15.82	557.60	1.034	4.96	5.33	N.D.

N.D. = not detected

Table: Chemical Composition of the Bituminous Marl Formation
Compare columnar section of the area

Sample Number		HV-5A	HV-5A	HV-5A	HV-5A	HV-5A	HV-5A	FS-71	FS-71	S-41	S-70
Date		31/8/77	3/8/80	12/3/81	22/4/81	25/5/81	23/6/81	10/9/80	22/4/81	20/9/80	24/9/80
Source Type		Borehole	Borehole	Borehole	Borehole	Borehole	Borehole				
Temperature °C		-	26.0	-	-	-	-	28.5	-	28.0	25.0
pH		8.02	6.5	6.8	6.8	6.9	6.8	7.2	-	8.5	6.9
Ca^{++}	mg/l	83.97	86.17	82.16	88.17	84.17	88.18	20.04	14.03	26.05	122.24
	m eq/l	4.19	4.30	4.10	4.40	4.20	4.40	1.00	0.70	1.30	3.90
	m eq%	49.53	40.76	40.84	42.59	41.58	43.96	14.93	11.82	26.59	36.93
Mg^{++}	mg/l	17.88	35.26	36.48	36.48	36.48	34.05	14.59	7.30	9.73	31.62
	m eq/l	1.47	3.30	3.00	3.00	3.00	2.80	1.20	0.60	0.80	1.80
	m eq%	17.38	31.28	29.88	29.04	29.70	27.97	17.91	16.14	16.36	17.05
Na^{+}	mg/l	62.07	64.37	64.37	64.37	63.77	61.55	93.34	94.26	57.48	108.28
	m eq/l	2.07	2.80	2.80	2.80	2.77	2.68	4.06	4.10	2.50	4.71
	m eq%	31.48	26.54	27.89	27.11	27.43	26.77	60.60	69.26	51.13	44.60
K^{+}	mg/l	4.69	5.87	5.47	5.08	5.11	4.85	17.20	20.33	11.34	5.81
	m eq/l	0.12	0.15	0.14	0.13	0.13	0.13	0.44	0.52	0.29	0.15
	m eq%	1.27	1.42	1.39	1.26	1.29	1.30	5.57	8.78	5.93	1.42
Total cations (m eq/l)		8.48	10.55	10.04	10.33	10.10	10.01	6.70	5.92	4.89	10.56

Table continued

Sample Number		HV-5A	HV-5A	HV-5A	HV-5A	HV-5A	HV-5A	FS-71	FS-71	S-41	S-70
	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	12.00	18.07	12.00	0.00
CO_3^{--}	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.60	0.40	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	5.95	9.67	8.49	0.00
	mg/l	383.85	475.96	421.04	445.45	427.14	433.24	48.82	0.00	61.02	231.88
HCO_3^-	m eq/l	6.19	7.80	6.90	7.30	7.00	7.10	0.80	0.00	1.00	3.80
	m eq%	64.75	68.78	65.28	69.92	68.16	68.01	11.91	0.00	21.23	33.51
	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OH^-	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	mg/l	75.18	84.54	83.17	77.23	82.18	84.16	105.16	105.94	67.02	103.10
Cl^-	m eq/l	2.12	2.38	2.35	2.18	2.32	2.37	2.97	2.99	1.89	2.91
	m eq%	22.18	20.99	22.23	20.88	22.59	22.70	44.20	47.69	40.13	25.66
	mg/l	2.86	0.96	1.40	1.20	0.85	1.24	3.31	1.55	2.96	3.38
NO_3^-	m eq/l	0.05	0.02	0.02	0.02	0.01	0.02	0.05	0.03	0.05	0.06
	m eq%	0.52	0.18	0.19	0.19	0.10	0.19	0.74	0.48	1.66	0.59
	mg/l	57.64	54.76	53.63	45.32	44.94	45.54	120.08	127.26	66.00	219.50
SO_4^{--}	m eq/l	1.20	1.14	1.12	0.94	0.94	0.95	2.50	2.65	1.37	4.57
	m eq%	12.55	10.05	10.60	9.00	9.15	9.10	37.20	42.27	29.09	40.30
Total anions (m eq/l)		9.86	11.34	10.57	10.44	10.27	10.44	6.72	6.27	4.71	11.34
T.D.S.(mg/l)		576.00	569.91	532.20	540.58	531.07	536.19	410.13	388.68	283.09	709.87

Table continued

Sample Number		BV-4	S-18	HV-10	HV-10	HV-10	HV-8	HV-8	HV-8	HV-2	HV-2
Date		25/9/80	10/9/80	19/5/78	3/8/80	3/6/81	24/9/80	12/3/81	12/3/81	3/8/80	12/3/81
Source Type				Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole
Temperature °C		26.0	28.0	-	29.0	-	27.5	-	-	24.5	-
pH		8.5	7.0	7.25	6.5	6.8	6.9	6.8	6.8	6.8	6.8
Ca^{++}	mg/l	18.04	14.03	72.34	78.15	74.80	100.20	88.18	98.20	76.15	66.13
	m eq/l	0.90	0.70	3.64	3.90	3.70	5.00	4.40	4.80	3.30	3.30
	m eq%	25.35	13.59	47.82	50.98	49.87	49.70	43.56	47.81	49.16	44.24
Mg^{++}	mg/l	8.51	13.38	24.20	24.32	25.54	30.40	35.26	34.05	27.97	29.18
	m eq/l	0.70	1.10	1.99	2.00	2.10	2.50	2.90	2.80	2.30	2.40
	m eq%	19.72	21.36	26.36	26.14	28.30	24.85	28.71	27.80	29.75	32.17
Na^{+}	mg/l	38.62	71.27	41.38	36.78	34.72	53.89	63.54	52.88	34.43	36.78
	m eq/l	1.68	3.10	1.80	1.60	1.51	2.34	2.76	2.30	1.50	1.60
	m eq%	47.32	60.19	23.84	20.92	20.35	23.26	27.33	22.91	19.41	21.45
K^{+}	mg/l	10.56	9.78	5.87	5.87	4.30	8.41	1.56	5.47	5.19	6.26
	m eq/l	0.27	0.25	0.15	0.15	0.11	0.22	0.04	0.14	0.13	0.16
	m eq%	7.61	4.85	1.99	1.96	1.48	2.19	0.40	1.39	1.68	2.15
Total cations (m eq/l)		3.55	5.15	7.55	7.65	7.42	10.06	10.10	10.04	7.73	7.46

Table continued

Sample Number		BV-4	S-18	HV-10	HV-10	HV-10	HV-8	HV-8	HV-8	HV-2	HV-2
	mg/l	30.01	12.00	0.00	0.00	0.00	0.00	0.00	0.00	24.01	0.00
CO_3^{--}	m eq/l	1.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.00
	m eq%	29.67	8.25	0.00	0.00	0.00	0.00	0.00	0.00	10.97	0.00
	mg/l	36.61	36.61	321.83	341.71	303.90	262.39	292.90	280.69	280.69	305.10
HCO_3^-	m eq/l	0.60	0.60	5.19	5.60	4.90	4.30	4.80	4.60	3.60	5.00
	m eq%	17.80	12.42	68.29	68.54	66.13	44.75	51.01	48.68	49.38	69.25
	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OH^-	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	mg/l	57.74	89.70	51.06	50.52	47.53	98.98	83.51	86.14	45.36	48.52
Cl^-	m eq/l	1.58	2.53	1.44	1.42	1.34	2.79	2.36	2.44	1.28	1.73
	m eq%	46.88	52.38	18.95	17.38	18.08	29.03	25.08	25.82	17.56	
	mg/l	3.38	2.53	2.17	0.29	0.00	1.42	1.05	1.00	0.71	0.95
NO_3^-	m eq/l	0.06	0.04	0.04	0.00	0.00	0.02	0.02	0.02	0.01	0.02
	m eq%	1.78	0.83	0.53	0.00	0.00	0.21	0.21	0.21	0.14	0.28
	mg/l	6.24	60.60	44.67	55.23	56.20	120.00	106.43	114.62	28.57	39.90
SO_4^{--}	m eq/l	0.13	1.26	0.93	1.15	1.17	2.50	2.23	2.39	0.60	0.83
	m eq%	3.86	26.09	12.24	14.08	15.79	26.02	23.70	25.29	8.23	11.50
Total anions (m eq/l)		3.37	4.83	7.60	8.17	7.41	9.61	9.41	9.45	7.29	7.22

Table continued

Sample Number		S-29	HV-7	FS-26	AV-2	AV-2	AV-2	AV-2	AV-1	AV-1	BV-2
Date		4/8/80	4/8/80		23/8/80	12/3/81	25/5/81	23/6/81	25/5/81	23/6/81	31/8/77
Source Type		Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole
Temperature °C		26.0	29.5	-	28.0	-	-	-	-	-	-
pH		6.8	6.8	-	6.8	6.8	6.9	6.8	7.4	6.8	7.3
Ca^{++}	mg/l	104.21	68.14	68.14	84.17	84.17	78.16	82.16	70.14	70.14	80.16
	m eq/l	5.20	3.40	3.40	4.20	4.20	3.90	4.10	3.50	3.50	4.00
	m eq%	58.56	46.26	41.87	44.21	51.41	52.56	51.57	45.81	54.26	53.41
Mg^{++}	mg/l	8.51	25.54	6.08	25.54	30.40	23.47	27.97	29.18	17.02	23.10
	m eq/l	0.70	2.10	0.50	2.10	2.50	1.93	2.30	2.40	1.40	1.90
	m eq%	7.88	28.57	6.16	22.11	30.60	26.01	28.93	31.41	21.71	25.37
Na^{+}	mg/l	64.37	39.08	101.16	68.97	29.89	32.13	31.14	37.08	32.63	34.49
	m eq/l	2.80	1.70	4.04	3.00	1.30	1.40	1.36	1.61	1.42	1.50
	m eq%	31.53	23.13	49.75	31.58	15.91	18.87	17.11	21.07	22.01	20.03
K^{+}	mg/l	7.04	5.87	7.04	7.82	6.65	7.40	7.41	5.11	4.85	5.45
	m eq/l	0.18	0.15	0.18	0.20	0.17	0.19	0.19	0.13	0.13	0.14
	m eq%	2.03	2.04	0.22	2.11	2.08	2.56	2.39	1.70	4.65	1.34
Total cations (m eq/l)		8.88	7.35	8.12	9.50	8.17	7.42	7.95	7.64	6.45	7.49

Table continued

Sample Number		S-29	HV-7	FS-26	AV-2	AV-2	AV-2	AV-2	AV-1	AV-1	BV-2
	mg/l	0.00	0.00	24.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO_3^{--}	m eq/l	0.00	0.00	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	10.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	mg/l	353.92	341.71	42.71	378.32	317.30	311.20	317.30	311.20	274.59	321.21
HCO_3^-	m eq/l	5.80	5.60	0.70	6.20	5.20	5.10	5.20	5.10	4.50	5.18
	m eq%	61.44	72.26	9.00	67.39	66.67	68.64	65.16	67.11	70.31	69.34
	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OH^-	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	mg/l	46.40	41.24	113.41	43.30	44.56	46.54	43.56	45.55	47.53	45.39
Cl^-	m eq/l	1.31	1.16	3.20	1.22	1.26	1.31	1.23	1.29	1.35	1.22
	m eq%	13.88	14.97	41.18	13.26	16.15	17.63	15.41	16.97	21.09	17.14
	mg/l	0.55	0.60	3.52	1.57	2.45	1.46	1.86	0.00	0.00	0.00
NO_3^-	m eq/l	0.00	0.00	0.06	0.03	0.04	0.02	0.03	0.00	0.00	0.00
	m eq%	0.00	0.00	0.77	0.33	0.51	0.27	0.38	0.00	0.00	0.00
	mg/l	111.91	47.62	144.57	84.13	63.45	68.70	73.21	58.23	41.07	48.51
SO_4^{--}	m eq/l	2.33	0.99	3.01	***		copy unreadable			***	1.01
	m eq%	24.68	12.77	38.74	***		copy unreadable			***	13.52
Total anions (m eq/l)		9.44	7.75	7.77	9.20	7.82	7.43	7.98	7.60	6.40	7.47
T.D.S.(mg/l)		*** copy cut off ***			504.66	420.22	413.46	425.96	379.89	350.54	* cut *

Table continued

Sample Number		BV-2	BV-2	BV-2	BV-2
Date		3/8/80	12/3/80	22/3/81	25/5/81
Source Type		Borehole	Borehole	Borehole	Borehole
Temperature °C		28.2	-	-	-
pH		6.5	6.8	6.8	6.8
Ca^{++}	mg/l	102.20	86.17	84.17	102.20
	m eq/l	5.10	4.30	4.20	5.10
	m eq%	56.67	56.21	54.40	67.55
Mg^{++}	mg/l	24.32	23.10	26.75	12.16
	m eq/l	2.00	1.90	2.20	1.00
	m eq%	22.22	24.84	28.50	13.25
Na^{+}	mg/l	39.08	29.94	27.59	29.66
	m eq/l	1.70	1.30	1.20	1.29
	m eq%	18.89	16.99	15.54	17.09
K^{+}	mg/l	7.82	14.35	4.69	6.13
	m eq/l	0.20	0.15	0.12	0.16
	m eq%	2.22	1.96	1.55	2.12
Total cations (m eq/l)		9.00	7.65	7.72	7.55

Table continued

Sample Number		BV-2	BV-2	BV-2	BV-2
CO_3^{--}	mg/l	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00
HCO_3^-	mg/l	366.12	311.20	317.30	392.51
	m eq/l	6.00	5.10	5.20	5.40
	m eq%	69.61	70.25	68.06	69.23
OH^-	mg/l	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00
Cl^-	mg/l	44.33	43.56	40.59	41.58
	m eq/l	1.25	1.23	1.15	1.17
	m eq%	14.50	16.94	15.05	15.00
NO_3^-	mg/l	1.03	1.45	0.32	0.00
	m eq/l	0.02	0.02	0.00	0.00
	m eq%	0.23	0.28	0.00	0.00
SO_4^{--}	mg/l	64.29	43.73	61.44	58.93
	m eq/l	1.34	0.91	1.29	1.23
	m eq%	15.55	12.53	16.88	15.77
Total anions (m eq/l)		8.62	7.62	7.64	7.80
T.D.S.(mg/l)		***	copy cut off		***

Table: Trace Metal Composition of the Bituminous Marl Formation

Location	Date	pH	T.D.S. p.p.m.	Cu p.p.b.	Mn p.p.b.	Cr p.p.b.	Ni p.p.b.	Zn p.p.m.	Pb p.p.b.	Fe p.p.m.	Co p.p.b.	Cd p.p.b.	Mo p.p.b.
HV-5A	Aug 77	-	576.0	-	-	-	-	-	-	-	-	-	-
HV-5A	Aug 80	6.5	570.0	6.81	41.37	8.25	17.98	0.04	20.67	0.360	5.91	2.89	25.38
HV-5A	Nov 80	6.8	-	1.98	40.93	4.31	18.24	0.01	15.95	0.065	10.80	1.39	N.D.
HV-5A	Mar 81	6.8	537.0	4.29	40.11	N.D.	9.77	0.03	9.63	0.907	20.13	1.23	15.46
HV-5A	Apr 81	6.8	540.0	4.59	27.42	3.34	8.54	0.03	14.97	0.304	18.58	2.13	N.D.
HV-5A	May 81	6.9	531.0	4.22	43.48	39.04	11.53	0.02	13.61	0.347	16.36	2.64	11.05
HV-5A	Jun 81	6.8	536.0	3.85	46.93	11.79	12.38	0.01	20.42	0.187	15.58	3.13	N.D.
AV-2	Aug 80	6.8	505.0	4.47	36.44	4.13	22.64	0.09	17.57	0.446	88.12	2.27	28.85
AV-2	Mar 81	6.8	420.0	5.18	26.94	4.45	19.64	0.10	11.77	0.350	21.08	1.88	9.57
AV-2	May 81	6.9	413.0	2.75	18.98	7.73	14.95	0.18	22.39	0.607	19.48	1.96	17.37
AV-2	Jun 81	6.8	426.0	5.51	10.52	9.21	19.64	0.27	13.60	0.263	19.25	2.64	N.D.
BV-2	Aug 80	6.5	466.0	8.51	14.80	5.85	3.33	0.04	17.57	0.249	7.39	2.19	27.69
BV-2	Mar 81	6.8	398.0	1.63	1.25	N.D.	12.32	0.02	N.D.	0.042	13.94	N.D.	16.93
BV-2	Apr 81	6.8	407.0	4.98	13.95	N.D.	21.78	0.03	14.97	0.153	13.16	1.96	9.57
BV-2	May 81	7.2	383.0	N.D.	9.83	6.63	6.41	0.02	19.03	0.404	16.36	2.70	15.00
BV-2	Jun 81	6.8	447.0	3.12	34.33	11.79	7.69	0.01	N.D.	0.355	16.36	2.23	N.D.
HV-10	Aug 80	6.5	421.3	9.36	14.52	3.10	16.32	0.04	16.53	0.120	N.D.	1.02	17.21
HV-10	Jan 81	6.8	394.0	3.49	13.11	12.52	13.67	0.01	22.63	0.131	20.26	2.89	13.42
HV-8	Sep 80	6.8	545.0	7.47	48.81	7.19	24.68	11.76	86.35	0.505	N.D.	1.59	13.71
HV-8	Jan 81	6.8	526.0	2.44	18.96	N.D.	12.38	0.59	19.13	0.329	40.69	2.35	19.88
HV-8	Mar 81	6.8	533.0	3.47	6.27	10.32	21.24	0.11	N.D.	0.129	19.36	1.43	15.46
AV-1	May 81	7.4	381.0	2.75	28.64	19.52	15.37	3.16	31.35	0.857	11.69	1.39	N.D.
AV-1	Jun 81	6.8	394.0	4.40	24.84	9.21	18.54	1.80	N.D.	0.200	16.36	2.14	N.D.
HV-2	Aug 80	6.8	383.0	10.00	13.15	7.22	20.64	3.59	21.70	0.325	N.D.	3.90	N.D.
HV-2		6.8	380.0	6.78	49.70	8.15	8.54	0.73	13.90	0.183	12.39	0.98	10.31

Table continued

Location	Date	pH	T.D.S. p.p.m.	Cu p.p.b.	Mn p.p.b.	Cr p.p.b.	Ni p.p.b.	Zn p.p.m.	Pb p.p.b.	Fe p.p.m.	Co p.p.b.	Cd p.p.b.	Mo p.p.b.
S-29	Aug 80	6.8	520.0	5.32	11.51	2.75	13.65	1.41	14.03	0.088	8.86	1.46	N.D.
HV-7	Aug 80	6.8	394.0	5.53	30.14	2.06	11.99	0.24	N.D.	0.393	19.94	1.71	13.85
FS-47		6.8	-	48.27	74.49	17.71	69.67	19.05	84.19	0.227	31.15	5.09	62.07
FS-70		6.8	466.0	11.47	70.43	3.25	12.77	0.33	33.89	0.477	6.37	N.D.	N.D.
FS-26		7.4	489.0	16.27	87.95	7.95	22.61	6.60	162.91	0.613	N.D.	0.97	11.59
S-20		8.0	-	16.09	14.09	15.18	26.63	6.44	159.63	0.673	12.74	2.42	16.55
S-8		12.5	1009.9	19.57	13.65	12.69	37.52	4.21	102.18	0.623	23.78	4.35	135.00
S-26		7.0	1078.83	15.45	28.44	7.54	61.52	8.80	117.06	0.931	26.75	3.26	54.10
FS-71		7.2	410.13	26.27	36.68	5.49	20.96	15.32	136.86	1.876	N.D.	1.50	N.D.
S-18		7.0	291.57	12.10	14.22	10.63	12.17	-	39.68	0.593	N.D.	1.00	N.D.
S-41		8.5	283.09	15.19	16.49	2.74	10.17	6.87	101.19	0.423	N.D.	N.D.	N.D.
S-70		6.9	709.87	9.01	46.64	6.17	23.66	3.69	48.61	0.250	N.D.	1.51	24.30
AV-5		8.2	-	21.37	13.08	7.90	19.94	14.91	754.84	0.512	N.D.	1.51	N.D.
BV-4		8.5	224.97	24.98	24.70	8.62	13.18	14.60	1119.04	0.710	N.D.	1.22	6.10
BV-5		6.8	-	20.99	61.02	13.65	40.56	12.38	560.53	0.781	13.29	4.51	8.38
FS-5		8.5	-	15.80	21.50	6.83	27.38	17.96	1001.03	0.781	N.D.	2.52	41.11

N.D. = not detected