World Heritage Scanned Nomination

File Name: 1207.pdf **UNESCO Region:** Arab States

SITE NAME: ***Aflaj* Irrigation Systems of Oman**

DATE OF INSCRIPTION: 16th July 2006

STATE PARTY: Oman

CRITERIA: C (v)

DECISION OF THE WORLD HERITAGE COMMITTEE:
Excerpt from the Decisions of the 29th Session of the World Heritage Committee

Criterion (v): The collection of Aflaj irrigation systems represents some 3,000 still functioning systems in Oman. Ancient engineering technologies demonstrate long standing, sustainable use of water resources for the cultivation of palms and other produce in extremely arid desert lands. Such systems reflect the former total dependence of communities on this irrigation and a time-honoured, fair and effective management and sharing of water resources, underpinned by mutual dependence and communal values.

BRIEF DESCRIPTIONS

The property includes five aflaj irrigation systems and represents some 3,000 such systems still in use in Oman. The origins of this system of irrigation may date back to 500 A.D., but archaeological evidence suggests that irrigation systems existed in this extremely arid area as early as 2,500 B.C. Aflaj, is the plural of falaj which, in classical Arabic means to divide into shares and equitable sharing of a scarce resource to ensure sustainability remains the hallmark of this irrigation system. Using gravity, water is channelled from underground sources or springs to support agriculture and domestic use, often over many kilometres. The fair and effective management and sharing of water in villages and towns is still underpinned by mutual dependence and communal values and guided by astronomical observations. Numerous watchtowers built to defend the water systems form part of the listed property reflecting the historic dependence of communities on the aflaj system. Other buildings listed in association with the aflaj are mosques, houses, sundials, and water auction buildings. Threatened by the lowering level of the underground water table, the aflaj represent an exceptionally well-preserved form of land use.

Les cinq systèmes d'irrigation inscrits représentent les quelques 3 000 systèmes d'irrigation encore en activité en Oman. La construction la plus ancienne pourrait remonter aux environs de 500 apr. J.C. mais des preuves archéologiques récentes suggèrent que les systèmes d'irrigation existaient dans la région dès 2 500 avant J.C. Aflaj est le pluriel de falaj qui signifie, en arabe classique, « diviser en parts ». Un partage équitable d'une ressource rare afin de garantir sa pérennité, tel est la marque de ce système d'irrigation qui conduit l'eau des sources souterraines, par gravité, sur des kilomètres pour alimenter l'agriculture et les peuplements permanents. La gestion et le partage équitable et efficace de l'eau dans les villages et les villes sont toujours sous-tendus par des notions de dépendance mutuelle et de collectivité, et guidés par des observations astronomiques. De nombreuses tours de guet construites pour défendre les systèmes d'adduction d'eau sont intégrées au site. Elles reflètent la dépendance des communautés aux aflaj. D'autres constructions sont associées au système : des mosquées, maisons, cadrans solaires, maisons de vente aux enchères de l'eau. Menacé par la baisse du niveau des eaux souterraines, l'aflaj représente une forme d'occupation des sols exceptionnellement bien conservée.

1.b State, Province or Region: Dakhiliya, Sharqiya and Batinah Regions

1.d Exact location:

Serial ID Number	Name	Locations	Coordinates
1207-001	Falaj Al-Katmeen	Nizwa, Dakhiliya, Oman	N22 56 15.5 E57 40 32.8
1207-002	Falaj Al-Malki	Izki, Interior, Oman	N22 44 22.3 E57 46 35.6
1207-003	Falaj Daris	Nizwa, Dakhiliya, Oman	N22 59 56.0 E57 32 09.8
1207-004	Falaj Al-Jeela	Sur, A'Sharqiya, Oman	N22 47 15.9 E59 10 26.1
1207-005	Falaj Al-Muyasser	Al Rustaq, Interior, Oman	N23 21 08.2 E57 27 57.6

Sultanate of Oman
Ministry of Regional Municipalities,
Environment & Water Resources
Directorate General of Water
Resources Affaies

The Aflaj irrigation system of Oman

Nomination to the UNESCO World Heritage List

Falaj Daris-Nizwa

The *aflaj* irrigation system of Oman

1. IDENTIFICATION OF THE PROPERTY

1.a State Party

The Sultanate of Oman

1.b State, Province or Region

	Name of property	*Region*	*Wilayat*
1.	Falaj Al-Khatmeen	Dakhiliya	Nizwa
2.	Falaj Al-Malki	Dakhiliya	Izki
3.	Falaj Daris	Dakhiliya	Nizwa
4.	Falaj Al-Jeela	Sharqiya	Sur
5.	Falaj Al-Muyassar	Batinah	Al Rustaq

1.c Name of Property

The *aflaj* irrigation system of Oman

1.d Geographical coordinates

The upstream part of the nominated property are linear features (in some cases branched) and they are almost entirely below ground. The UTM coordinates shown here refer to the starting and finishing points, the mother well and the *shari'a* respectively. The below-ground sections are delineated by a strip of *c* 250 m immediately overlying them.

The downstream part of the nominated property is the overall cultural system of the falaj consisting of the water distribution structures and traditional buildings (mosques, watchtowers, ancient houses, sundials, auction buildings etc...) which are a part of agricultural demand areas. The UTM coordinates refer to farthest northern, eastern, southern and western limits of the demand areas.

1. Falaj Al-Khatmeen *Mother well* *Shari'a*

569288 E, 2536777 N 568473 E, 2535269

Agricultural Demand area

Northern limit	*Eastern limit*	*Southern limit*	*Western limit*
569603 E,2535548 N	*570382 E,2535193 N*	*569253 E,2534433 N*	*568614 E, 2534936 N*

2. Falaj Al-Malki *Mother well* *Shari'a*

579736 E, 2514896 N 578197 E, 2537266 N

Agricultural Demand area

Northern limit	*Eastern limit*	*Southern limit*	*Western limit*
579110 E, 2537112 N	*578701 E, 2535951 N*	*577903 E, 2535036 N*	*577480 E, 2536203 N*

3. Falaj Daris *Mother well* *Shari'a*

554936 E, 2543496 N 556315 E, 2540635 N

Agricultural Demand area

Northern limit	*Eastern limit*	*Southern limit*	*Western limit*
556065 E,2539544 N	*555757 E,2538373 N*	*554698 E, 2536800 N*	*554066 E, 2538196 N*

4. Falaj Al-Jeela *Mother well* *Shari'a*

723172 E, 2521664 N 717900 E, 2521730 N

Agricultural Demand area

Northern limit	*Eastern limit*	*Southern limit*	*Western limit*
717905 E, 2521829 N	*718104 E, 2521751 N*	*717927 E, 2521721 E*	*717826 E, 2521792 N*

5. Falaj Al-Muyassar *Mother well* *Shari'a*

547631 E, 2582594 N 545097 E, 2586228 N

Agricultural Demand area

Northern limit	*Eastern limit*	*Southern limit*	*Western limit*
544265 E, 2587090 N	*545082 E, 2586240 N*	*543824 E,2585671 N*	*543272 E, 2586133 N*

1.e Maps and plans, showing the boundaries of the nominated property and buffer zone [see Annex A]

The topographical maps cover:

- The upstream part of the nominated property, the starting and finishing points, the *shari'a* respectively. The below-ground sections are delineated by a strip of *c* 250 m immediately overlying them. These are linear features (in some cases branched) and they are almost entirely below ground.

- The downstream part of the nominated property include the cultural system of the falaj such as watchtowers , mosques , old buildings, washing facilities, open irrigation structures and their associated structures, palm groves, sundials and auctions buildings which are an integrated part of the agricultural demand area.

1 Topographical map showing the location of the five nominated properties

2 Falaj Al-Khatmeen: topographical map showing :

a)- boundaries of upstream part of the nominated property and buffer zone

b)- major water structures and buildings proposed for the nomination.

3 Falaj Al-Khatmeen: *Aflaj* inventory record map

4 Falaj Al-Malki: topographical map showing:

a)- boundaries of upstream part of the nominated property and buffer zone.

b)- major water structures and buildings proposed for the nomination.

5 Falaj Al-Malki: *Aflaj* inventory record map.

6 Falaj Daris: topographical map showing:

a)- boundaries of upstream part of the nominated property and buffer zone.

b)- major water structures and buildings proposed for the nomination.

7 Falaj Daris: *Aflaj* inventory record map

8 Falaj Al-Jeela: topographical map showing:

a)- boundaries of upstream part of the nominated property and buffer zone

b)- major water structures and buildings proposed for the nomination.

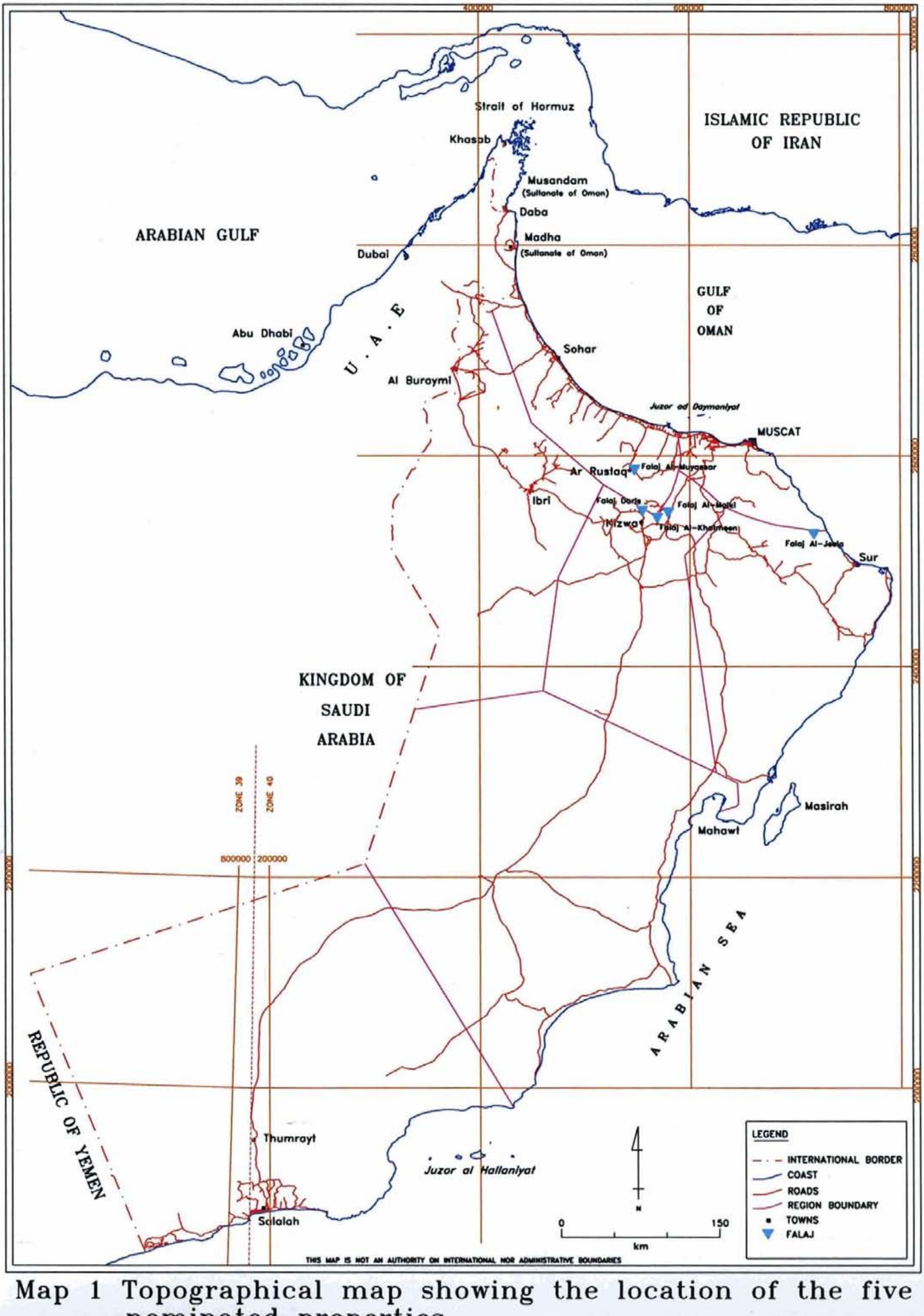
9 Falaj Al-Jeela: *Aflaj* inventory record map

10 Falaj Al-Muyassar: topographical map showing:

a)- boundaries of upstream part of the nominated property and buffer zone

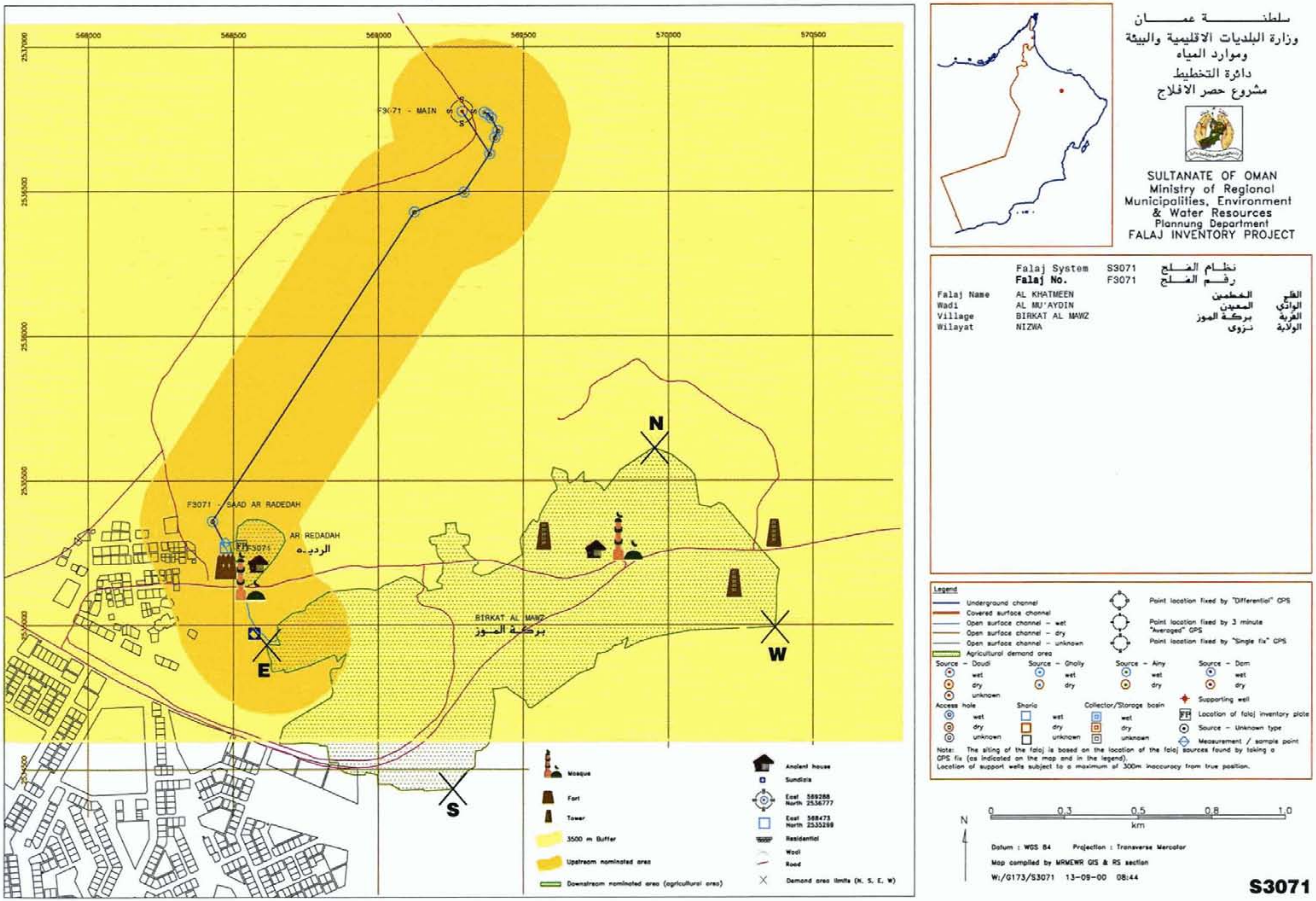
b)- major water structures and buildings proposed for the nomination

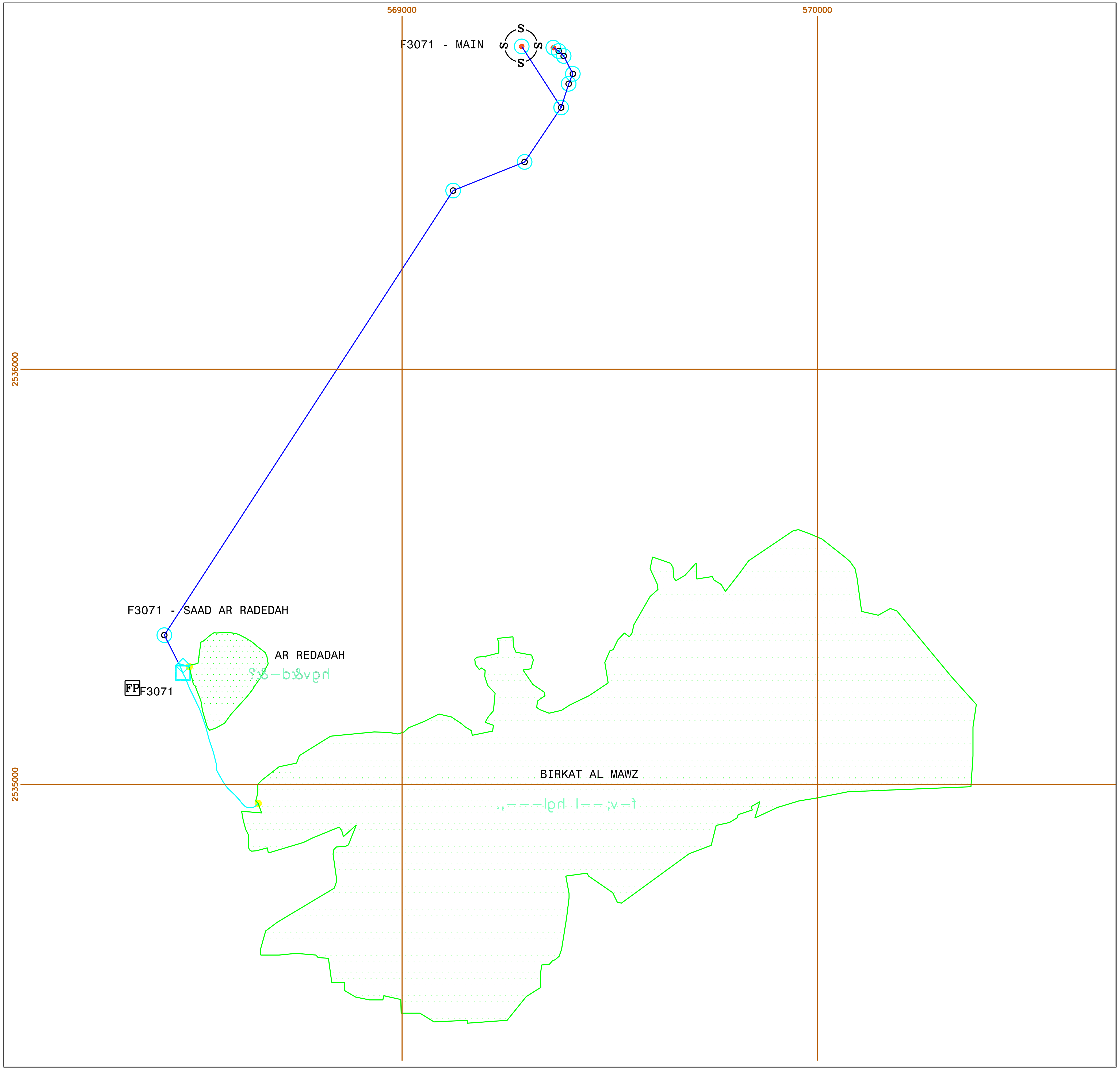
11 Falaj Al-Muyassar: *Aflaj* inventory record map

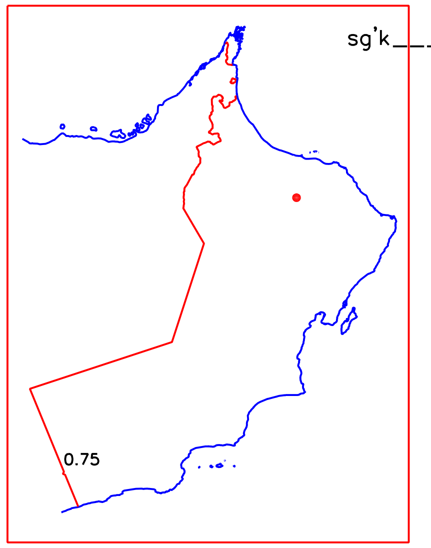


Map 1 Topographical map showing the location of the five nominated properties

Falaj Al-Khatmeen : Topographical map showing boundaries of nominated property and buffer zone







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SULTANATE OF OMAN
Ministry of Regional Municipalities, Environment & Water Resources
Plannung Department
FALAJ INVENTORY PROJECT

Falaj System	S3071	نظام الفلج
Falaj No.	F3071	رقم الفلج
Falaj Name	AL KHATMEEN	
Wadi	AL MU'AYDIN	
Village	BIRKAT AL MAWZ	
Wilayat	NIZWA	

Legend

- Underground channel
- Covered surface channel
- Open surface channel - wet
- Open surface channel - dry
- Open surface channel - unknown
- Agricultural demand area
- Point location fixed by "Differential" GPS
- Point location fixed by 3 minute "Averaged" GPS
- Point location fixed by "Single fix" GPS

Source - Daudi: wet, dry, unknown
Source - Ghaily: wet, dry
Source - Ainy: wet, dry
Source - Dam: wet, dry
Access hole: wet, dry, unknown
Sharia: wet, dry, unknown
Collector/Storage basin: wet, dry, unknown
Supporting well
Location of falaj inventory plate
Source - Unknown type
Measurement / sample point

Note: The siting of the falaj is based on the location of the falaj sources found by taking a GPS fix (as indicated on the map and in the legend).
Location of support wells subject to a maximum of 300m inaccuracy from true position.

N

0 0.25 0.50 0.75
km

Datum : WGS 84 Projection : Transverse Mercator

Map compiled by MRMEWR GIS & RS section

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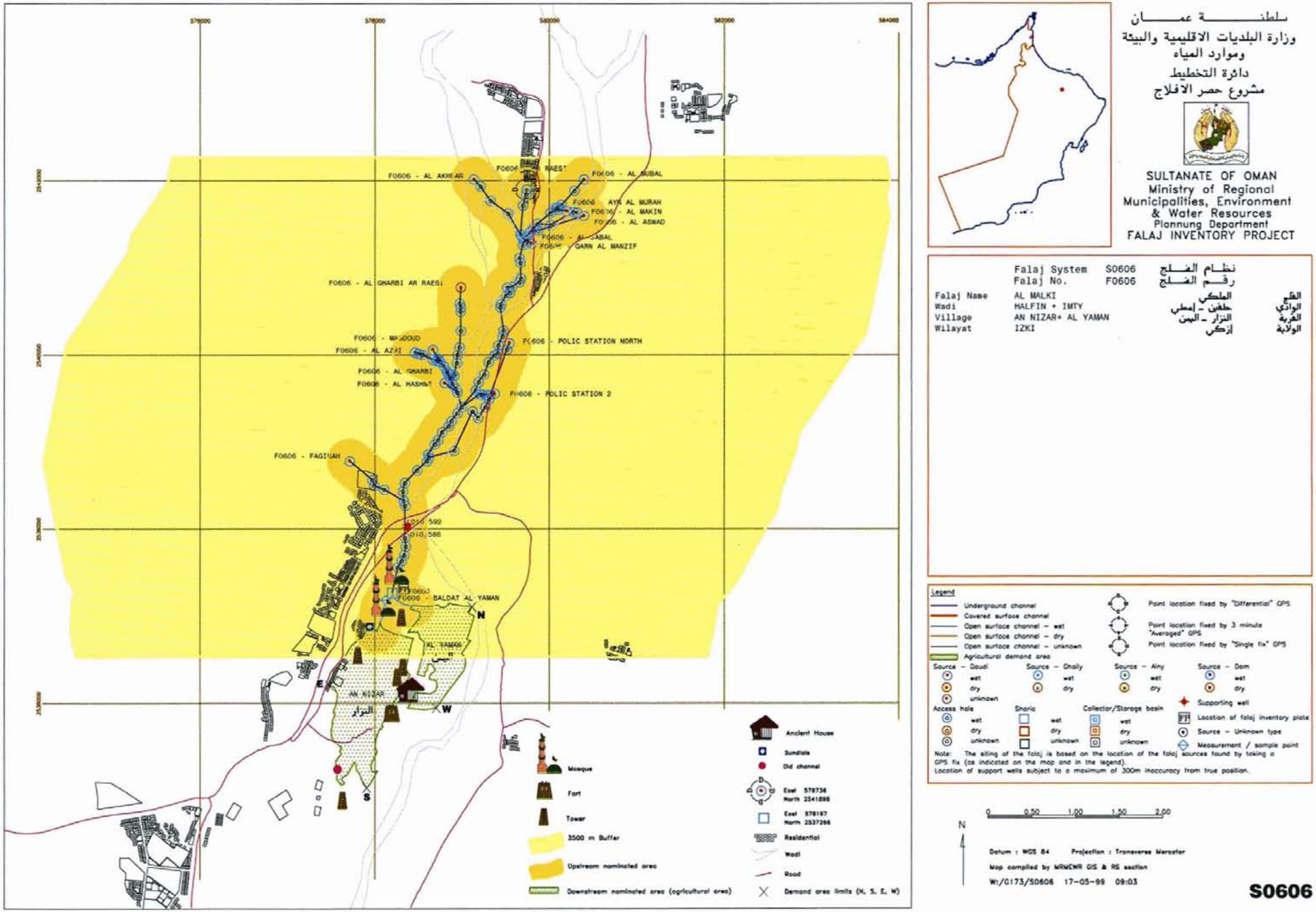
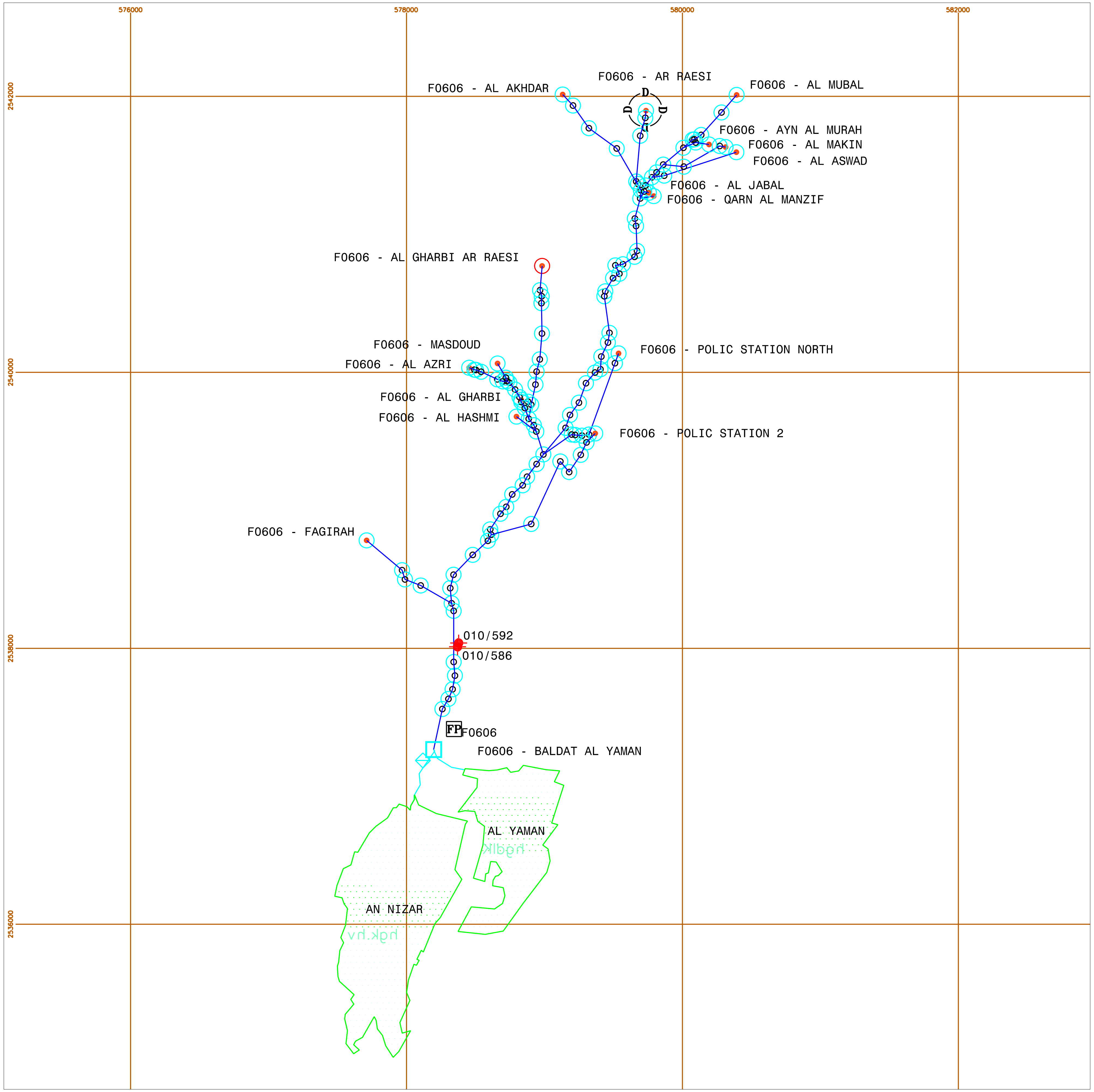
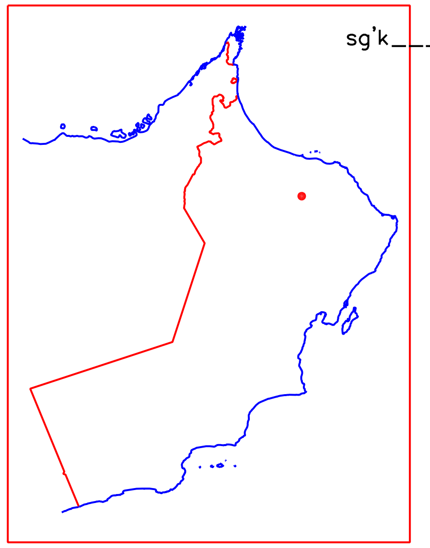
S3071



Falaj Al-Malki : Topographical map showing boundaries of nominated property and buffer zone





SULTANATE OF OMAN
Ministry of Regional Municipalities, Environment & Water Resources
Plannung Department
FALAJ INVENTORY PROJECT

	Falaj System	S0606	نظـام الفـلج
	Falaj No.	F0606	رقـم الفـلج
Falaj Name	AL MALKI		
Wadi	HALFIN + IMTY		
Village	AN NIZAR+ AL YAMAN		
Wilayat	IZKI		

Legend

- Underground channel
- Covered surface channel
- Open surface channel - wet
- Open surface channel - dry
- Open surface channel - unknown
- Agricultural demand area
- Point location fixed by "Differential" GPS
- Point location fixed by 3 minute "Averaged" GPS
- Point location fixed by "Single fix" GPS

Source - Daudi	Source - Ghaily	Source - Ainy	Source - Dam
wet	wet	wet	wet
dry	dry	dry	dry
unknown			

Access hole	Sharia	Collector/Storage basin
wet	wet	wet
dry	dry	dry
unknown	unknown	unknown

- Supporting well
- FP Location of falaj inventory plate
- Source - Unknown type
- Measurement / sample point

Note: The siting of the falaj is based on the location of the falaj sources found by taking a GPS fix (as indicated on the map and in the legend).
Location of support wells subject to a maximum of 300m inaccuracy from true position.

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Datum : WGS 84 Projection : Transverse Mercator

Map compiled by MRMEWR GIS & RS section

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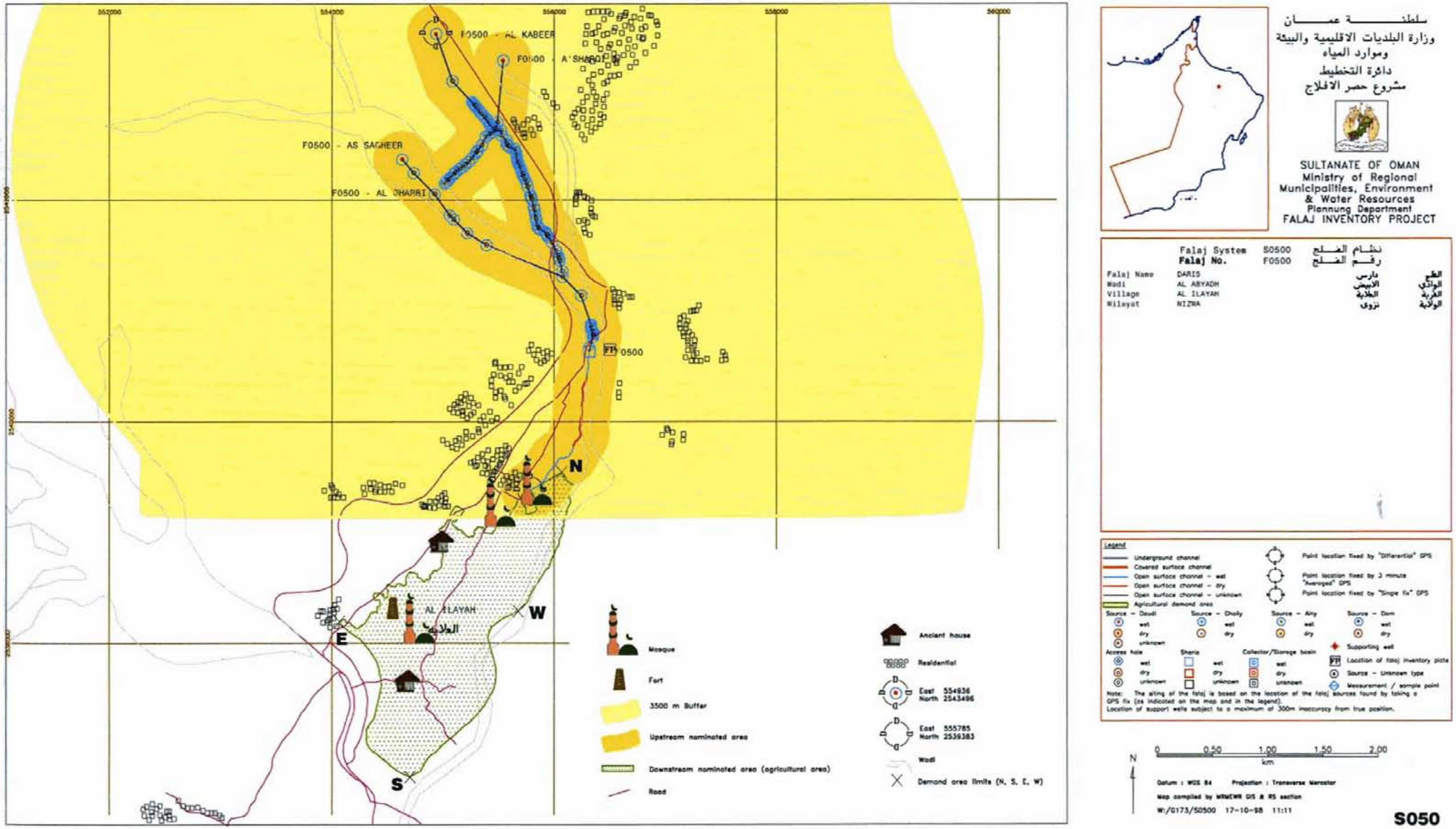
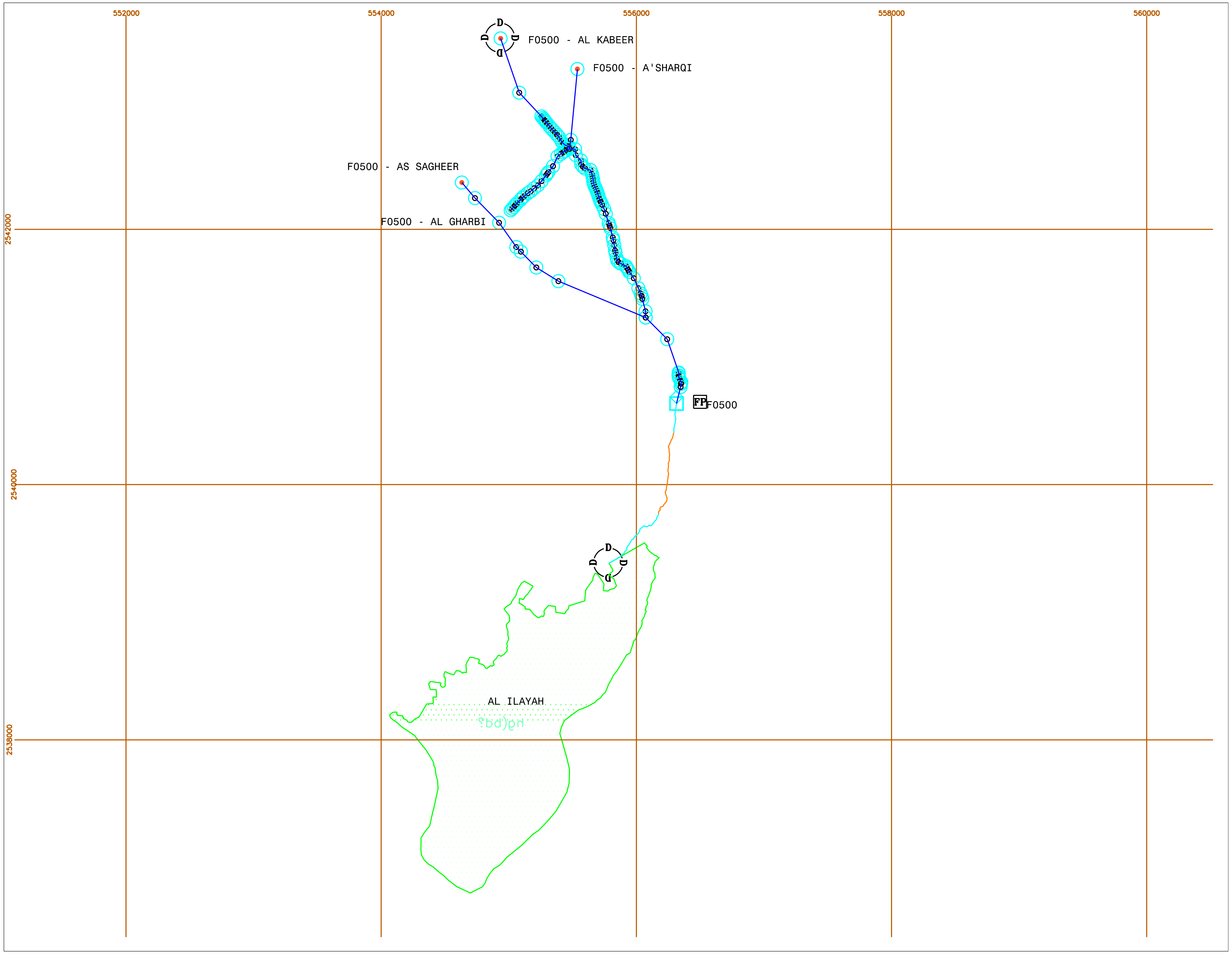
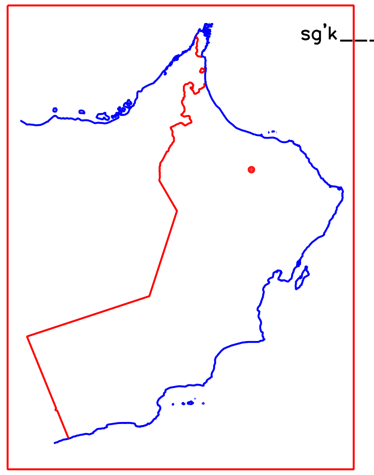
Falaj Daris : Topographical map showing boundaries of nominated property and buffer zone







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SULTANATE OF OMAN
Ministry of Regional Municipalities, Environment & Water Resources
Plannung Department
FALAJ INVENTORY PROJECT

Falaj System	S0500	نظام الفلج
Falaj No.	F0500	رقم الفلج

Falaj Name	DARIS	
Wadi	AL ABYADH	
Village	AL ILAYAH	
Wilayat	NIZWA	

Legend

- Underground channel
- Covered surface channel
- Open surface channel - wet
- Open surface channel - dry
- Open surface channel - unknown
- Agricultural demand area
- Point location fixed by "Differential" GPS
- Point location fixed by 3 minute "Averaged" GPS
- Point location fixed by "Single fix" GPS

Source - Daudi: wet, dry, unknown
Source - Ghaily: wet, dry
Source - Ainy: wet, dry
Source - Dam: wet, dry
Access hole: wet, dry, unknown
Sharia: wet, dry, unknown
Collector/Storage basin: wet, dry, unknown
Supporting well
Location of falaj inventory plate
Source - Unknown type
Measurement / sample point

Note: The siting of the falaj is based on the location of the falaj sources found by taking a GPS fix (as indicated on the map and in the legend). Location of support wells subject to a maximum of 300m inaccuracy from true position.

N
0 0.50 1.00 1.50 2.00
km

Datum : WGS 84 Projection : Transverse Mercator
Map compiled by MRMEWR GIS & RS section
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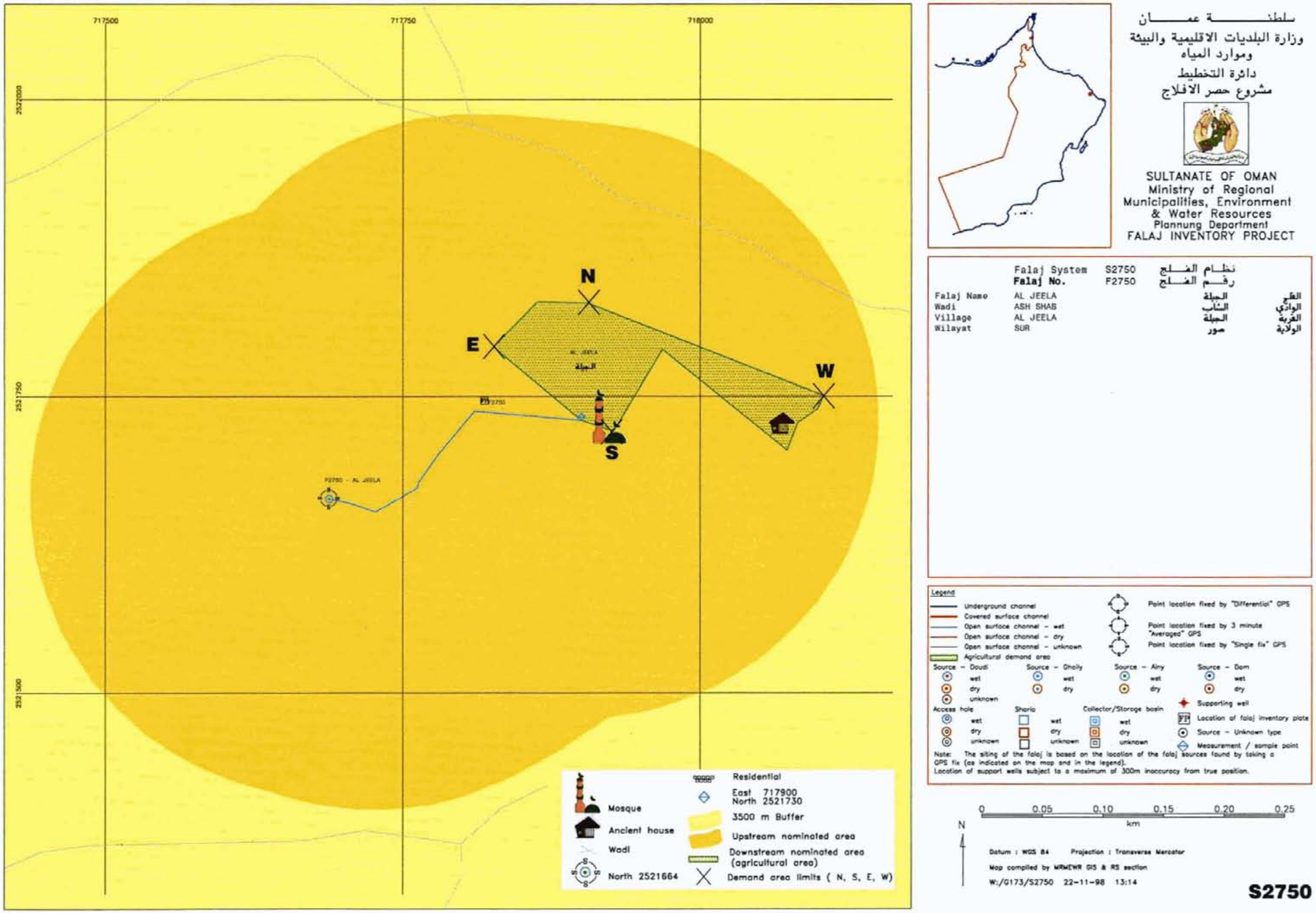
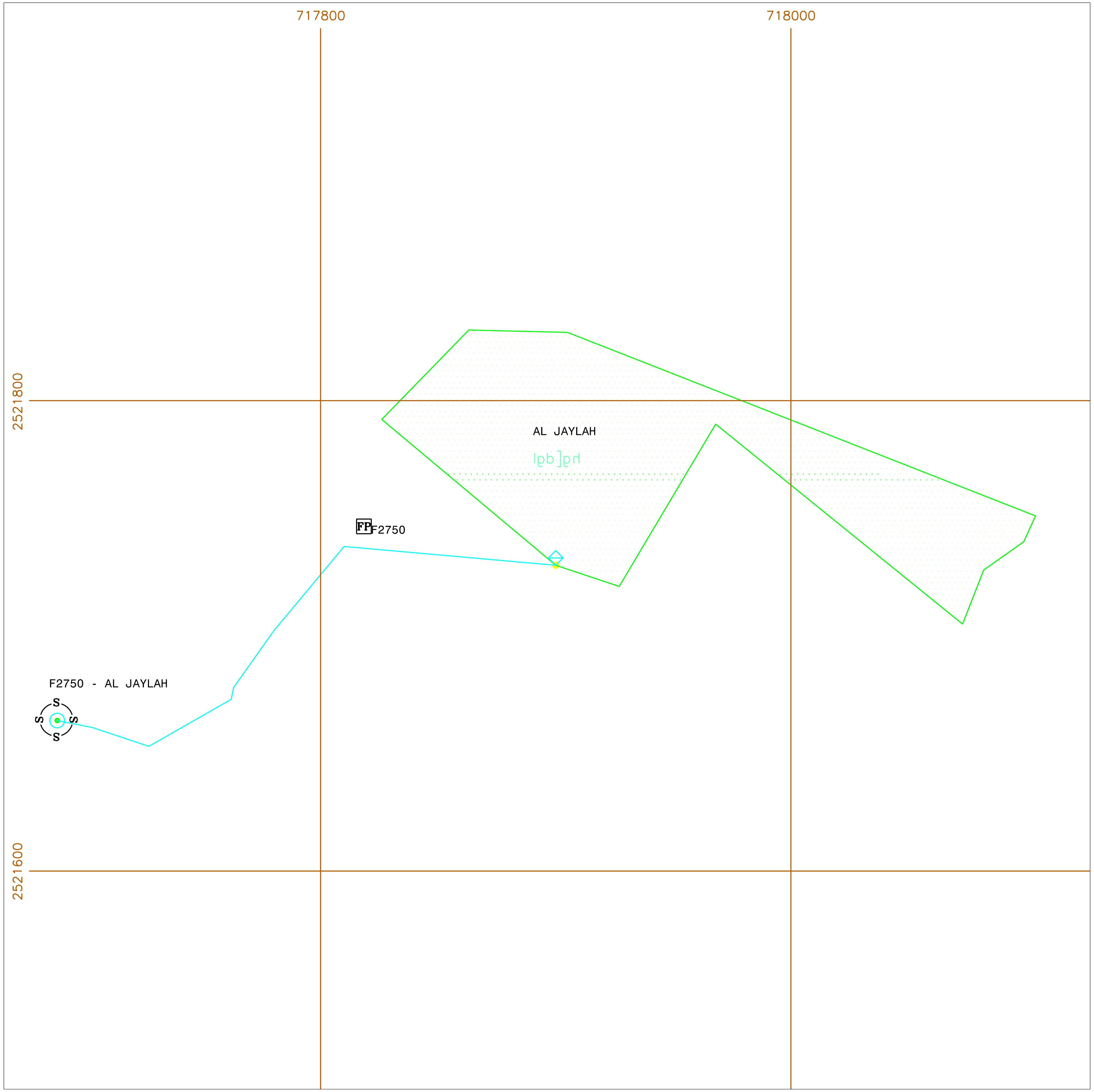
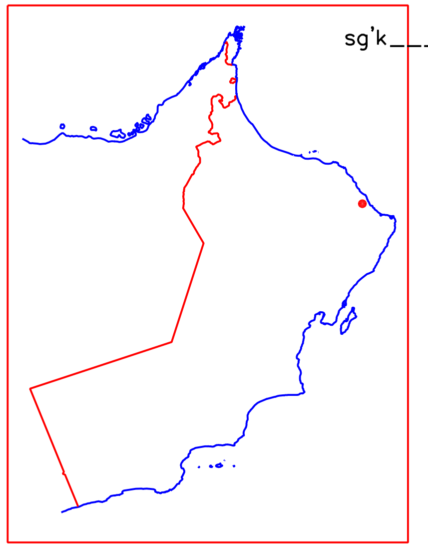
S0500

Falaj Al-Jeela : Topographical map showing boundaries of nominated property and buffer zone







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SULTANATE OF OMAN
Ministry of Regional
Municipalities, Environment
& Water Resources
Plannung Department
FALAJ INVENTORY PROJECT

	Falaj System	S2750	نظـــام الفــــلج	
	Falaj No.	F2750	رقــــم الفــــلج	
Falaj Name	AL JAYLAH		lpb]pd	}ptpd
Wadi	ASH SHAB		7doपd	"ऊd,pd
Village	AL JAYLAH		lpb]pd	lbvापd
Wilayat	SUR		v,w	lbd,pd

Legend

- Underground channel
- Covered surface channel
- Open surface channel - wet
- Open surface channel - dry
- Open surface channel - unknown
- Agricultural demand area

Point location fixed by "Differential" GPS

Point location fixed by 3 minute "Averaged" GPS

Point location fixed by "Single fix" GPS

Source - Daudi: wet, dry, unknown

Source - Ghaily: wet, dry

Source - Ainy: wet, dry

Source - Dam: wet, dry

Access hole: wet, dry, unknown

Sharia: wet, dry, unknown

Collector/Storage basin: wet, dry, unknown

Supporting well

FP Location of falaj inventory plate

Source - Unknown type

Measurement / sample point

Note: The siting of the falaj is based on the location of the falaj sources found by taking a GPS fix (as indicated on the map and in the legend).
Location of support wells subject to a maximum of 300m inaccuracy from true position.

0 0.050 0.100 0.150
km

N

Datum : WGS 84 Projection : Transverse Mercator

Map compiled by MRMEWR GIS & RS section

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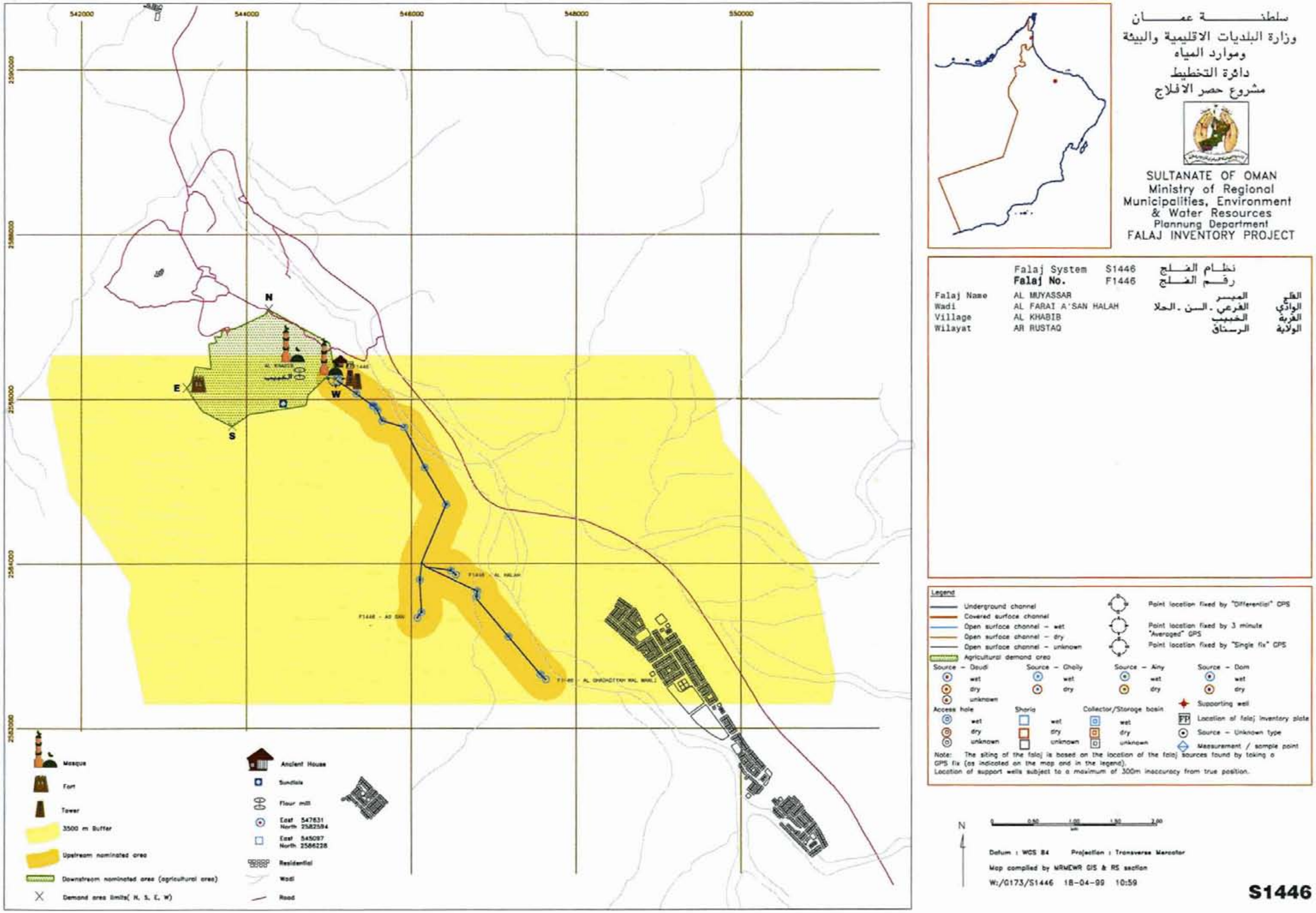
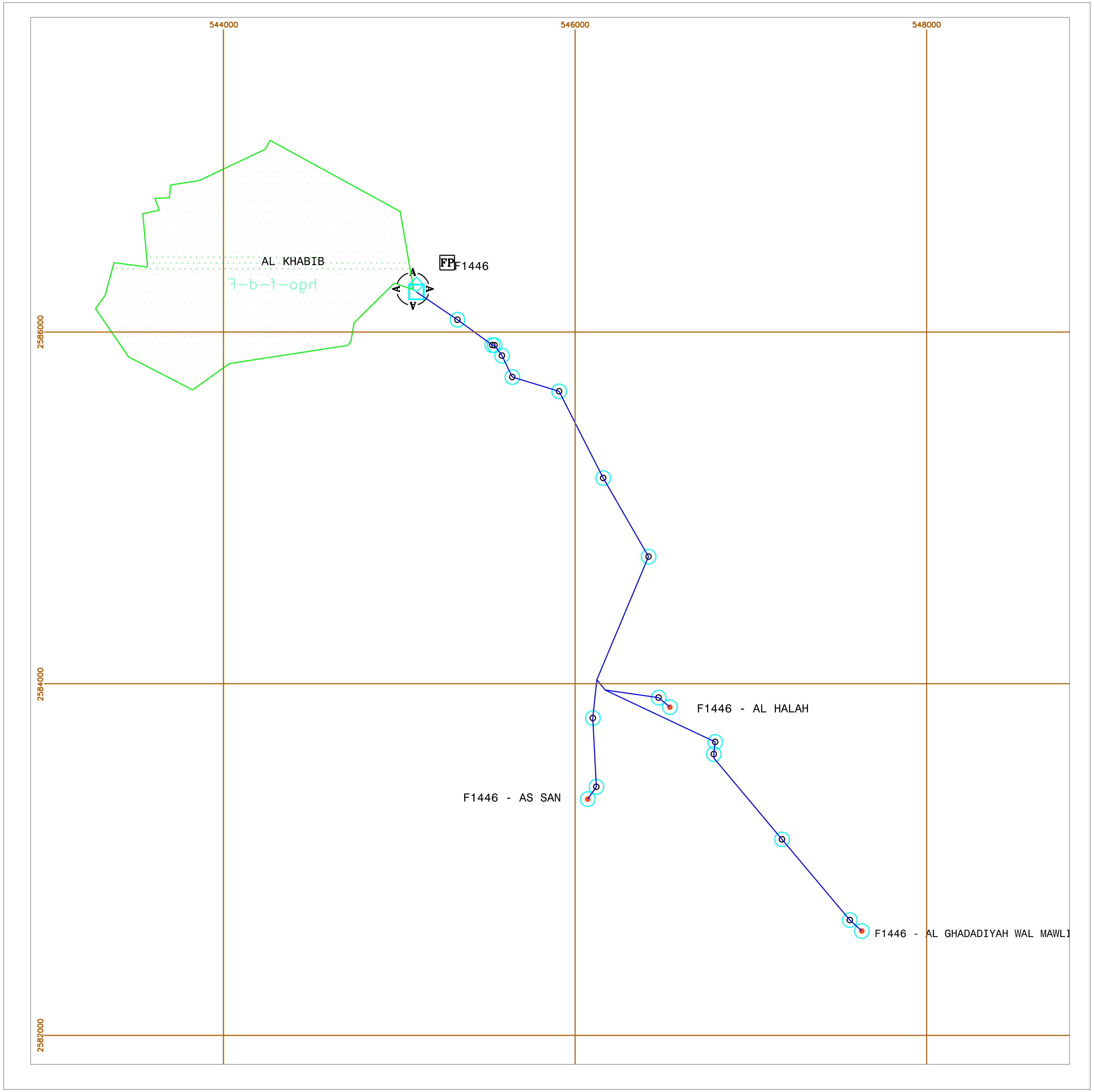
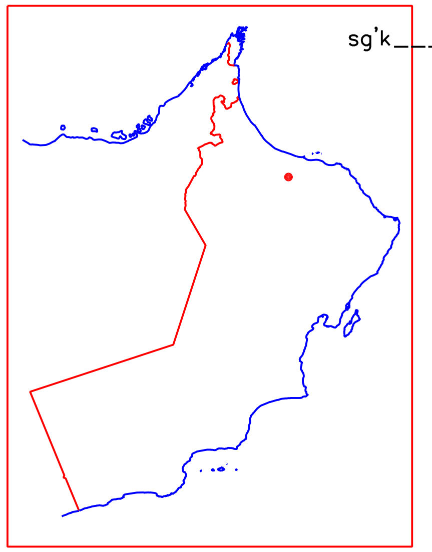
Falaj Al-Muyassar : Topographical map showing boundaries of nominated property and buffer zone







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SULTANATE OF OMAN
Ministry of Regional
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& Water Resources
Plannung Department
FALAJ INVENTORY PROJECT

Falaj System S1446 نظام الفلج
Falaj No. F1446 رقم الفلج

Falaj Name	AL MAYASSAR	
Wadi	AL FARAI A'SAN HALAH	
Village	AL KHABIB	
Wilayat	AR RUSTAQ	

Legend

- Underground channel
- Covered surface channel
- Open surface channel - wet
- Open surface channel - dry
- Open surface channel - unknown
- Agricultural demand area
- Point location fixed by "Differential" GPS
- Point location fixed by 3 minute "Averaged" GPS
- Point location fixed by "Single fix" GPS
- Source - Doudi: wet, dry, unknown
- Source - Ghaily: wet, dry
- Source - Ainy: wet, dry
- Source - Dam: wet, dry
- Supporting well
- Access hole: wet, dry, unknown
- Sharia: wet, dry, unknown
- Collector/Storage basin: wet, dry, unknown
- Location of falaj inventory plate
- Source - Unknown type
- Measurement / sample point

Note: The siting of the falaj is based on the location of the falaj sources found by taking a GPS fix (as indicated on the map and in the legend).
Location of support wells subject to a maximum of 300m inaccuracy from true position.

N

0 0.50 1.00 1.50 2.00
km

Datum : WGS 84 Projection : Transverse Mercator

Map compiled by MRMEWR GIS & RS section

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S1446

1.f Areas of upstream part of the nominated property , the proposed buffer zone and the agricultural demand area.

These figures relate to the areas delineated in the topographical maps (see 1.e above).

		Area of upstream nominated property (Km^2)	*Area of buffer zone (Km^2)*	*Area of Agricultural demand Zone (Km^2)*
1.	Falaj Al-Khatmeen	1.35028	17.564	1.004
2.	Falaj Al-Malki	6	42.5571	1.572
3.	Falaj Daris	3.89468	33.701	2.383
4.	Falaj Al-Jeela.	0.309522	38.3946	0.14
5.	Falaj Al-Muyassar	3.00501	31.8266	1.134

2. DESCRIPTION

2.a Description of the property

2.a.1 THE AFLAJ SYSTEM OF IRRIGATION

The word falaj (plural aflaj) is applied to a complete irrigation system. In classical Arabic the cognate word falaj means to divide property into shares, and in this case is applied to the division of water among shareholders. The word therefore means an organization for the distribution of water among those who have a right to it.

In physical terms, aflaj may be defined as an integrated system that collects groundwater, natural spring water, or surface water and delivers it , by means of underground or surface channels using the force of gravity alone, for domestic and agriculture purposes. It is distributed by means of irrigation channels (fuljan) to individual agricultural holdings (falalij).

Three types of *aflaj* are recognized in Oman (their distribution is shown in Table I).

Governorate or Region	*Daoudi*		*Aini*		*Ghaili*		*Total*		*Grand Total*
	Live	*Dead*	*Live*	*Dead*	*Live*	*Dead*	*Live*	*Dead*	
Batinah	153	40	382	61	674	251	1209	352	1561
Sharqiyah	193	125	215	23	253	37	661	185	846
Dakhiliya	183	96	169	27	149	126	501	249	750
Dhahira	86	66	114	31	273	146	473	243	716
Muscat	12	13	109	21	52	32	173	66	239
Total	627	340	989	163	1401	592	3017	1095	
	967		1152		1993		**4112**		

Table I ***Aflaj* statistics at Governorate and Regional level (data from *Aflaj* Inventory Project, March 1997–June 1998)**

Note: A *falaj* is described at 'live' when water reaches its *shari'a* and irrigates existing agricultural land that is dependent upon its water. It also applies to *aflaj* whose flow stops suddenly or the water of which does not reach the *shari'a* as the result of a collapse or channel blockage. A 'dead' *falaj* is one in which the mother well has dried up completely, no water has flowed for a considerable time, and no existing agricultural land is dependent upon its water.

- *Ghaili* This form is based on the perennial flow in a wadi (the name comes from the Arabic word *ghail*, meaning water flowing on the surface). Water diverted by means of a partial dam from the wadi is conveyed by means of covered or open channels to the demand area. In cases where the water flow is small or intermittent, reserves are stored in holding tanks for distribution in periods of drought.

The longitudinal section of a *ghaili* falaj is shown in Figure 1. Since the channels are open, the water is not considered to be clean enough for domestic purposes. *Ghaili aflaj* represent 48% of the total of those known in the Sultanate; their distribution is shown in Table II.

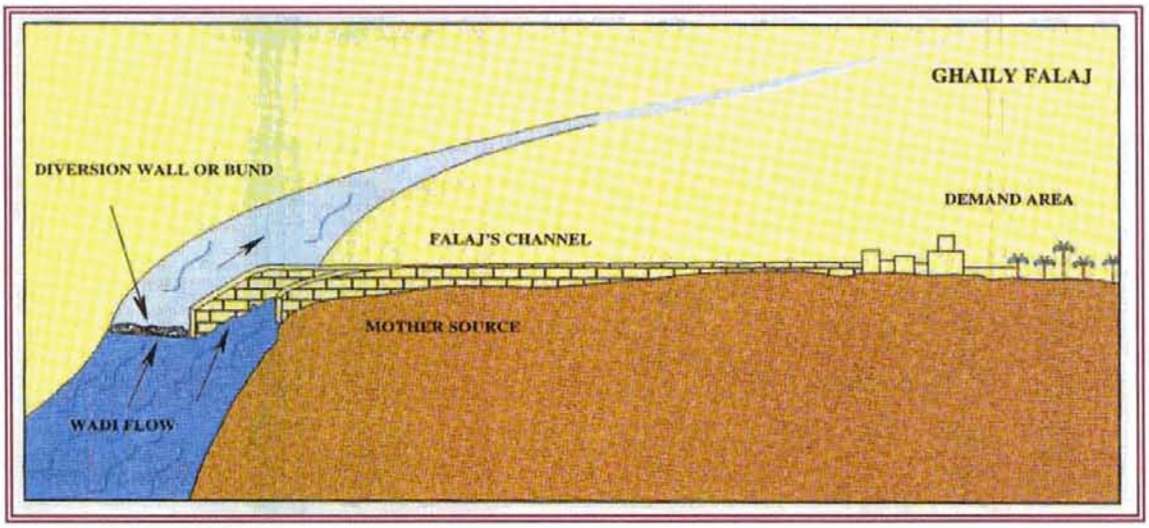

Figure 1 Schematic longitudinal section of a *ghaili falaj*

Governorate or Region	*Ghaili Aflaj*		*Total*
	Live	*Dead*	
Batinah	674	251	925
Sharqiyah	253	37	290
Dakhiliyah	149	126	275
Dhahirah	273	146	419
Muscat	52	32	84
Total	**1401**	**592**	**1993**

Table II Distribution of *ghaili aflaj* in the Sultanate

- *Aini* The sources of water in this case are perennial mountain springs. They never dry up completely, but their water flow is not constant, varying according to the season and the climatic conditions in any given year. In form they are similar to *ghaili aflaj*, but because they are in use in mountainous areas the broken terrain requires their relatively short delivery channels (100–250 m) to be more complicated than those elsewhere, often making use of short stretches of stone-built aqueduct. Figure 2 shows a schematic longitudinal section of an *aini* falaj. *Aini aflaj* feed holding tanks, from which water is delivered to individual users. They make up 28% of the total number of *aflaj* in Oman; their distribution is shown in Table III.

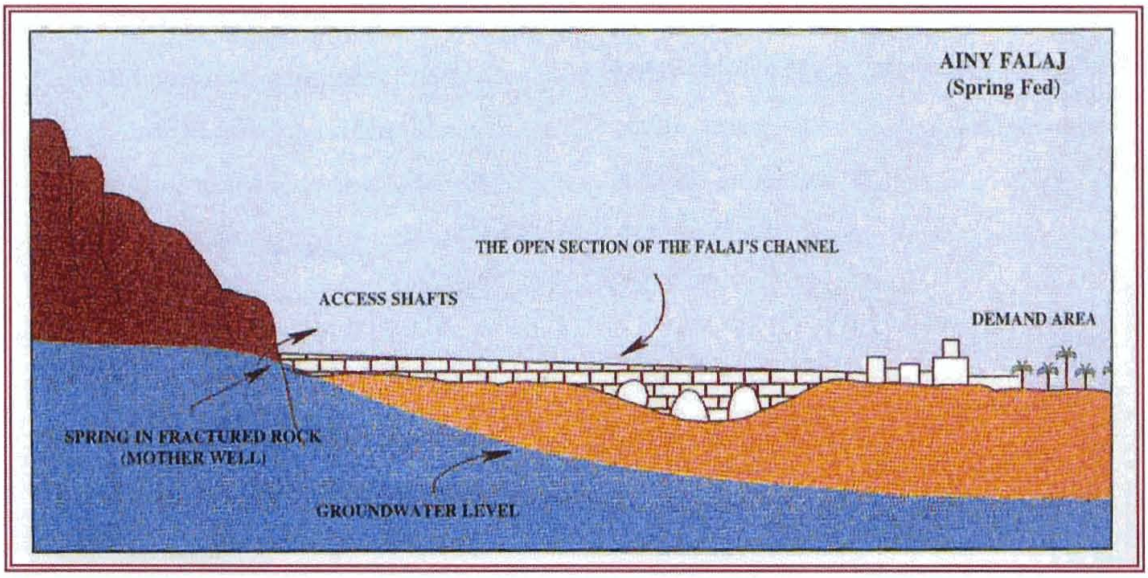

Figure 2 Schematic longitudinal section of an *aini falaj*

Governorate or Region	*Aini Aflaj*		*Total*
	Live	*Dead*	
Batinah	382	61	443
Sharqiyah	215	23	238
Dakhiliyah	169	27	196
Dhahirah	114	31	145
Muscat	109	21	130
Total	**989**	**163**	**1152**

Table III Distribution of *aini aflaj* in the Sultanate

- *Daoudi* This type of *falaj* takes its name from the Prophet Suleiman bin Daoud, who according to legend ordered the *djinn* to dig them. It is also know by the Arabic name *qanāt*; the Pashtu word *karez* is used in Iran and Central Asia, whilst in Morocco and elsewhere in the Maghreb countries the term *foggara* is used.

The first step in creating a *daoudi falaj* is to identify the point at which what is known as the 'mother well' (*umm al-falaj*) is to be sunk, a process for which there is considerable traditional expertise, based on close observation of the upper slopes of the alluvial fan and on generations of experience. Surface seepage and changes in vegetation are among the indicators used. The mother well, which may sometimes be as much as 60m deep, is dug down to the aquifer at the base of a mountain (additional wells are in some cases excavated that feed into the main system). It may be necessary to sink several trial shafts before the aquifer is reached. The eventual mother well is left for a few days, to confirm that it accesses a genuine aquifer with an abundant and steady supply of water, and its sides are then lined with rock or fired brick (made with 'Omani concrete,' clay with a burnt palm tree filler) to ensure stability. From that point onwards an underground delivery conduit is dug, sloping slightly, down towards the settlement. The depths of the channels naturally decrease as they approach the *shari'a*, and the final stretch is usually created using the cut-and-cover technique.

The course of the delivery channel, which may be several kilometres in length, must be determined down to the site of the *shari'a*. The water level at the mother well having been recorded, levels are taken down the length of the route between the mother well and the proposed outlet point. From this it is possible for the gradient of the underground channel (usually between 1:1000 and 1:500, and sometimes at an even shallower gradient of 1:2500) to be determined. The tunnel, normally about 0.9 m wide and 1.5 m high, is excavated with the water flowing freely in its course, enabling the workers to ensure that the channel slopes down evenly. Where it passes through hard rock there is no need for supports or lining (photograph 31), but in soft rock formations the roof is supported in various ways, using palm tree trunks and flat stone slabs, stone blocks, or hoops of baked clay(photograph 32). It is sometimes necessary for wadis or other obstacles to be crossed, and in such cases inverted siphons or stretches of aqueduct are constructed.

Access shafts (*al farda*) for cleaning and ventilation are dug at regular intervals along the route of the channel, at intervals of between 20m and 100m. The access shafts, the depths of which naturally decrease progressively as the settlement that the *falaj* serves is approached, are carefully lined in the same way as the mother well. In some cases these have a dogleg profile (see Figure 3), in order to avoid interruption to or pollution of the water supply as a result of natural or human damage (in times of war) and the upper, vertical, section of the shaft becomes filled with earth or damaged in some way. In some cases alternative channels were constructed for use when hostile groups deliberately blocked the main channels. Spoil from the construction and cleaning of the access shafts is heaped up around their mouths so as to form protective dams (photograph 30) when flash floods occur.

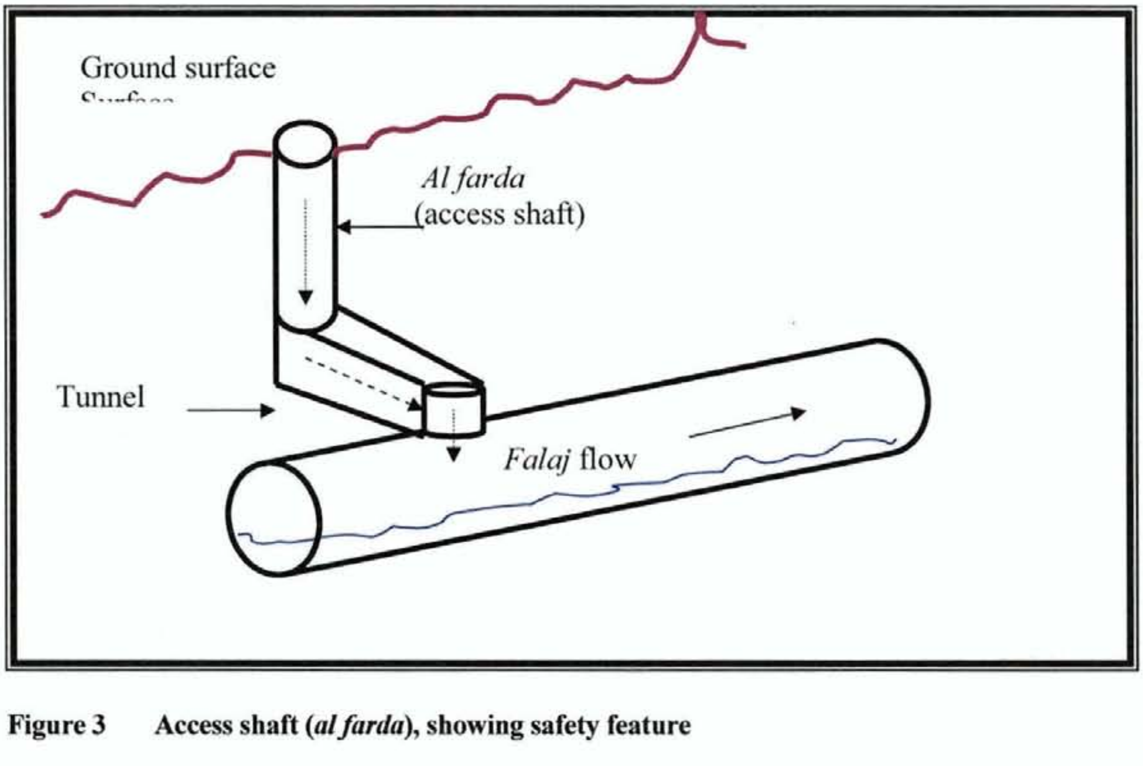

Figure 3 Access shaft (*al farda*), showing safety feature

The water emerges at ground level at an outlet point known as the *shari'a*, where access is free for all. Water may only be used in the first stretch after it emerges from underground at the *shari'a* for drawing water for drinking and cooking purposes and for watering animals. The next stretch is reserved for ablutions, in separate sections for, first, men and then women and children. After passing through forts and mosques the channel reaches the area for washing the dead (*mughisla*). The following stretch is reserved for washing clothes. Only from this point onwards is the water available for irrigation of palm groves and other crops such as alfalfa, vegetables, and cereals. It is conducted by an intricate networks of open channels to the holdings of the partners in the individual *falaj* system. In the case of the larger *aflaj* the main channel may be split into two at the *shari'a*.The arrangements at the *shari'a* vary according to the size of the *falaj* and the community that it serves. In some cases access is provided by means of elaborate constructions, but in others the facilities at the *shari'a* are simple and functional.

Figure 4 shows a schematic longitudinal section of a *daoudi falaj*, and their distribution in the Sultanate is given in Table IV.

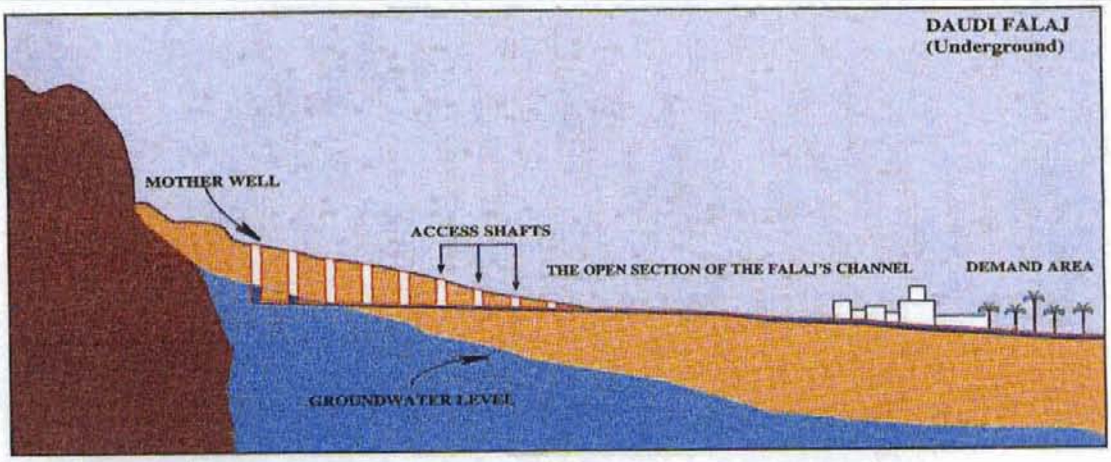

Figure 4 Schematic longitudinal section of a *daoudi falaj*

Governorate or Region	*Daoudi Aflaj*		*Total*
	Live	*Dead*	
Batinah	153	40	193
Sharqiyah	193	125	318
Dakhiliyah	183	96	279
Dhahirah	86	66	152
Muscat	12	13	25
Total	**627**	**340**	**967**

Table IV Distribution of *daoudi aflaj* in the Sultanate

2.a.2 THE SOCIAL ORGANIZATION OF THE *AFLAJ*

An outstanding feature of the *aflaj* system in the Sultanate of Oman is the social and economic structure that has permitted it to function successfully and largely unchanged for centuries. This is based on an accurate system of water distribution which guarantees fair shares to stakeholders. As such it plays an integral role in the socio-economic life of the country. Without it Oman would never have been able to achieve nationhood, since only the availability of water made it possible for nomadic peoples to adopt a settled way of life, which encouraged the development of agricultural and craft skills.

The system is not based on any form of written or statute law, but rather on a traditional system of time-sharing that is passed from one generation to the next. This confers a number of benefits to society as a whole by:

- Maintaining mutual cooperation among those individual who use the *falaj* water for domestic and agricultural purposes (photograph 43);
- Providing a source of family income by making it possible for shareholders to put their water shares up for public auction or by leasing those shares for specific periods;
- Providing a constant source of water for a variety of crops, especially date palms;
- Encouraging the development of traditional crafts in the towns and villages through which the *aflaj* pass and thereby creating employment;
- Strengthening a sense of community and strengthening social relationships between all those benefiting from the supply of water;
- Establishing procedures for settling disputes relating to water shares or maintenance obligations in the form of an autonomous administration responsible for the management of each *falaj*.

The highest executive authority in each system is the *falaj* agent (*wakeel falaj*), appointed by the local sheikh in consultation with the shareholders in the *aflaj*, who is assisted by experienced advisers. The *wakeel* is responsible for the overall management of the *falaj*: his duties include responsibility for the funds, regulation of the sale and rental of individual shares, and day-to-day overseeing of the operation of the system. His subordinates, known as *areefs* (of which there may be a number, especially at the larger *aflaj*), are responsible for distributing water shares. Individual shareholders have an obligation to respect the quantity of water assigned to them and the periods when it becomes available.

Distribution is carried out by the *areef*, who diverts the water flow by applying or removing sluices at the appropriate times of day or night for the agreed periods. Before the advent of clocks these were determined by various methods, including close observation of the stars at night. It is not surprising, therefore, that the Omani people should become very proficient in astronomy and be responsible for important developments in this branch of science.

Monitoring is carried out by a group of experienced shareholders, who measure the flow rate of the water in the *falaj* and take into account other factors, such as the tolerance of the crops being irrigated to being without water. From this the distribution of the water is determined and also its periodicity, which may range between seven and ten days. Irrigation is allocated to each user on the basis of this periodicity. The overall period of distribution is divided into main and subsidiary share units. The main division (*baddah*) is 12 hours, and these are further subdivided into *kathba* (1.5 hours), *athar* (30 minutes), *ruba'a* (7.5 minutes), *thameen* (3.75 minutes), and *quyash* (1.25 minutes). This system of division is shown in Table V. The length of these units may vary from one region to another, according to the capacity of the *falaj*. There are also variations adjusted to periods of drought and high flow: thus, during droughts the *athar* may be reduced to 15 minutes (*athar ghaez*).

Division	**Period of time**	**Subsidiary division**
Baddah	12 hours	24 athar
Kathba	1 ½ hours	3 athar
Athar	30 minutes	-
Ruba'a	7.5 minutes	Athar = 4 ruba'a
Thameen	3.75 minutes	Ruba'a = 2 thameen
Qeyash	1.25 minutes	Thameen = 3 quyash

Table V Time distribution of *falaj shares*

2.a.3 THE AGRICULTURAL DEMAND AREA

The agricultural demand areas owe their existence to the falaj system for hundreds of years. Their sizes vary from few to hundreds of hectares and change slightly from year to year according to the falaj flow. The most common cultivated crops are date palms, lemon trees, fodder grasses and seasonal crops. The trees offer the required shading for the houses and limit the evaporation for the seasonal planting. Goats, sheep and cows are the most common encountered animals. Poultry raising is also common. The management and operations of the water distribution system within the demand area is undertaken by few experienced people as explained above, but for large areas a committee selected among those who know more about the system may be required.

The natural beauty is the most common characteristics of the agricultural demand area. This beauty is not spoiled by the new housing constructions, roads asphalting and the installation of wastewater and potable water distribution systems. As it was for hundred of years most of the houses are located within the private properties. The old watchtowers, mosques, building, washing facilities, palm groves, sundials and auctions buildings testify on the genius, intelligence and engineering capabilities of the falaj communities.

The demand areas are criss-crossed by a network of natural open channels varying in sizes according to the area to be irrigated. Rocks mad or rags are the natural sluice gates from main to the distribution channels. The falaj community is still attached to the old values and reluctant to drastic changes mainly for the falaj system management.

Aware of the importance of the falaj in Oman History, restriction issued by local municipalities are being implemented regarding the removal of palms and construction of new houses instead (Nizwa, *Falaj Al-Muyassar*).

2.a.4 THE FIVE NOMINATED PROPERTIES

The five *aflaj with all water structures and traditional buildings* that make up this nomination were selected as being representative of the total stock of irrigation systems and demand areas communities of this type in the Sultanate of Oman.

– ***Falaj Al Khatmeen*** [Inventory No. 3071]

Upstream part of the nominated area

This *daoudi falaj* is fed from the Wadi Al Meaidin, which is notable for its abundant flow during periods of rain and its continuous (though not constant) flow throughout the year. The total length from mother well to *shari'a* is 2450 m. For most of its length the channel runs underground.

The open channel passes beneath one of the well known Omani forts, Bait Al-Redadah (photographs 1 and 2), which was built during the Yaruba Imamates (1649–1711). At the entrance to the town the channel is split into three equal sections (photographs 3 and 4), one of which irrigates the holdings of the local people and the other two the agricultural land belonging to the State Treasury (*Bait Al Mal*). The water for each of the three users is very accurately controlled: it has been shown that if three balls of the same size and weight thrown into the channel before it splits into three, each will run automatically into a separate branch channel.

The water quality is high: electrical conductivity 440 μS/cm, pH 7.61, temperature 30°C. The water flow rate can vary between 800 and 100 l/s, according to the water table level.

Downstream part of the nominated area

The total demand area is 1,004,345 m^2 of which 723,124 m^2 is cultivated area. Most of the demand area is owned by the government State treasury (Bait al Mal). Dates, lemons, Banana fodder, seasonal crops and sugar cane are the most common cultivated crops. Surface irrigation (furrow and flood) is the only method used.

The demand area is a touristical attraction known for its history, falaj water distribution system, traditional buildings and its proximity from Jabal Al Akhdar another well known site for tourism.

The water structures and buildings proposed for the nomination are the following:

- The water distribution open channels and the structure used for distributing water among users . This old system has been used for years and continues to get the full satisfaction of all users. No mechanical devices are used (meters or measuring devices etc…). This is a proof that simple solutions can solve complicated problems (photographs 3, 4).
- The abandoned traditional houses (Photograph 5,6) which occupy a large section of the demand area as well as the watchtower (photograph 7) located on strategic point overlooking the demand area. The most important features of these buildings are still there. These traditional houses and watchtowers require renovation which cannot be done by the private owners. It is understood that these structures are included among the monuments to be renovated by the Ministry of Heritage and Culture (photographs 5 and 6).
- The traditional distribution system within the agricultural demand area which can compete with the most sophisticated modern distribution system in terms of efficiency and water distribution equity among users (photographs 8).

The inclusion of these sites among the world heritage list is very welcomed by the citizens who find in tourism a very important economical activity and a way of showing to the rest of the world the wealth of Omani culture and history.

- ***Falaj Al-Malki*** [Inventory No. 0606]

Upstream part of the nominated area

Falaj Al-Malki is one of the largest *aflaj* in the Sultanate: its total length from mother well to *shari'a* (including all its 17 branches) is some 14.875 m. It is believed to have been built during the major *falaj* building in the Yaruba Imamates period. The *falaj* splits into two branches, supplying the former towns of Nazar and Al-Yaman (photographs 9 and 10).

Recent intensive building in the area has resulted in severe pressure on the aquifer and this effect, coupled with a scarcity of rain has led to a decrease in the water flow of the *falaj*, especially in periods of drought. However, the state of conservation of the *shari'a* and the feeder channels remains high.

The water quality is high: electrical conductivity 764.5 µS/cm, pH 7.82, temperature 30°C.

Downstream part of the nominated area

The agricultural demand area covers 1,572,730 m^2, 1,132,472 m^2 of which is planted.

Dates, fodder and seasonal crops are the most common cultivated crops. Surface irrigation (furrow and flood) is the only method used. The municipality is not allowing the construction of new buildings in replacement of the removed date palms.

The water structures and buildings proposed for the nomination are the following:

- The upstream water distribution open channels and the structure used for distributing water among users (Photographs 9 and 10 and 11).
- The watchtower located on a hill overlooking the demand area and the few scattered traditional houses (photographs 12).

- ***Falaj Daris*** [Inventory No. 0500]

Upstream part of the nominated area

The largest in the Dakhiliya Region, this *daoudi falaj* is thought to be the oldest in the Sultanate, built early in the Yaruba Imamates period. The total length of its three channels is 7,990 m. Most of the water derives from the Wadi Al-Abiyadh.. The water flow reaches over 2,000 l/s, but the aquifer has been affected as a result of development pressures and so the flow rate falls during periods of drought.

The structure of the channel is in excellent condition, and the *shari'a* has been the object of some simple but elegant landscaping (photographs 13 and 14) and interpretation (photograph 15).

The water quality is high: electrical conductivity 477 µS/cm, pH 7.30, temperature 37°C.

Downstream part of the nominated area

The cultivated area of the town of Nizwa that it supplies is 1,715,502 m^2, whilst the total demand area is 2,382,642 m^2 (Photograph 16).

There is an effort made by the government to preserve the falaj and demand area through the implementation of strict restrictions through local municipalities regarding the removal of palms and construction of new houses instead. Also a wastewater collection system will be constructed within the demand area in addition to the existing potable water distribution network.

Dates, fodder, sugar cane are the most common cultivated crops. Surface irrigation (furrow and flood) is the only method used.

According to the latest census (2003) the total number of inhabitants and houses are ? and ? respectively.

The renovated fort and the landscaping of the shari'a of falaj Daris are very appreciated by visitors and are among the most visited sites in the Sultanate.

The water structures and buildings proposed for the nomination are the following:

- The shari'a and downstream structures as well as water distribution open channels and the structure used for distributing water among users.

The inclusion of these sites among the world heritage list will help in the protection of the demand area from the increasing houses construction which is taking place (photograph 17).

- ***Falaj Al-Jeela*** [Inventory No. 2750]

Upstream part of the nominated area

The *aini* form of *falaj* is represented in this nomination by Falaj Al-Jeela. It is a located in a very small town in a remote and barren mountainous area of Wilayat Sur (photograph 18). The water comes from a spring of the Wadi Shab (photograph 19), which is located in tertiary limestone above the town, and is conveyed by means of tortuous open channels (photographs 20) and a small bridge (photograph 21) over a length of 161 m to a collection basin in the town itself (photograph 22). The water is used principally for irrigating palm and pomegranate trees and tropical fruits. All the planting is high on the edge of the wadi, and there is a protective wall against mudslides.

The *falaj* water is very pure (electrical conductivity 378 µS/cm, pH 7.87, temperature 29°C), with an average flow of 44 l/s. Like other *aini aflaj*, Falaj Al-Jeela maintains a stable flow rate throughout the year and is barely affected by rises and falls in groundwater levels,.

Downstream part of the nominated area

The planted area is 10,034 m^2, out of a total demand area of about 14,000 m^2 (photograph 18).

The demand area is limited in size by the surrounding mountains and can be a very attractive touristical site.

The water structures and buildings proposed for the nomination are the following:

- The water distribution open channels are built along the side of the Mountains (photograph 20). These channels are a proof of the expertise of the falaj community in the construction of water distribution channels in very difficult environment. These structures shall be preserved for the coming generations.

- The small bridge supporting the water channel (photograph 22), for its ability to channel water over the destructive wadi floods for hundred of years.
- The mosque (photograph 23). Beside its religious importance it is the symbol of the unity and place of gathering of this small community.
- The on-farm water distribution open channels and the structure used for distributing water among users (Photograph 24).

- ***Falaj Al-Muyassar*** [Inventory No. 1446]

Upstream part of the nominated area

Another *daoudi falaj*, Falaj Al-Muyassar originates from a mother well 50 m deep. Including its branches, the *falaj* is 5,783 m in length. The water is very pure (electrical conductivity 508 µS/cm, pH 7.61, average temperature 31.9°C). The flow is relatively stable, but it can sometimes be affected by the flow in the Wadi Al-Fara and the Wadi A-San, rising occasionally to 900 l/s and sinking as low as 100 l/s.

Downstream part of the nominated area

The total cultivated area is 1,133,698 m^2 by means of two main branches (photographs 25). Dates, lemons, fodder and seasonal crops are the most common cultivated crops. Surface irrigation (furrow and flood) is the only method used.

To prevent pollution to the aflaj and groundwater a wastewater collection system is under construction within the demand area.

The water structures and buildings proposed for the nomination are the following:

- The access to shari'a. It is a sort of short tunnel (photgraph 26) to permit an easy access to execute maintenance works and the inspection of the falaj flow.
- The old houses , mosque and fort in the vicinity of the falaj (photograph 27).
- The watchtower (photograph 28).
- The sundial (photograph 29).

2.b History and Development

There is some uncertainty about precisely where and when the *daoudi falaj* type of water management system was invented. Its origins have been traced to the mining areas of Armenia and the northern Elburz mountains along the southern shores of the Caspian at the end of the 2nd millennium BC. From here it spread southwards into Persia, where it is known that the Assyrian ruler Sargon II, who reigned at the end of the 8th century BC, and his successor Sennacherib built a number of *aflaj*. It began to be diffused more widely during the Achaemenid period in Persia, from the mid-6th to the mid-4th centuries BC. This was a period of Persian expansion, especially during the reign of Cyrus the Great, and there is abundant evidence from the archaeological and historical records of contacts between Persia and Arabia. Much of Oman came under Achaemenid rule in the mid-6th century BC, and from AD 226 it formed part of the Sassanian Empire of Persia, until the Sassanians were finally driven out with the coming of Islam in the 7th century AD. The close similarities between the *aflaj* in Iran and those in Oman suggest that it was during the Sassanian period that this technique of water management became common in Oman. According to legend, the Persians destroyed most of the ten thousand *aflaj* that had been constructed there when they were expelled.

The importance of the frankincense trade through Oman to the world of the Near East from a very early date makes it likely that cultural influences from Persia were entering the region before the Achaemenids. There is archaeological evidence that the earliest period of *aflaj* construction in Oman dates back to the 8th or 7th centuries BC, which suggests an Assyrian origin. However, some Omani historians attribute the introduction of the technique to the Prophet Suleiman bin Daoud, who lived in the 10th century BC.

Historical records indicate that there was a second period of *falaj* construction during the Yaruba Imamates in the second half of the 17th century, when the Portuguese were finally expelled from Oman, which became the first independent state in the Arab world.

The histories of the five *aflaj* that make up this nomination are unknown, since there are no written records surviving. However, a number of inferences can be drawn from their size and location in relation to old urban settlements. By virtue of its size and complexity, and the importance of the town of Izki that it supplies, a case can be made for Falaj Al-Malki as one of the earliest in Oman. There are similar indications that Falaj Daris, with its links to the town of Nizwa, is also of considerable antiquity. The relationship of Falaj Al-Khatmeen to the Bait Al-Redadah fort, known to have been built during the Yaruba Imamates, suggests that this *falaj* originated in the 17th century.

3. JUSTIFICATION FOR INSCRIPTION

3.a Criteria under which inscription is proposed

Criterion ii The *aflaj* system in Oman is an outstanding example of an irrigation system of considerable antiquity developed in the Near East and applied widely in the arid territory of Oman, which survives intact and of immense socio-economic significance in contemporary life.

Criterion iv Human occupation of large desert areas of Arabia did not become feasible until the *aflaj* irrigation system was introduced into Oman. It made possible the development of a successful state which played a vital role in the development of trade between Europe and Asia in the medieval and later periods.

Criterion v The *aflaj* irrigation system in Oman has produced an exceptionally well preserved example of a form of land-use which found widespread application over much of western and central Asia. It is threatened by lowering of the water table over much of the area as a result of increased contemporary demand for water and by climatic change. From the points of view of continuity and conservation of water supply, and long-term sustainability of agriculture in a region where water shortage through over-extraction will become an increasingly serious problem, the aflaj have a number of important characteristics which justify a continuing faith in the falaj system and which must be enhanced and not diminished by any changes to it. These characteristics are; water generally of very good (or good) and near constant chemical quality; no possibility of endangering the water table (in contrast with wells which are easily deepened) unless by a support well; water is brought to the ground surface by gravity, and therefore without any pumping cost; village falaj land is long nurtured and of good quality; falaj villages are a model of crop water use prioritisation; aflaj are the best example of co-operative water management in Oman; a model of self-funding and self-help; the falaj committees could form the basis of future local water management organisations (in partnership with MRMEWR and its regional offices)

3.b Statement of outstanding universal value

The statement in the Holy Quran that '... we have made from water every living thing' epitomizes the dependence of humankind on water. This is nowhere more true than in the arid lands of Arabia, where permanent human settlement did not become possible until the introduction of irrigation systems that permitted the extension of agriculture beyond the immediate surroundings of springs or wells. Relatively constant supplies of water were ensured for large areas of desert throughout the year, and this in turn led to the growth of permanent urban settlements based on an assured agricultural production and water resources for both people and livestock.

The *aflaj* system of irrigation consists of tapping substantial underground water resources and conducting the water by means of deep underground channels, often over long distances, to towns and villages where it is distributed to domestic and agricultural users. This technique is believed to have originated in ancient Persia, and it has spread widely in desert lands, from Morocco to China, and even into south and central Europe (where its use was confined to mining areas). The system in use in northern Oman has been developed over many centuries and has resulted in the creation of a strong social and economic structure that has survived intact to the present day.

There are four elements in the Omani *aflaj* systems that justify the attribution of 'outstanding universal value.' First, without the existence of *aflaj* there would have been no more than sparse, impoverished settlement in this region (or elsewhere in the desert regions that stretch from Xinjiang to Morocco).

Secondly, the technology has been brought to a high level in Oman, and has been functioning successfully for more than two millennia. Thirdly, the organization of the water distribution system is an outstanding example of a traditional structure that is at least a thousand years old and which continues to play a vital role in the social and economic structure of Oman in the 21st century. Fourthly, it is one of the largest concentrations of irrigation systems of this kind anywhere in the world: over four thousand active or defunct systems have been identified.

The agricultural demand area is an outstanding example of sustainable agriculture. The cultivated area is reduced or expanded according to the natural flow of the falaj. No mechanical intervention is required. Water distribution structures are constructed efficiently by mean of open channels adapted to the topographical situation. The aflaj with their demand areas create a unique environment where the man lives in harmony with nature.

3.c Comparative analysis (including state of conservation of similar properties)

The network of *aflaj* systems in Oman is neither the oldest nor the largest in the world. There are older systems in northern Iran and that country has many thousands of *aflaj*. This method of irrigation is to be found at the present time in many other countries: for example, China (Xinjiang), Cambodia, Kazakhstan, Kyrgyzstan, Afghanistan, Pakistan, Turkey, Jordan, Iraq, Saudi Arabia, Egypt, Libya, Tunisia, Algeria, and Morocco. The unique feature of the Omani system relates to the management of the *aflaj*. The autonomous cooperative form of organization in Oman, which of considerable antiquity, has survived intact since the sheikhs of the nomadic tribes in this part of the Arabian peninsula adopted the Persian form of irrigation, making it possible for members of the tribes to adopt a sedentary way of life based on agriculture, and established a tribal administrative apparatus. Not until very recently, as a result of pressures resulting from rapid commercial and industrial development, has there been any involvement on the part of central government, and only in the form of financial and technical assistance: day-to-day management still remains in the hands of the shareholders in each *falaj*.

The traditional houses mosques and the watchtowers can be found in some other countries in the area; however the Omani traditional houses and watchtowers have a particular architecture which cannot be found in other places in the world. These houses were designed to provide a suitable environment during the hot season and to take advantage of the available materials (stones from mountains, palm trees etc..) for their construction. The location of the traditional houses is dictated by the proximity to the falaj. Watchtowers are located in strategic place to insure a clear view of the whole demand area. The sundials constitute a unique method for time measurement and consequently a very efficient tool for water sharing between users.

3.d Authenticity and integrity

The basic layout of the contemporary Omani *aflaj* is wholly authentic. Records and archaeological investigations confirm that this form of water location and distribution has not changed for more than two millennia. Modern techniques are not used in their location, excavation, and design, and modern materials such as concrete are used only for reinforcing the tops of the mother wells and access shafts, at some of the *shari'a*, and in the distribution channels to individual agricultural plots.

The authenticity of the management of the *aflaj* is equally incontrovertible. The traditional system of ownership and management, which is centuries-old, functions efficiently alongside and complements the contemporary administrative and scientific structure for the management of water resources in the Sultanate. It is based on many generations of Omani citizens who have ensured its integrity as a fundamental element in the survival of human society in this arid land.

4. STATE OF CONSERVATION OF THE PROPERTY

4.a Present state of conservation

The state of conservation of the five nominated *aflaj* is excellent. This is directly attributable to the fact that they play a fundamental role in the social and economic life of the communities that they serve. They are in no sense monuments or antiquities: they are essential components of the socio-economic structure of the northern part of the Sultanate (the present-day Regions of Batinah, Dakhiliya, Dharirah, and Sharqiyah and the Governorate of Muscat). Failure to maintain them properly would have a disastrous impact at both local and national level.

This is not the case, however, for the totality of the *aflaj* in Oman. Economic developments within the Sultanate in recent decades, in particular the exploitation of the country's oil reserves, have led to the creation of high-income employment possibilities in the larger cities and a consequent migration from the countryside. The enhanced affluence of the population has led to a substantial increase in the level of imported goods and a reduction in the demand for local agricultural products. The economic value of the *aflaj* has declined and landowners have converted their agricultural holdings into more profitable commercial and residential areas. The cost of maintaining old *falaj* systems and the lack of interest in them on the part of the younger generations have made a substantial contribution to this state of affairs.

As for the historical traditional houses, watchtowers and water distribution structures they constitute an important part of the falaj community and its history. Their preservation is given a very high priority by the citizens.

In spite of the government effort to preserve this very important cultural heritage for Oman and human history, there is a need for better maintenance of these structures in collaboration with all concerned authorities in the country.

As for the agricultural demand areas, they are surviving these changes, owing this to the old generation of farmers who are trying to cope with the economical and technological changes. Date palms and the cultivation of grass are no longer profitable compare to other activities such as commerce and work with the government. The increase in the sizes of farms coupled with drought periods are leading to the losses of date palms. The temptation of new generation and the expectation of new housing similar to those of towns have led to a disinterest in the houses and a tendency to either renovate these houses with the introduction of new building materials and electrification. In many case the old towns in demand areas are completely replaced by new towns in new locations

The main conservation problems are due to:

- Intrusion into the channels by water from wadis or excessive rainfall, leading to the blockage and collapse.
- Collapse of tunnels as a result of erosion of old structures.
- Unauthorized human interventions.
- Accumulation of lime on the beds of channels.
- Penetration of tunnels by tree roots.onal houses
- The relatively high cost to maintain the traditional houses and fort and watchtowers.
- The lack of qualified people to preserve these valuable structures.
- Disinterest in agriculture which is less profitable.
- Lack of maintenance of the old properties.
- Tendency for new housing and more profitable agriculture with large size and modern irrigation relying on wells.

4.b Factors affecting the property

i Development pressures

The past four decades have seen immense changes in the economy of the Sultanate of Oman, as in most of the Gulf states, due to a considerable extent to the exploitation of the oil resources of the region. The cities have expanded enormously, with the development of large residential, commercial, and industrial zones, whilst smaller settlements around them have been transformed into dormitory towns. The resulting changes in lifestyle have created a large increase in the domestic demand for water.

There has been extensive highway construction, a process that is still continuing, and entirely new industrial settlements have been created in formerly rural areas. The physical impact of these processes on the traditional *aflaj* has been severe. The water requirements of new urban settlements cannot be satisfied by *aflaj* and so these have been met by the drilling of very deep wells. The increased demand has put the aquifers under extreme pressure, considerably greater than that arising from the low-level *falaj* utilization. New roads have created direct and indirect threats to the *aflaj*, since their siting has caused problems of vibration from heavy traffic and pollution from petrol filling stations, whilst residential expansion has required rigorous control of domestic waste disposal, in order to avoid pollution of the aquifers.

The tendency of new generation to have their own residency far from the old system of family, has led to a disinterest in these houses and style of living in these area. This has led to the abundance of this properties and a movement to cities where more facilities are available. Farming is no longer a lucrative activity. Jobs in the cities especially with the government has led to a migration to cities which led to the abandonment of agriculture which is run by expatriates who are coming from different environment and don't have the expertise to operate this typical irrigation system relying on limited water resources.

ii Environmental pressures

Recent decades have seen marked climatic changes across the world, which are now generally accepted as resulting from global warming. This effect is abundantly illustrated in desert lands such as the Arabian peninsula and confirmed by meteorological data: annual rainfall on the mountainous areas which supply the aquifers has fallen steadily and periods of drought are more frequent and last longer (photographs 33 and 34). As a result groundwater levels have been lowered, an effect exacerbated by the depletion resulting from hydraulic pumping down to depths of several hundred metres, which is widely practised in modern farms. Paradoxically, this climatic change has also brought with it occasional episodes of exceptionally heavy rainfall, which can cause serious damage to the *falaj* channels and other structures.

iii Natural disasters and risk preparedness

Flooding is the most immediate threat to the stability and survival of the *aflaj*. It is impossible to devise adequate precautions to counteract the erosive effect of heavy flooding on the underground water channels. However, the Government allocates funds for the rapid restoration of sections of *falaj* channels damaged by flooding.

The region is not subject to earthquakes and there are no volcanoes.

iv Visitor/tourism pressures

At the present time there are no problems relating to visitor or tourism pressure. Tourist and educational visits take placed infrequently, but these have no perceptible impact on the conservation or management of the *aflaj*, traditional houses, mosques, and water distribution structures. In the event of inscription on the World Heritage List it will be desirable for arrangements to be made with tourist authorities and agencies to regulate access to the five properties that make up this nomination.

In general the visits to these aflaj are frequent and there is a tendency from visitors to respect the local cultural traditions. The aflaj community is in general in favour of tourism which can be an important source of income and development of infrastructure.

(v) Estimated number of inhabitants within property, buffer zone

In each of the five aflaj there is no one living in the nominated area. The figures below relate therefore solely to the 3.5 Km buffer zones. The figures are estimated, since there has been no recent census, and refer to the condition of the areas in the year 2004.

1	Falaj Al-Khatmeen	300
2	Falaj Al-Malki	3000
3	Falaj Daris	2000
4	Falaj Al-Jeela	0
5	Falaj Al-Muyassar	500

5. PROTECTION OF THE PROPERTY

5.a Ownership

The *aflaj* are owned by the individual shareholders, with certain shares allocated to the mosque for its private lands (*awqaf*) and others to the religious school (*madrassah*). The legal title to shares is recorded in the form of a registration document (*sukk*); ownership of these shares is absolute, and they can be inherited. Only rarely is an entire *baddah* owned by a single individual, who will be a rich proprietor with several farms. The details of ownership and all transactions are recorded by the *wakeel* in a register (*nooksha*).

Certain *baddah* are owned communally by all the shareholders in the falaj, and these are available for rent: tenants, known as *mustaqad*, pay agreed rents (*qadat alma'a*). Rental auction sessions are held weekly at a specific time and place, when a traditional auction procedure is followed. The auctioneer (who may be an areef) sits in the middle of a circle of would-be tenants. One of these opens the bidding by naming a price and placing a stick behind the auctioneer. Others can then indicate that they are prepared to rent at this price in the same way, by placing a stick behind the auctioneer, who then raises the price. Those not wishing to pay that rent remove their sticks progressively as the price rises, until only one stick remains and the transaction is concluded at that price. The *wakeel* is in attendance to collect the money, which is then available for overall *falaj* management purposes.

Individual shareholders may also buy or sell shares; this is only applied at *athar* level or below. The average price of an *athar* is currently US$ 8290.00.

In periods of heavy rainfall, when the supply of water available exceeds the requirements of the shareholders, surplus water is diverted away from the settlement to replenish the aquifer in a process known as *almghrad*.

The agricultural demand area farms are owned by individual farmers and in some cases by the government. The houses are owned and shared between members of the family. As for the the old houses forts and mosques they are owned by one or a group of people. The irrigation network is owned and managed by the falaj community.

5.b Protective designation

The Ministry of Regional Municipalities, Environment, and Water Resources (Directorate General of Water Resources) created an inventory of *aflaj* in the Sultanate between March 1997 and June 1998. The Ministry published an *Aflaj Inventory Project Summary* Report in 2001 which contains full details of the objectives, scope, methods used, analytical data, and examples of the records; a copy of this report accompanies this nomination (Annex E).

The inventory includes the following data:

- Location and depth of mother wells (photograph 36);
- The routes of *falaj* channels (photograph 37);
- Measurement of flow rates,
- Data on water quality (photograph 38);
- Definition and measurement of planted and demand areas;
- Data on state of conservation of channels and the nature of the flows.

Each inventoried *falaj* has been assigned a registration number and a registration plate has been placed at the *shari'a* of each inventoried *falaj* (photograph 35).

The project was undertaken by 134 Ministry staff members, who were trained in recording and were responsible for confirming the data; they were divided into 45 working teams distributed across the Sultanate. Field laboratories were set up to measure water quality: 2958 samples were analysed. The geographical distribution shown by the inventory is shown in Table I.

The overall results of the inventory are shown in Table VI.

Governorate or Region	*Aflaj counted*	*Demand areas*	*Total area, ha*	*Estimated water demand, million m^3*	*No. of chemical samples taken*
Batinah	1561	1651	6458	104	1195
Sharqiyah	846	602	5819	115	634
Dakhiliyah	750	644	8132	135	497
Dhahirah	716	644	4626	79	466
Muscat	239	159	1463	26	166
Total	**4112**	**3684**	**26498**	**459**	**2958**

Table VI Results of the *aflaj* inventory

The following data were obtained as a result of the inventory:

- A total of 3648 demand areas and 5326 branches of the different types of *falaj* were inventoried.
- The total area dependent upon *aflaj* water in the Sultanate is 26,498 ha, made up of 17,561 that are cropped, 976 ha that are developed but uncropped, and 7,961 ha that are undeveloped.
- The total annual demand for *aflaj* water is about 459 million cubic metres, 99.8% of which is used to meet agricultural demands.
- Falaj Al-Malki (Dakhiliyah Region) has the largest number of branches (17).
- Falaj Ash-Shariq (Sharqiyah Region) is the longest *falaj* in terms of the total length of its branches (17, 289 m).
- The demand area of *falaj* system S0472 (Dakhiliyah Region) is the largest (1,227 ha).
- The highest electrical conductivity value (16,700 μS/cm) was recorded at Falaj Arhuyan (Sharqiyah Region) and the lowest (115 μS/cm) at Falaj Hail Muhadham (Batinah Region).
- The highest water pH value (12.9) was recorded at Falaj Qubil Malah (Dhahirah Region) and the lowest (4.6) at Falaj Al-Harf (Batinah Region).
- The highest water temperature (60°C) was recorded at Falaj Hammam (Muscat Governorate) and the lowest (10°C) at Falaj Al-Chamita Al-Sofa (Dakhiliyah Region).

A number of protective measures, which are set out in a standard official letter sent to all Aflaj shareholders (see Annex G) been implemented relating to the aflaj :

New wells may not be dug within 3.5 km of mother wells.

- There shall be no water distribution in the vicinity of the mother well or the branches of the *falaj* (this a traditional requirement that is scrupulously enforced by the *aflaj*).
- In the event of new development (roads; residential areas; industrial areas; buried oil, gas, electricity, telephone, or water pipelines), protection zones must be created on either side of the route of a *falaj*. Effective protection must be provided where the line of a *falaj* crosses any developments of this kind .
- If a petrol filling station is to be built near a *falaj*, it must be sited no less than 30 m from the line of an underground channel and 10 m from an open channel. All fuel tanks must be lined with impermeable reinforced concrete to avoid pollution .

In addition, according to a traditional requirement that is scrupulously enforced by all the aflaj, there may be no water distribution in the vicinity of the mother well or the branches of the falaj.

The government is allocating annual budget for the maintenance of Aflaj. Priority is given to damaged aflaj according to their economical and social importance.

5.c Means of implementing protective measures

Maintenance programmes are based on regular monitoring programmes (see 6. below). Two main actions are taken:

- *Integrated construction* consists of creating a new course for the *falaj*, whether by changing the old course or extending it upward from the existing mother well. This involves mechanical excavation of the channel and the construction of a new one, using modern materials, and also the construction of courses across wadis, in the form of bridges or siphons.
- *Restoration* including repair of the existing channels and access shafts (photographs 39 and 40).

If these measures fail to improve the water supply situation resulting from prolonged drought conditions, support wells are dug to increase the water flow rate (photograph 41). These are modern constructions, consisting of a well, a turbine-driven pump, a pipeline from the pump to the *shari'a*, a control room, and, where there is no connection to the main electricity grid, a generator. Support wells are actions of last resource and are only installed where the measures listed above have failed to improve the *falaj* flow or it has been contaminated by hydrocarbons.

5.e Property management plan or documented management system and statement of management objectives for the proposed World Heritage property

The very nature of the *aflaj* system is such that it is controlled and managed by the individual shareholders working according to traditional practice. However, following the assumption of responsibility by central government as part of the Second Five-Year Plan, these are supplemented and supported by the programmes of the Ministry of Regional Municipalities, Environment, and Water Resources. Details of relevant sections of the Ministry's policies are given in Annex B.

Following the recommendations of Oman International Conference on Development and Management of Water Channels (Aflaj), the Ministerial Decree **(219/2003)** was issued to form a committee grouping several ministries to follow and implement the conference's recommendations (Appendix I). These ministries are the Ministries of Regional Municipalities Environment and Water Resources, the Ministry of Legal Affairs, he Ministry of Heritage and Culture, the Ministry of Interior, the Ministry of Agriculture and Fisheries, Sultan Qaboos University, the Ministry of Social Development, Ministry of Information, Ministry of Housing Electricity and Water, and the Ministry of Education.

5.f Sources and levels of finance

Traditionally, *aflaj* have been financed entirely by their shareholders. However, the high costs of manpower and materials, as well as the deteriorating condition of the roofs of many channels, made it increasingly difficult in the 1970s for shareholders to maintain their *aflaj* adequately. As a result, the Government of Oman assumed responsibility for *falaj* maintenance in the Second Five-Year Plan (1981–85) in the form of an extensive drilling and rehabilitation programme.

5.g Sources of expertise and training in conservation and management techniques

Expertise in the construction and management of *aflaj* has been handed down from generation to generation, and the requisite knowledge and skills survive in most of the *aflaj*. However, migration from the countryside and the unwillingness on the part of many of the younger generation to acquire the necessary skills led to the responsibility for training in conservation and management skills being taken over by the Government. Qualified staff are now working closely with the *aflaj* communities in the application of modern maintenance and conservation techniques.

The Ministry of Regional Municipalities, Environment, and Water Resources operates annual work camps(photograph 42), in coordination with other government and local sectors, the objectives of which are:

- To transmit experience from fathers to sons in the maintenance and construction of *falaj* channels; this takes the form of group projects jointly between young people and *falaj* owners and agents.
- To educate young people about the unique irrigation system represented by the *aflaj* so as to prevent the loss of this information as the older generations die out.
- To make young people aware of the importance of water conservation, especially in the form of the *falaj* system, since it will be they who will suffer in the event of a serious lack of water resources in the future when the population grows and yet more demands are made on those resources.
- To transmit the expertise acquired by farmers regarding the on-farm management which survived for centuries in a sustainable manner.

5.h Visitor facilities and statistics

Although *aflaj* constitute a very important aspect of the Omani heritage, they still do not figure prominently on tourist and visitor programmes (see 4.b.iv above). However, in order to make them more accessible to visitors, the Government has built new roads and paved existing ones in the more inaccessible areas, with a limited amount of signposting on major roads. Of the five nominated *aflaj*, only Falaj Daris has an interpretation board at its *shari'a*, and this will be expanded for the four remaining aflaj. Also in collaboration with the relevant authorities for each Falaj a kind of presentation room will be equipped with all traditional water flow measuring devises the construction and maintenance and necessary information on the history of falaj and the demand area. For the purpose a local will be trained to serve as a guide for tourists. The hospitality of the falaj community will be reflected in this type a visitors showing the tradition of the falaj community. Appropriate signs will be implemented in key locations to allow visitors to understand the falaj philosophy and traditional living way of the community..

5.i Policies and programmes related to the presentation and promotion of the property

As part of the encouragement of tourism and the diversification of touristical sites aflaj will be the present time the Ministry of Regional Municipalities, Environment, and Water Resources has no specific programme related to the presentation and promotion of *aflaj* in the Sultanate. However, it has established links with the Directorate of Tourism of the Ministry of Commerce and Industry, and discussions will be initiated to consider the implications of World Heritage listing. The first interpretation boards have been set up at the *shari'a* of Falaj Daris

At the present time the Ministry of Regional Municipalities, Environment, and Water Resources has no specific programme related to the presentation and promotion of *aflaj* in the Sultanate. However, it has established links with the Directorate of Tourism of the Ministry of Commerce and Industry, and discussions are taking to consider the implications of World Heritage listing. Also there is an effort to promote aflaj as part of the touristical attraction in the Sultanate and. The first interpretation boards have been set up at the *shari'a* of Falaj Daris.

5.j Staffing levels (professional, technical, maintenance)

Staffing levels vary according to the size and complexity of individual *aflaj*. In the smaller ones there may be only the *wakeel* and a single *areef*, whilst for larger *aflaj* there may be two or three *wakeels* and as many *areefs*: Falaj Al-Malki, Falaj Daris, and Falaj Al-Khatmeen, for example, each have two *wakeels*.

Within the Ministry of Regional Municipalities, Environment, and Water Resources, the staffing of Directorate of Aflaj, Springs and Water Permits (technical personnel – hydrologists, geologists, civil engineers, and *aflaj* experts) is as follows:

Head Office (Muscat)	26
Dakhiliya Region	8
Sharqiya Region	12
Batinah Region	8
Dhahira Region	7
Dhofar	5

It is impossible to assign a figure to the numbers of people involved in the management and maintenance of the five *aflaj* that make up this nomination. This is the responsibility of the entire community that depends upon its *falaj* for survival.

6. MONITORING

6.a Key indicators for measuring state of conservation

The key indicators for monitoring are:

- *Falaj* flow;
- Water quality;
- State of conservation of structural elements (mother wells, underground channels, access shafts, *shari'a*).

6.b Administrative arrangements for monitoring property

The Ministry of Regional Municipalities, Environment, and Water Resources monitors the water flow and quality at all the *aflaj* on its inventory monthly. Individual *falaj* communities carry out regular monitoring of their systems and submit requests for assistance in maintenance or conservation whenever their structural or hydrological structures are affected. Upon receipt of these requests, the Ministry prepares technical specifications and drawings and supervises the maintenance work. The Ministry of Agriculture and Fisheries is responsible for issues related to the protection and safeguarding of traditional farming (dates) and the improvement of irrigation systems. The Ministry of Culture and Heritage is actively taking the necessary measures to conserve and maintain cultural sites.

Beside the activities already undertaken by the existing above-mentioned ministerial committee, it is proposed that a high level committee from the concerned ministries will meet to finalise the required program and actions to be taken to achieve the objectives of this nomination.

6.c Results of previous reporting exercises

The most recent published report covers the entire Sultanate. *Falaj Flow Data 1983–2002* was published in December 2003 in five volumes. A specimen of these reports in attached as Annex F.

7. DOCUMENTATION

7.a Photographs, slides, image inventory and authorization table and other audiovisual materials

See Annexes C, D, and H

7.b Texts relating to protective designation, copies of property management plans or documented management systems and extracts of other plans relevant to the property

The key protection measure is the Water Wealth Protection Law, which was promulgated by Royal Decree No. 29/2000. A copy of this Decree (in Arabic) is attached to this nomination as Annex B.

The articles of relevance to the *aflaj*

are the following:

Article 2

The water resources of the Sultanate shall be considered to be the wealth of the nation, the use of which shall be subject to the controls that will be set by the Ministry [of Regional Municipalities, Environment and Water Resources] in order to regulate such resources and their optimal use for the benefit of the comprehensive development plans of the State.

Article 3

The Ministry shall take the necessary actions and measures to prevent deterioration of water quality and quantity in any region of the Sultanate. In the event of any deterioration the Ministry shall take the actions necessary for its control and treatment.

Article 5

It shall be prohibited to undertake any works which may adverse affect the underground recharge of the aquifer whomsoever the owner of the land beneath which the aquifer lies may be.

It shall not be permissible to undertake any work which may change the route of *aflaj* or their facilities without obtaining a permit from the Ministry.

Procedure for aflaj permits

Article 29

Aflaj owners and agents shall obtain a permit from the [Aflaj, Spring and Water Permits] Department before carrying out any enlargement, repairs or maintenance on their *aflaj* (from the *shari'a* to the *falaj* mother well), with the exception of necessary repairs in cases of emergency, provided that the Department shall be notified of such repairs.

Article 30

If it is proved that enlargement or maintenance works have been carried out without a permit, the *falaj* agent and the contractor shall be notified that the work must cease until a permit has been obtained.

In all cases the *Wali* of the Region shall be informed of works carried out on *aflaj* and the *Wali* shall notify the Department of such works.

There are no formal management plans in force for the five *aflaj*. They are managed by the *wakeel* in each case, using the traditional form of management, in close collaboration with shareholders and the local community.

7.c Form and date of most recent records of property

See Annex E – Aflaj Inventory Project Summary Report form (Ministry of Regional Municipalities, Environment and Water Resources ; 2001)

7.d Address where inventory, records and archives are held

Ministry of Regional Municipalities, Environment and Water Resources

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7.e Bibliography

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8.b Official local institution/agency

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Ministry of Regional Municipalities, Environment and Water Resources
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Sultanate of Oman

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8.c Other Local Institutions

The Ministry has Regional Offices in each of the Regions in the Sultanate, from which officials of the Department operate

8.d Official web site

http://www.mrmewr.gov.om

Contact name:

E-mail:

9. SIGNATURE ON BEHALF OF THE STATE PARTY

Signature

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Date 17 - 02 - 2006

ANNEX C Photographs

Falaj Al-Khatmeen

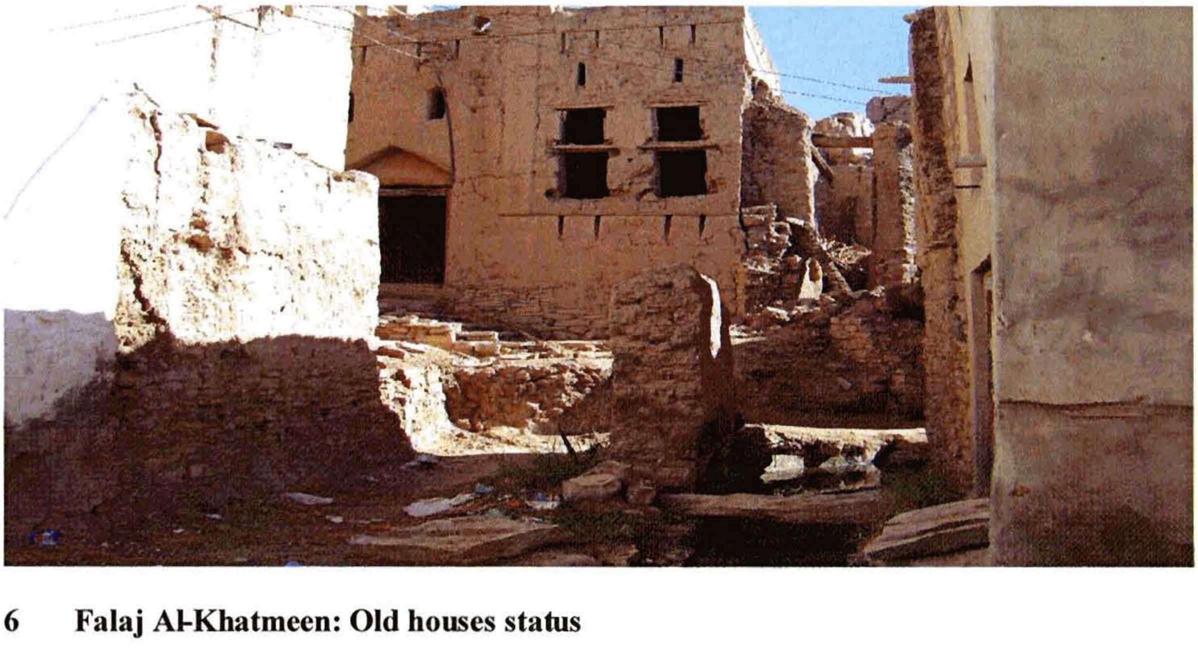
1 Falaj Al-Khatmeen: The *shari'a* passing beneath Bait Al-Redadah Fort

2 Falaj Al-Khatmeen: The *shari'a* passing alongside Bait Al-Redadah Fort

3 **Falaj Al-Khatmeen: Distribution point at the end of the *shari'a***

4 **Falaj Al-Khatmeen: Distribution point, showing division into three equal flows**

5 Falaj Al-Khatmeen: General view of old village and part of the demand area



6 Falaj Al-Khatmeen: Old houses status


7 Falaj Al-Khatmeen: A watchtower overlooking the agricultural demand area

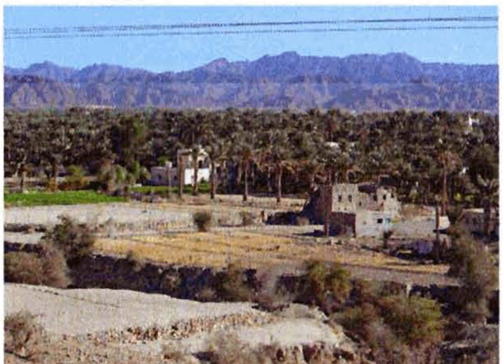

8 Falaj Al-Khatmeen: Renovated and old irrigation water distribution systems

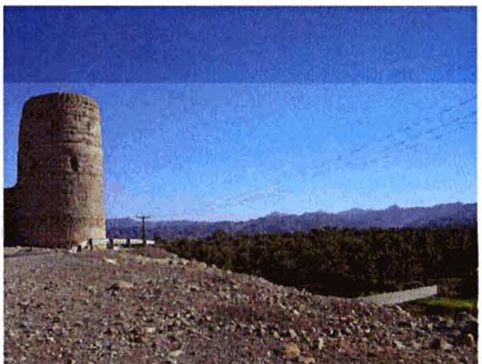
Falaj Al-Malki

Falaj Al-Malki: Distribution point at the end of the *shari'a*

Falaj Al-Malki: Detail of *shari'a*, showing state of conservation

11 Falaj Al-Malki: Irrigation water distribution system



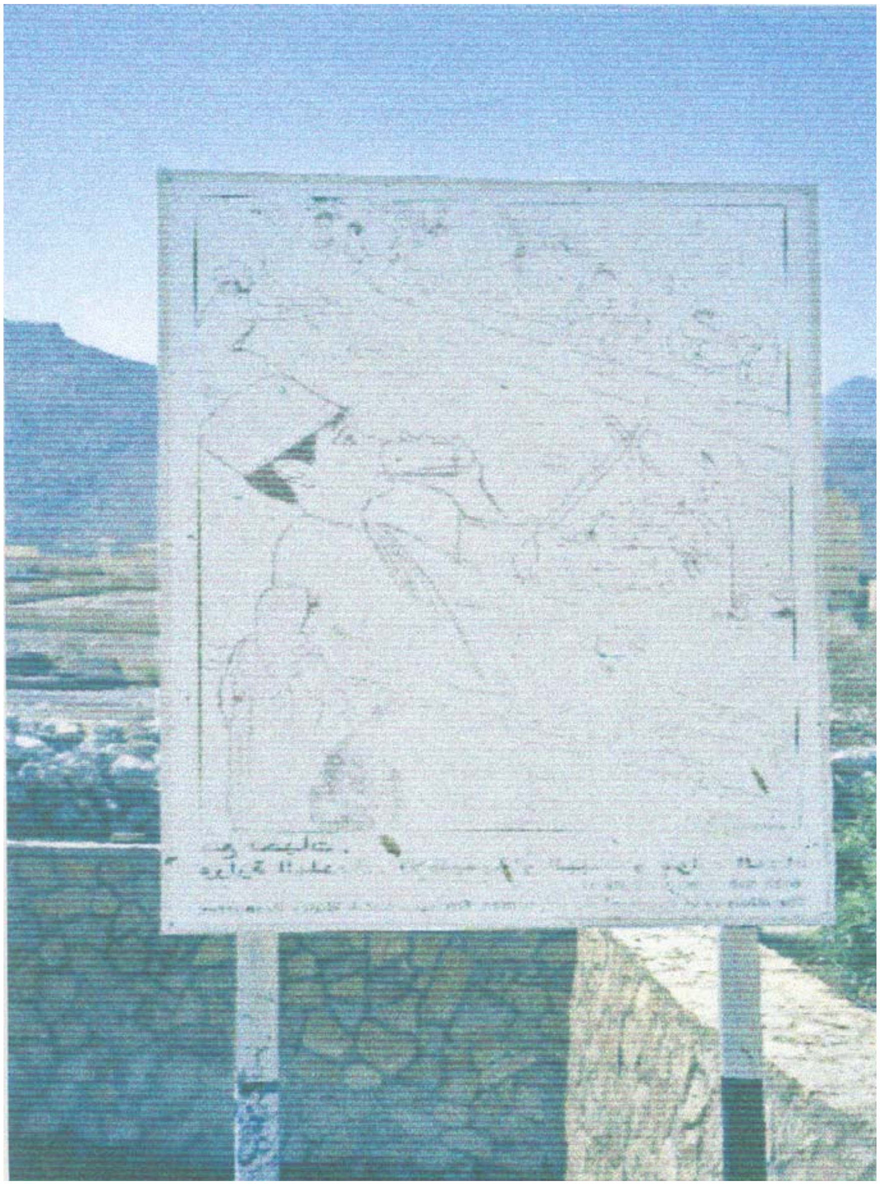


12 Falaj Al-Malki: Traditional houses *(left)* and a watchtower *(right)*

Falaj Daris

Falaj Daris: View of *shari'a,* showing access platform for drawing water for domestic purposes

Falaj Daris: *shari'a*



Falaj Daris: information board at *shari'a*,

16 Falaj Daris: General view of the agricultural demand area

17 Falaj Daris: Advance of modern housing towards the demand area

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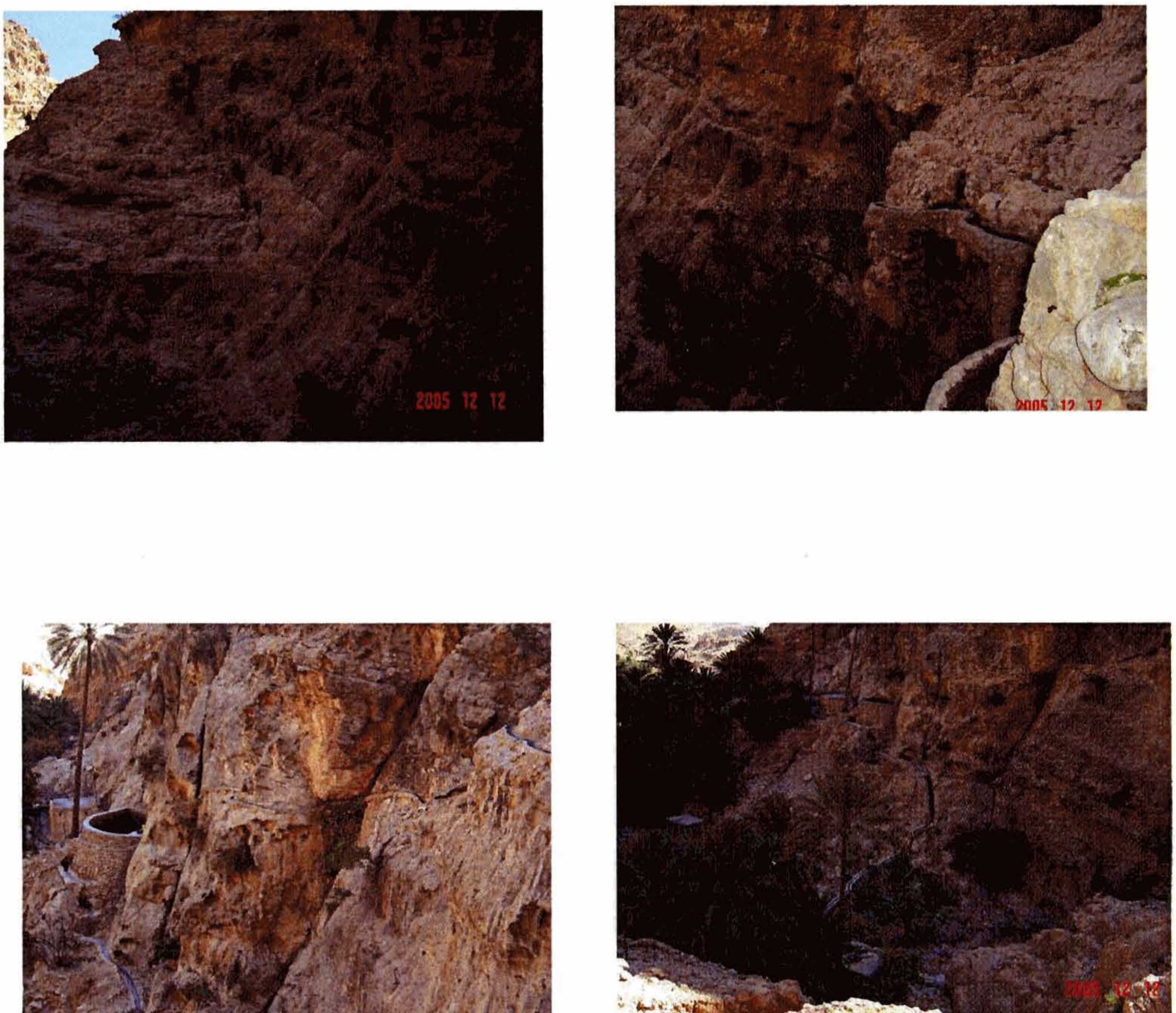
18 **Falaj Al-Jeela: General view of the town** *(left)* **falaj source** *(right)*

19 **Flaj Al-Jeela: The spring from which the** ***falaj*** **is supplied**

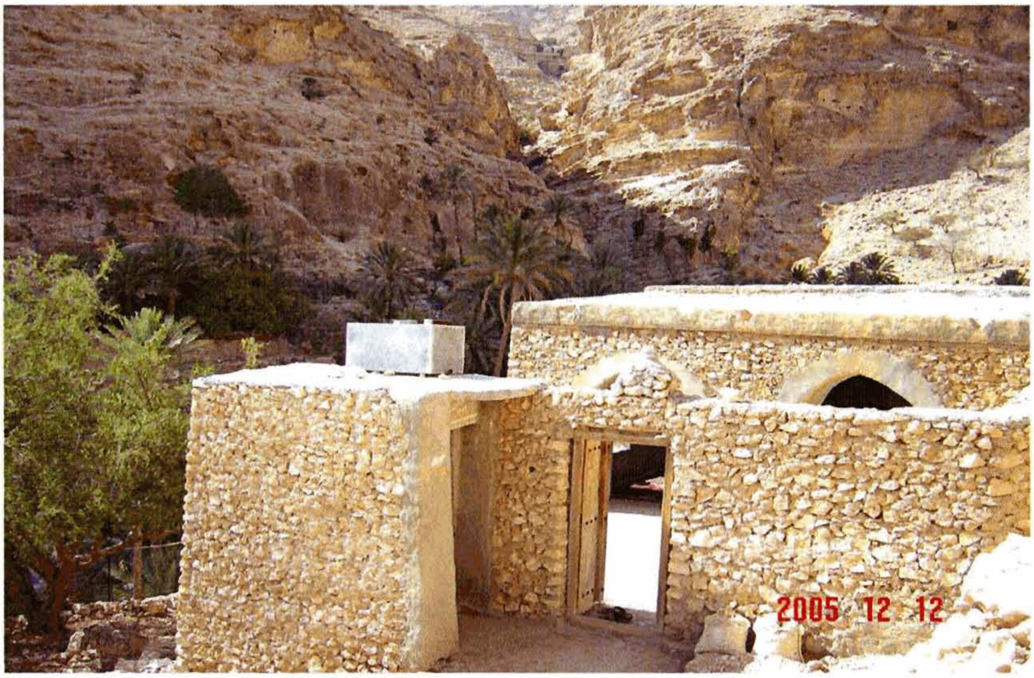


20 **Flaj Al-Jeela: General views of the conveyance open channels system from the spring to the demand area.**

Falaj Al-Jeela

Falaj Al-Jeela: The spring from which the *falaj* is supplied

Falaj Al-Jeela: The open water channel (*left*) and the small aqueduct crossing the wadi (*right*)



23 Falaj Al-Jeela: Old mosque

24 Falaj Al-Jeela: Irrigation water distribution system

Falaj Al-Muyassar

25 Falaj Al-Muyassar: two views of the distributioTn channels of the *shari'a*

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Falaj Construction

Falaj Al-Muyassar

Falaj Al-Muyassar: two views of the distribution channels of the *shari'a*

 

Falaj Al-Jeela: General view of the town (*left*) and the retaining wall for the palm groves (*right*)

Falaj construction

Top of an access channel (*farda*)

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Affixing a inventory plate

Measuring coordinates at a mother well

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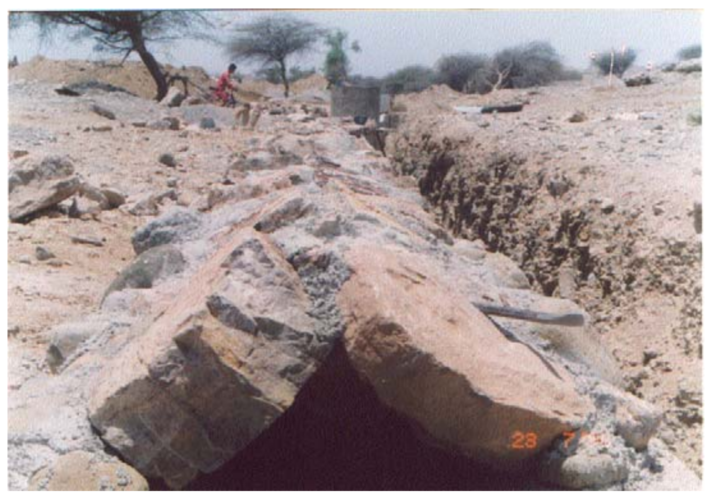
Roofing with flat stone slabs



Roofing using pitched stone slabs

A support Well

Measuring the length of channels

Water quality measurement

A youth work camp

Local citizens working on preserving an *aflaj*

بسم الله الرحمن الرحيم

وجعلنا من الماءِ كل شيء حي

سورة الأنبياء أية رقم [٣٠]

صدق الله العظيم

"We made from water every living thing"
Holy Quran 21:30

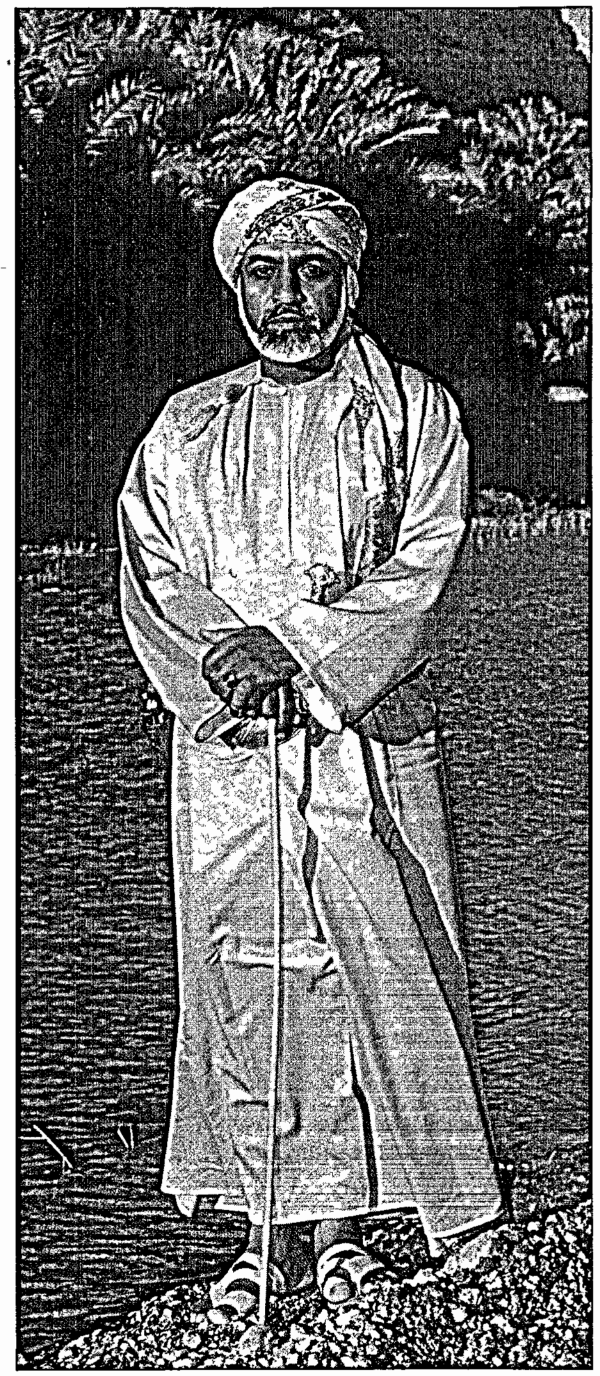
From the speech of
His Majesty Sultan Qaboos bin Said
On the 21st Anniversary of Oman's National Day

18 November 1991

My Dear People,

Of all the gifts which God has blessed us, water is the greatest. It must be cherished and husbanded. Every effort must continue to be made to develop this resource. If extravagance is forbidden by Islam, it is even more applicable to water. Indeed, Islam emphasises in its teaching that it is our duty to conserve it. We cannot stress too strongly the need to observe the conservation measures laid down by the Government in this respect. The use of this vital resource throughout the world can have a great impact on future development strategies, and indeed could become a decisive factor in political tension and thus world security.

Our Government has plans to increase our country's water resources to meet our national requirements without arduously affecting the demands of conservation. These conservation demands will continue to indicate the degree of our people's ability to abide by these measures. Here, we urge you all to cooperate with the Government in implementing these plans and measures. We are confident that you will respond positively to this call.



من نص الخطاب السامي
لحضرة صاحب الجلالة السلطان قابوس بن سعيد المعظم
بمناسبة احتفالات السلطنة بالعيد الوطني الحادي والعشرين المجيد

١٨ نوفمبر ١٩٩١

شعبنا العزيز:

إن المياه ثروة وطنية ينبغي المحافظة عليها والعمل على تنميتها وتطوير مصادرها وهي نعمة كبرى من نعم الله التي يجب شكرها، وعدم الإسراف في استخدامها حتى يبارك المولى عز وجل في مواردها ومصادرها "لئن شكرتم لأزيدنكم" وإذا كان الإسراف مذموماً بوجه عام في الشريعة الإسلامية فانه مذموم بصفة أكبر في استعمال الماء وقد نهى الرسول عليه الصلاة والسلام عن الإسراف في الماء حتى في الوضوء. إن تعاليم ديننا الحنيف تحثنا على الاقتصاد في استخدام المياه، وهي بذلك تعبر عن الأهمية القصوى لهذه الثروة الطبيعية وضرورة المحافظة عليها. لذلك فإننا نؤكد على احترام سياسات الترشيد التي وضعتها الحكومة في هذا المجال من أجل الاستغلال الأمثل لهذا المورد الذي له تأثير بالغ على استراتيجيات التنمية في مختلف دول العالم ومن ثم تكتسب القضايا المتعلقة به بعداً أمنياً وسياسياً خطيراً قد يؤدي إلى توترات دولية.

إن لدى الحكومة خطة لزيادة موارد المياه بالقدر الذي يتناسب وتطلعات السلطنة في هذا المضمار دون أن يعني ذلك التخلي عن سياسات الترشيد التي ستظل هي المؤشر الحقيقي على مدى قدرة المواطنين في الحفاظ على الثروة المائية. ومن هنا فإننا نهيب بكم جميعاً أن تتعاونوا مع الحكومة في تنفيذ الخطط والبرامج الموضوعة في هذا الشأن. ونحن على ثقة تامة من أنكم ستتجاوبون بلا شك مع هذا النداء تأميناً لاحتياجاتنا الكبيرة من المياه سواء للزراعة أو لغيرها من القطاعات.

FOREWORD

Water is a great blessing bestowed by God on Creation Without water there would be no life in any of its diverse forms Where there is water nations progress and develop in various fields because water forms the base for the success and continuity of progress in both developed and developing countries.

It goes without saying that Oman's supply of water is limited. In this respect, Oman is in a similar position to most countries in the Arab world, many of which depend on ground water as the principal source for their water requirements. This limited water supply stems from several factors, including rainfall, water usage, the extent and efficiency of efforts to maintain and develop water resources and the extent to which such efforts find a response.

His Majesty Sultan Qaboos and the Government of Oman focused on water resources from an early date, giving water the attention it deserves. This is evidence of the Sultan's pragmatic and realistic reading of the water situation in Oman and his faith in the vital role it plays.

Such interest continues to progress and keep pace with general developmental circumstances, the changes that have taken place in all development sectors and the concomitant increase in water demand. The Ministry set up to take responsibility for the maintenance and preservation of all Oman's water resources, crowned all previous efforts in this direction.

There are more than 4,000 aflaj in Oman, and they represent a priority for both the Government and the people. The aflaj stand as a symbol of Oman's ancient civilisation, whose importance equals that of the legacy of forts and castles we have inherited. In fact, they are arguably more important at the present time because the aflaj are inseparably linked to the lives of many of Oman's people, for whom agriculture is their livelihood

Owing to their importance, the Ministry initiated a project in 1997 to create an inventory of aflaj in Oman, to collate and document all relevant data on the aflaj accurately for future reference.

This report focuses on the project's activities, and sets out the information collated about the aflaj. As we write this foreword, the importance of the information here collated and the role it will play in facilitating the preservation of this legacy of Oman's ancient civilisation fill us with optimism. We hope that this legacy will continue to flow in future ages, bearing witness to the ingenuity of the Omani people and irrigating more of the date palms that stretch across our land.

Ministry of Regional Municipalities, Environment and Water Resources

تقديم

إن المياه من أجل وأعظم نعم الله على خلقه، ووجودها يعني وجود الحياة بكافة أشكالها، كما أن توفرها يعني رقي الأمم وتقدمها في مختلف جوانب التنمية، كونها تشكل حجر الأساس لنجاح واستمرار أي تنمية في البلدان المتقدمة أو النامية على حد سواء.

ولعله من نافلة الحديث أن نقول إن موارد المياه في السلطنة محدودة، شأنها في ذلك شأن معظم الدول العربية، وكثير من هذه البلدان بما فيها السلطنة تعتمد على المياه الجوفية كمصدر رئيسي لتلبية احتياجاتها من المياه، وهذه المحدودية في المياه مرتبطة بعدة عوامل أهمها: هطول الأمطار، وحجم الاستخدام، وحجم ومدى فاعلية الجهود للحفاظ على هذا المورد الحيوي وتنمية مصادره، ومدى التجاوب مع تلك الجهود.

ولقد كان الاهتمام السامي لحضرة صاحب الجلالة السلطان قابوس بن سعيد المعظم – يحفظه الله – وحكومته الرشيدة المبكر بموارد المياه عند مستوى الأهمية الكبيرة للمياه، وبرهن على قراءة جلالته الحقيقية والواقعية لوضع المياه في السلطنة، وإيمانه العميق بدورها الحيوي.

وكان ولازال ذلك الاهتمام يتطور وفقاً لما تمليه ظروف التنمية الشاملة، والتغيرات التي تشهدها كافة قطاعات التنمية، وما واكبها من زيادة في الطلب على المياه. وما إنشاء الوزارة لتعنى بكافة سبل الحفاظ على موارد المياه في السلطنة إلا تتويجاً لكل الجهود التي سبقت قيام الوزارة.

إن الأفلاج البالغ عددها في السلطنة أكثر من أربعة آلاف فلج تشكل أهمية كبيرة للحكومة والمواطنين، كونها تمثل رمزاً من أهم رموز الحضارة العمانية العريقة، وأهميتها تضاهي أهمية ما ورثناه من قلاع وحصون تاريخية، إن لم نقل أنها تفوق عليهما في الأهمية في الوقت الحاضر، وهي ترتبط بحياة الكثيرين من أبناء هذا الوطن العزيز، ممن تشكل الزراعة مصدر رزق لهم.

وانطلاقاً من أهمية الأفلاج، شرعت الوزارة في عام ١٩٩٧م في تنفيذ مشروع حصر الأفلاج على مستوى السلطنة، لجمع كافة المعلومات والبيانات المتعلقة بها، وتوثيقها بدقة للرجوع إليها عند الحاجة.

وهذا التقرير يسلط الضوء على فعاليات المشروع، والبيانات التي تم جمعها من خلاله عن الأفلاج في السلطنة، وإننا إذ لقدم لهذا المشروع الهام، لننظر بتفاؤل إلى أهمية البيانات والمعلومات التي وفرها عن الأفلاج، ودورها في تسهيل سبل الحفاظ على ذلك الموروث الحضاري العماني، ليبقى شامخاً متدفقاً على مر العصور، وشاهداً على براعة الإنسان العماني، ويروي المزيد من بساتين النخيل الممتدة على مساحات شاسعة من أرض عمان الغالية.

وزارة البلديات الإقليمية والبيئة وموارد المياه

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Note: On 14th May 2001 A Royal Decree No. 47/2001 was issued to merge MWR and MRME

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DEFINITION OF TERMS :

GENERAL DEFINITIONS

Falaj (plural, Aflaj)

A channel dug into the earth or running along the earth's surface that is used to collect ground water, natural spring water, surface water, or to halt and collect flood water. The channel may be covered or open. The water collected in this manner is transported from the source along the channel using only the force of gravity in the direction of the shari'a (q.v.), i.e. no machinery is employed to raise the water.

Falaj System

An integrated system comprising falaj and demand area The system may be limited to one falaj and one demand area; alternatively, it may include more than one falaj and more than one demand area linked by some means of water distribution.

Mother Well (Umm Al-Falaj)

The last access shaft (q.v) to the falaj in the opposite direction to the shari'a (q.v.), where water first begins to flow in the channel (to supply the channel or part of the channel with water) is termed the mother well The level of the water flowing into the mother well must be higher than that of the shari'a for the falaj to continue to flow.

Branch (Al-Sa'id)

A branch of a falaj possessing the same characteristics of a falaj and increasing the amount of water entering the principal channel. The branch joins the falaj at a junction known as the branch junction

Access Shaft (Furda)

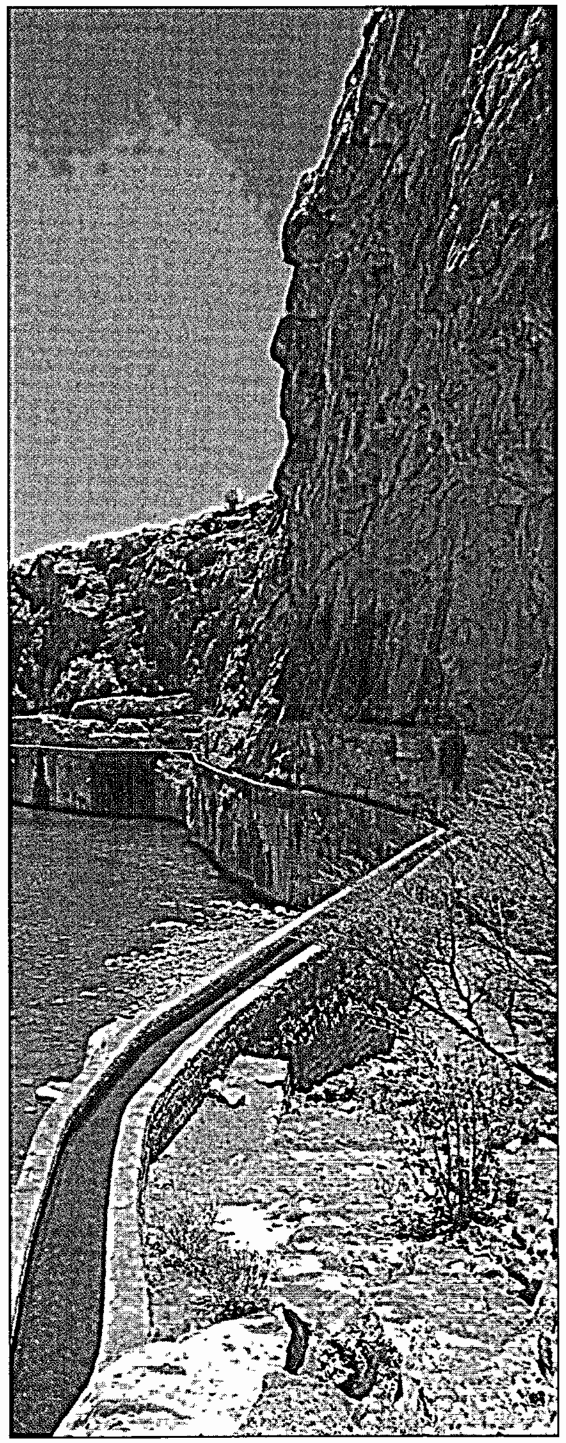
An opening in the form of a vertical shaft linking a covered subterranean falaj channel with the surface. Cleaning, blockage removal, maintenance, repair and periodic supervision are carried out at the access shaft

Shari'a

The point at which water first appears on the surface of the earth, or a point close to the area where the water appears on the surface, in the case of the daudi falaj (q v) The term shari'a is also used to describe the point where water arrives at the demand area or the village benefiting from the water in the case of the aini (q.v.) and ghaili (q.v.) categories of falaj.

Live/Dead Falaj

A falaj is termed "live" when water reaches the shari'a and irrigates existing agriculture dependent on the water The term further includes aflaj whose flow stops suddenly or whose water does not reach the shari'a (q.v.) on account of a collapse or channel blockage A falaj is termed "dead" when it has dried up completely from the mother well (q.v.) to the shari'a, no water has flowed for some time and no existing agriculture is dependent on the water.



تعريف بالمصطلحات المستخدمة :

تعريفات عامة

الفلج

هو قناة محفورة في باطن الأرض أو على سطحها سواء كانت مغطاة أم مكشوفة لتجميع المياه الجوفية أو مياه العيون والينابيع الطبيعية أو المياه السطحية أو اعتراض وتجميع مياه السيول بحيث يتم انتقال المياه المتجمعة من مواردها في قناة الفلج طبيعياً بواسطة قوة الجاذبية الأرضية فقط في اتجاه الشريعة دون استعمال الآلات لرفعها.

نظام الفلج

هو عبارة عن نظام متكامل للفلج يتكون من الفلج ومنطقة الاحتياج، وقد يتكون نظام الفلح من فلج واحد ومنطقة احتياج واحدة وقد يحوي نظام الفلج أيضاً أكثر من فلج وأكثر من منطقة احتياج ترتبط فيما بينها بطريقة معينة لتوزيع المياه.

أم الفلج

آخر فرضة على الفلح في عكس اتجاه سريان مياهه يبدأ عندها دخول المياه إلى قناته (لإمداده بالمياه أو جزء منها) ويجب أن يكون منسوب المياه بها أعلى من الشريعة حتى يستمر الفلج في الجريان.

الساعد

فرع من الفروع له نفس صفات الفلج التي تساعد على زيادة كمية المياه الداحلة إلى القناة الرئيسية ويلتقي الساعد معها عند فرضة تسمى فرضة ملتقى السواعد.

الفرضة

عبارة عن فتحة على هيئة ثقب رأسي يصل بين قناة الفلج المغطاة تحت الأرض وبين سطح الأرض، ويتم من خلالها إجراء عمليات تطيف وإزالة الكبس والصيانة والإصلاح والمتابعة الدورية.

الشريعة

هي أول مكان لظهور المياه على سطح الأرض أو قريباً منه بالسبة للفلج الداؤودي وهو كدلك مكان وصول الماء إلى منطقة الاحتياج أو القرية المستفيدة بالنسبة للأفلاج العينية والغيلية.

فلج حي/ميت

يسمى الفلج فلجاً حياً عدما تصل مياهه إلى الشريعة ويروي زراعات قائمة تعتمد عليه كما يشمل أيضاً تلك الأفلاج التي تنقطع فحأة عن الجريان ولا تصل المياه إلى الشريعة بسبب انهيار فلجي أو كبس قناته. أما الفلج الميت فهو فلج جاف تماماً من الأم وحتى الشريعة وانقطع عن الجريان منذ فترة طويلة ولا توجد زراعات قائمة تعتمد عليه.

DEFINITION OF TERMS :

AFLAJ TYPES

تعريف بالمصطلحات المستخدمة :

أنواع الأفلاج

Daudi

A falaj that draws water from significant subterranean depth is termed daudi. Usually, the flow continues without being significantly affected by the changes of season at the locale A falaj is termed daudi when at least one subsidiary branch conforms to the definition.

Aini

A falaj that draws water from one or more natural springs is termed aini. The water flows from springs into the falaj channel, which transports it to agricultural land. A falaj is termed aini when at least one subsidiary branch conforms to the definition and when there are no branches that conform to the definition of a daudi

Ghaili

A falaj that draws water from a wadi, from water flowing on the surface of the earth, or from subsurface water close to the surface of the earth in wadi channels or at the foot of mountains A falaj is termed ghaili when it depends only on a subsidiary branch or branches that conform to the definition

داؤودي (عدّي)

وهو ذلك الفلج الذي يستمد مياهه على عمق كبير من سطح الأرض وغالباً يستمر تدفقه دون تأثير كبير بفترات المحل، ويسمى الفلج فلجاً داؤودياً إذا كان يوجد به ساعداً داؤودياً واحداً على الأقل.

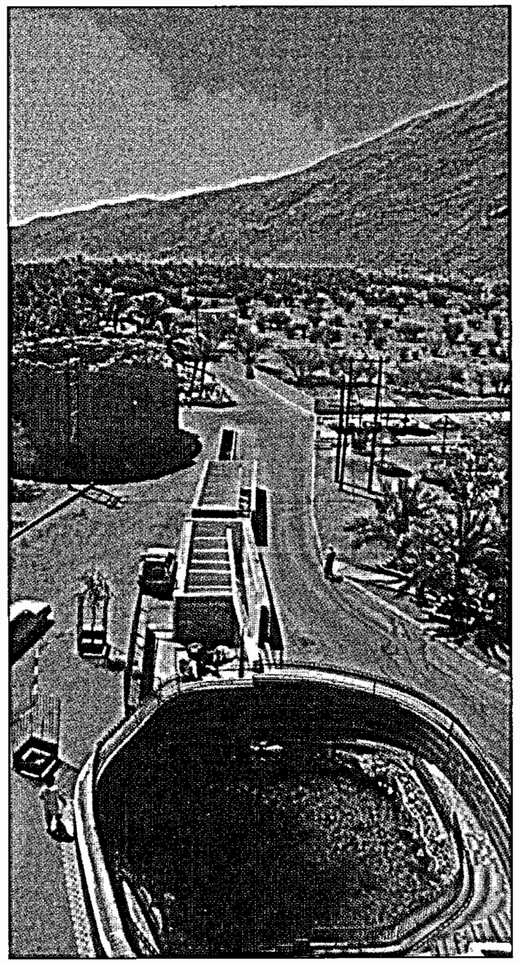
عيني

يستمد مياهه من ينبوع أو عين طبيعية أو مجموعة عيون تتدفق منها المياه وتنساب في قناة الفلج إلى الزراعات، ويسمى الفلج فلجاً عينياً إذا وجد به ساعداً عينياً واحداً على الأقل مع عدم وجود ساعد/سواعد داؤودية.

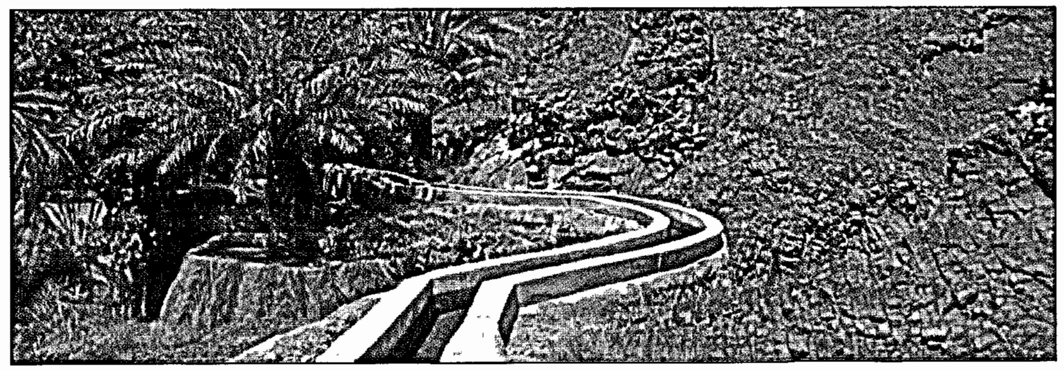
غيلي

يستمد مياهه من غيول الأودية أو من المياه السطحية الجارية على سطح الأرض أو من المياه تحت السطحية بالقرب من سطح الأرض في مجاري الأودية أو على سفوح الجبال، ويسمي الفلج غيلياً إذا كان يعتمد فقط على ساعد/سواعد غيلية.

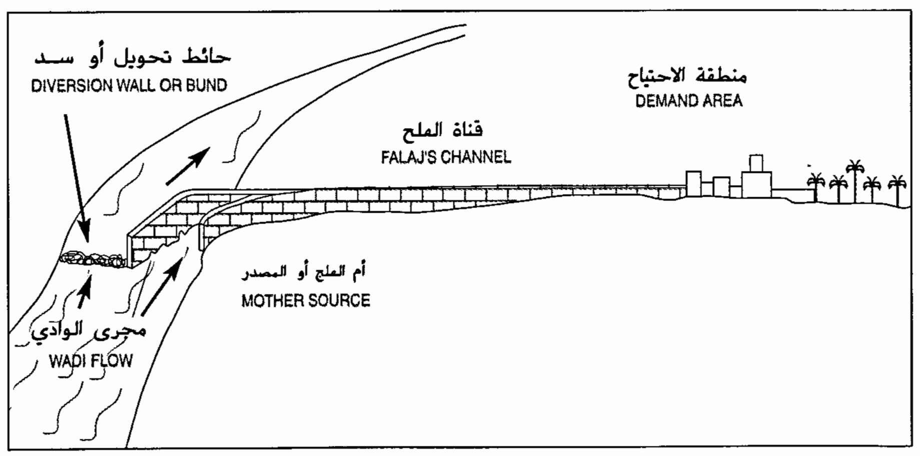
Ghaili Falaj الفلج الغيلي

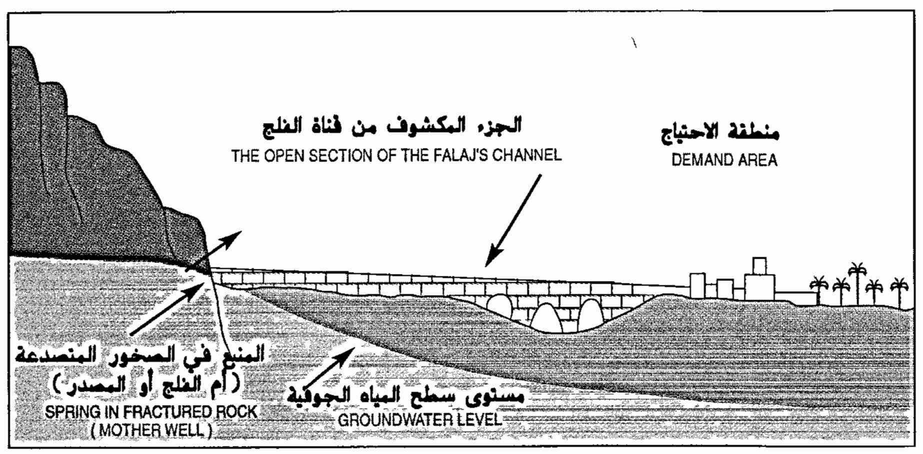


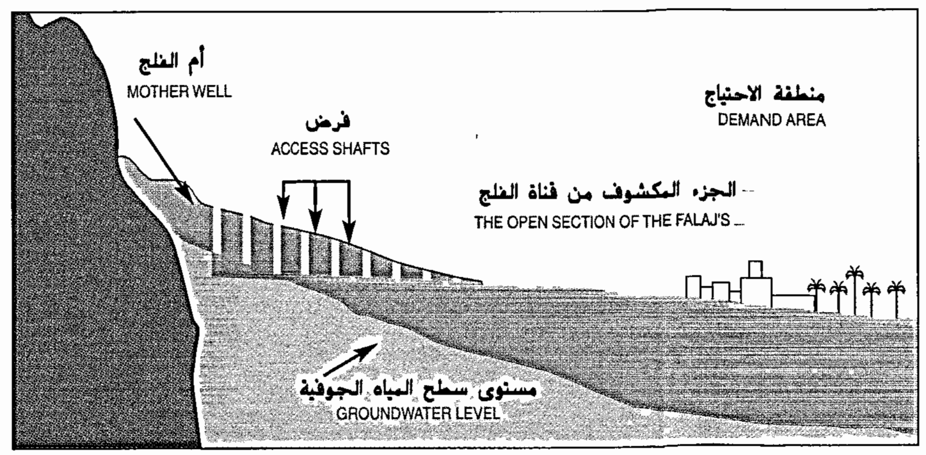
Aini Falaj الفلج العيني



Daudi Falaj الفلج الداؤودي







PART 1 :
OVERVIEW

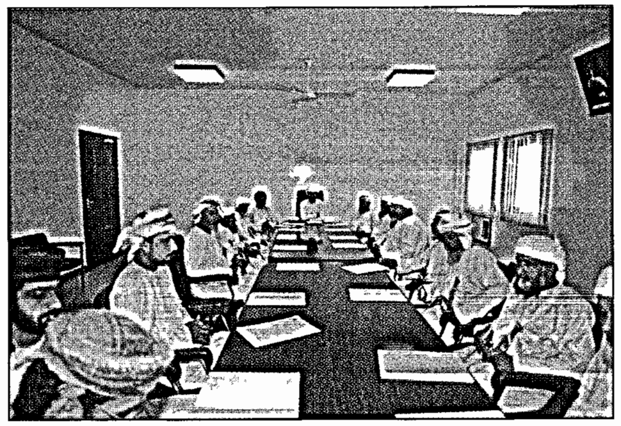
الجزء الأول :
مقدمة عامة

The Ministry's Role in the Project

The Omani Government believes the preservation, development and management of water resources to be a key element in the agricultural, industrial and urban development of the country and has done so since the dawn of Oman's recent renaissance. Its interest in this field resulted in the establishment of the Ministry of Water Resources, which was empowered to protect Oman's water resources and provide guidance on water conservation.

To enable the Ministry to draw up a comprehensive plan to meet the end for which it was established, a reliable reference of scientific information was required, on which it could draw when taking measures to ensure the success of the Water Resources Comprehensive Development Plan. The Ministry took the initiative to collate water-related information as part of a database, including ground and surface water research. It further conducted a well inventory project - a pioneering step that represents one of the Ministry's key achievements

To complete the information on Omani water consumption, the Ministry needed to deal with the other aspect of natural water supplies, namely the aflaj, and give them the same level of attention. In Oman aflaj represent the sole water source for some communities, who depend on them for all their water, including agricultural, livestock and domestic requirements. The Ministry therefore commenced implementation of the Aflaj Inventory Project and made available everything necessary for the Project to succeed and realise its aims



قامت الوزارة بحملات إعلامية توعوية مكثفة للتعريف بالمشروع وأهدافه

The Ministry mounted an intensive information awareness campaign about the Project and its aims

الوزارة والمشروع

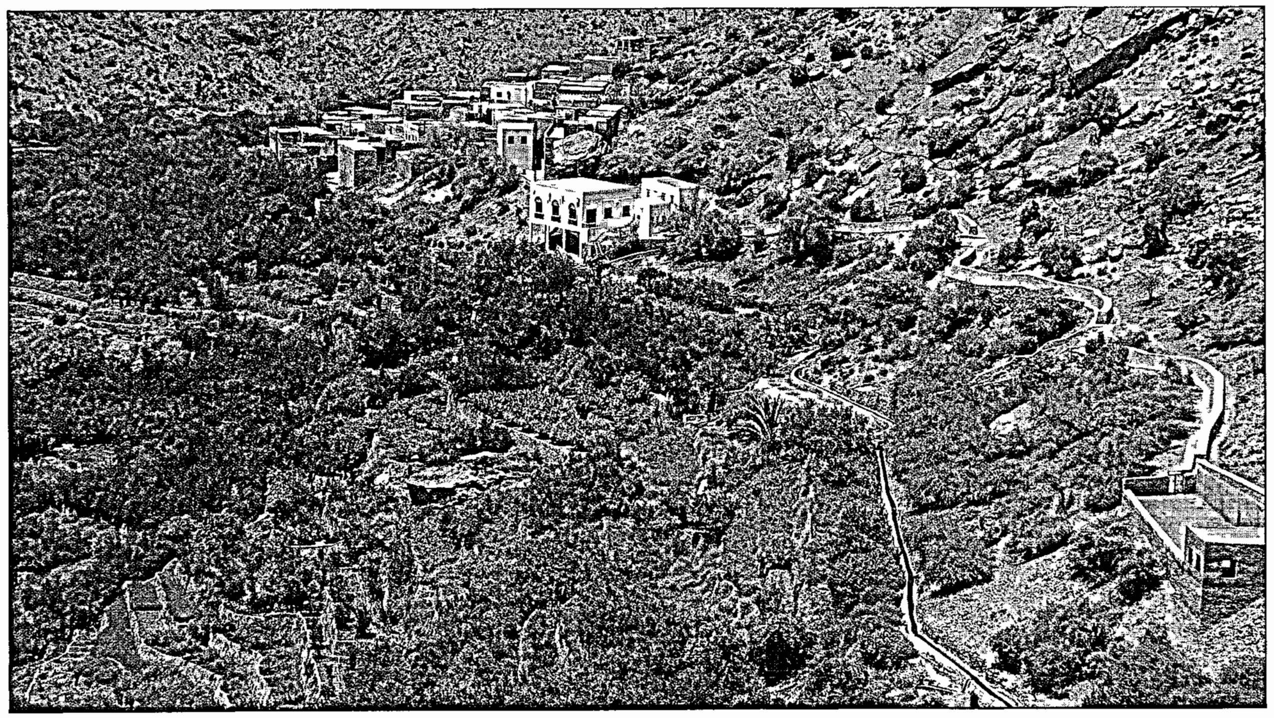
منذ فجر النهضة المباركة، أولت الحكومة الرشيدة مسألة توفير وتنمية وإدارة موارد المياه كعنصر حيوي على صعيد التنمية الزراعية والصناعية والعمرانية، اهتماماً بارزاً توجته بإنشاء وزارة موارد المياه التي أنيط بها حماية مصادر المياه في السلطنة وترشيد استهلاكها.

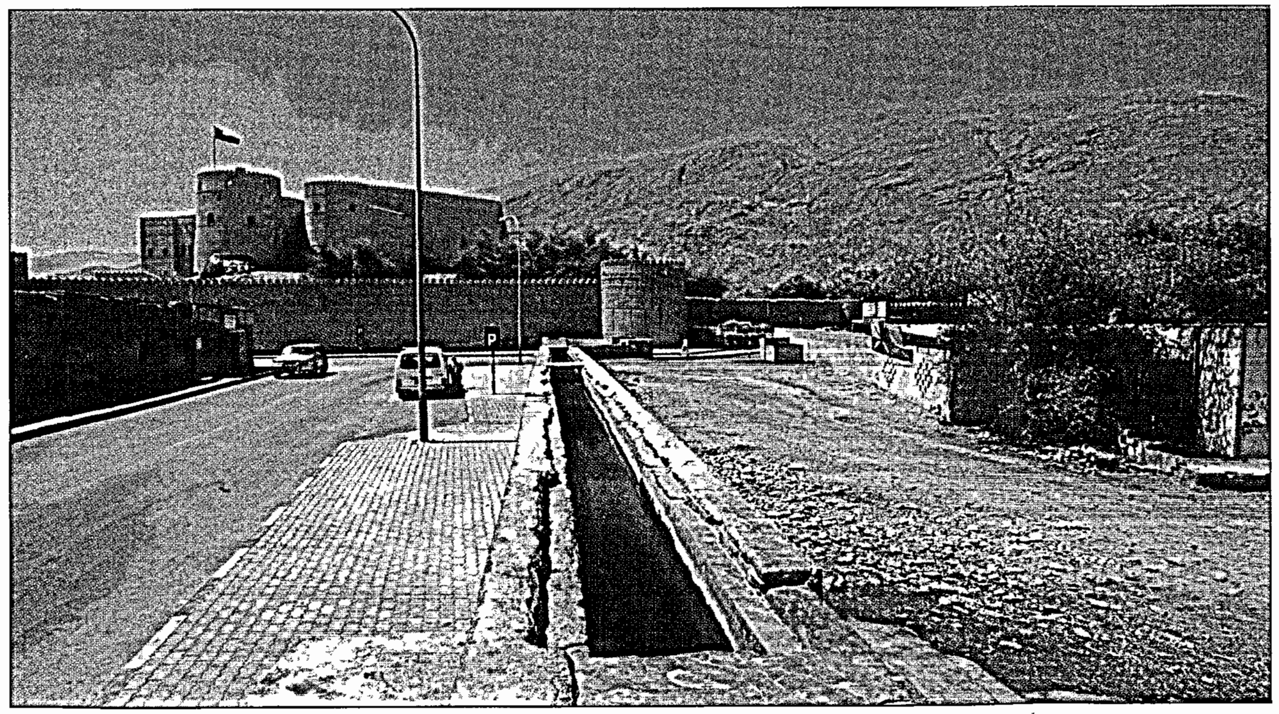
وحتى تتمكن الوزارة من وضع خطة شاملة لتنفيذ الغرض الذي أنشئت من أجله، كان عليها خلق مرجعية بيانية علمية موثوقة تعتمد عليها في اتخاذ التدابير الكفيلة بإنجاح الخطة الشاملة لتنمية الموارد المائية فعكفت على جمع البيانات والمعلومات المتعلقة بالمياه وذلك باستحداث قاعدة للبيانات لتشمل دراسات وبحوث المياه الجوفية والسطحية وقامت بتنفيذ مشروع حصر الآبار ذلك العمل الرائد الذي يعتبر من الإنجازات المهمة للوزارة.

واستكمالاً للبيانات المتعلقة بالمياه المستهلكة كان لابد للوزارة أن تولي الشق الآخر من روافد الاستهلاك وهو الأفلاج نفس القدر من الاهتمام، فالفلج في البيئة العمانية يمثل المصدر المائي الأوحد لبعض من المجتمعات التي تعتمد عليه اعتماداً كلياً في سد احتياجاتها المائية لجميع الأغراض الزراعية وسقي الحيوانات والاستخدامات المنزلية الأخرى. ومن هذا المنطلق شرعت الوزارة في تنفيذ مشروع حصر الأفلاج وسخرت له كل الإمكانيات لإنجاحه وتحقيق أهدافه.

Aflaj in the Sultanate of Oman are closely linked to nature and the people

الأفلاج في سلطنة عمان مرتبطة ارتباطاً وثيقاً بكل من الإنسان والطبيعة





PART 1 :
OVERVIEW

الجزء الأول :
مقدمة عامة

Objectives and Results

The goal of the Aflaj Inventory Project was to create a reliable database of aflaj in Oman, and to link that information to the Central Database at the Ministry The aflaj database comprises the following:

- the location and depth of mother well, other falaj features and source type.
- the route of subsidiary channels, the location and depth of access shafts
- aflaj discharge rate.
- information about water quality (salinity, pH, temperature) and a complete analysis of major ions.
- data on the overall size of the demand area, cropped area, developed uncropped area and undeveloped area.
- information on the condition of the channel and flow nature.
- an estimate of consumption, demand and usage purpose

The results of the project revealed that one third of Oman's total water consumption is provided by aflaj, thereby confirming their importance as a source of water in the country. The management and conservation of aflaj water is thus a key priority. The evaluation and analysis of the data collated on the aflaj achieved the following:

1 Assisted in the drafting of a water policy to meet developmental needs
2 Aided in the observation of potential changes to aflaj as a result of continued pumping or activities that might pollute the aflaj.
3 Helped the Ministry to estimate the scale of demand for water provided by aflaj and to formulate a program of maintenance priorities

Fixing an inventory number to one of the Aflaj

تثبيت رقم الحصر على أحد الأفلاج

الأهداف والنتائج

يهدف مشروع حصر الأفلاج إلى استحداث قاعدة بيانات مائية موثوقة للأفلاج بالسلطنة وربطها بقاعدة البيانات المركزية بالوزارة، وهذه القاعدة للبيانات تشمل الآتي:

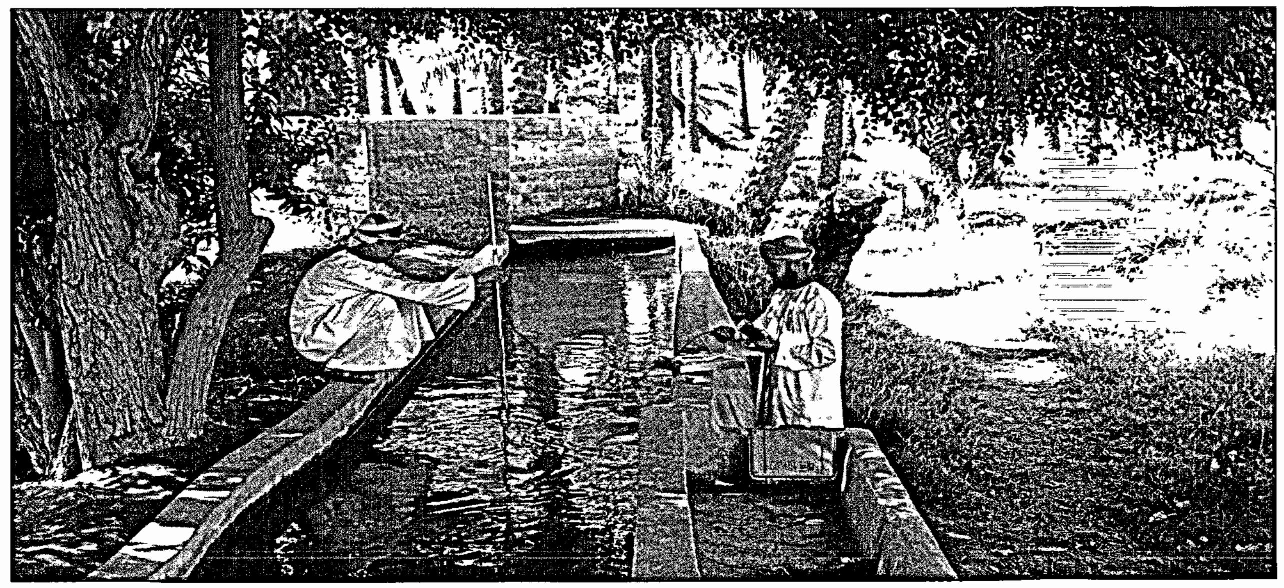
- مواقع أمهات الأفلاج وأعماقها ومعالم الفلج الأخرى وتحديد نوع المصدر.
- مسارات السواعد ومواقع الفرض وأعماقها.
- معدل تدفق الأفلاج.
- بيانات عن نوعية المياه (الملوحة، درجة الحامضية، درجة الحرارة) إضافة إلى تحليل شامل للعاصر الرئيسية للمياه.
- بيانات عن مساحة منطقة الاحتياج الكلية والمساحة المزروعة والمساحة المستصلحة الغير مزروعة والمساحة عير المستصلحة.
- بيانات عن حالة القناة وطبيعة الجريان.
- تقديم بيانات تقديرية عن حجم الطلب وتحديد العرض من الاستخدام.

أوضحت نتائج المشروع أن حوالي ثلث حجم الاستهلاك المائي الكلي في السلطنة يأتي عن طريق الأفلاج الأمر الذي يؤكد أهميتها كمصدر هام من مصادر المياه بالسلطنة، وبالتالي فإن إدارة وترشيد مياه الأفلاج يعتبر من أهم الأولويات التي ينبغي الإهتمام بها. وقد أتاح تقييم وتحليل البيانات المجمعة عن الأفلاج تحقيق الآتي:

١– ساهمت في وضع سياسة مائية رشيدة تخدم أغراض التمية.
٢– ساعدت في مراقبة التغيرات التي قد تطرأ على الأفلاج نتيجة للضخ المتزايد أو الأنشطة المختلفة التي قد تؤدي إلى تلوث الأفلاج.
٣– ساعدت الوزارة على تقييم حجم الطلب على المياه المتوفرة من الأفلاج ووضع برنامح وأولويات صيانتها.

Measuring Aflaj discharge rate

قياس معدل تدفق الأفلاج



PART 1 :
OVERVIEW

Inventory Requirements

Given the importance of the project and the information collated, from the outset the Ministry devoted full attention to the project and made available every resource, in order to guarantee the success of the project and to ensure it met the objectives set. The Ministry benefited greatly from the experience gained during the Well Inventory Project, which was carried out from December 1992 to December 1995. A total of 134 staff from Ministry departments and offices were seconded to work on the Aflaj Inventory Project, most had previously worked on the Well Inventory Project and had prior practical experience. This enabled them to complete the tasks required by this pioneering project to the fullest extent

Forty Five field teams were formed for the purpose of collating information. All personnel were Omani nationals, trained to collate information about the aflaj and complete the field forms correctly The field teams were distributed in the Water Resources Departments within the various regions of the country, according to the number of aflaj in each region.

The Aflaj Inventory Project used equipment, machinery and vehicles from Well Inventory Project (after maintenance had been carried out and fitness for use confirmed). This saved the Ministry much time and money

Vehicles and equipment used for inventory field operations

السيارات والأجهزة المستخدمة في عمليات الحصر الميداني

الجزء الأول :
مقدمة عامة

متطلبات العمل

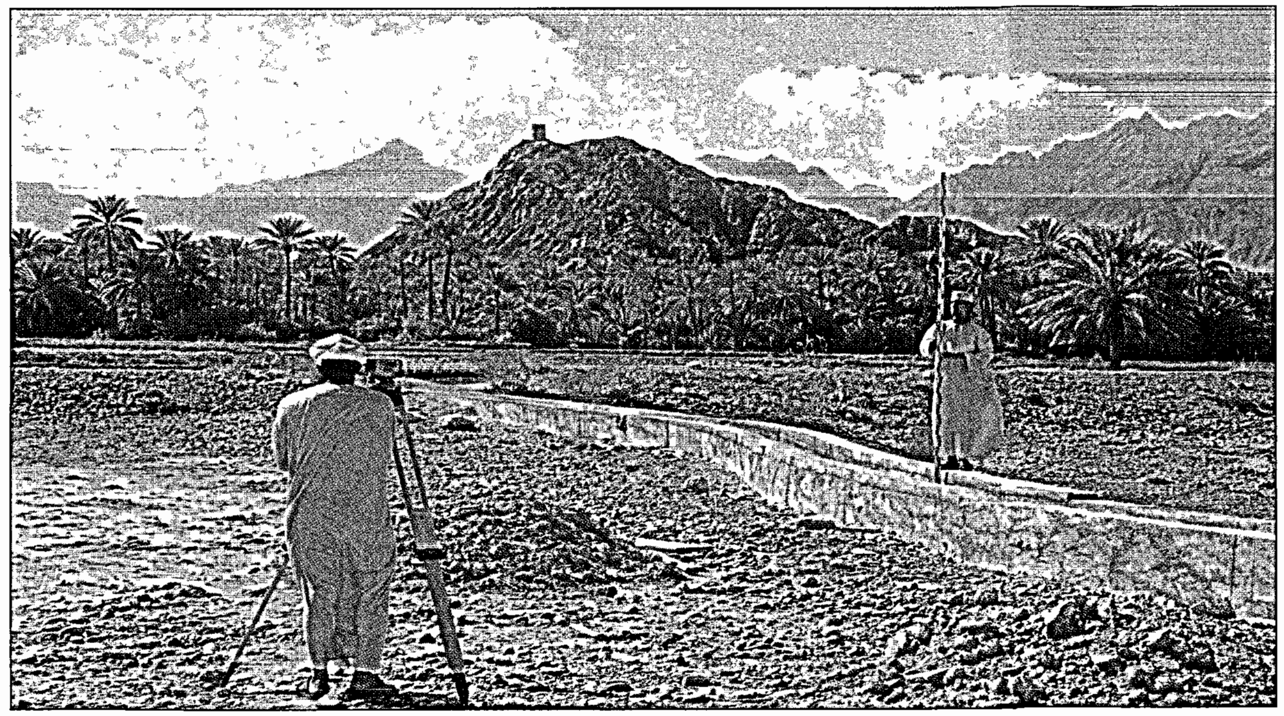
نظراً لأهمية مشروع حصر الأفلاج وأهمية البيانات المتعلقة به فقد أولت الوزارة هذا المشروع منذ البداية جل اهتمامها وسخرت له كل الإمكانيات المتاحة ضماناً لنجاحه وتحقيق الأهداف التي نفذ من أجلها. وقد استفادت الوزارة كثيراً من معطيات مشروع حصر الآبار الذي نفذ حلال الفترة من ديسمبر ١٩٩٢م ولغاية ديسمبر ١٩٩٥م، حيث تم انتداب ١٣٤ موطفاً من دوائر وإدارات الوزارة للعمل بمشروع حصر الأفلاج، معطمهم ممن سبق لهم العمل بمشروع حصر الآبار والدين اكتسبوا الخرة والتجربة العملية إبان تنفيذ ذلك المشروع الرائد مما ساعدهم كثيراً على القيام بالأعمال الموكلة إليهم على أكمل وجه.

ولقد تم تشكيل ٤٥ فريقاً ميدانياً لعمليات الحصر جميعهم من العمانيين الدين تم إعدادهم وتدريبهم على عملية جمع البيانات عن الأفلاج وتعبئة الاستمارات الحقلية بالصورة الصحيحة. وقد تم توزيع الفرق الحقلية على إدارات موارد المياه بالمناطق حسب كثافة الأفلاج في كل مطقة.

استخدم مشروع حصر الافلاج الأجهزة والمعدات والسيارات التي تم توفيرها من مشروع حصر الآبار وذلك بعد صيانتها والتأكد من صلاحيتها للاستحدام مما وفر على الوزارة الكثير من الوقت والمال.

Training staff for inventory activities

تدريب الموظفين على عمليات الحصر



PART 2 :
DESCRIPTION OF PROJECT ACTIVITIES

Inventory Activities

The locations of the aflaj mother wells and branches were determined using Global Positioning System technology, which determines location by reference to satellites. The differential mode was adopted in order to accurately and reliably determine the aflaj location Maps - topographical, aerial-photo and other - were also used.

All aflaj branches were surveyed and the necessary measurements taken; for example, total length, route and junctions with the falaj principal channel. Flow readings for every live falaj were taken in order to determine the total annual flow for aflaj water for comparison with annual consumption (for the aflaj demand areas).

A sample of water was taken from live aflaj and analysed in the field to determine the water quality in terms of temperature, pH and salinity. A second sample was sent to the Ministry Laboratory for further chemical analysis

Various typical aflaj were selected for each aflaj size and type, to represent aflaj in a specific area A detailed and comprehensive survey was carried out on the selected areas. Measurements were taken for the cropped area and water requirement for each individual crop calculated. Irrigation methods in each demand area were recorded in detail for the purpose of evaluating efficiency of water use and to reach a realistic figure when calculating the total water demand in areas dependent on aflaj.

Determining mother well location by GPS

تحديد مواقع أمهات الأفلاج باستخدام جهاز تحديد المواقع (GPS)

الجزء الثاني :
وصف مجالات العمل

أنشطة الحصر

حددت مواقع أمهات الأفلاج والسواعد باستخدام أجهزة تحديد المواقع التي تعمل على أساس تقنيات الأقمار الصناعية وتم إدخال النظام التفاضلي لتحديد مواقع الأفلاج وذلك للحصول على إحداثيات دقيقة يمكن الاعتماد عليها وكذلك تمت الاستعانة بالخرائط – الطوبعرافية والصور الجوية والخرائط الأخرى.

مسحت حميع سواعد الأفلاج وأخذت القياسات اللازمة مثل أطوالها الكلية ومساراتها ونقاط إلتقائها مع القناة الرئيسية للفلج وأخذت قياسات التدفق لكل فلج من الأفلاج الحية من أجل معرفة حجم التدفق الإحمالي السنوي لمياه الأفلاج ومقارنته بحجم الاستهلاك السوي (لمناطق الاحتياج التابعة للأفلاج).

كما أحدت عينات من مياه الأفلاج الحية وتم تحليلها في الحقل لمعرفة نوعية المياه من حيث درجة الحرارة ودرحة الحامضية والملوحة، وأرسلت عينات أحرى إلى مختر الوزارة لإجراء بقية التحاليل الكميائية عليها.

اختيرت مناطق مثالية لأفلاج متنوعة من حيث المساحة وأنواع الأفلاج بحيث تمثل الأفلاج في منطقة محددة، وتم مسح هذه المناطق المختارة مسحاً تفصيلياً شاملاً إذ أخذت قياسات المساحة المرروعة لكل محصول على حده وحسبت احتياجاتها المائية، وسُحلت تفاصيل الطرق المتبعة في الري بكل منطقة احتياج وذلك بهدف تقييم كفاءة استحدام المياه للوصول إلى تقدير أقرب للواقع عند احتساب الاحتياحات المائية الكلية للمناطق المعتمدة على الأفلاح.

Field measurements and taking samples of Aflaj water

القياسات الحقلية وأحذ عينات مياه الأفلاح

PART 2 :
DESCRIPTION OF PROJECT ACTIVITIES

Data Processing

The success of any large project relies wholly on the accuracy and quality of the data it provides. Many human and material resources were thus made available to the project. Native Omani cadres well-trained in data processing operations took part in data entry and quality control. Experts specialising in the configuration and design of computer systems were also employed.

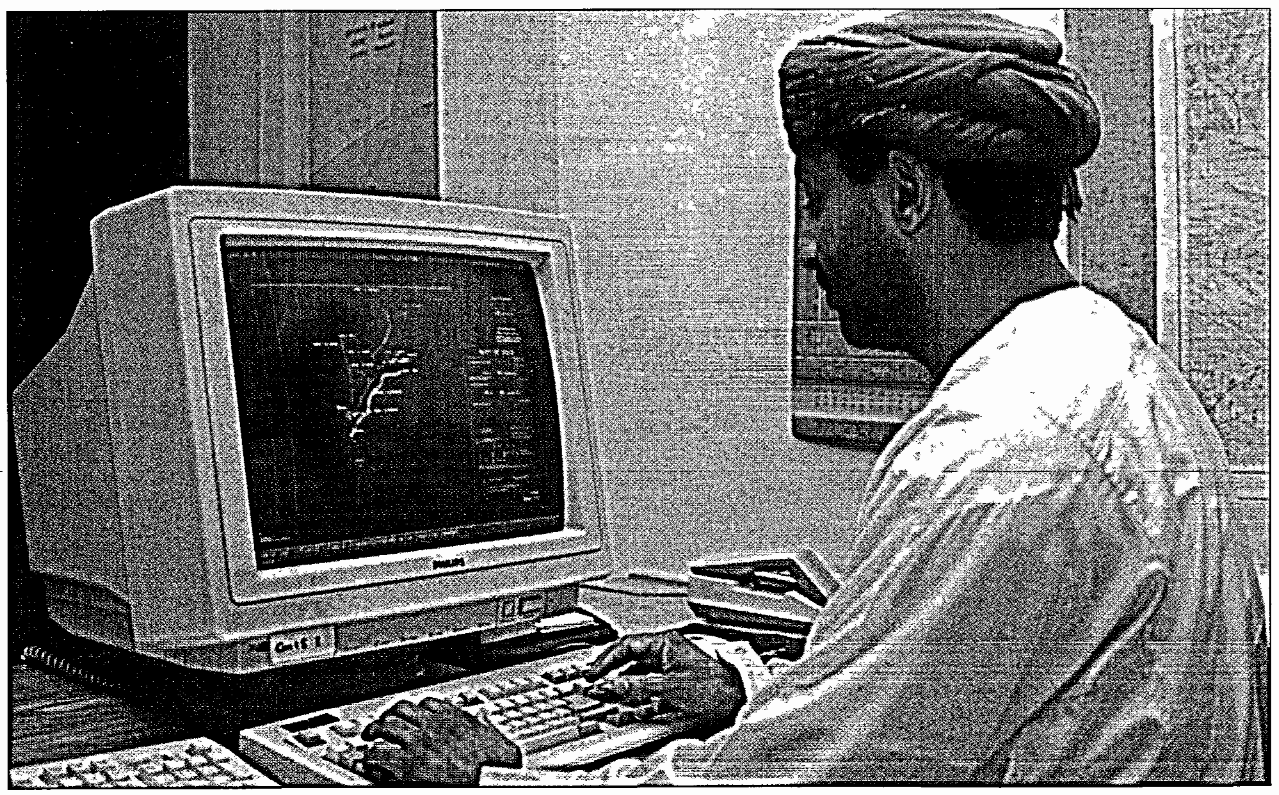
The data collated on the inventory forms were subject to a preliminary check and then input to a computer configured and designed for this purpose. The accuracy of the input process was checked.

Data input was further subjected to a series of stages of automated quality control to establish the accuracy of the collated data and to correct technical errors that were not detected during the preliminary review.

The first stage checked aflaj names and other documentary data, and confirmed that all the required data was present The second stage data checked for technical conformity and confirmed the absence of any internal contradiction that might affect data accuracy The third stage verified that the data could be plotted on the computer and that all the data necessary for this purpose was available

Plotting Aflaj systems using AutoCAD

رسم أنطمة الأفلاج باستخدام نظام الأوتوكاد



الجزء الثاني :
وصف مجالات العمل

معالجة البيانات

ولأن نجاح هدا المشروع الكبير يعتمد اعتماداً كلياً على دقة وجودة البيانات التي سيوفرها فقد سخرت له الكثير من الإمكانيات البشرية والمادية، فقد شارك في عمليات إدخال وضبط جودة البيانات كوادر وطنية مدربة تدريباً جيداً على عمليات معالجة البيانات كما تمت الاستعانة بخبراء مختصين في مجال إعداد وتصميم نظم الحاسب الآلي.

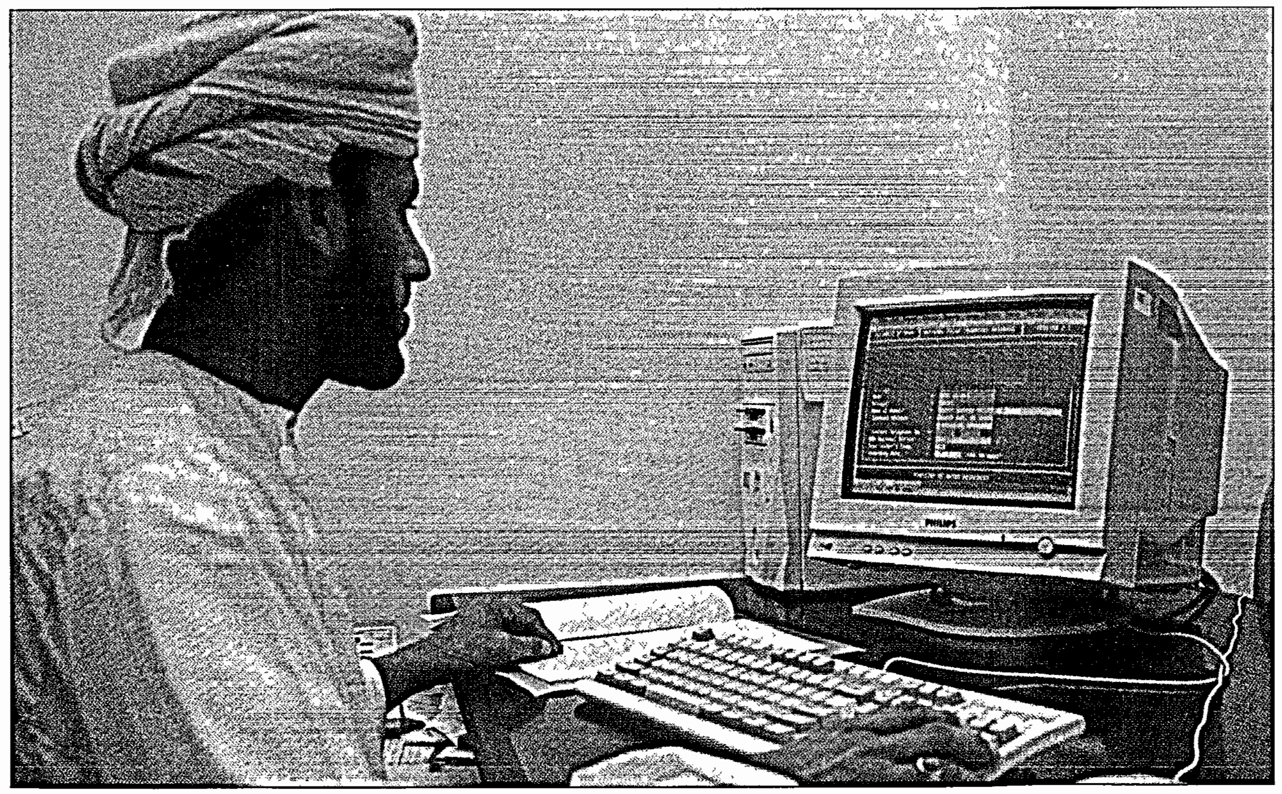
أحضعت البيانات المجمعة في استمارات الحصر إلى مراجعة أولية ثم أدحلت اليانات في نظام حاسب آلي تم إعداده وتصميمه خصيصاً لهذا العرض، وتم التأكد من صحة إدخالها بالحاسب الآلي.

وقد أجريت على البيانات المدخلة سلسلة من المراحل المتعلقة بضبط الجودة باستخدام جهاز الحاسب الآلي وذلك للتأكد من صحة ودقة البيانات المجمعة ولتصحيح الأخطاء الفنية التي لم يتم اكتشافها حلال المراجعة الأولية للاستمارة.

ففي المرحلة الأولى تم التدقيق على أسماء الأفلاح والبيانات التوثيقية الأحرى، وتم التحقق من توفر جميع البيانات المطلوبة عن الأفلاج. وفي المرحلة الثانية تم التحقق من توافق البيانات من الناحية الفنية والتأكد من عدم وجود تضارب قد يؤثر على دقتها. وفي المرحلة الثالثة تم التحقق من إمكانية رسمها على جهاز الحاسب الآلي وتوفر كل اليانات المطلوبة لذلك الإجراء.

Data quality control

ضبط جودة البيانات



PART 2 :
DESCRIPTION OF PROJECT ACTIVITIES

الجزء الثاني :
وصف مجالات العمل

Report Preparation

After the confirmation of accuracy and completeness of data, the project published a report on each individual falaj system containing the most important data; for example, general information, specifications, water quality measurements, channel length, supporting wells, size of demand area, and an estimate of the water demand The demand for water from the aflaj was estimated for each demand area, using the results of the detailed survey and analysis. The total demand of areas dependent on aflaj water was thus conducted on a proper basis. Ministry specialists and experts were employed to obtain the optimum results.

The routes and features of the aflaj were plotted using a special AutoCAD system, which showed the location of mother wells, branch routes, demand areas and other falaj features. These plots are one result of the project that confirms the veracity and accuracy of the collated data.

Attached in the Appendix sample of falaj system reports and plots.

The Ministry published booklets containing aflaj statistics and lists for the Sultanate. These booklets contain aflaj names, inventory numbers, villages benefitting from aflaj, aflaj type and status, and mother well coordinates

إعداد التقارير

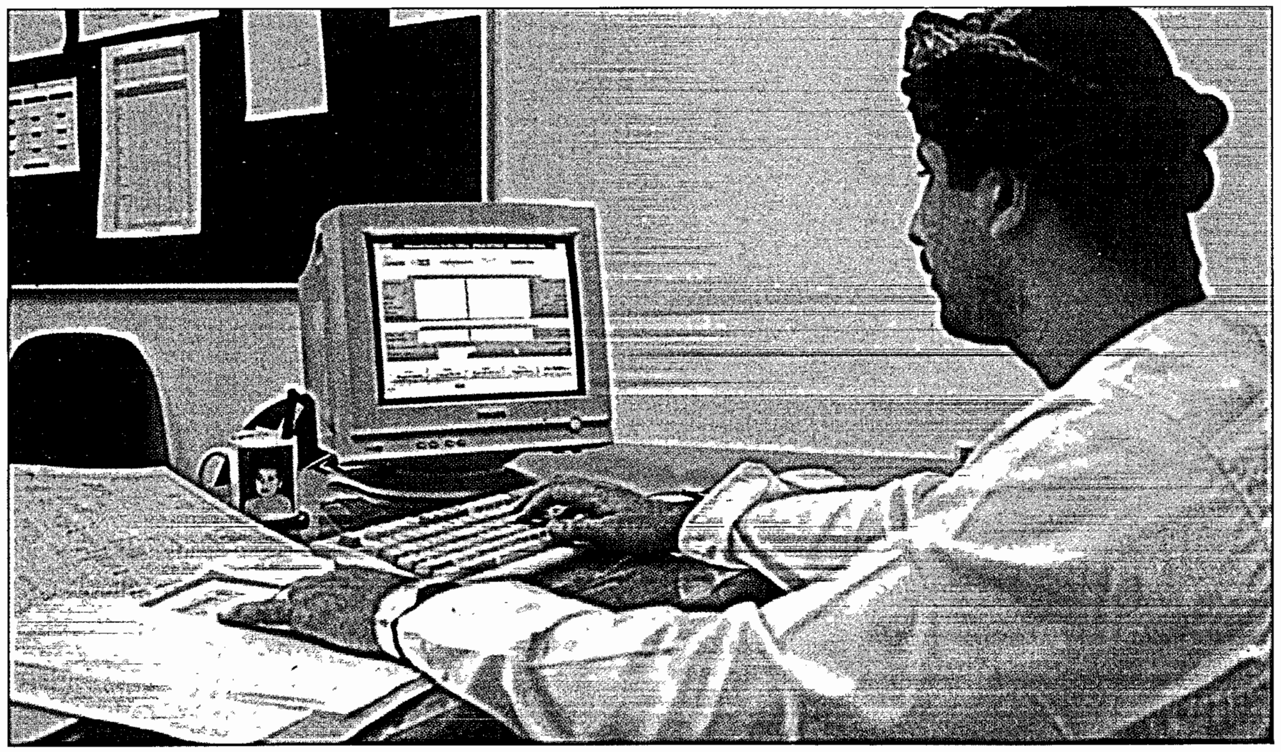
بعد أن تم التأكد من دقة واكتمال البيانات، أصدر المشروع تقريراً لنظام الفلج يحوي ملخصاً لأهم البيانات الخاصة بالفلج وهذه البيانات تشمل بيانات تعريفية بالفلج ومواصفات الفلج وقياسات جودة المياه وبيانات لأطوال القنوات والآبار المساعدة ومساحة منطقة الاحتياج وكذلك بيانات تقديرية عن حجم الاحتياجات المائية، حيث تم تقدير حجم الطلب على المياه المتوفرة من الأفلاج لكل منطقة من مناطق الاحتياج اعتماداً على نتائج المسح التفصيلي باستخدام الحاسب الآلي وبالتالي قدر حجم الطلب الإجمالي للمناطق المعتمدة على مياه الأفلاج على أسس علمية صحيحة، وقد أستعين بمختصين وخبراء من الوزارة للحصول على أفضل النتائج.

بعد أن تم التحقق من دقة البيانات رسمت مسارات ومعالم الفلج وذلك باستخدام نظام خاص برسم الأفلاج عن طريق نظام الأوتوكاد، حيث تظهر مواقع أمهات الأفلاج ومسارات السواعد ومناطق الاحتياج وبقية معالم الفلج الأخرى. وهذه الرسومات تعتبر إحدى نتائج المشروع التي تؤكد صحة ودقة البيانات المجمعة.

مرفق بالملحق عينة من تقارير أنظمة الأفلاج ورسوماتها.

أصدر المشروع كتيبات بإحصائيات وقوائم الأفلاج على مستوى السلطنة. وتتضمن هذه الكتيبات بيانات عن أسماء الأفلاج وأرقام الحصر الخاصة بها وكذلك القرى التابعة لها وأنواع الأفلاج وحالتها إحداثيات أمهات الأفلاج.

Preparing Falaj systems reports — إعداد تقارير أنظمة الأفلاج



Printing the Falaj System diagram — طباعة رسمة نظام الفلج

PART 3 :
PROJECT RESULTS AT NATIONAL LEVEL

الجزء الثالث :
نتائج المشروع على مستوى السلطنة

General Features

This and succeeding sections of the report present a summary of the project's statistical results, initially at national level and subsequently at regional and governorate level

There is a total of 4112 aflaj of all types (live and dead) in Oman, irrigating a total of 3684 demand area. A total of 2958 samples of water were collected and subjected to chemical analysis at the Ministry's Water Quality Laboratory. All data was processed and entered in the project database, which is now complete and available to interested parties, researchers and decision-makers.

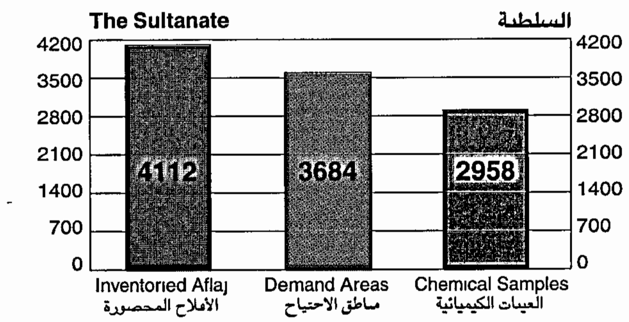
Note that the inventory included the Al Wusta and Al Janubiya regions; no aflaj were inventoried in the Al Wusta region and only 184 natural springs were inventoried in the governorate of Dhofar.

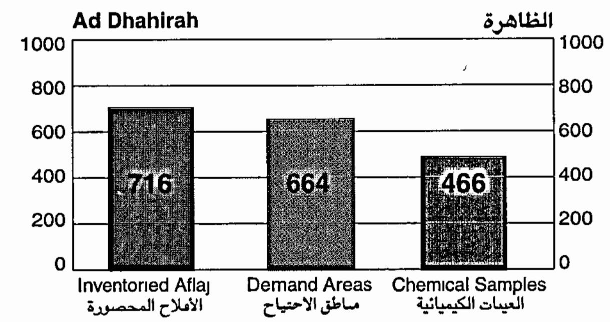
ملامح عامة

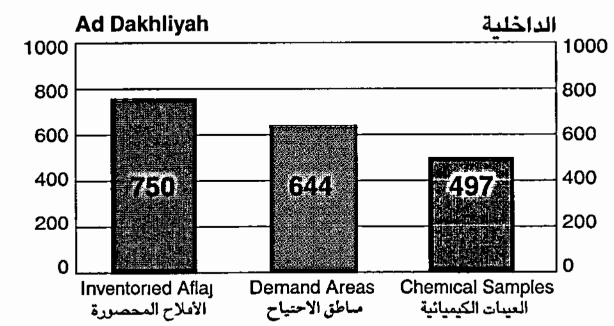
هذا الجزء وبقية الأجزاء التالية من التقرير يلقي الضوء على النتائج الإحصائية التي توصل إليها المشروع ويبدأ عامة على مستوى السلطنة ومن ثم يدخل في النتائج التفصيلية تباعاً حسب المحافظات والمناطق.

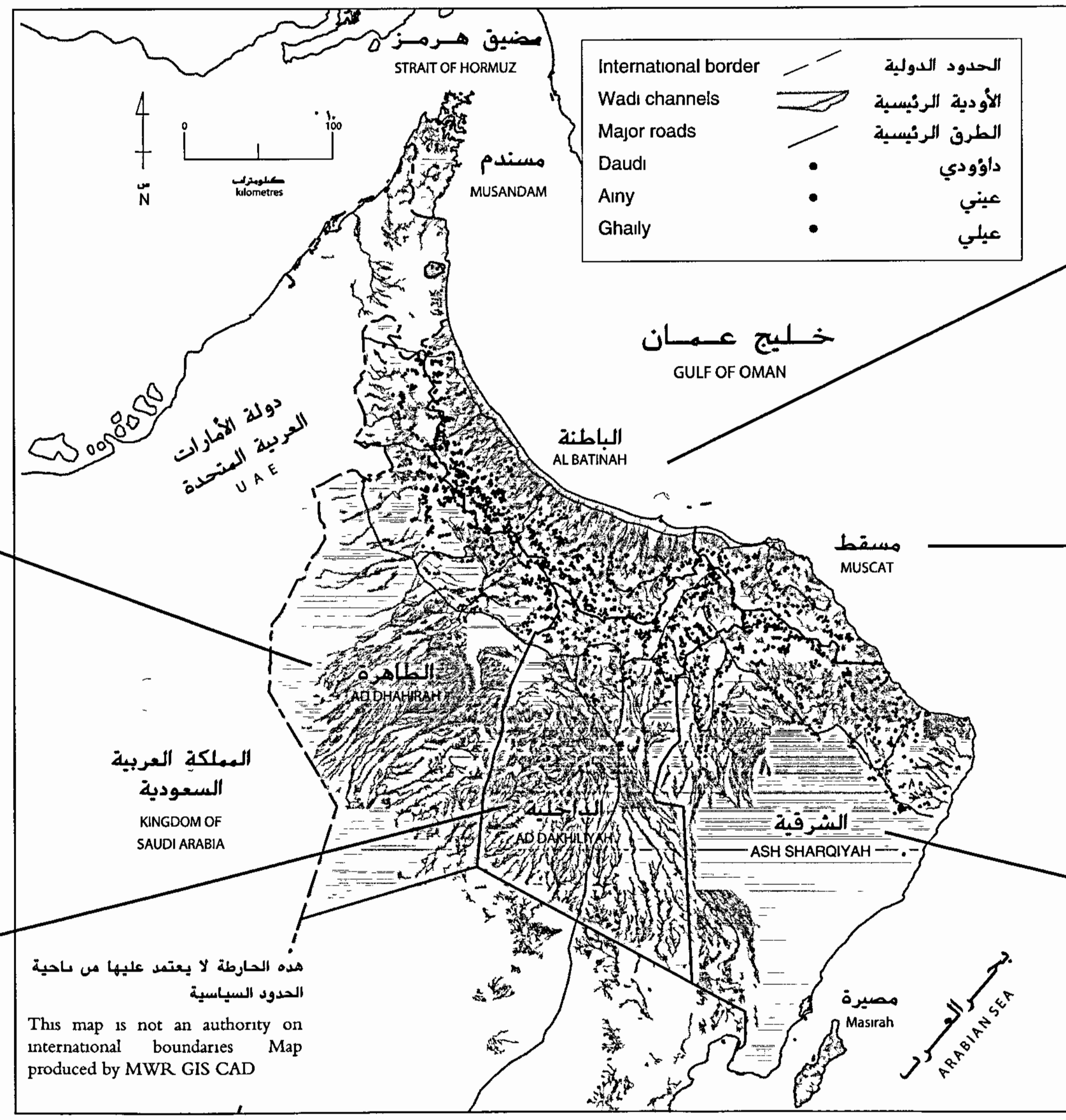
تم حصر ٤١١٢ فلجاً على مستوى السلطنة بجميع أنواعها. كما حصرت ٣٦٨٤ منطقة احتياج، وجمعت ٢٩٥٨ عينة مياه تم تحليلها كيميائياً بمختبر جودة المياه التابع للوزارة. وعولجت جميع هذه البيانات وأودعت في قاعدة بيانات المشروع التي أصبحت حاهزة وفي متناول المهتمين والدارسين وأصحاب القرار.

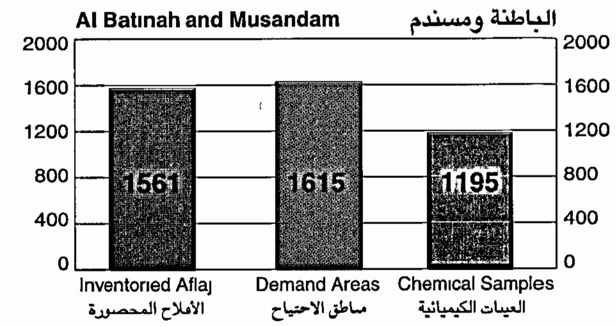
والجدير بالذكر أن عمليات الحصر شملت أيضاً كل من المنطقة الوسطى محافظة ظفار، لم يتم حصر أي فلج في المنطقة الوسطى بيسما تم حصر ١٨٤ عيناً طبيعية في المنطقة الحوبية.

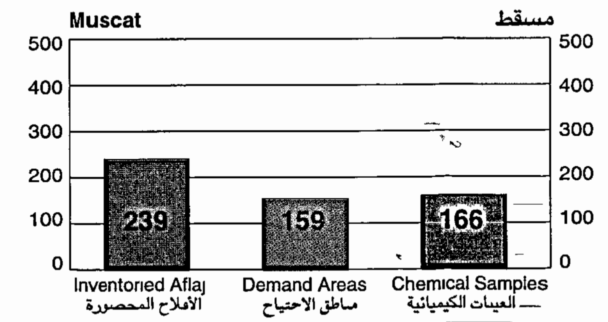


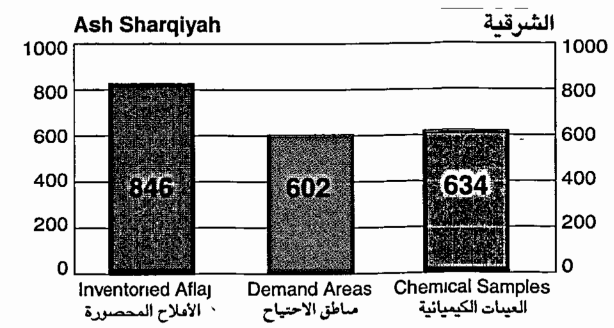












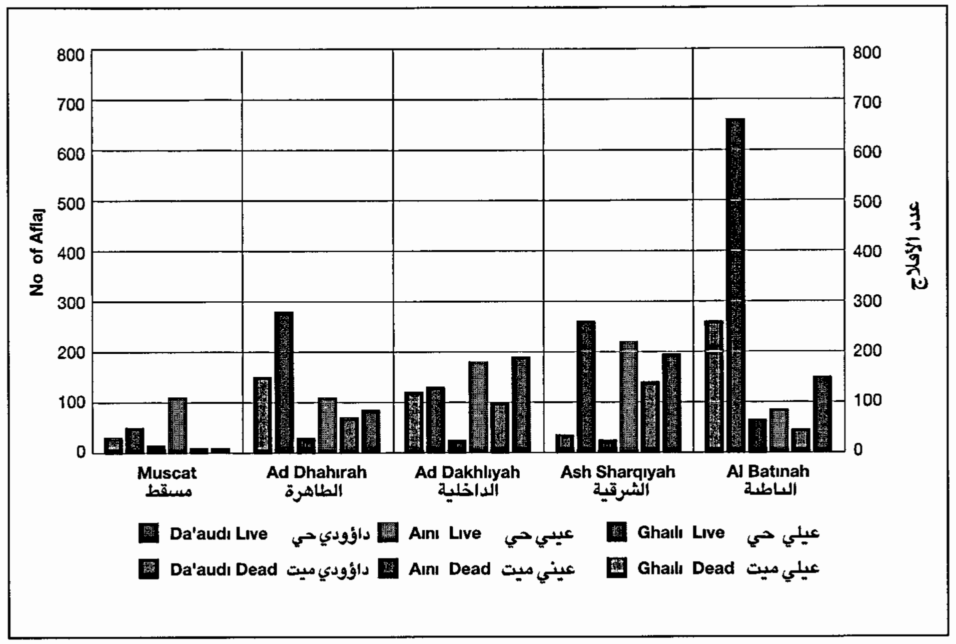
PART 3 : PROJECT RESULTS AT NATIONAL LEVEL

الجزء الثالث : نتائج المشروع على مستوى السلطنة

Aflaj Type and Status

Aflaj inventoried nationally totalled 4112, of which 73 4% (3108) were live. The aflaj included in the inventory were divided into the three categories recognised in Oman. daudi, aini and ghaili of which 23% were daudi, 28% aini type; and 49% ghaili.

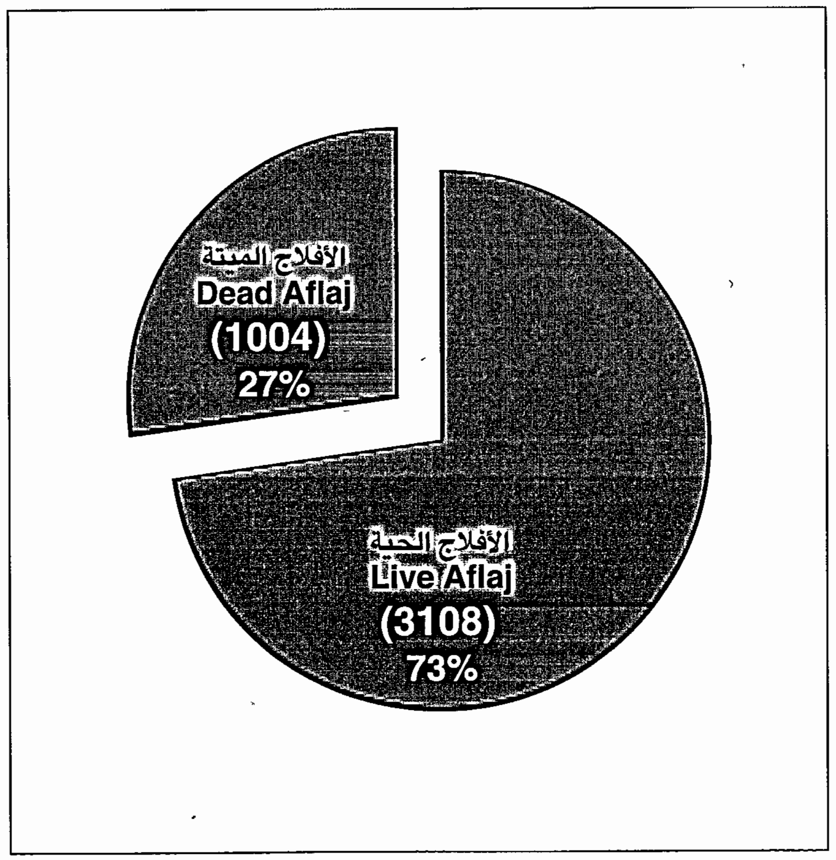
Most of the dead aflaj (1004) in Oman were of the ghaili type (54%) and daudi and aini were 31% & 15% respectively. The results show that aflaj can be found in 41 of Oman's 59 wilayats. The number of aflaj inventoried varied between wilayat The largest number (408) were in Sohar wilayat, folowed by Ibri (363) and Al Rustaq (294).

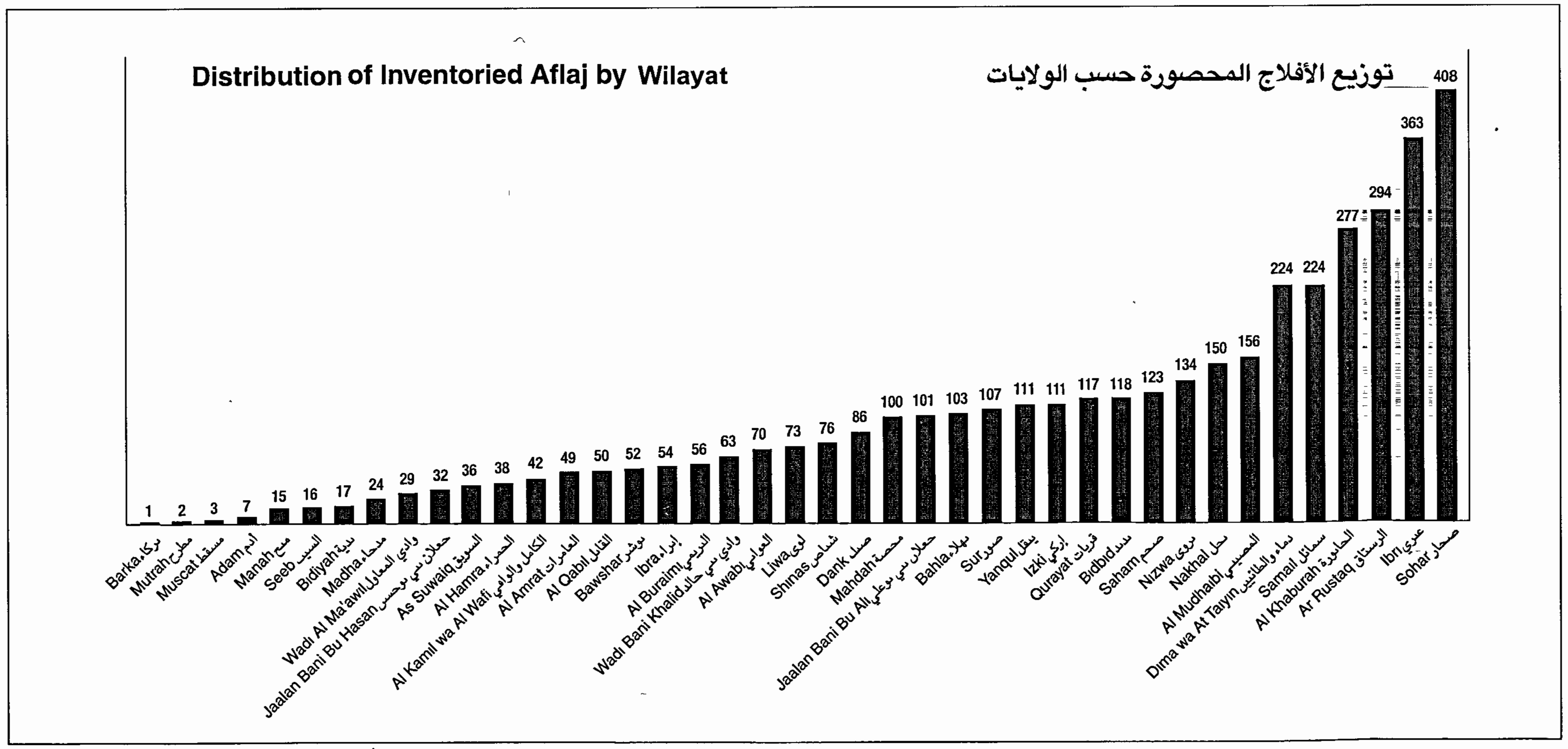


الأفلاج حسب النوع والحالة

بلغ عدد الأفلاج المحصورة على مستوى السلطنة ٤١١٢ فلحاً. وتشكل الأفلاح الحية ٧٣,٤٪ من مجموع الأفلاح المحصورة ووزعت الأفلاج المحصورة إلى ثلاثة أنواع من الأفلاج المتعارف عليها بالسلطنة وهي الأفلاج الداؤودية والعينية والعيلية، حيث شكلت الأفلاج الداؤودية نسبة ٢٣٪ منها، والأفلاج العينية شكلت نسبة ٢٨٪ من محموع الأفلاج المحصورة والأفلاح الغيلية بلعت نسبتها ٤٩٪.

معظم الأفلاج الميتة على مستوى السلطنة كانت من بوع الأفلاج الغيلية حيث بلغت نسبتها ٥٤٪ من مجموع الأفلاج الميتة، ثم الأفلاح الميتة الداؤودية وشكلت نسبة ٣١٪ وأخيراً الأفلاج الميتة العينية وكانت نسبتها ١٥٪ من مجموع الأفلاج الميتة بالسلطنة. كما أوضحت النتائج أن الأفلاج تتوفر في ٤١ ولاية من ولايات السلطنة البالغ عددها ٥٩ ولاية، وقد تبايست أعداد الأفلاج المحصورة من ولاية إلى أحرى وجاءت ولاية صحار في المرتبة الأولى حيث تم حصر ٤٠٨ أفلاح في هذه الولاية، تلتها ولاية عري بمنطقة الطاهرة وضمت ٣٦٣ فلحاً وفي المرتبة الثالثة حاءت ولاية الرستاق إحدى ولايات منطقة الباطنة وقد احتضست ٢٩٤ فلجاً.





PART 3 :
PROJECT RESULTS AT NATIONAL LEVEL

الجزء الثالث :
نتائج المشروع على مستوى السلطنة

Areas Irrigated by Aflaj and Water Demand

The area dependent on aflaj water in Oman is 26498 hectares, 66.3% of which is cropped; 3.7% is developed uncropped; and 30% is undeveloped. The Dakhliyah region has the largest area dependent on aflaj water - a total of 30.7% of the total aflaj dependent area in Oman. Batinah has the next largest - a total of 24.4%. Sharqiyah, Dhahirah and Muscat follow with figures of 22%, 17.4% and 5 5% respectively.

The demand area of Falaj System S0472 in the wilayat of Manah, Dakhliyah region, is the largest in Oman and comprises a total area of 1227 hectares.

The total annual demand for aflaj water in Oman is 460 million m³. Agricultural demand makes up the bulk of this figure, requiring 99.8% of the total.

Dakhliyah has the highest annual level of demand for aflaj water, representing 29.4% of Oman's total water demand Sharqiyah, Batinah, Dhahirah and Muscat follow with levels of 25.1%, 22 7%, 17.2% and 5.6% respectively.

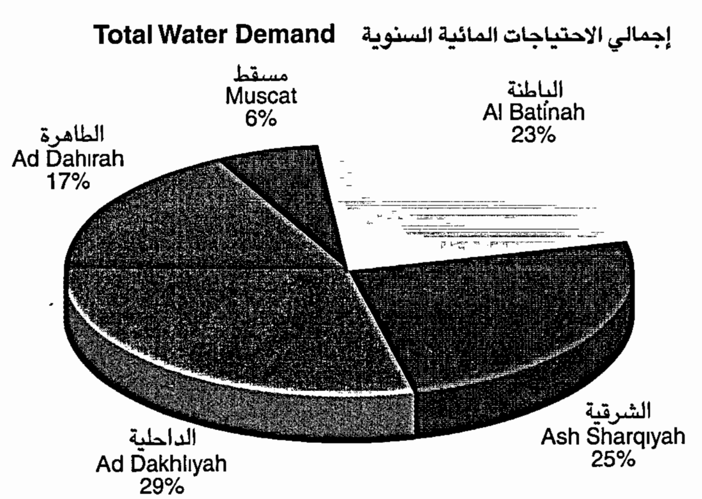
مناطق الاحتياج المروية بالأفلاج وحجم الاحتياجات المائية

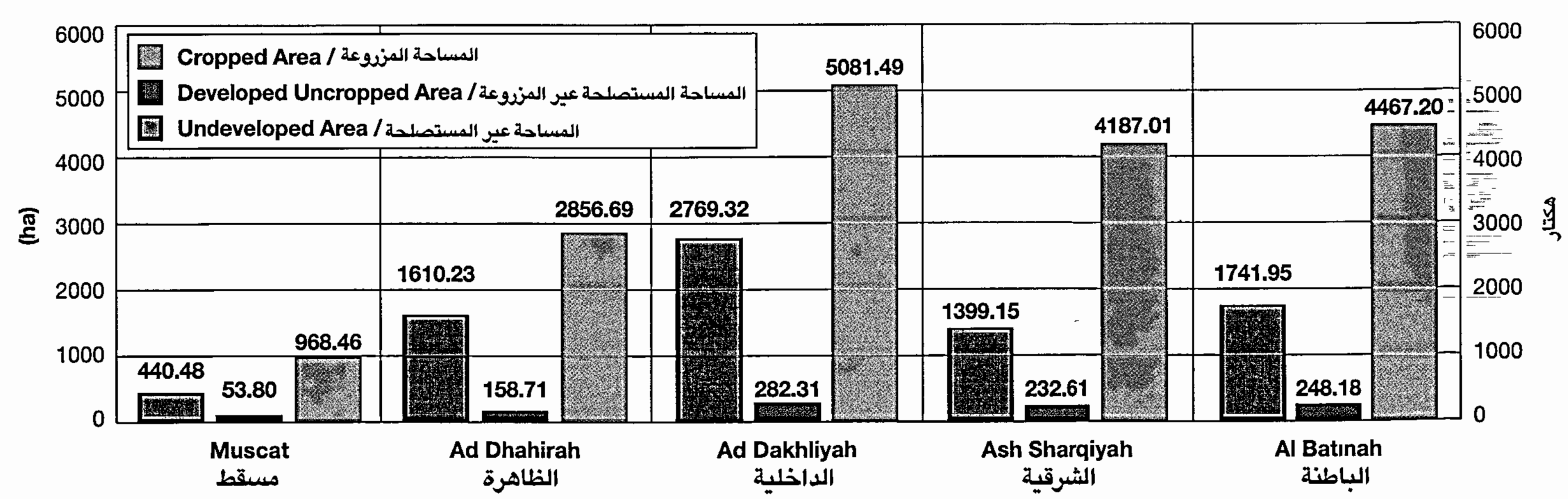
بلغت مساحة المناطق المعتمدة على مياه الأفلاج في السلطنة ٢٦٤٩٨ هكتاراً، منها ٦٦,٣٪ مساحة مزروعة و٣,٧٪ مساحة مستصلحة (غير مزروعة)، و٣٠٪ مساحة غير مستصلحة. جاءت منطقة الداخلية في المرتبة الأولى من حيث مجموع المساحة المعتمدة على مياه الأفلاج مشكلة نسبة ٣٠,٧٪ من مجموع المساحة على مستوى السلطنة، ثم منطقة الباطنة بنسبة ٢٤,٤٪ والمطقة الشرقية بسبة ٢٢٪ تلتها منطقة الطاهرة بنسبة ١٧,٤٪ و أخيراً محافظة مسقط سسبة ٥,٥٪.

تعتبر منطقة الاحتياج التابعة لنطام الفلح رقم (ف٠٤٧٢) التابع لولاية مىح بالمطقة الداخلية أكر مناطق الاحتياج على مستوى السلطنة وتبلغ مساحتها الإجمالية ١٢٢٧ هكتاراً.

بلغ إجمالي حجم الاحتياجات المائية السنوية من مياه الأفلاج في سلطنة عمان ٤٦٠ مليون متر مكعب، وشكلت الاحتياجات المائية الزراعية النصيب الأعطم منه، حيث بلغت نسبتها ٩٩,٨٪ من محموع حجم الاحتياجات المائية السوية.

وجاءت المنطقة الداخلية في المرتبة الأولى من حيث إحمالي حجم الاحتياجات المائية السنوية من مياه الأفلاج، وقد بلغ ٢٩,٤٪ من حجم الاحتياجات المائية الإجمالي للسلطة، تلتها المنطقة الشرقية بسبة ٢٥,١٪ ثم مطقة الباطنة نسبة ٢٢,٧ ٪ بعد ذلك مطقة الظاهرة بنسة ١٧,٢وأخيراً محافظة مسقط بنسة ٥,٦٪ من حجم الاحتياحات المائية الإحمالي للسلطنة.





PART 3 :

PROJECT RESULTS AT NATIONAL LEVEL

Aflaj Water Quality

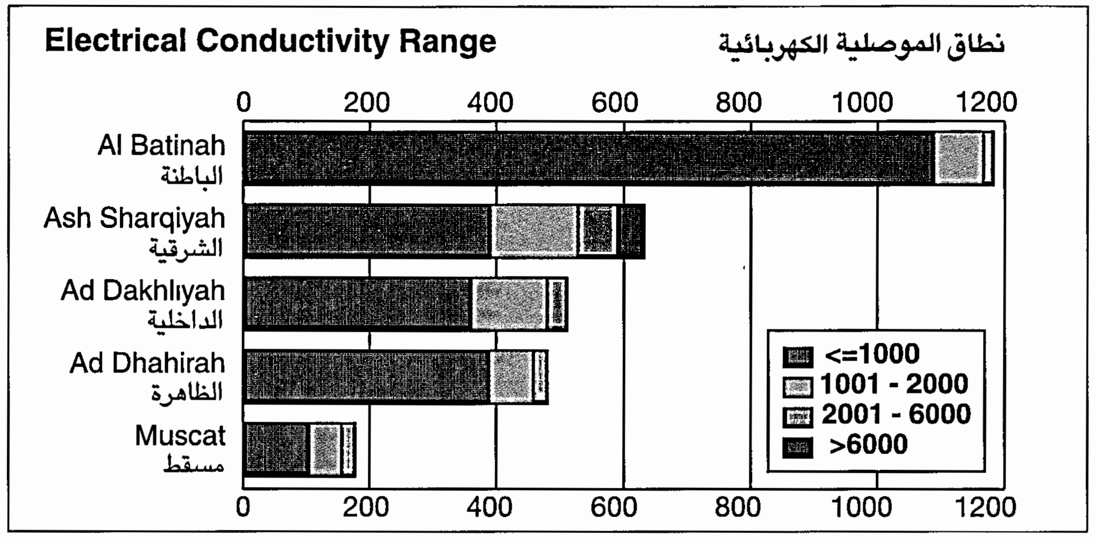
A total of 2,958 samples of aflaj water were analysed at the Ministry's Water Quality Laboratory. The chemical composition was recorded, and the data linked to the project database, for use by researchers and specialists for purposes of scientific research.

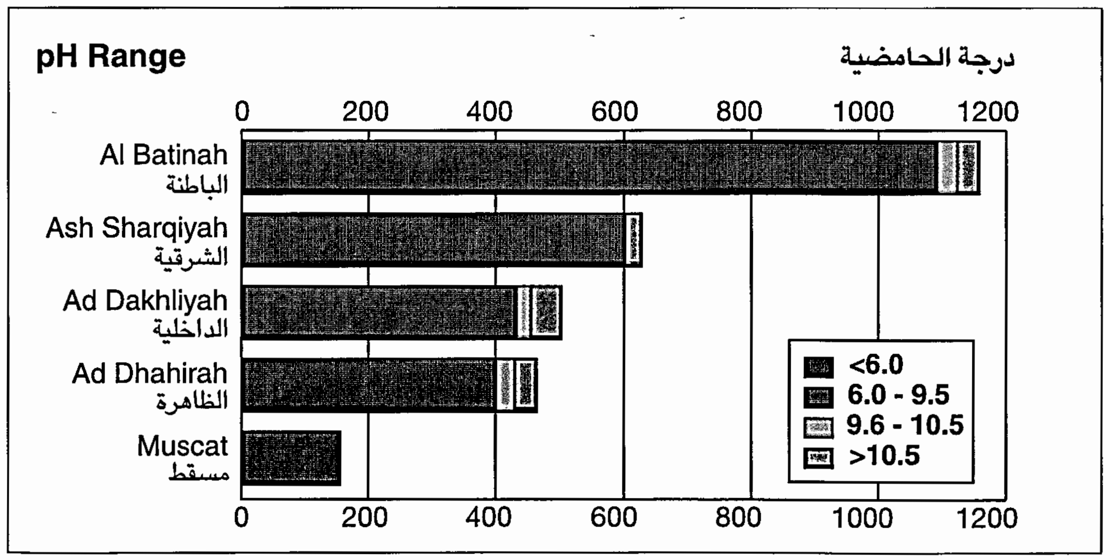
Measurement of electrical conductivity, pH and temperature is an indicator of water quality and suitability of a particular water for different uses.

The electrical conductivity of aflaj water ranged between 115 µS/cm (a figure recorded at Hail Muhadham falaj (F3166) located in Saham wilayat, Batinah region) to 16,700 µS/cm (a figure recorded at Arhyan falaj (F0917) located in Jaalan Bani Bu Ali wilayat, Sharqiyah region). The tests revealed (in terms of electrical conductivity) that the water of 2762 aflaj was suitable for cultivation of all crops. The water of 159 aflaj was found to be suitable for most crops and the water of 37 falaj was found to be unsuitable for some crops.

The lowest pH value (4.6) for aflaj water in Oman was recorded at Al Harf falaj (F4357) in the wilayat of Al Awabi, Batinah region. The highest pH value (12.9) was recorded at Qubail Malah falaj (F2151) in Ibri wilayat, Dhahirah region, The results demonstrated that the pH value of water of 2708 falaj was suitable for all crops (pH value between 6 and 9.5). The water of 75 aflaj was slightly alkaline (pH value ranging between 9.6 and 10 5). The water of 142 aflaj in the area had a high alkaline (greater than 10.5). The water of five other aflaj was relatively acidic (pH less than 6) which is unsuitable for some crops

The lowest aflaj water temperature (10 2°C) was recorded in Al-Khamir Al-Sufla falaj (F2597) in Nizwa wilayat, Dakhliyah region. While the highest temperature (60.5°C) was recorded at Al-Hamam falaj in the wilayat of Bawshar, Muscat Governorate.





الجزء الثالث :

نتائج المشروع على مستوى السلطنة

جودة مياه الأفلاج

تم تحليل ٢٩٥٨ عينة لمياه الأفلاج بمختبر جودة المياه التابع للوزارة وتم تسجيل مكوناتها من الناحية الكيميائية وتم ربط هذه البيانات مع قاعدة بيانات المشروع لتكون جاهزة وفي متناول الدارسين والمختصين في مجال البحث العلمي.

يعتبر قياس الموصلية الكهربائية ودرجة الحامضية ودرجة الحرارة إحدى مؤشرات جودة المياه وتعطي انطباعاً عن مدى ملائمة هذه المياه للاستخدامات المختلفة.

تراوحت درجة الموصلية الكهربائية لمياه الأفلاج في السلطنة بين ١١٥ مايكروسيمنس/سم، وسجلت بفلج حيل مهطم (ف٣١٦٦) الواقع بولاية صحم بمنطقة الباطنة، وبين ١٦٧٠٠ مايكروسيمنس/سم وسحلت بفلج أرحيان (ف٠٩١٦) الواقع بولاية جعلان بني بو علي بالمنطقة الشرقية. ووجد أن مياه ٢٧٦٢ فلجاً مناسبة لزراعة جميع المحاصيل الزراعية من حيث درجة الموصلية الكهربائية، وجاءت مياه ١٥٩ فلجاً ملائمة لمعظم المحاصيل الزراعية، بيسما أظهرت التائج أن مياه ٣٧ فلجاً غير ملائمة لبعض المحاصيل الزراعية.

سجلت أقل قراءة للحامضية (pH) لمياه الأفلاح على مستوى السلطنة بفلج الحرف (ف٤٣٥٧) التابع لولاية العوابي بمنطقة الباطنة وكانت ٤,٦، وسحلت أعلى قراءة للحامضية بفلج قبل ملاح (ف٢١٥١) التابع لولاية عبري بمنطقة الظاهرة حيث بلعت ١٢,٩، وأظهرت النتائج أن مياه ٢٧٠٨ فلحاً صالحة لجميع المحاصيل الزراعية من حيث الحامضية (تتراوح درجة الحامضية بين ٦ و٩,٥) وحاءت مياه ٧٥ فلجاً مائلة إلى القلوية (تتراوح درجة الحامضية بين ٩,٦ و١٠,٥) بينما جاءت مياه ١٤٢ فلحاً في المنطقة عالية القلوية (درحة الحامضية أكبر من ١٠,٥)، ومياه حمسة أفلاج أحرى في المنطقة حامضية نسبياً (درجة الحامضية أقل من ٦)، وهذه النوعية من المياه غير صالحة لبعض المحاصيل الزراعية.

تم تسجيل أقل قراءة لدرجة الحرارة لمياه الأفلاج على مستوى السلطنة بفلح الحمير السفلي (ف٢٥٩٧) التابع لولاية نزوى بالمنطقة الداخلية وكانت ١٠,٢ درجة مئوية، بينما سحلت أعلى قراءة للحرارة بفلج الحمّام التابع لولاية بوشر بمحافظة مسقط وكانت ٦٠,٥ درجة مئوية.

PART 3 :
PROJECT RESULTS AT NATIONAL LEVEL

الجزء الثالث :
نتائج المشروع على مستوى السلطنة

Aflaj Branches and Discharge Rate

Field teams succeeded in measuring the discharge of 72% live aflaj in Oman; flow in the remainder was not measured for various reasons, including bursts in aflaj channels, floods resulting from substantial rainfall creating an over flow , and the low discharge rate in some of the smaller aflaj. The total flow for those aflaj whose flow was measured was found to be approximately seven million m³ per day based on a single reading Note that most measurements were taken during the wet season of 1997, which explains the high figure recorded.

Data analysis revealed that 68% of aflaj had an area of less than 2 hectares and were 60% of live aflaj in Oman.

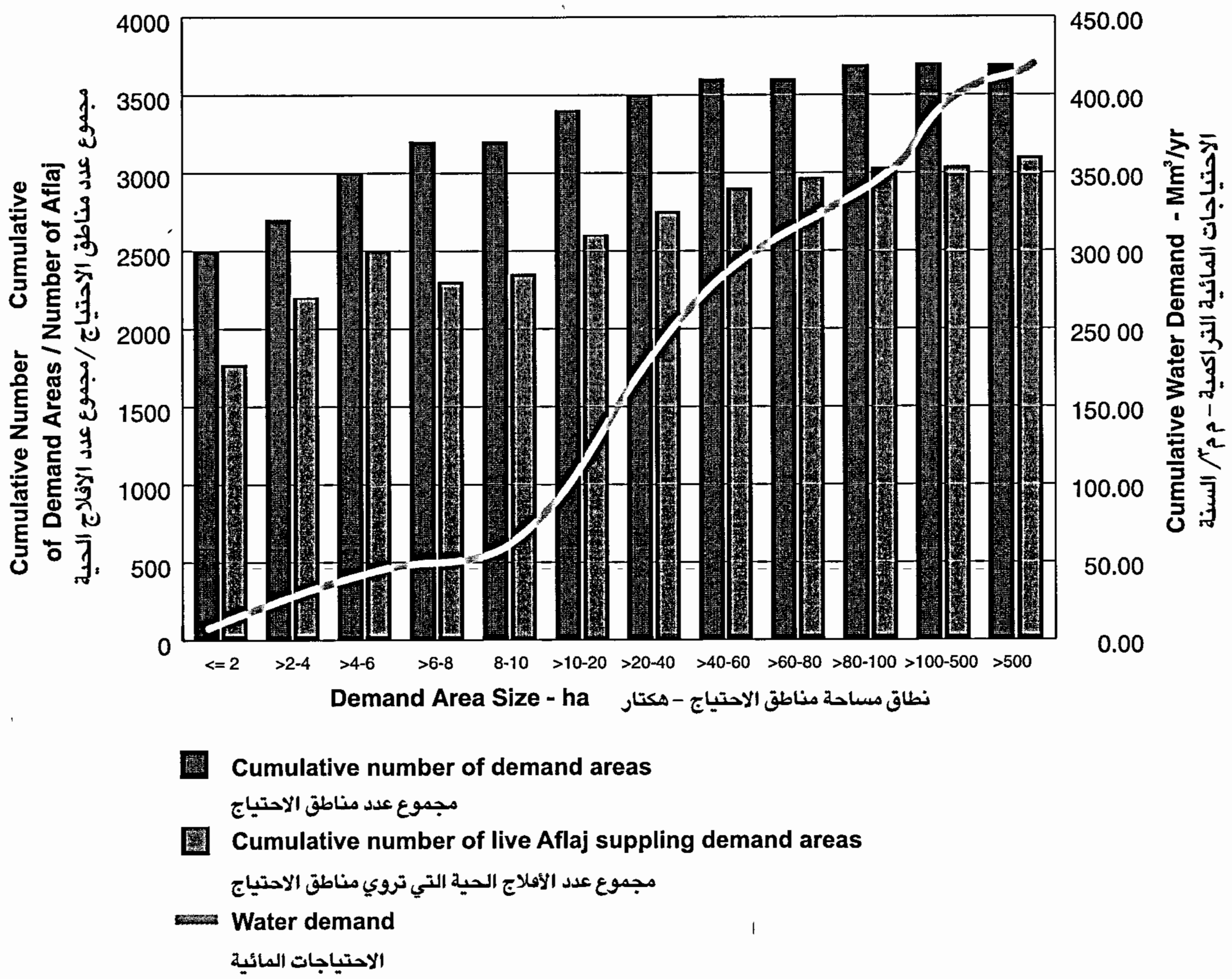
A total of 5326 branches of various types - daudi, aini or ghaili - were counted in the inventory. Note that the number of branches exceeds that of the aflaj in Oman because each falaj may comprise more than one subsidiary branch

Data analysis revealed that the total length of branches in Oman reached a figure of 2726 km; 959 km of this length consist of surface channels whilst 1767 km are underground

The data shows that Ash Sharıq (F1306) in Bidiyah, Sharqiyah, is the longest falaj in terms of the total length of its branches of 17.3 km, a 100 metres of surface channels and 17 2 km are underground.

The Al Jahis subsidiary branch of Al Jahis falaj (F1307) in Bidiyah, Sharqiyah, is the longest branch in Oman with a total length of 14 5 km.

The Al-Maliki falaj (F0606) located in Izki, Dakhliyah is the largest falaj in Oman in terms of the number of branches. It comprises a total of 17 branches.



تفاصيل سواعد وتدفقات الأفلاج

تمكنت الفرق الحقلية من قياس تدفق ٧٢٪ من الأفلاج الحية على مستوى السلطنة بينما لم يتم قياس تدفقات الأفلاج الأخرى نتيجة لعدة أسباب من أهمها تصدع قنوات الأفلاج تسرب المياه منها وفيضان بعض الأفلاج نتيجة لغزارة الأمطار وعدم استيعاب قناة الفلح لهدا الحجم الكبير من المياه المتدفقة وكذلك ضآلة حريان بعض الأفلاج الصغيرة. ووجد أن مجموع تدفقات الأفلاح المقاسة قد بلغ سبعة ملايين متر مكعب في اليوم تقريباً مأحوذة من قراءة واحدة فقط لتدفق الأفلاج وهي بالتالي لا تعر عن الواقع (نظراً لتذبذب جريانها لأسباب مناخية). من الحدير بالذكر أن معطم هذه القياسات أحذت حلال فترة مطيرة من عام ١٩٩٧م وهدا يفسر ارتفاع تدفق الأفلاج المقاسة.

وتبين من خلال تحليل البيانات أن ٦٨٪ من مناطق الإحتياج مساحتها أقل من ٢ هكتار وتستأثر بنسبة ٦٠٪ من الأفلاج الحية على مستوى السلطنة.

بلغ مجموع عدد سواعد الأفلاج المحصورة بالسلطنة ٥٣٢٦ ساعداً من مختلف الأنواع الداؤودية والعينية والغيلية. ومن الملاحظ أن عدد السواعد المحصورة يفوق عدد الأفلاج المحصورة على مستوى السلطنة نطراً إلى أن الفلح قد يتكون من أكثر من ساعد واحد.

وجد من تحليل البيانات أن مجموع أطوال سواعد الأفلاج على مستوى السلطة يصل إلى ٢٧٢٦ كيلومتر منها ٩٥٩ كيلومتر قنوات سطحية و ١٧٦٧ كيلومتر قنوات تحت سطح الأرض.

تين في البيانات أن أطول فلج من حيث مجموع أطوال سواعده هو فلح الشارق (ف١٣٠٦) التابع لولاية بدية في المنطقة الشرقية حيث بلغ طول سواعده الإجمالي ١٧,٣ كيلو متر منها ١٠٠ متر قنوات سطحية و ١٧,٢ كيلو متر قنوات تحت سطح الأرض.

يعتبر ساعد الجاحس بفلج الجاحس (ف١٣٠٧) التابع لولاية بدية في المنطقة الشرقية أطول ساعد على مستوى السلطنة ويبلغ طوله الإحمالي ١٤,٥ كيلو متر.

يعتر فلح الملكي (ف٠٦٠٦) الواقع بولاية إزكي بالمنطقة الداخلية أكر أفلاج السلطنة من حيث عدد السواعد حيث بلغ مجموع عدد السواعد التي حصرت بهدا الفلج ١٧ ساعداً.

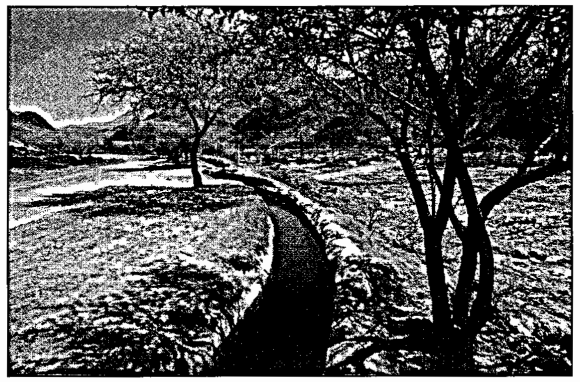
PART 4 : الجزء الرابع :

MUSCAT GOVERNORATE AFLAJ STATISTICS
إحصائيات أفلاج محافظة مسقط

Aflaj Type and Status

Of all Oman's regions, Muscat has the lowest number of inventoried aflaj, 239 aflaj were inventoried in the Governorate Live aflaj make up 72.4% of the total. The Muscat aflaj include all types - daudi, aini and ghaili Daudi aflaj were 10.5% of the total; aini aflaj 54.4% and ghaili aflaj make up the remainder of 35.1%

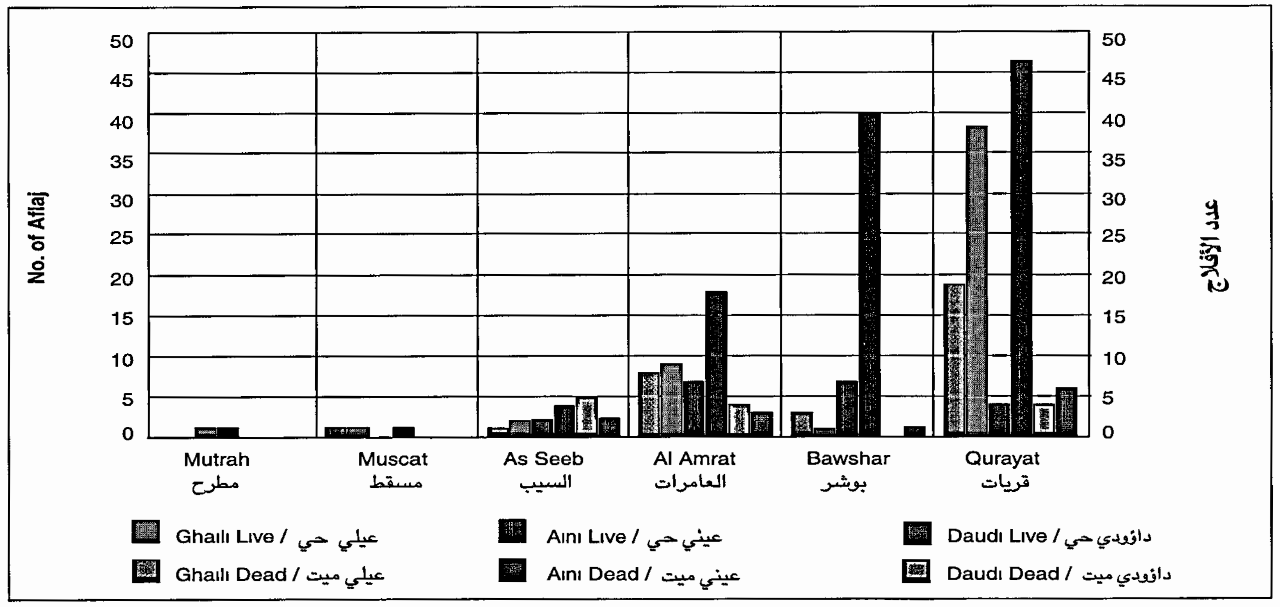
The majority of dead aflaj in Muscat are ghaili, which represent 48.5% of the total Aini and daudi aflaj make up the remainder with of 31.8% and 19.7% respectively.

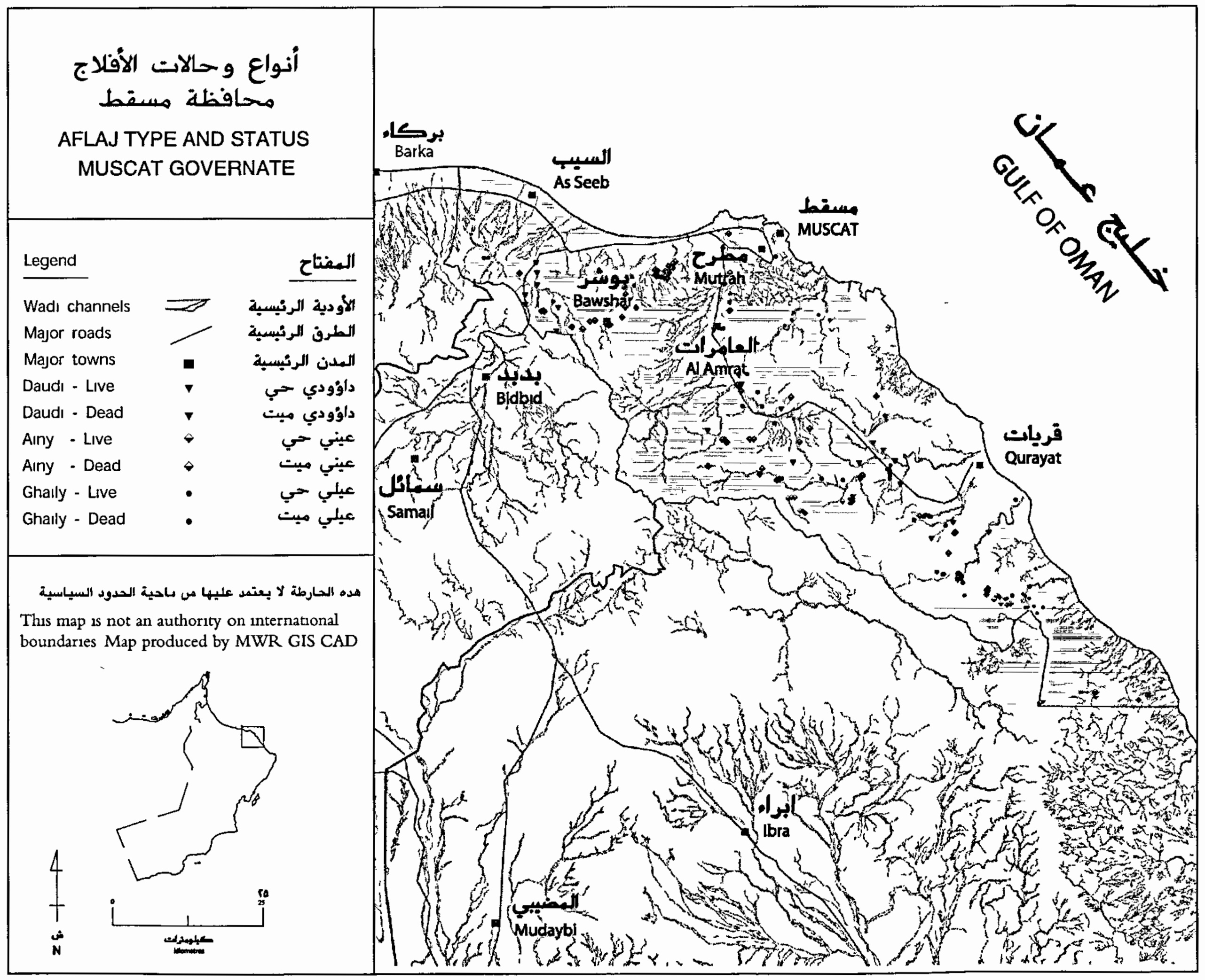


أنواع وحالات الأفلاج

تأتي محافظة مسقط في المرتبة (الخامسة) من حيث عدد الأفلاج المحصورة فيها، حيث تم حصر ٢٣٩ فلجاً في هده المحافظة. وتشكل الأفلاج الحية ٧٢,٤٪ من مجموع الأفلاج المحصورة، وتتوفر الأفلاج في محافظة مسقط بكافة أنواعها الداؤودية والعينية والغيلية. حيث بلعت نسبة الأفلاج الداؤودية ١٠,٥٪ من مجموع الأفلاج في المحافظة، وبلغت سبة الأفلاج العيية ٥٤,٤٪ والأفلاج العيلية شكلت نسبة ٣٥,١٪ من مجموع الأفلاج.

أكثر الأفلاج الميتة في المحافظة كانت أفلاجاً غيلية حيث بلعت نسبتها ٤٨,٥٪ من مجموع الأفلاج الميتة في المحافظة تلتها الأفلاح الميتة العينية وشكلت نسبة ٣١,٨٪، ثم الأفلاج الميتة الداؤودية وكانت نسبتها ١٩,٧٪ من مجموع الأفلاج الميتة.





Aflaj Type & Status أنواع وحالات الأفلاج

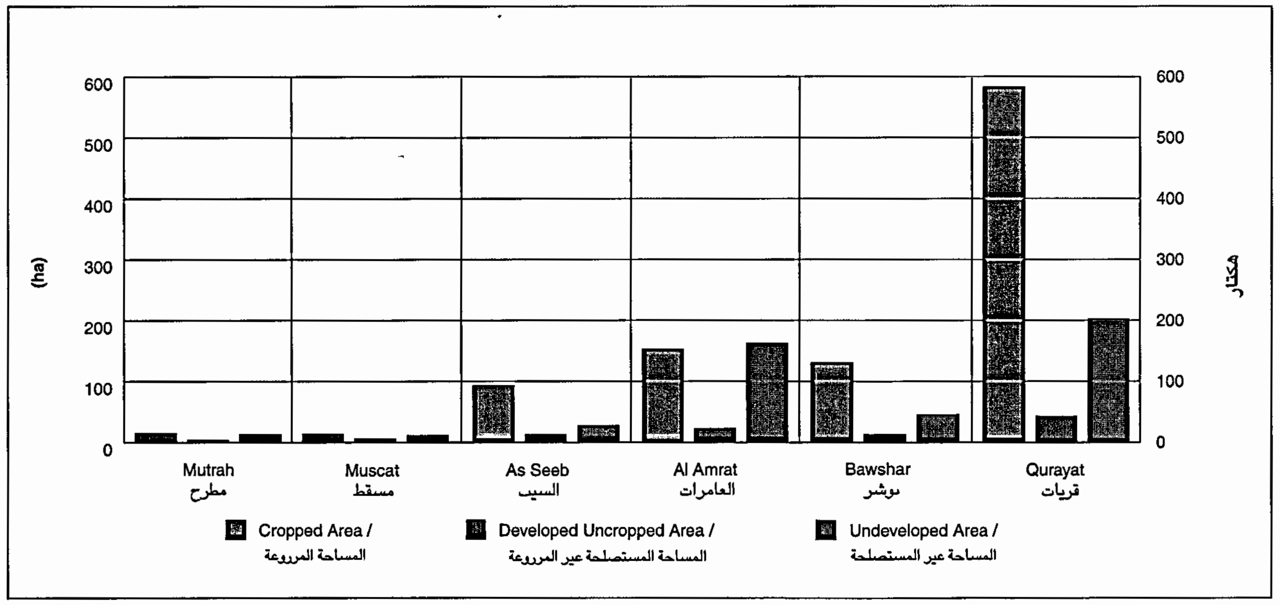
Wilayat	Total Dead ميت	المجموع Live حي	Ghaili Dead ميت	عيلي Live حي	Aini Dead ميت	عيني Live حي	Daudi Dead ميت	داؤودي Live حي	الولاية
Qurayat	27	90	19	38	4	46	4	6	قريات
Bawshar	10	42	3	1	7	40	0	1	بوشر
Al Amrat	19	30	8	9	7	18	4	3	العامرات
Seeb	8	8	1	2	2	4	5	2	السيب
Muscat	1	2	1	1	0	1	0	0	مسقط
Mutrah	1	1	0	1	1	0	0	0	مطرح
Total	66	173	32	52	21	109	13	12	المجموع

PART 4 :
MUSCAT GOVERNORATE AFLAJ STATISTICS

Aflaj Demand Areas

The area dependent on aflaj water in Muscat Governorate is 1462.7 hectares. 66.2% of this area is cropped land 3.7% is developed uncropped land and 30.1% is undeveloped land.

Qurayat district has the largest area dependent on aflaj water with 55.1% of the total area. The wilayats of Al Amrat and Bawshar have the next largest areas, forming 22.1% and 12.4% respectively. As Seeb, Muscat and Mutrah collectively form 10.4% of the area. Note that Qurayat district also forms the largest area of agricultural land within Muscat Governorate, representing 59 9% of the total cropped area.



Demand Areas مناطق الاحتياج

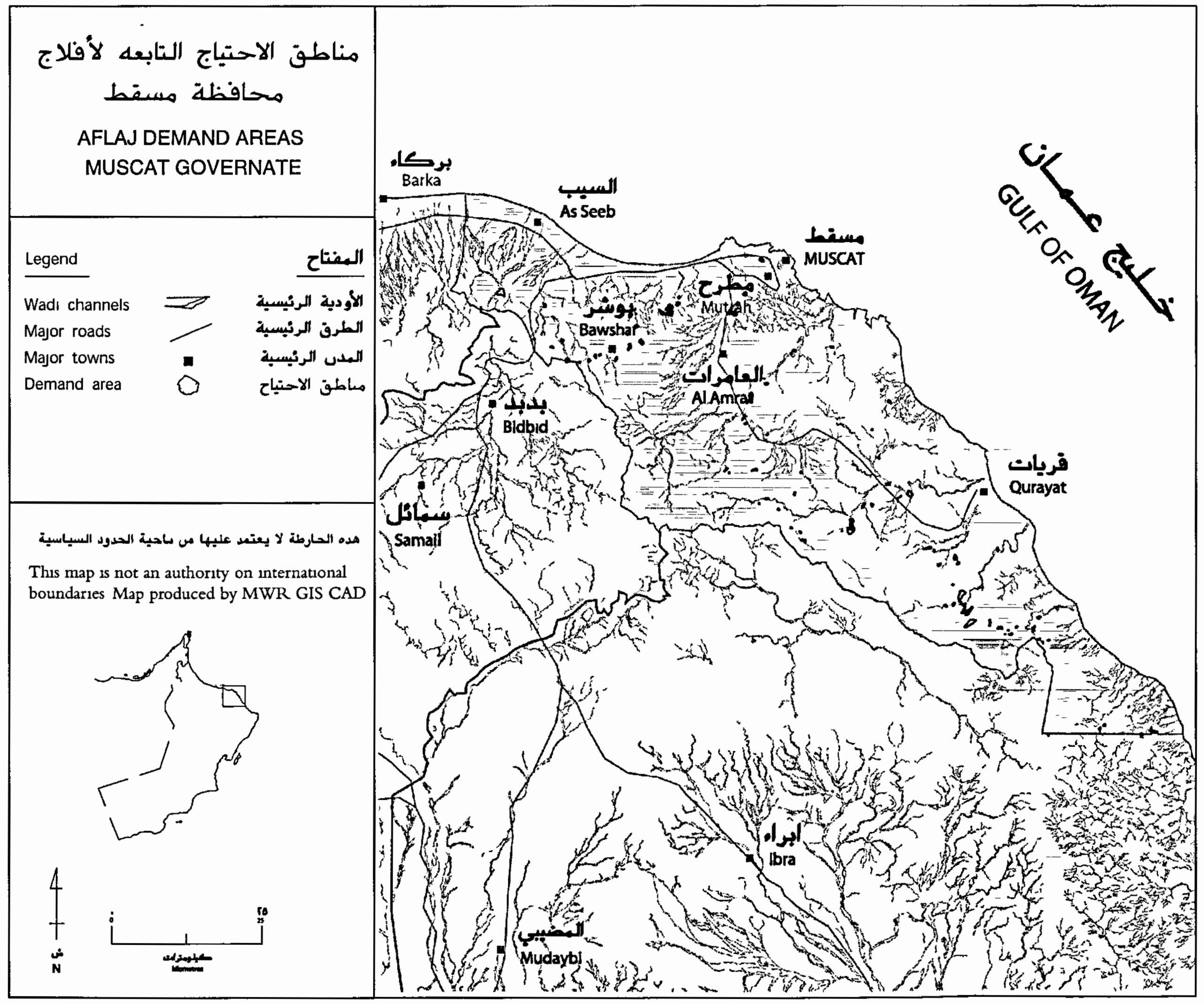
Wilayat	Total Area (ha) مجموع المساحة (هكتار)	Undeveloped Area (ha) المساحة غير المستصلحة (هكتار)	Developed Uncropped Area (ha) المساحة المستصلحة غير المزروعة (هكتار)	Cropped Area (ha) المساحة المزروعة (هكتار)	الولاية
Qurayat	806 29	193 51	32 25	580 53	قريات
Bawshar	181 37	44 52	7 20	129 65	بوشر
Al Amrat	323 76	165 80	8 31	149 65	العامرات
Seeb	119 33	28 96	4 75	85 62	السيب
Muscat	18 71	4 49	0 74	13 48	مسقط
Mutrah	13 20	3 17	0 52	9 51	مطرح
Total	**1462.66**	**440.45**	**53.77**	**968.44**	المجموع

الجزء الرابع :
إحصائيات أفلاج محافظة مسقط

المساحات المعتمدة على الأفلاج

بلعت مساحة المناطق المعتمدة على مياه الأفلاج في محافظة مسقط ١٤٦٢,٧ هكتاراً، منها ٦٦,٢٪ مساحة مزروعة و٣,٧٪ مساحة مستصلحة غير مزروعة و٣٠,١٪ مساحة غير مستصلحة.

جاءت ولاية قريات في المرتبة الأولى من حيث مجموع المساحة المعتمدة على مياه الأفلاج مشكلة ما نسبته ٥٥,١٪ من مجموع المساحة في المحافظة ثم ولاية العامرات بنسبة ٢٢,١٪ وولاية بوشر بنسبة ١٢,٤٪ بيمما شكلت ولايات السيب ومسقط ومطرح مجتمعة نسبة ١٠,٤٪ من مجموع المساحة. وجاءت ولاية قريات كذلك في المرتبة الأولى من حيث مجموع المساحة المزروعة بنسبة ٥٩,٩٪ من مجموع المساحة المزروعة في المحافظة.



PART 4 :

MUSCAT GOVERNORATE AFLAJ STATISTICS

الجزء الرابع :

إحصائيات أفلاج محافظة مسقط

Annual Water Demand

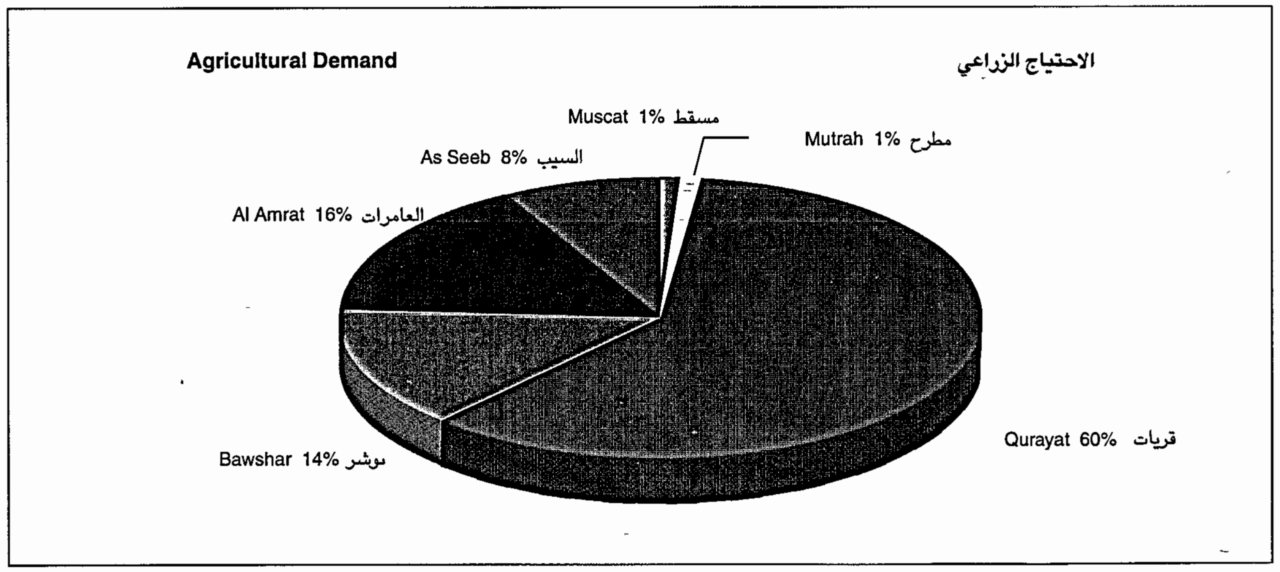
The annual demand for aflaj water in Muscat is 25.45 million m³. Agricultural demand makes up 99.9% of this figure.

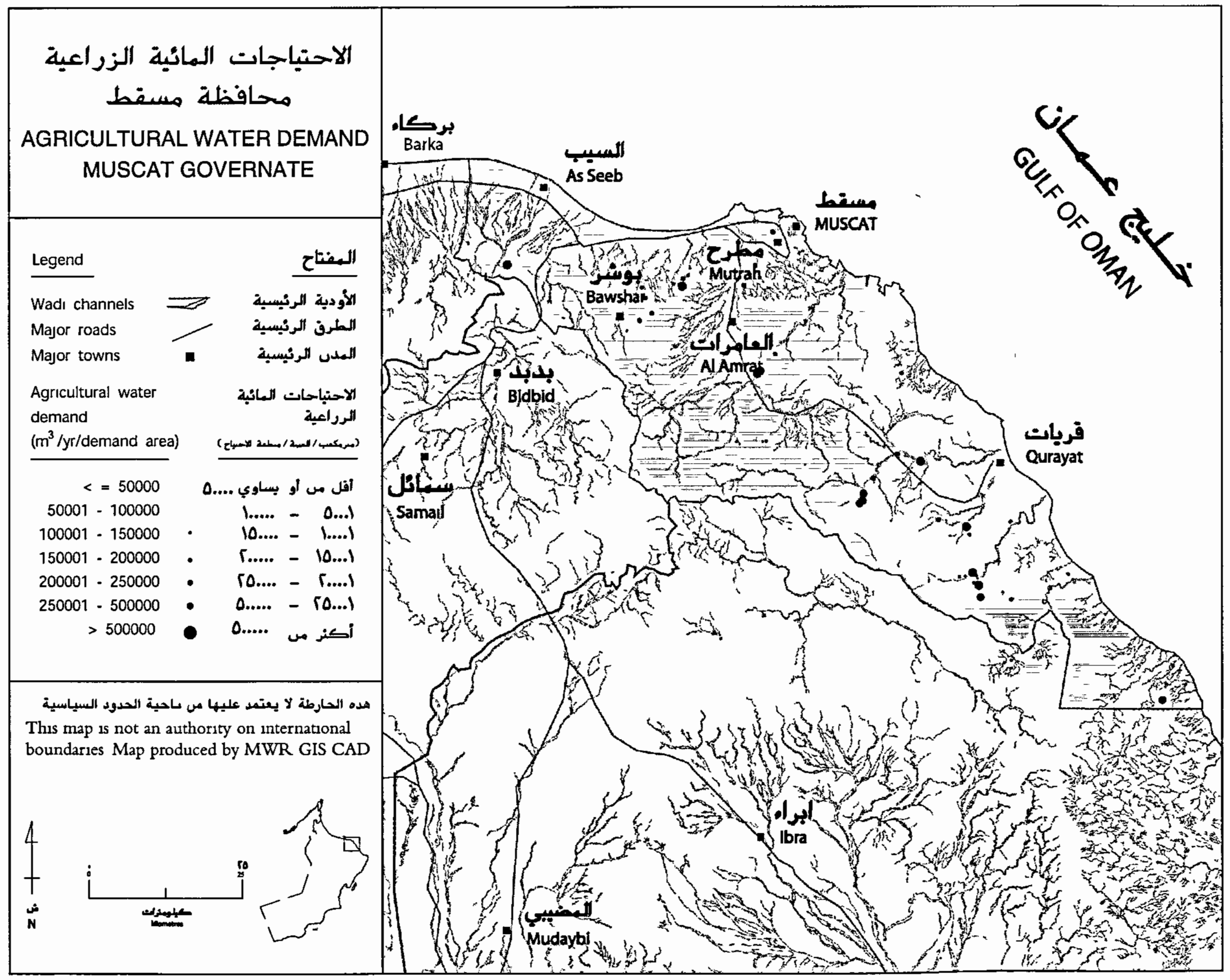
Qurayat has the largest annual demand for aflaj water with a figure of 15.29 million m³. It is followed by Al Amrat, Bawshar, Al Seeb, Muscat and Mutrah, which have an annual demand of 3.99, 3 49, 2.16, 0.36 and 0.25 million m³ respectively.

الاحتياج المائى السنوى

بلغ مجموع الاحتياح السنوي من مياه الأفلاح في محافظة مسقط ٢٥,٥٤ مليون متر مكعب. كان للاحتياج الزراعي النصيب الأعظم منها حيث بلغ ٩٩,٩٪ من مجموع حجم الاحتياح.

جاءت ولاية قريات في المرتبة الأولى من حيث حجم الاحتياج السنوي من مياه الأفلاج وبلغ حجم الاحتياج المائي السوي في هذه الولاية ١٥,٢٩ مليون متر مكعب تلتها ولاية العامرات بحجم ٣,٩٩ مليون متر مكعب فولاية بوشر بحجم ٣,٤٩ مليون متر مكعب ثم ولاية السيب بحجم ٢,١٦ مليون متر مكعب وولاية مسقط بحجم ٠,٣٦ مليون متر مكعب وأخيراً ولاية مطرح بحجم ٠,٢٥ مليون متر مكعب في السنة.





Annual Water Demand — **الاحتياج المائي السنوي**

Wilayat	Total Water Demand (Mm³/yr) إجمالي الاحتياح المائي (م م³/سنة)	Livestock Demand (Mm³/yr) الاحتياج الحيواني (م م³/سنة)	Agricultural Demand (Mm³/yr) الاحتياج الزراعي (م م³/سنة)	الولاية
Qurayat	15 29	0	15 29	قريات
Bawshar	3 49	0 02	3 47	بوشر
Al Amrat	3 99	0	3 99	العامرات
Seeb	2 16	0	2 16	السيب
Muscat	0 36	0	0 36	مسقط
Mutrah	0 25	0	0 25	مطرح
Total	**25.54**	**0.02**	**25.52**	المجموع

PART 4 : الجزء الرابع :

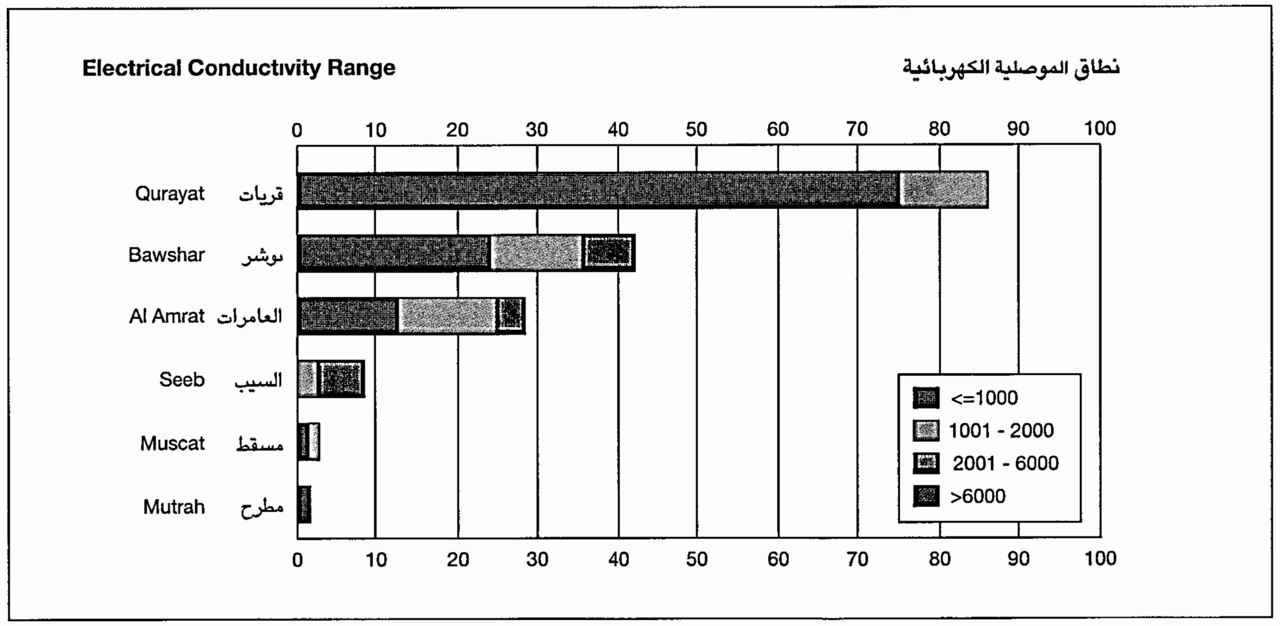
MUSCAT GOVERNORATE AFLAJ STATISTICS إحصائيات أفلاج محافظة مسقط

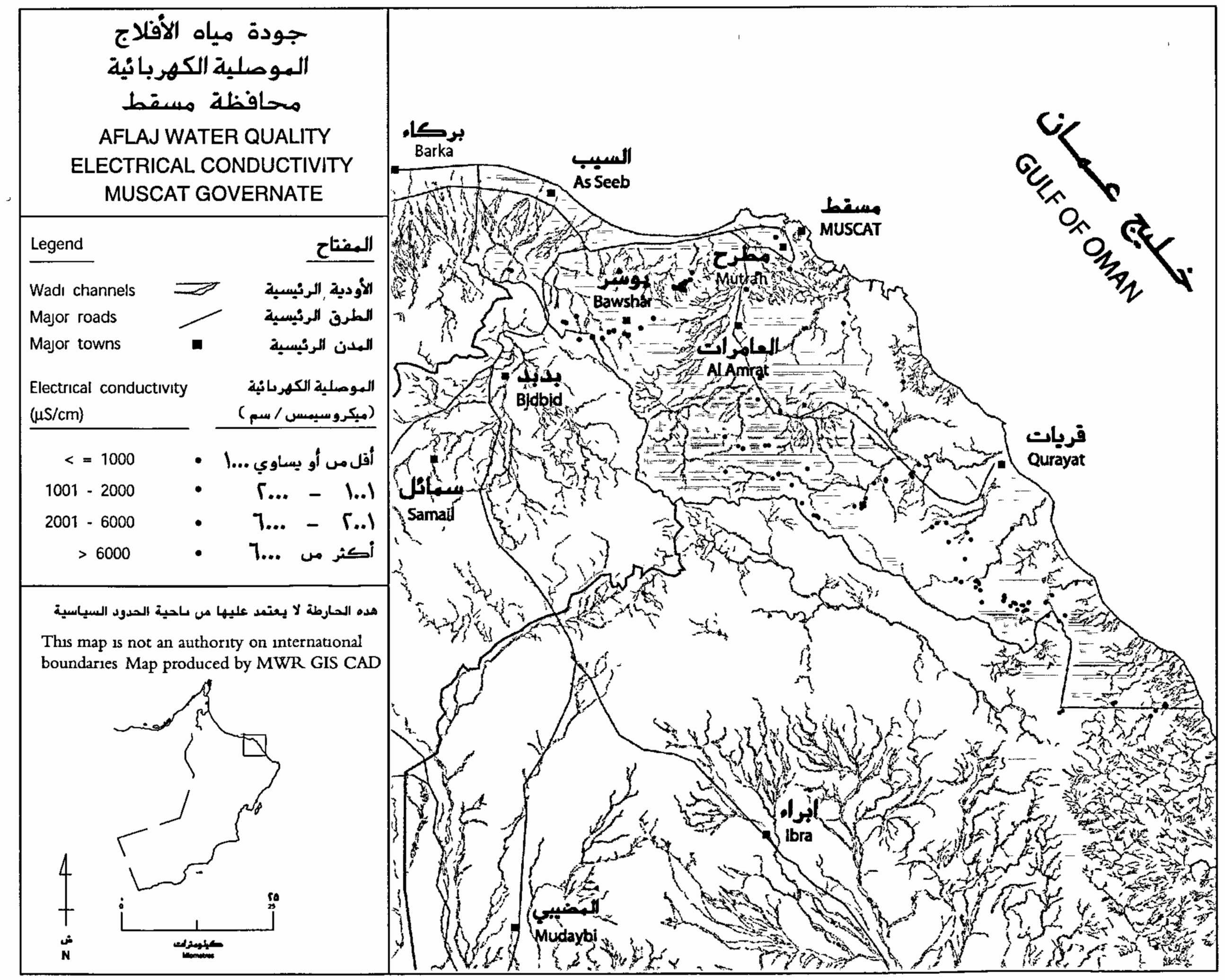
Water Quality : Electrical Conductivity

The lowest Electrical Conductivity (EC) reading for aflaj water in Muscat Governorate was recorded at At Tuwaimiyah falaj (F2150) in Qurayat, which gave a figure of 272 µS/cm. The highest EC reading was recorded at Al Ghaiz falaj (F0342) in Bawshar, which produced a reading of 4720 µS/cm The results showed that the water of 153 aflaj in Muscat Governorate was suitable for all crops and that the water of 13 was suitable for most The highest reading for salinity in the Governorate did not exceed 6000 µS/cm.

جودة المياه : الموصلية الكهربائية (EC)

سجلت أقل قراءة للموصلية الكهربائية لمياه الأفلاج في محافظة مسقط بفلج الطوية (ف٢١٥٠) التابع لولاية قريات، وكانت ٢٧٢ مايكروسيمنس/سم بينما سجلت أكبر قراءة للموصلية الكهربية في المحافظة بفلج الغيز (ف٠٣٤٢) التابع لولاية بوشر، وقد بلغت ٤٧٢٠ مايكروسيمنس/سم. ووجد أن مياه ١٥٣ فلجاً في المحافظة مناسبة لجميع المحاصيل الزراعية. ومياه ١٣ فلجاً ملائمة لمعظم المحاصيل الزراعية. و لم تسجل أي قراءة للملوحة في المحافظة أعلى من ٦٠٠٠ مايكروسيمنس/سم.





Electrical Conductivity الموصلية الكهربائية

Wilayat	Electrical Conductivity Range - µS/cm نطاق الموصلية الكهربائية – ميكروسيمنس/سم >6000	2001-6000	1001-2000	<=1000	الولاية
Qurayat	0	0	11	75	قريات
Bawshar	0	5	14	22	بوشر
Al Amrat	0	2	13	13	العامرات
Seeb	0	6	2	0	السيب
Muscat	0	0	1	1	مسقط
Mutrah	0	0	1	0	مطرح
Total	**0**	**13**	**42**	**111**	**المجموع**

PART 4 :
MUSCAT GOVERNORATE AFLAJ STATISTICS

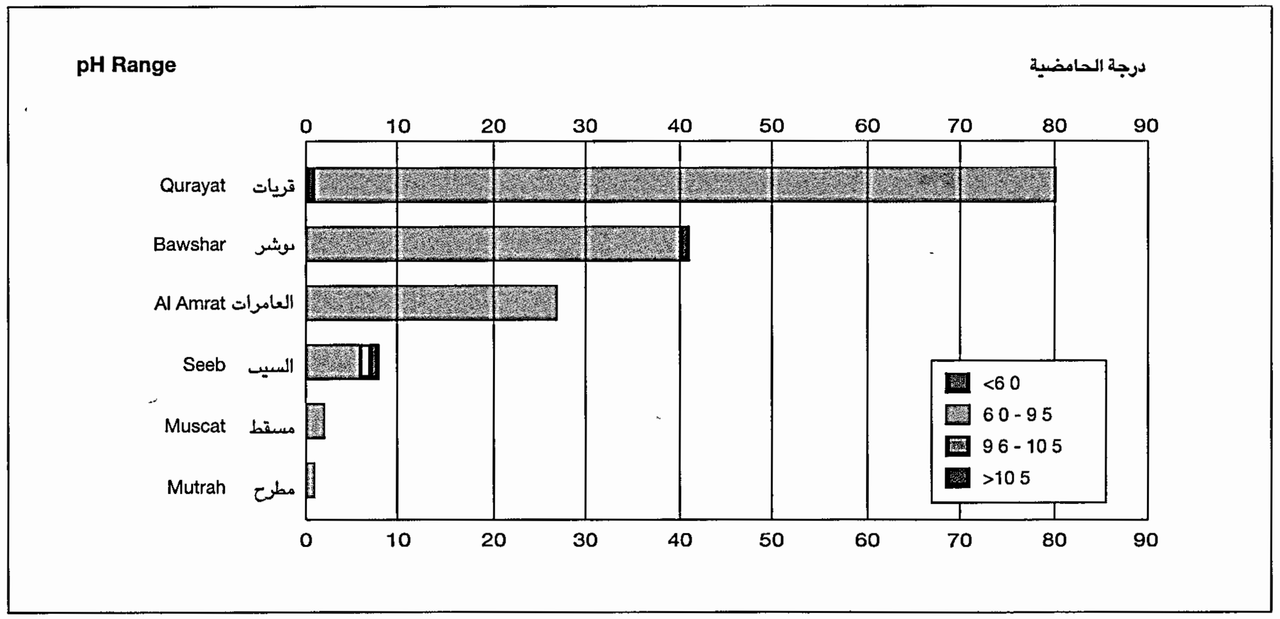
الجزء الرابع :
إحصائيات أفلاج محافظة مسقط

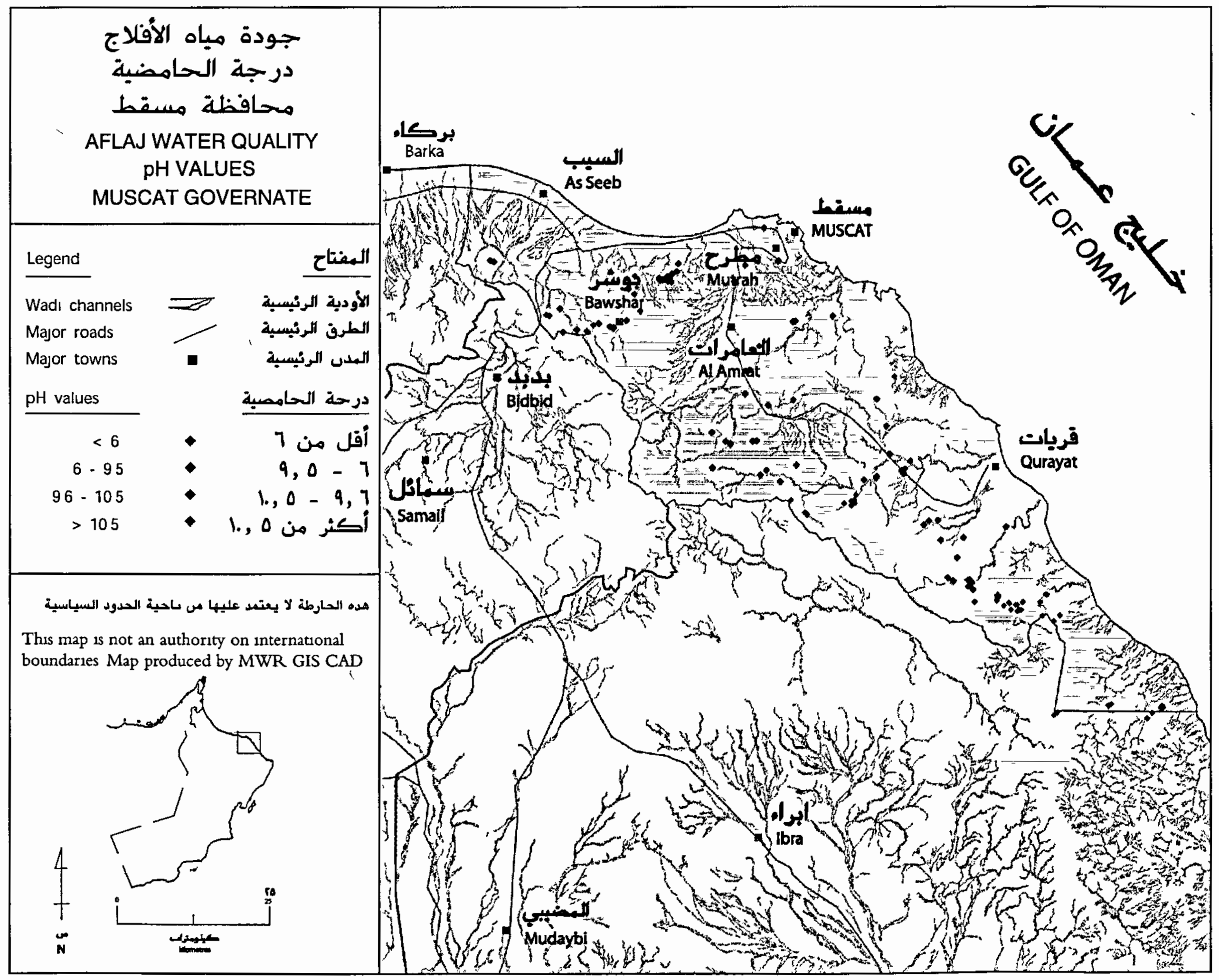
Water Quality : pH Levels

Al Muqta'ı falaj (F2924), Qurayat, produced the lowest pH value (5.4) recorded for aflaj water in Muscat Governorate. The highest readıng (11 4) occurred at Al Waqibah falaj (F0315), As Seeb. Generally, the results showed that the water of 155 aflaj ın the Governorate was suıtable for all crops (pH value rangıng between 6 and 9.5) Only one falaj had water that was slıghtly alkalıne (pH rangıng between 9.6 and 10 5), whılst the water of two aflaj ın the Governorate was sıgnıficantly alkalıne (pH value greater than 10.5). Only one falaj held water that was acıdıc (pH value below 6); such water is unsuitable for some crops

جودة المياه : درجة الحامضية (pH)

سجلت أقل قراءة للحامضية لمياه الأفلاج في محافظة مسقط بفلج المقطعي (ف٢٩٢٤) التابع لولاية قريات وكانت ٥,٤ بيما سجلت أعلى قراءة للحامضية بفلج الوقيبة (ف٠٣١٥) التابع لولاية السيب وقد بلعت درجة حامضية مياهه ١١,٤. وأظهرت النتائج أن مياه ١٥٥ فلجاً في المحافظة صالحة لجميع المحاصيل الزراعية (تتراوح درجة الحامضية بين ٦ و٩,٥) ومياه فلح واحد مائلة إلى القلوية (تتراوح درجة الحامضية بين ٩,٦ و١٠,٥) بينما جاءت مياه فلجين في المحافظة عالية القلوية (درجة الحامضية أكبر من ١٠,٥) ومياه فلج واحد فقط حامضية (درجة الحامضية أقل من ٦) وبالتالي فهي غير صالحة لبعض المحاصيل الزراعية.





pH Level | **درجة الحامضية**

Wilayat	pHRange >10.5	9.6-10 5	درجة الحامضية 6.0-9.5	<6 0	الولاية
Qurayat	0	0	79	1	قريات
Bawshar	1	0	40	0	بوشر
Al Amrat	0	0	27	0	العامرات
Seeb	1	1	6	0	السيب
Muscat	0	0	2	0	مسقط
Mutrah	0	0	1	0	مطرح
Total	2	1	155	1	المجموع

PART 5 :
BATINAH REGION AND MUSANDAM GOVERNORATE AFLAJ STATISTICS

الجزء الخامس :
إحصائيات أفلاج منطقة الباطنة ومحافظة مسندم

Aflaj Type and Status

Batinah possesses the largest number of inventoried aflaj of any Omani region - with 1561. Live aflaj form 77 5% of the total and the region includes aflaj from all categories: daudi, aini and ghaili. Daudi aflaj make up 12 4% of the total; aini aflaj 28.4%, and ghaili aflaj - the largest category - with 59.2%.

Most dead aflaj in Batinah are the ghaili category, 71.3% of dead aflaj. Aini and daudi types, which make up 17.3% and 11 4% of the total number of dead aflaj in Batinah respectively.

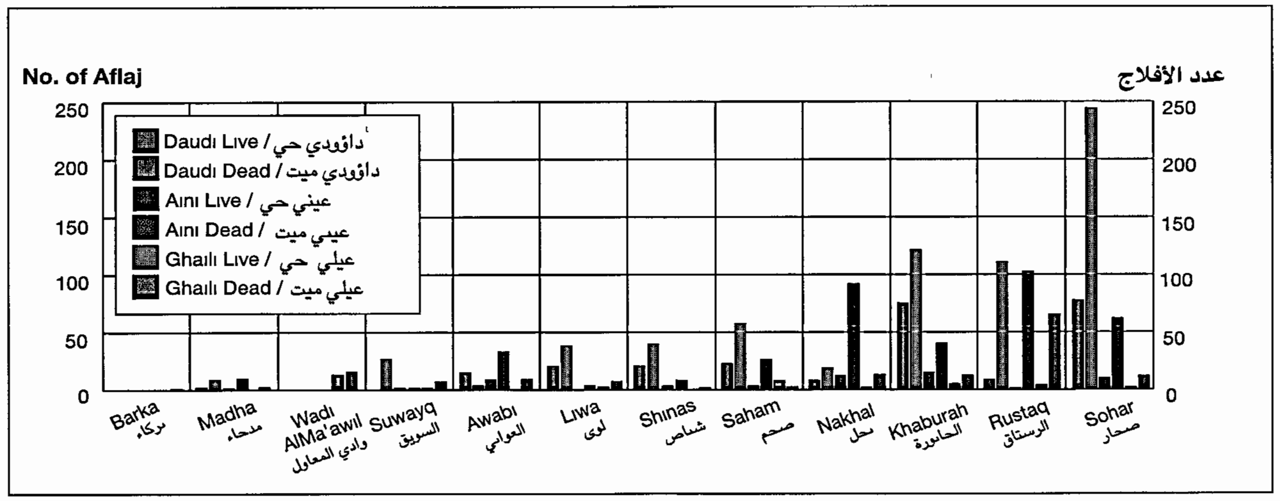
A total of 1616 demand areas were included in the inventory in Batinah, with a total area of 6,458 hectares 1219 samples of water were taken and sent to the Ministry's Water Quality Laboratory for chemical analysis

أنواع وحالات الأفلاج

تأتي منطقة الباطنة في المرتبة الأولى من حيث عدد الأفلاج المحصورة فيها، حيث تم حصر ١٥٦١ فلجاً في هذه المنطقة. وتشكل الأفلاج الحية ٧٧,٥٪ من مجموع الأفلاج المحصورة، وتتوفر الأفلاج في منطقة الباطنة بكافة أنواعها الداؤودية والعينية والغيلية، حيث بلغت نسبة الأفلاج الداؤودية ١٢,٤٪ من مجموع الأفلاج في المنطقة. وبلعت نسبة الأفلاج العينية ٢٨,٤٪ والأفلاج الغيلية شكلت نسبة ٥٩,٢٪ من مجموع الأفلاج.

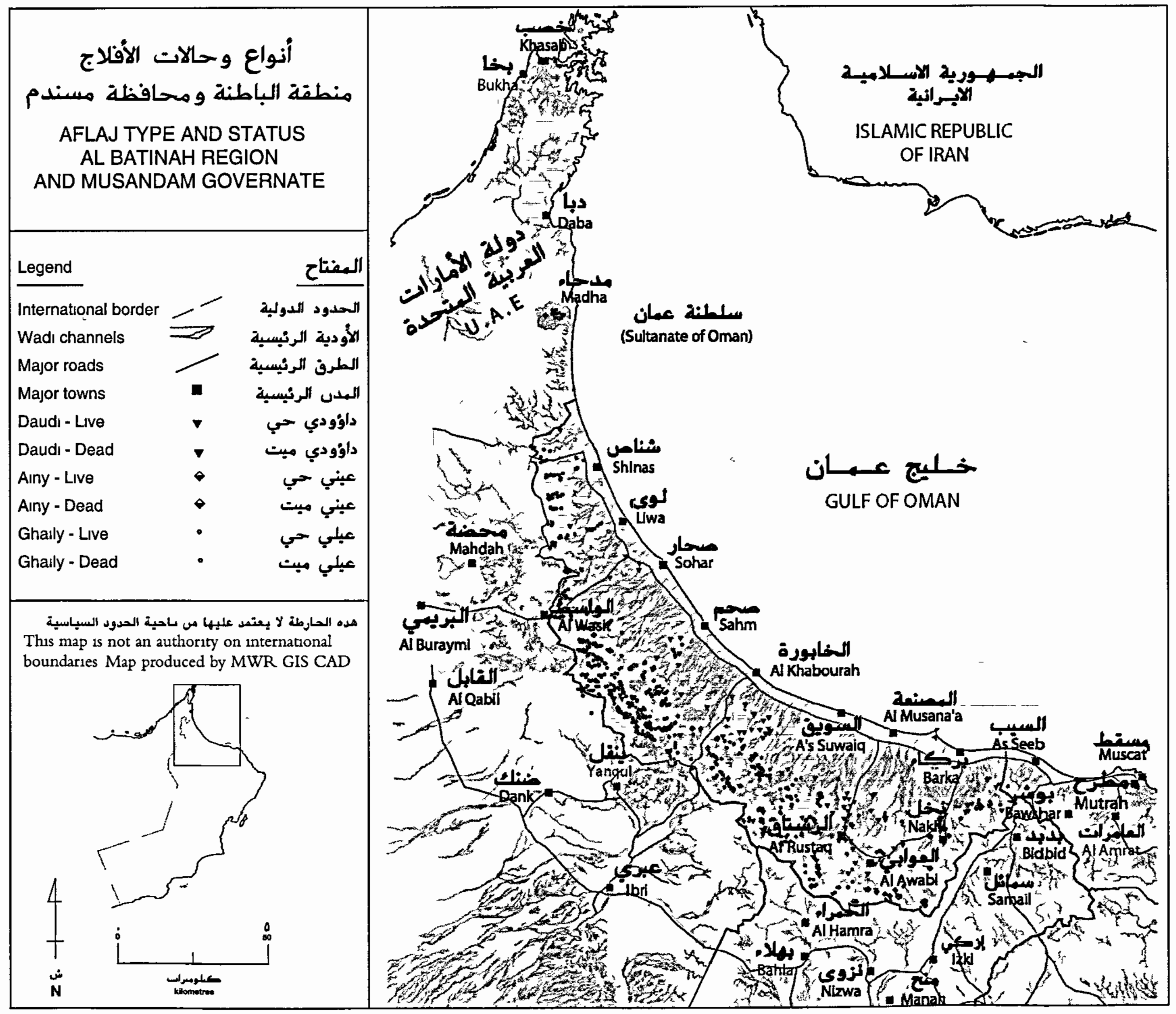
أكثر الأفلاج الميتة في المنطقة كانت أفلاجاً غيلية حيث بلعت نسبتها ٧١,٣٪ من مجموع الأفلاج الميتة في المطقة تلتها الأفلاج الميتة العينية وشكلت نسبة ١٧,٣٪ ثم الأفلاح الميتة الداؤودية وكانت نسبتها ١١,٤٪ من مجموع الأفلاج الميتة.

وقد تم حصر ١٦١٦ منطقة احتياج في مطقة الباطنة وشكلت مساحة إجمالية وقدرها ٦٤٥٨,٢ هكتاراً وقد تم جمع ١٢١٩ عينة مياه تم إرسالها إلى محتر جودة المياه التابع للوزارة لإجراء التحليلات الكيميائية عليها.



Aflaj Type & Status أنواع وحالات الأفلاج

Wilayat	Total Dead ميت	المجموع Live حي	Ghaili Dead ميت	غيلي Live حي	Aini Dead ميت	عيني Live حي	Daudi Dead ميت	داؤودي Live حي	الولاية
Sohar	91	317	79	243	10	61	2	13	صحار
Ar Rustaq	13	281	8	112	1	103	4	66	الرستاق
Al Khaburah	99	178	73	123	18	42	8	13	الخابورة
Nakhal	24	126	9	19	13	93	2	14	نخل
Saham	36	87	23	58	5	25	8	4	صحم
Shinas	24	52	21	41	3	10	0	1	شناص
Liwa	23	50	21	39	0	4	2	7	لوى
Al Awabi	24	46	15	4	9	33	0	9	العوابي
As Suwaiq	2	34	0	26	1	1	1	7	السويق
Wadi Al Ma'awil	13	16	0	0	0	0	13	16	وادي المعاول
Madha	3	21	2	9	1	10	0	2	مدحاء
Barka	0	1	0	0	0	0	0	1	بركاء
Total	**352**	**1209**	**251**	**674**	**61**	**382**	**40**	**153**	**المجموع**



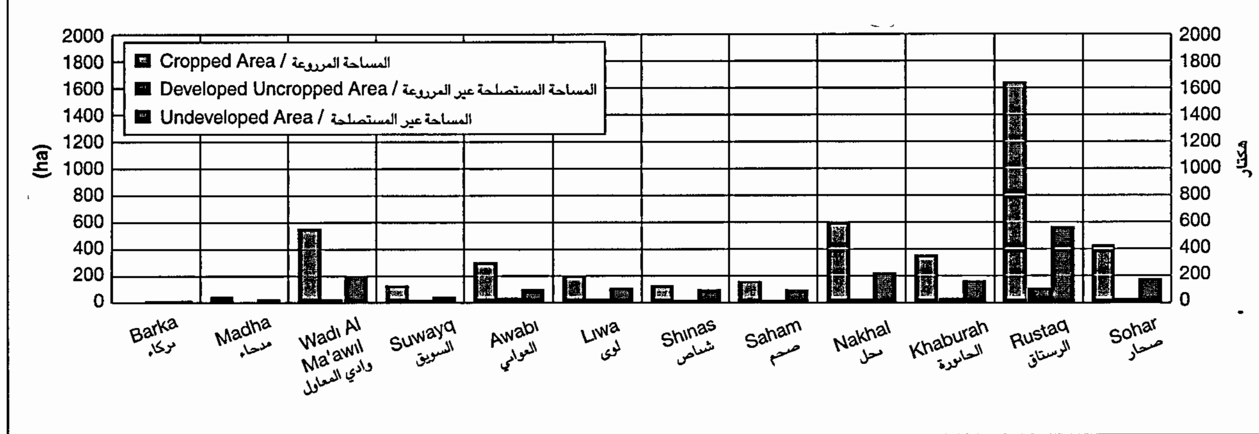
PART 5 :
BATINAH REGION AND MUSANDAM GOVERNORATE AFLAJ STATISTICS

الجزء الخامس :
إحصائيات أفلاج منطقة الباطنة ومحافظة مسندم

Aflaj Demand Areas

Aflaj dependent areas in the Batinah region total 6458 hectares, 69.2% of which is cropped land, 3.8% developed uncropped land and 27% undeveloped land.

The wilayat of Ar Rustaq had the highest area of land dependent on aflaj water, representing 35.2% of the total in the region. The wilayats of Nakhal, Wadi Al Ma'awil, Sohar, Al Khaburah and Al Awabi followed with figures of 12.8%, 11.9%, 9.8%, 8.5% and 6.4% respectively The wilayats of Lawi, Saham, Shinas, As Suwaiq, Mahdah and Barka collectively made up 15.4% of the total. Note that Ar Rustaq also formed the largest area of cropped land, with a figure of 36.6% of total cropped area in the region



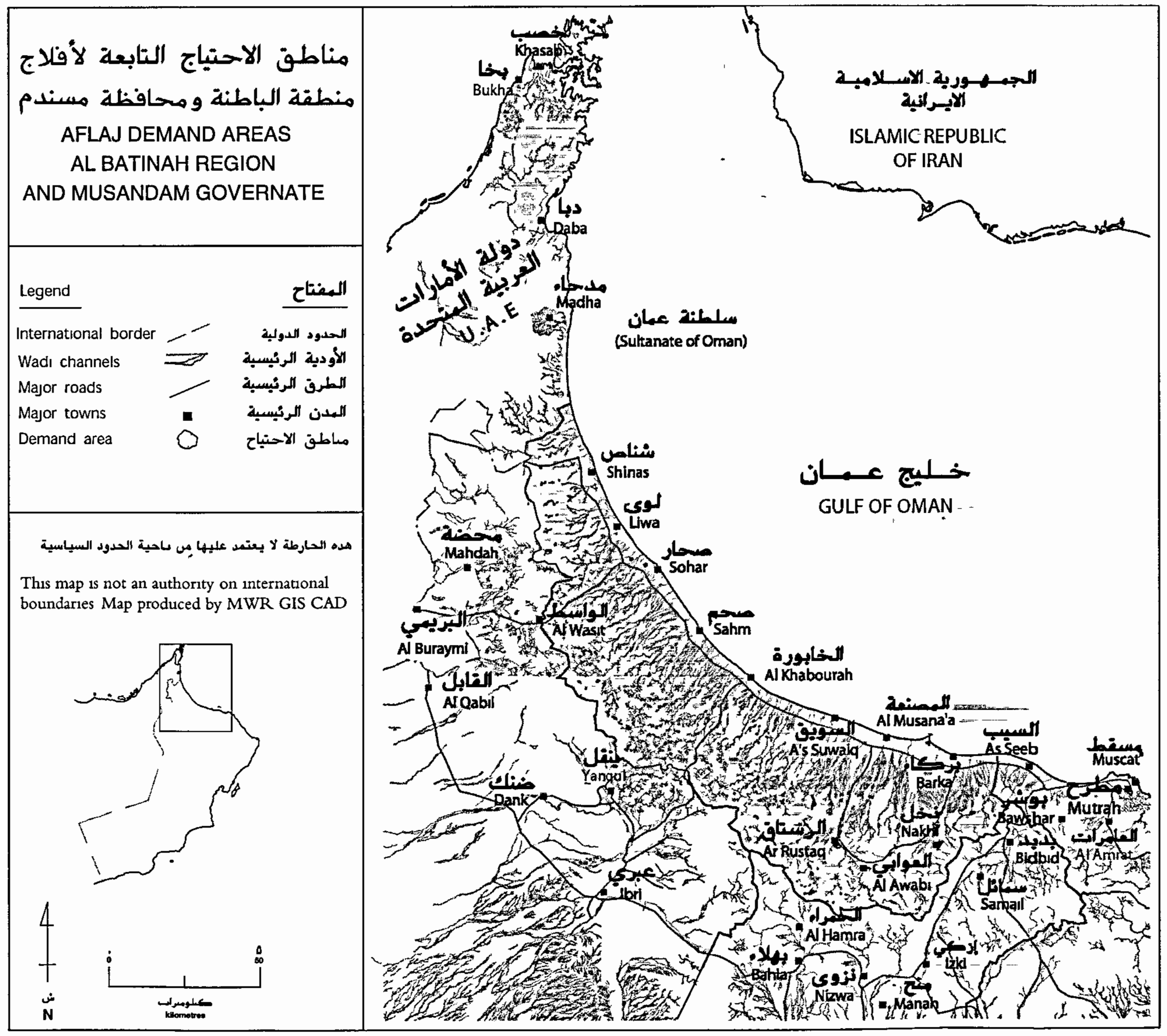
Demand Areas مناطق الاحتياج

Wilayat	Total Area (ha) مجموع المساحة (هكتار)	Undeveloped Area (ha) المساحة غير المستصلحة (هكتار)	Developed Uncropped Area (ha) المساحة المستصلحة غير المرروعة (هكتار)	Cropped Area (ha) المساحة المزروعة (هكتار)	الولاية
Sohar	633 97	180 24	23 88	429 85	صحار
Ar Rustaq	2272 52	546 50	90 84	1635 18	الرستاق
Al Khaburah	545 70	169 29	19 81	356 60	الخابورة
Nakhal	825 56	205 41	32 64	587 51	نخل
Saham	244 40	87 51	8 25	148 64	صحم
Shinas	233 41	101 83	6 92	124 66	شناص
Liwa	297 14	99 52	10 40	187 22	لوى
Al Awabi	413 55	101 00	16 45	296 10	العوابي
As Suwaiq	176 12	42 27	7 04	126 81	السويق
Wadi Al Ma'awil	767 60	196 50	30 05	541 05	وادي المعاول
Madha	42 25	10 64	1 66	29 95	مدحاء
Barka	5 96	1 43	0 23	4 30	بركاء
Total	**6458.18**	**1742.14**	**248.17**	**4467.87**	المجموع

المساحات المعتمدة على الأفلاج

بلغت مساحة المناطق المعتمدة على مياه الأفلاج في منطقة الباطنة ٦٤٥٨,٢ هكتاراً، منها ٦٩,٢٪ مساحة مزروعة و٣,٨٪ مساحة مستصلحة (غير مزروعة) و٢٧٪ مساحة غير مستصلحة.

جاءت ولاية الرستاق في المرتبة الأولى من حيث مجموع المساحة المعتمدة على مياه الأفلاج مشكلة ما نسبته ٣٥,٢٪ من مجموع المساحة في المنطقة ثم ولاية نخل بسبة ١٢,٨٪ وولاية وادي المعاول بسبة ١١,٩٪ ثم ولاية صحار بنسبة ٩٨٪ وولاية الحابورة بنسبة ٨,٥٪ وولاية العوابي بنسبة ٦,٤٪ بينما شكلت ولايات لوى وصحم وشناص والسويق ومدحاء وبركاء مجتمعة نسبة ١٥,٤٪ من مجموع المساحة، وجاءت ولاية الرستاق أيضا في المرتبة الأولى من حيث مجموع المساحة المزروعة بسبة ٣٦,٦٪ من محموع المساحة المزروعة في المنطقة.



PART 5 :

BATINAH REGION AND MUSANDAM GOVERNORATE AFLAJ STATISTICS

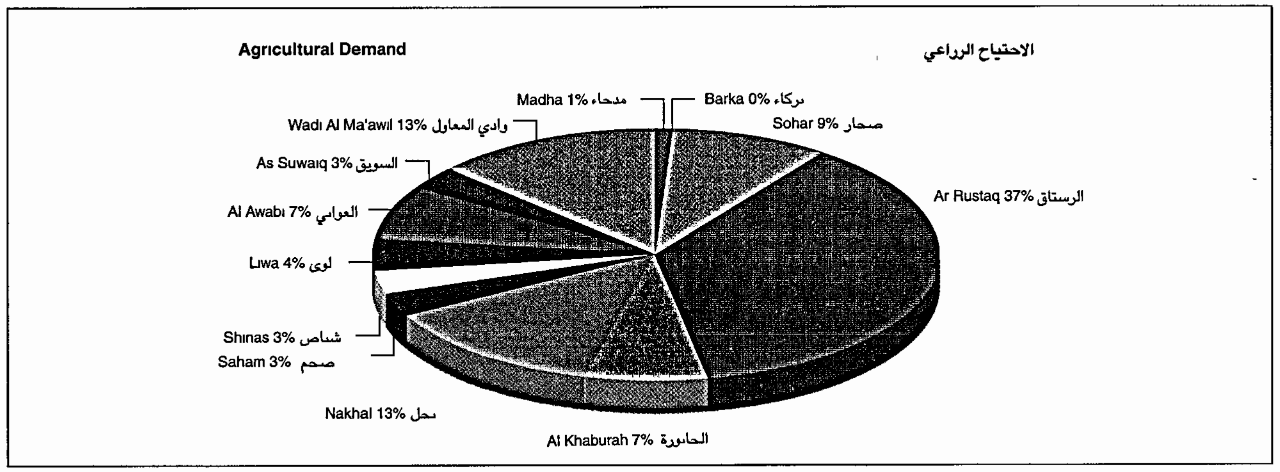
الجزء الخامس :

إحصائيات أفلاج منطقة الباطنة ومحافظة مسندم

Annual Water Demand

The annual demand for aflaj water in the Batinah region is 104.23 million m³. Agricultural land accounts for 99.9% of this figure.

Ar Rustaq has the highest annual demand for aflaj water with a figure of 39.91 million m³. The wilayats of Nakhal, Wadi Al Ma'awil, Sohar, Al Khabu, Al Awabi, Liwa, Saham, As Suwaiq and Shinas, Madha and Barka follow with figures of 13.96, 13.21, 9.12, 7.31, 7.19, 4.02, 3.05, 3.04, 2 67, 0.64 and 0.1 million m³ respectively.

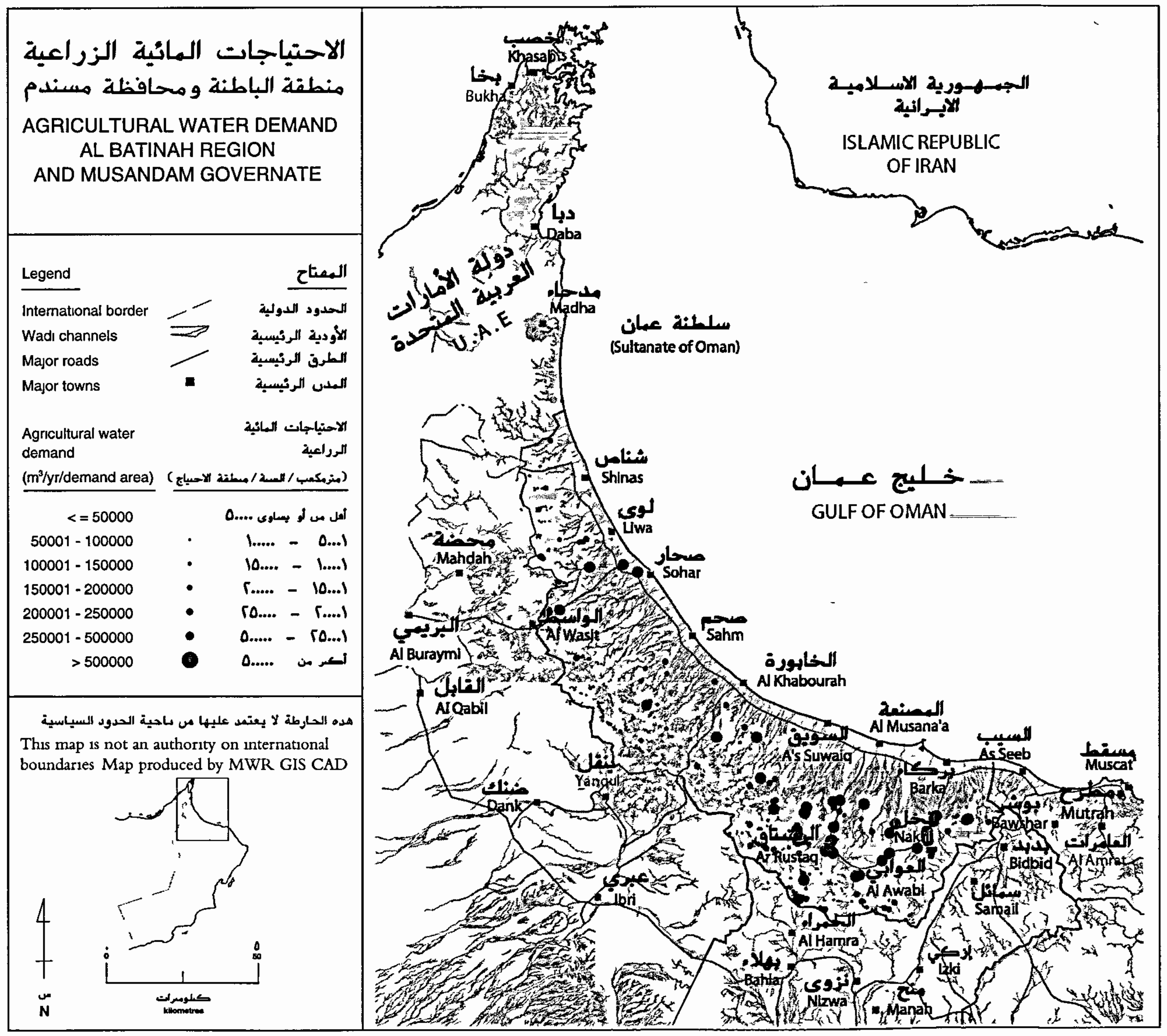


Annual Water Requirement — **الاحتياج المائي السنوي**

Wilayat	Total Water Demand (Mm³/yr) إجمالي الاحتياج المائي (م م³/سنة)	Livestock Demand (Mm³/yr) الاحتياج الحيواني (م م³/سنة)	Agricultural Demand (Mm³/yr) الاحتياج الزراعي (م م³/سنة)	الولاية
Sohar	9 12	0 00	9 12	صحار
Ar Rustaq	39 91	0 08	39 83	الرستاق
Al Khaburah	7.31	0 00	7 31	الخابورة
Nakhal	13 96	0 02	13 94	نخل
Saham	3 05	0 00	3 05	صحم
Shinas	2 67	0 00	2 67	شناص
Liwa	4 03	0 00	4 03	لوى
Al Awabi	7 19	0 00	7 19	العوابي
As Suwaiq	3 04	0 00	3 04	السويق
Wadi Al Ma'awil	13 21	0 00	13 21	وادي المعاول
Madha	0 64	0 00	0 64	مدحاء
Barka	0 1	0 00	0 1	بركاء
Total	**104.23**	**0.10**	**104.13**	المجموع

الاحتياج المائي السنوي

بلع مجموع الاحتياج السوي من مياه الأفلاج في منطقة الباطنة ١٠٤,٢٣ مليون متر مكعب، وكان للاحتياج الزراعي الصيب الأعظم منها، حيث بلغ ٩٩,٩٪ من مجموع حجم الاحتياج. جاءت ولاية الرستاق في المرتبة الأولى من حيث حجم الاحتياج السوي من مياه الأفلاج، وبلغ حجم الاحتياج المائي السنوي في هذه الولاية ٣٩,٩١ مليون متر مكعب، تلتها ولاية نخل بحجم ١٣,٩٦ مليون متر مكعب فولاية وادي المعاول بحجم ١٣,٢١ مليون متر مكعب ثم ولاية صحار بحجم ٩,١٢ مليون متر مكعب وولاية الخابورة بحجم ٧,٣١ مليون متر مكعب ثم ولاية العوابي بحجم ٧,١٩ مليون متر مكعب وولاية لوى بحجم ٤,٠٢ مليون متر مكعب وولاية صحم بحجم ٣,٠٥ مليون متر مكعب ثم ولاية السويق بحجم ٣,٠٤ مليون متر مكعب وولاية شناص بحجم ٢,٦٧ مليون متر مكعب وولاية مدحاء بحجم ٠,٦٤ مليون متر مكعب وأحيرا ولاية بركاء بحجم ٠,١ مليون متر مكعب في السة.

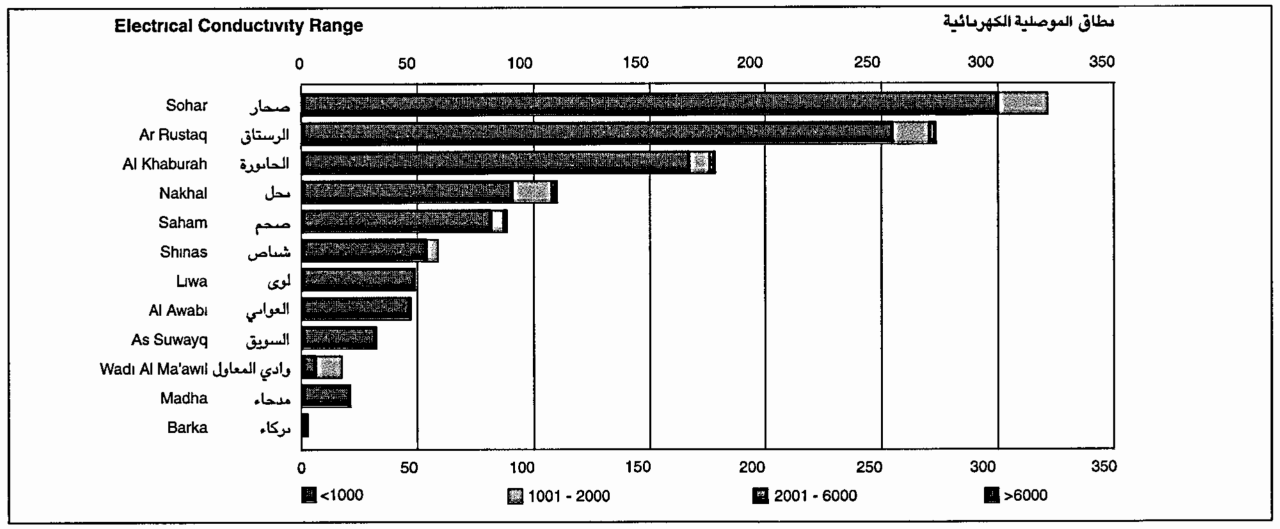


PART 5 :
BATINAH REGION AND MUSANDAM GOVERNORATE AFLAJ STATISTICS

الجزء الخامس :
إحصائيات أفلاج منطقة الباطنة ومحافظة مسندم

Water Quality: Electrical Conductivity

Zahra falaj (F3541), Shinas, gave the lowest electrical conductivity (EC) reading (115 µS/cm) for aflaj water in the Batinah region The highest EC reading (4268 µS/cm) recorded at Ain Al Mahdeth falaj (F2650) in the Nakhal district. The tests showed that the water of 1185 aflaj in the region was suitable for all crops and that the water of 10 was suitable for most crops The highest reading for salinity in the region did not exceed 6000 µS/cm.

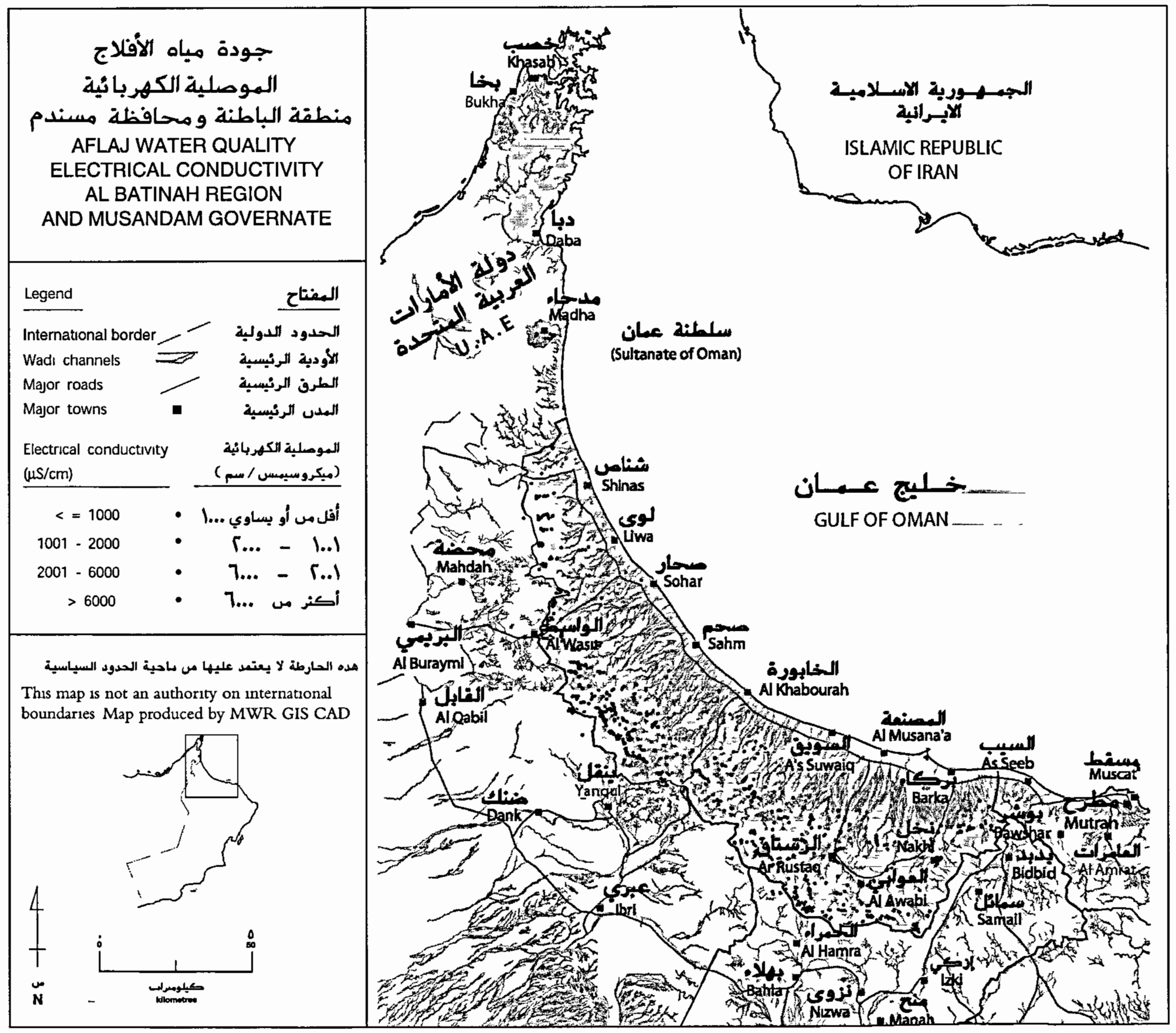


Electrical Conductivity | **الموصلية الكهربائية**

Wilayat	Electrical Conductivity Range - µS/cm نطاق الموصلية الكهربائية – ميكروسيمنس/سم >6000	2001-6000	1001-2000	<=1000	الولاية
Sohar	0	1	12	300	صحار
Ar Rustaq	0	3	20	254	الرستاق
Al Khaburah	0	2	3	172	الخابورة
Nakhal	0	2	23	88	نخل
Saham	0	2	8	80	صحم
Shinas	0	0	2	54	شناص
Liwa	0	0	1	49	لوى
Al Awabi	0	0	1	47	العوابي
As Suwaiq	0	0	0	33	السويق
Wadi Al Ma'awil	0	0	9	7	وادي المعاول
Madha	0	0	1	20	مدحاء
Barka	0	0	1	0	بركاء
Total	0	10	81	1104	المجموع

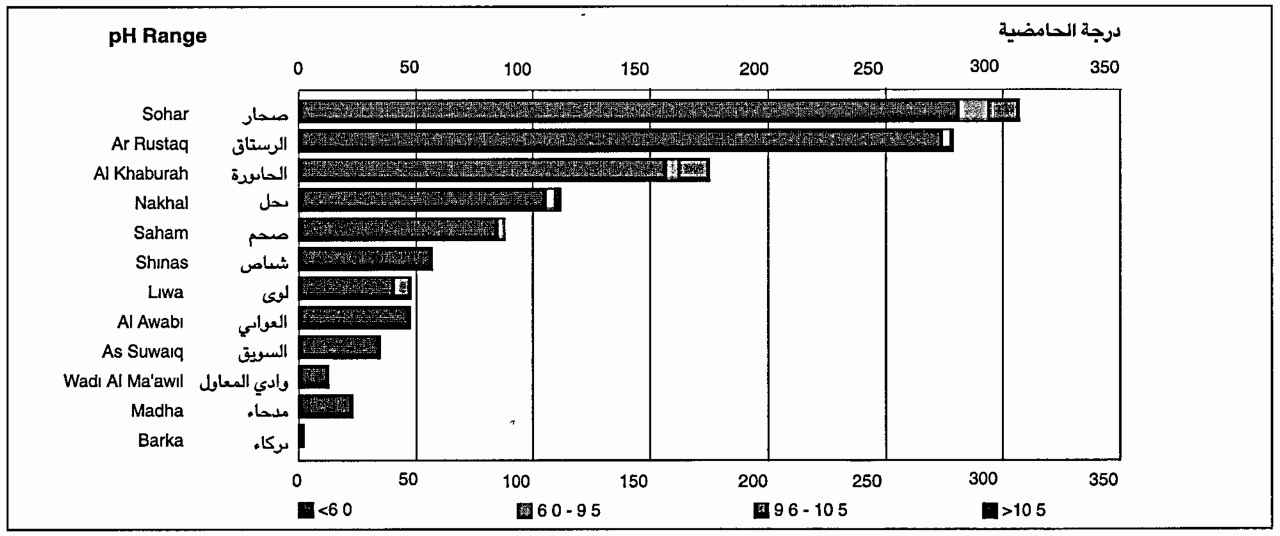
جودة المياه : الموصلية الكهربائية (EC)

سجلت أقل قراءة للموصلية الكهربية لمياه الأفلاج لمنطقة الباطنة بفلج طهره (ف ٣٥٤١) التابع لولاية شناص وكانت ١١٥ مايكروسيمنس/سم بينما سجلت أكبر قراءة للموصلية الكهربية في المنطقة بفلج عين المحيدث (ف ٢٦٥٠) التابع لولاية نخل وقد بلغت ٤٢٦٨ مايكروسيمنس/سم، ووحد أن مياه ١١٨٥ فلحاً في المنطقة مناسبة لجميع المحاصيل الزراعية. ومياه ١٠ أفلاج ملائمة لمعظم المحاصيل الزراعية. و لم تسجل أي قراءة للملوحة في المنطقة أعلى من ٦٠٠٠ مايكروسيمنس/سم.



Water Quality : pH Levels

Al Harf falaj (F4357), Al Awabı, gave the lowest pH value (4.6) recorded for aflaj water ın the Batınah region. The hıghest readıng (12.0) occurred at Al Bıh falaj (F3070) in the wilayat of Ar Rustaq. Generally, the results showed that the water of 1111 aflaj ın the region was suıtable for all crops (pH value rangıng between 6 and 9.5). Twenty nıne aflaj had water that was slıghtly alkalıne (pH rangıng between 9.6 and 10.5) whılst the water of 39 aflaj ın the regıon was sıgnıficantly alkalıne (pH value greater than 10.5). Only three aflaj held water that was acidıc (pH value below 6); water wıth thıs level of acıdıty ıs unsuıtable for some crops

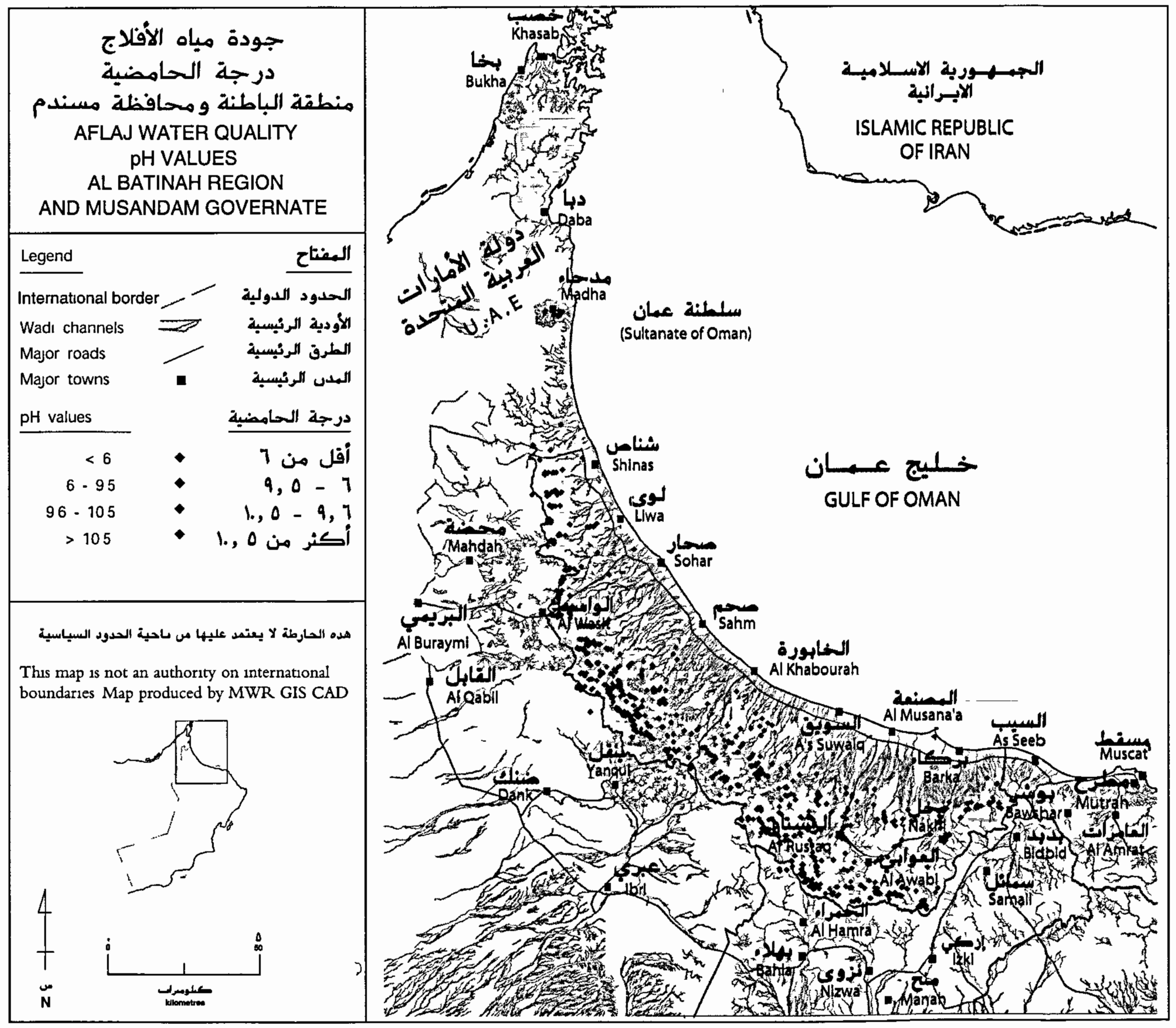


pH Level / **درجة الحامضية**

Wılayat	>10 5	9.6-10.5	6.0-9 5	<6.0	الولاية
		pH Range	درجة الحامضية		
Sohar	9	17	280	0	صحار
Ar Rustaq	4	1	272	0	الرستاق
Al Khaburah	13	4	158	1	الخابورة
Nakhal	2	3	108	0	نخل
Saham	1	3	82	0	صحم
Shınas	0	0	55	1	شناص
Lıwa	9	0	41	0	لوى
Al Awabı	0	0	47	1	العوابي
As Suwaıq	0	0	33	0	السويق
Wadı Al Ma'awıl	0	1	15	0	وادي المعاول
Madha	1	0	19	0	مدحاء
Barka	0	0	1	0	بركاء
Total	**39**	**29**	**1111**	**3**	**المجموع**

جودة المياه : درجة الحامضية (pH)

سجلت أقل قراءة للحامضية في منطقة الباطنة بفلج الحرف (ف٤٣٥٧) التابع لولاية العوابي وكانت ٤,٦، بيما سجلت أعلى قراءة للحامضية بفلج البيح (ف٣٠٧٠) التابع لولاية الرستاق وقد بلغت درحة حامضية مياهه ١٢,٠ وأطهرت النتائج أن مياه ١١١١ فلجاً في المطقة صالحة لجميع المحاصيل الزراعية (تتراوح درجة الحامضية بين ٦ و٩,٥) ومياه ٢٩ فلجاً مائلة إلى القلوية (تتراوح درجة الحامضية بين ٩,٦ و١٠,٥) بينما جاءت مياه ٣٩ فلجاً في المنطقة عالية القلوية (درجة الحامضية أكبر من ١٠,٥)، ومياه ثلاثة أفلاج أحرى في المطقة حامضية نسبياً (درجة الحامضية أقل من ٦)، وهذه النوعية من المياه عير صالحة لبعض المحاصيل الزراعية.



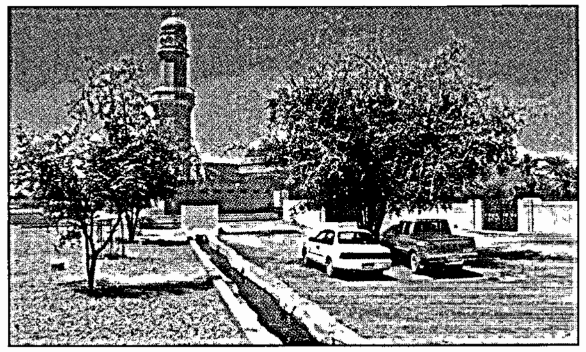
PART 6 :
Dhahirah Region Aflaj Statistics

الجزء السادس :
إحصائيات أفلاج منطقة الظاهرة

Aflaj Type and Status

Dhahirah possesses the fourth largest number of inventoried aflaj of any Omani region with a total of 716. Live aflaj form 66.1% of the total inventoried and the region includes aflaj from all categories: daudi, aini and ghaili. Daudi aflaj make up 21% of the total, aini 20% ghaili aflaj for the largest group with 59%.

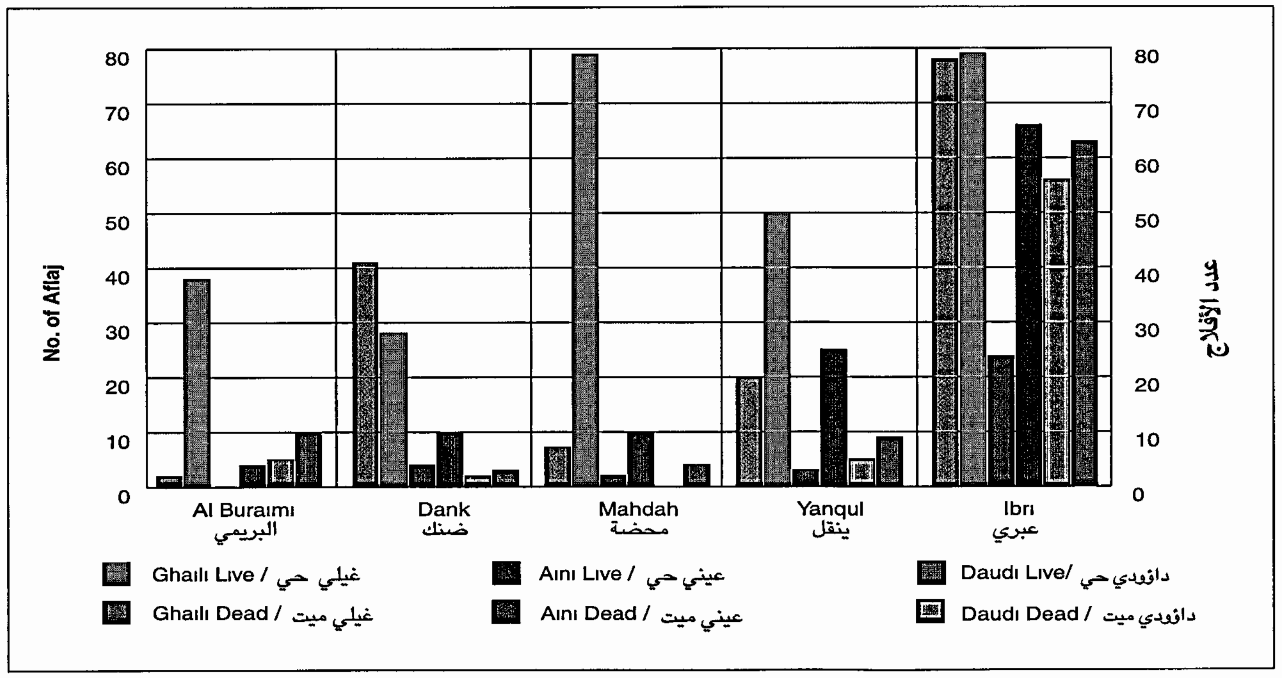
Most dead aflaj in the region were originally from the ghaili category, which forms 60.5% of dead aflaj. This group is followed by daudi and aini aflaj which make up 26.7% and 12.8% respectively.

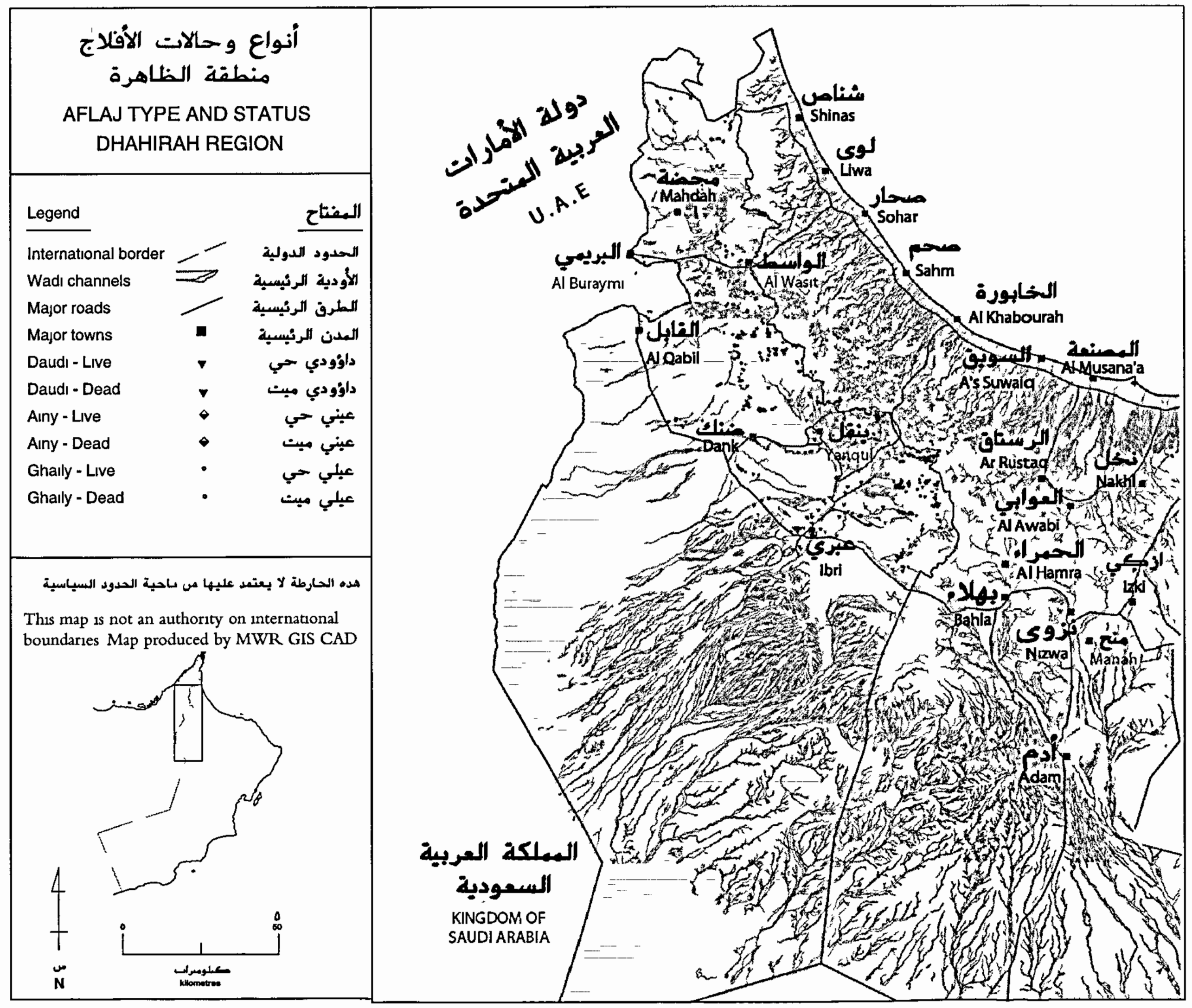


أنواع وحالات الأفلاج

تأتي منطقة الظاهرة في المرتبة الرابعة من حيث عدد الأفلاج المحصورة فيها، حيث تم حصر ٧١٦ فلجاً في هذه المنطقة. وتشكل الأفلاج الحية ٦٦,١٪ من مجموع الأفلاج المحصورة، وتتوفر الأفلاج في منطقة الظاهرة بكافة أنواعها الداوُودية والعينية والغيلية. حيث بلغت نسبة الأفلاج الداوُودية ٢١٪ من مجموع الأفلاج في المنطقة، وبلغت نسبة الأفلاج العينية ٢٠٪ والأفلاج الغيلية شكلت نسبة ٥٩٪ من مجموع الأفلاج.

أكثر الأفلاج الميتة في المنطقة كانت أفلاجاً غيلية حيث بلغت نسبتها ٦٠,٥٪ من مجموع الأفلاج الميتة تلتها الأفلاج الميتة الداوُودية وشكلت نسبة ٢٦,٧٪ من مجموع الأفلاج الميتة ثم الأفلاج الميتة العينية وكانت نسبتها ١٢,٨٪ من مجموع الأفلاج الميتة.





Aflaj Type and Status أنواع وحالات الأفلاج

Wilayat	Total Dead ميت	المجموع Live حي	Ghaili Dead ميت	غيلي Live حي	Aini Dead ميت	عيني Live حي	Daudi Dead ميت	داؤودي Live حي	الولاية
Ibri	156	207	77	79	23	66	56	62	عبري
Yanqul	27	84	20	50	3	25	4	9	ينقل
Mahdah	8	92	7	79	1	10	0	3	محضة
Dank	46	40	41	28	4	10	1	2	ضنك
Al-Buraimi	6	50	1	37	0	3	5	10	البريمي
Total	**243**	**473**	**146**	**273**	**31**	**114**	**66**	**86**	**المجموع**

PART 6 : Dhahirah Region Aflaj Statistics

الجزء السادس : إحصائيات أفلاج منطقة الظاهرة

Aflaj Demand Areas

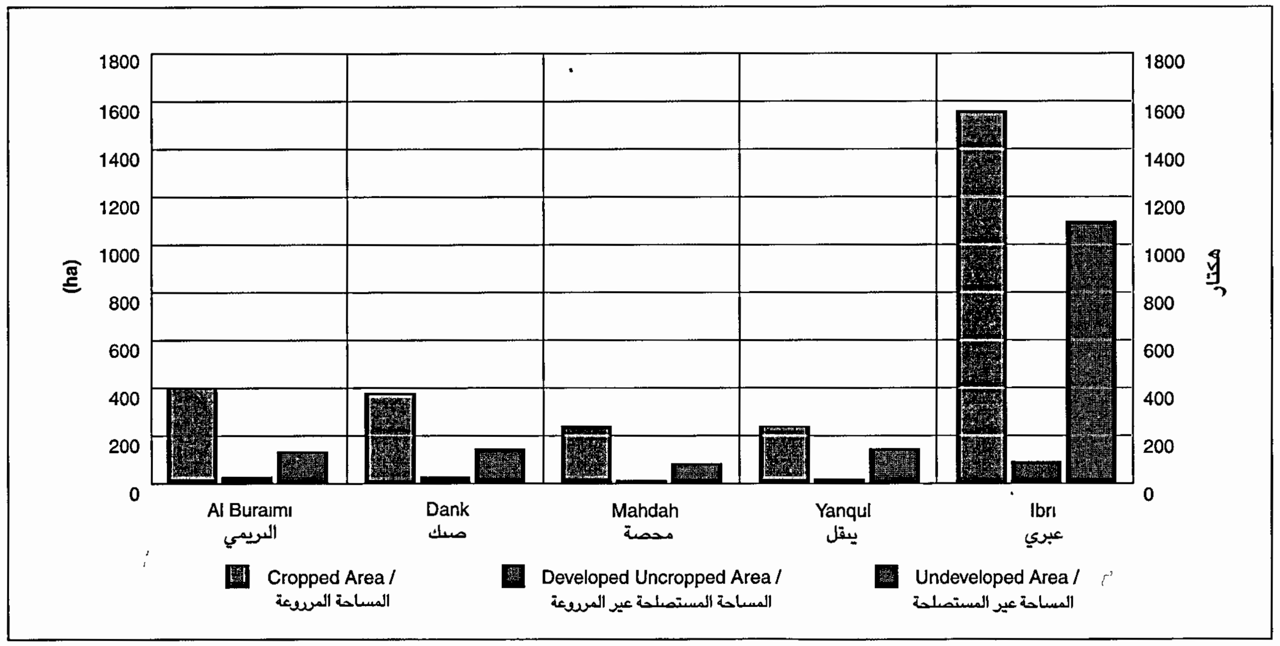
The area dependent on aflaj water in the Dhahirah region totals 4625.5 hectares of which 61.8% is cropped land, 3.4% developed uncropped lands and 34.8% undeveloped land.

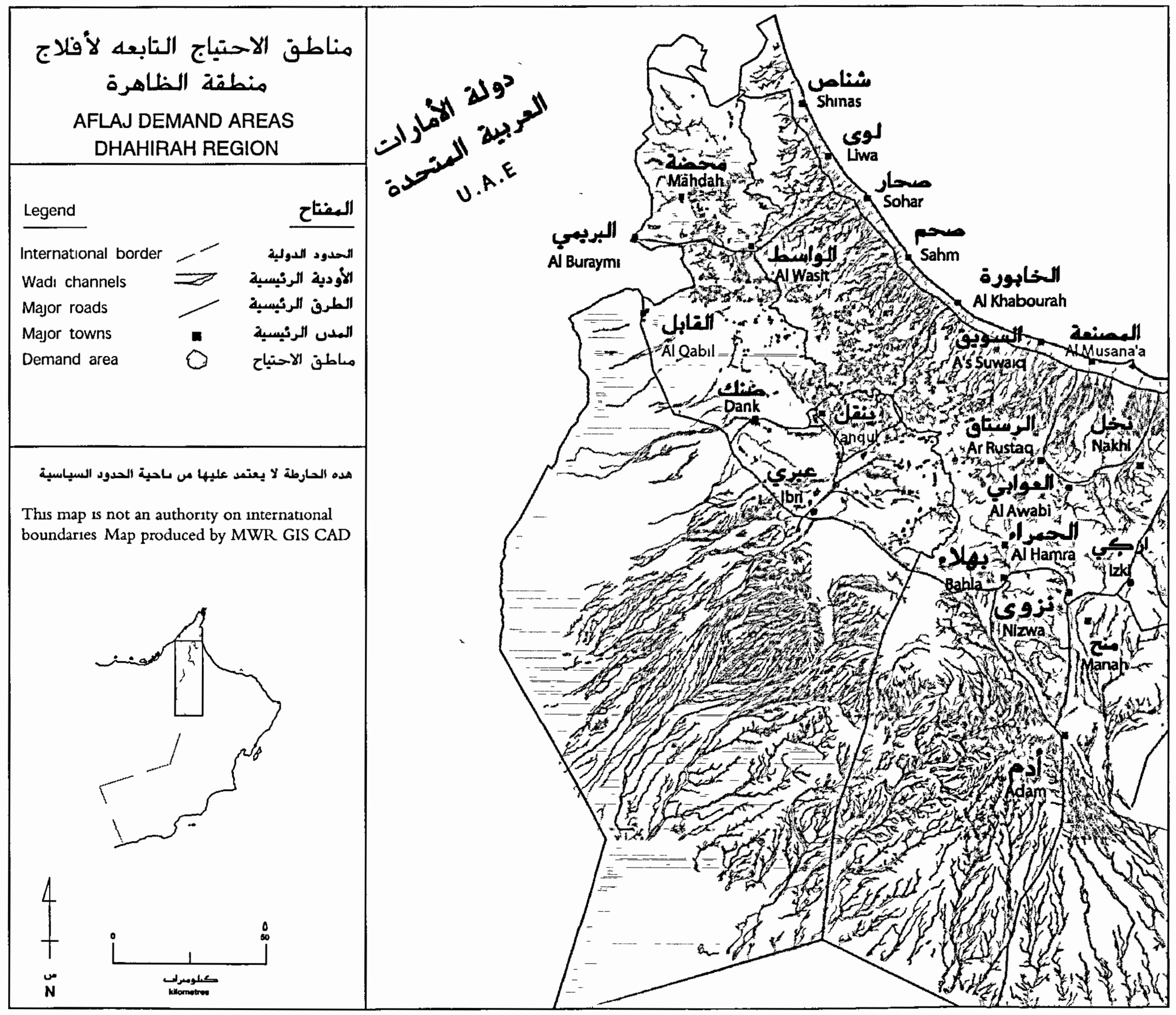
Ibri holds the highest area of aflaj-dependent land with 59.9% of the total in the region. The wilayats of Al Buraimi and Dank follow with figures of 12 1% and 12% respectively. The wilyatas of Mahdah and Yanqul collectively make up 16% of the total. Note that Ibri also forms the largest area of cropped land, with a figure of 55.6% of the total cropped area in the region.

المساحات المعتمدة على الأفلاج

بلغت مساحة المناطق المعتمدة على مياه الأفلاح في منطقة الطاهرة ٤٦٢٥,٥ هكتاراً، منها ٦١,٨٪ مساحة مزروعة و٣,٤٪ مساحة مستصلحة غير مزروعة و ٣٤,٨ ٪ مساحة عير مستصلحة.

جاءت ولاية عري في المرتبة الأولى من حيث مجموع المساحة المعتمدة على مياه الأفلاج مشكلة ما نسبة ٥٩,٩٪ من مجموع المساحة في المنطقة ثم ولاية البريمي بسبة ١٢,١٪ وولاية ضنك بنسبة ١٢٪ بينما شكلت ولايتا محضة وينقل مجتمعة نسبة ١٦٪ من محموع المساحة. وجاءت ولاية عبري كذلك في المرتبة الأولى من حيث مجموع المساحة المرروعة بنسبة ٥٥,٦٪ من محموع المساحة المزروعة في المطقة.





Demand Areas

مناطق الاحتياج

Wilayat	Total Area (ha) مجموع المساحة (هكتار)	Undeveloped Area (ha) المساحة عير المستصلحة (هكتار)	Developed Uncropped Area (ha) المساحة المستصلحة عير المزروعة (هكتار)	Cropped Area (ha) المساحة المزروعة (هكتار)	الولاية
Ibri	2770 98	1095 66	88 17	1587 15	عبري
Yanqul	406 09	157 20	13 09	235 80	ينقل
Mahdah	333 96	80 15	13 35	240 46	محضة
Dank	556 55	143 28	21 75	391 52	ضنك
Al-Buraimi	557 96	133 91	22 31	401 74	البريمي
Total	4625 54	1610 20	158 67	2856 67	المجموع

PART 6 :
Dhahirah Region Aflaj Statistics

الجزء السادس :
إحصائيات أفلاج منطقة الظاهرة

Annual Water Demand

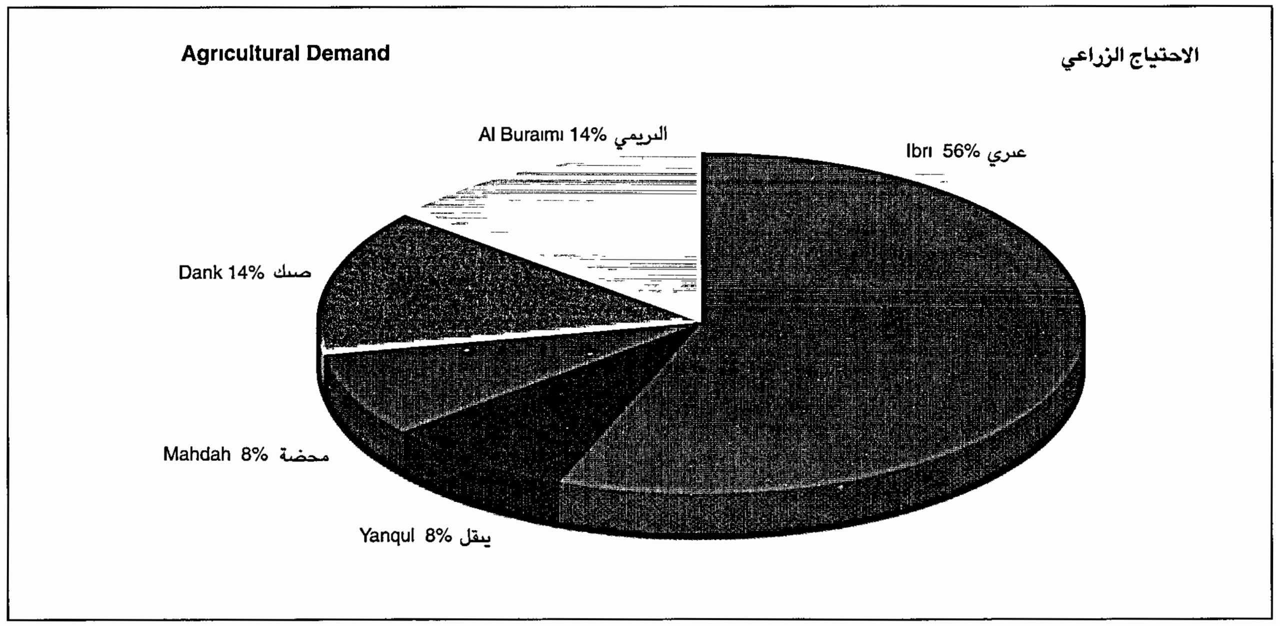
The annual demand for aflaj water in the Dhahirah region is 78 61 million m³. Agricultural land accounts for 99.9% of this figure.

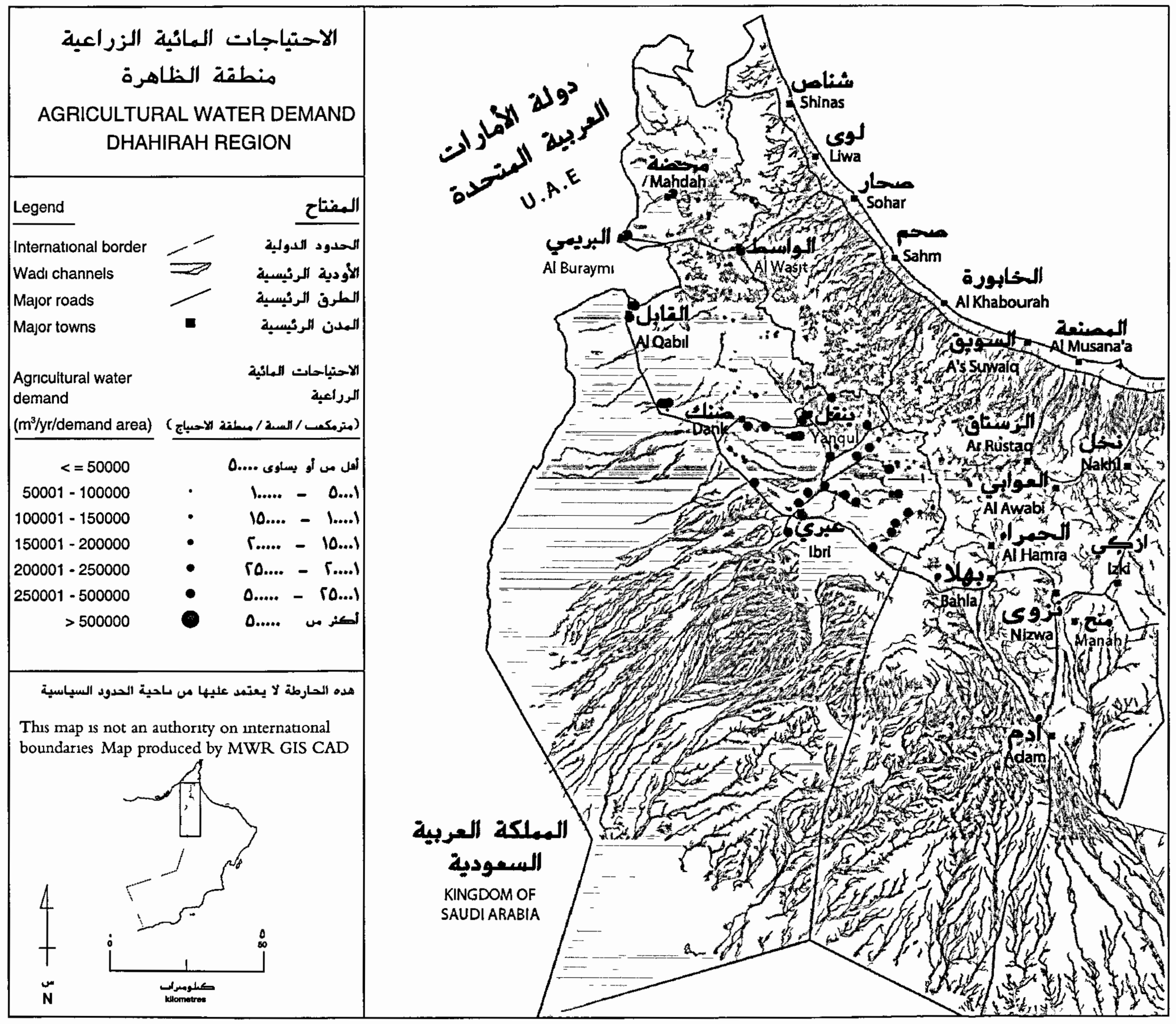
Ibri has the highest annual demand for aflaj water with a figure of 43.82 million m³. The wilayats of Al Buraimi, Dank, Mahdah and Yanqul follow with figures of 11.06, 10.76, 6.54 and 6.43 million m³ respectively

الاحتياج المائي السنوي

بلغ مجموع الاحتياج السنوي من مياه الافلاج في منطقة الظاهرة ٧٨,٦١ مليون متر مكعب. وكان للاحتياج الزراعي النصيب الأعظم منها حيث بلغ ٩٩,٩ ٪ من مجموع حجم الاحتياج.

جاءت ولاية عبري في المرتبة الأولى من حيث حجم الاحتياج السنوي من مياه الافلاح وبلغ حجم الاحتياج المائي السنوي في هذه الولاية ٤٣,٨٢ مليون متر مكعب تلتها ولاية البريمي بحجم ١١,٠٦ مليون متر مكعب وولاية ضنك بحجم ١٠,٧٦ مليون متر مكعب ثم ولاية محضة بحجم ٦,٥٤ مليون متر مكعب وأخيراً ولاية ينقل بحجم ٦,٤٣ مليون متر مكعب في السنة.





Annual Water Requirement — **الاحتياج المائي السنوي**

Wilayat	Total Water Demand (Mm³/yr) إجمالي الاحتياج المائي (م م³/سنة)	Livestock Demand (Mm³/yr) الاحتياج الحيواني (م م³/سنة)	Agricultural Demand (Mm³/yr) الاحتياج الزراعي (م م³/سنة)	الولاية
Ibri	43 82	0 06	43 76	عبري
Yanqul	6 43	0 00	6 43	ينقل
Mahdah	6 54	0 00	6 54	محضة
Dank	10 76	0 00	10 76	ضنك
Al Buraimi	11 06	0 00	11 06	البريمي
Total	**78.61**	**0.06**	**78.55**	المجموع

PART 6 :
Dhahirah Region Aflaj Statistics

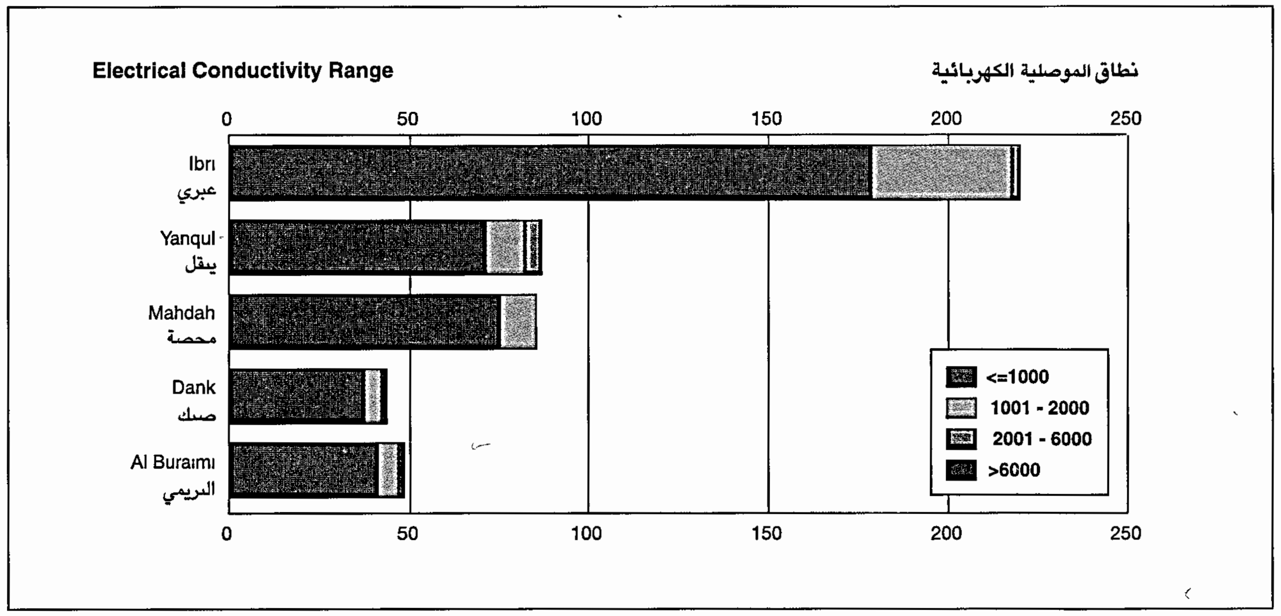
الجزء السادس :
إحصائيات أفلاج منطقة الظاهرة

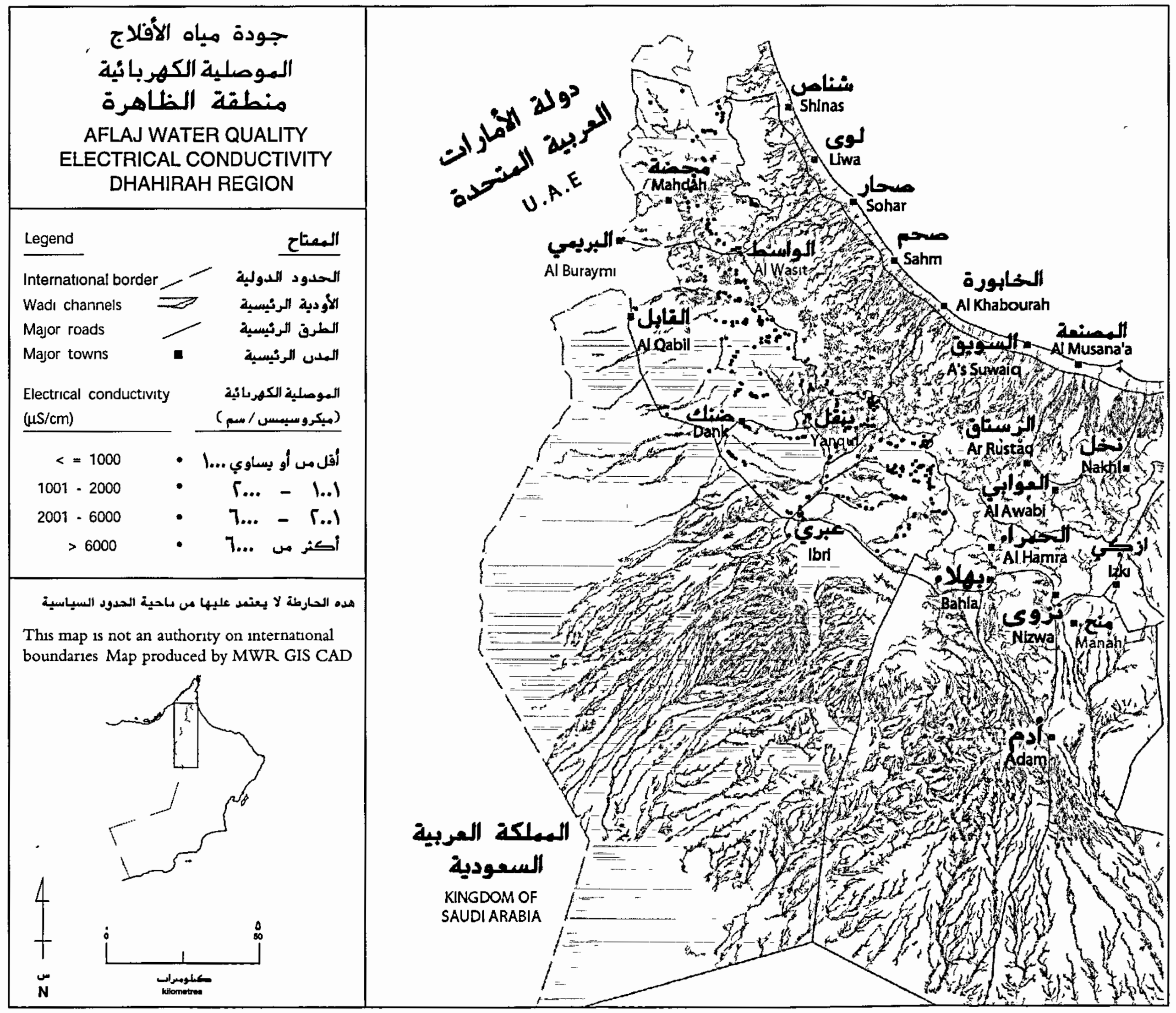
Water Quality: Electrical Conductivity

Al Aqul falaj (F0110), Yanqul, gave the lowest (117 µS/cm) electrical conductivity (EC) reading for aflaj water in the Dhahirah region. The highest EC reading (6333 µS/cm) was recorded at Al Mahduth falaj (F0404) in the wilayat of Ibri. The tests showed that the water of 452 aflaj in the region was suitable for all crops and the water of 13 aflaj suitable for most crops. Only one falaj was relatively saline (>6000 µS/cm); such water is suitable only for certain crops, such as clover and date palms.

جودة المياه : الموصلية الكهربائية (EC)

سجلت أقل قراءة للموصلية الكهربية لمياه الأفلاج بمنطقة الظاهرة بفلح العاقول (ف٠١١٠) التابع لولاية ينقل وكانت ١٧٧ مايكروسيمنس/سم بينما سحلت أكبر قراءة للموصلية الكهربية لمياه الأفلاج بالمنطقة بفلح المحدوث (ف٠٤٠٤) التابع لولاية عبري وقد بلغت ٦٣٣٣ مايكروسيمنس/سم. وجد أن مياه ٤٥٢ فلحاً في المنطقة مناسبة لجميع المحاصيل الزراعية. ومياه ١٣ فلجاً في المطقة ملائمة لمعظم المحاصيل الزراعية بينما وجد أن مياه فلج واحد فقط كانت مالحة نسبياً (> ٦٠٠٠ مايكروسيمس/سم) وهذه النوعية من المياه لا تصلح إلا لزراعة بعض أنواع المحاصيل مثل البرسيم وأشجار النخيل.





Electrical Conductivity — الموصلية الكهربائية

Wilayat	>6000	2001-6000	1001-2000	<=1000	الولاية
	Electrical Conductivity Range - µS/cm نطاق الموصلية الكهربائية – ميكروسيمنس/سم				
Ibri	1	6	33	176	عبري
Yanqul	0	5	8	68	ينقل
Mahdah	0	0	7	72	محضة
Dank	0	1	4	36	ضنك
Al Buraimi	0	1	3	45	البريمي
Total	1	13	55	397	المجموع

PART 6 :
Dhahirah Region Aflaj Statistics

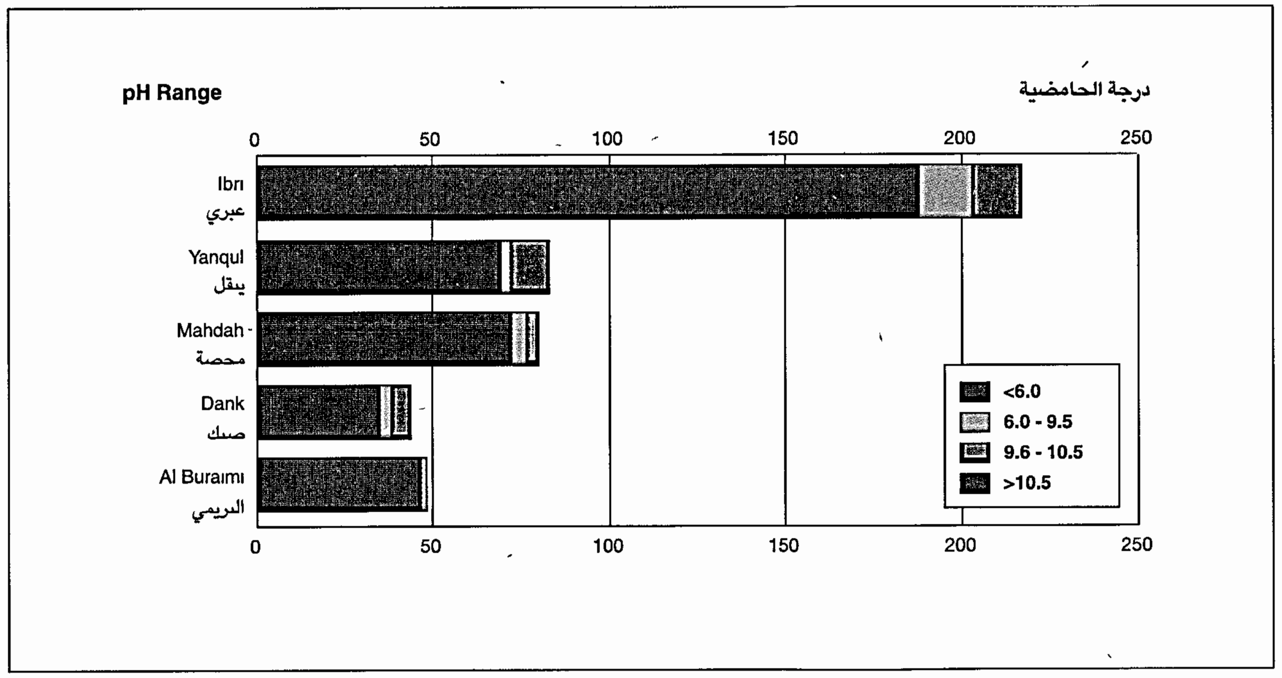
الجزء السادس :
إحصائيات أفلاج منطقة الظاهرة

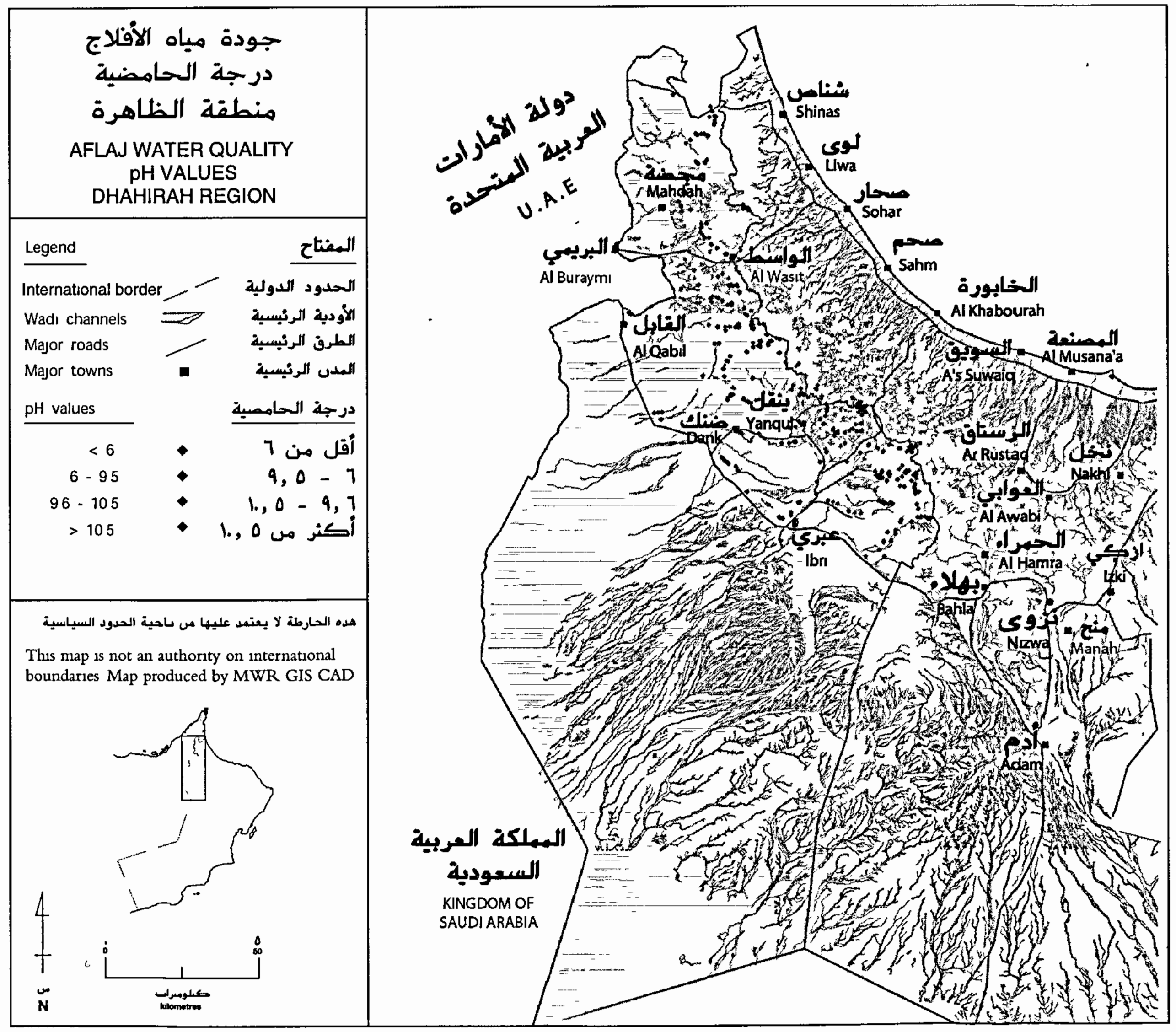
Water Quality: pH Levels

Abu Khabi falaj (F2523), Ibri, produced the lowest pH (6.3) value recorded for aflaj water in the Dhahirah region. The highest reading (12.9) occurred at Qubail Mallah falaj (F2151), also in the wilayat of Ibri Generally, the results showed that the water of 404 aflaj in the region was suitable for all crops (pH value ranging between 6 and 9.5). 25 aflaj had water that was slightly alkaline (pH ranging between 9.6 and 10.5), whilst that of 34 aflaj was significantly alkaline (pH value greater than 10.5), which is unsuitable for some crops.

جودة المياه : درجة الحامضية (pH)

سجلت أقل قراءة للحامضية (pH) لمياه الافلاج بمنطقة الظاهرة لفلج أبو حابي (ف٢٥٢٣) التابع لولاية عري وكانت ٦,٣ بينما سجلت أعلى قراءة للحامضية بفلح قبيل ملاح (ف٢١٥١) التابع لولاية عبري وقد بلغت درجة حامضية مياهه ١٢,٩ وأظهرت النتائج أن مياه ٤٠٤ فلجاً في المنطقة صالحة لجميع المحاصيل الزراعية (تتراوح درجة الحامضية بين ٦ و٩,٥) ومياه ٢٥ فلجاً مائلة إلى القلوية (تتراوح درجة الحامضية بين ٩,٦ و١٠,٥) بينما جاءت مياه ٣٤ فلجاً في المنطقة عالية القلوية (درجة الحامضية اكبر من ١٠,٥) وبالتالي فهي غير صالحة لبعض المحاصيل الزراعية.





pH Level | درجة الحامضية

Wilayat	>10.5	9.6-10.5	6.0-9.5	<6.0	الولاية
Ibri	14	13	189	0	عبري
Yanqul	11	2	68	0	ينقل
Mahdah	4	5	69	0	محضة
Dank	5	4	32	0	ضنك
Al Buraimi	0	1	46	0	البريمي
Total	34	25	404	0	المجموع

PART 7 :
DAKHLIYAH REGION AFLAJ STATISTICS

الجزء السابع :
إحصائيات أفلاج المنطقة الداخلية

Aflaj Type and Status

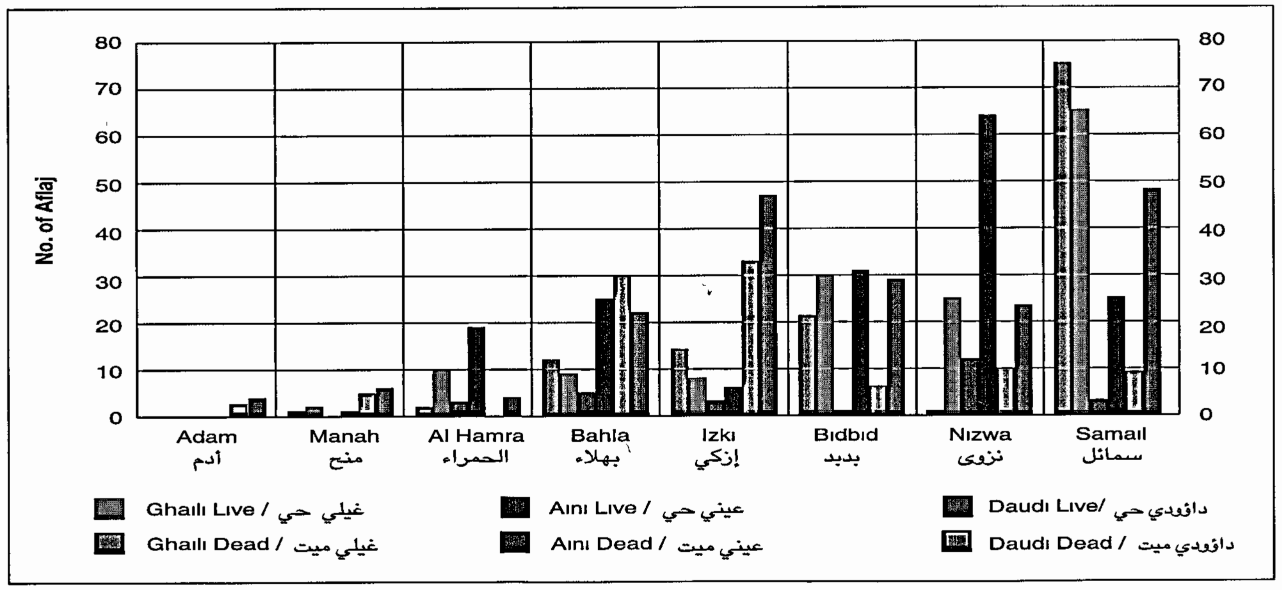
Dakhlıyah has the third largest number of inventoried aflaj of any Omani region with 750. Live aflaj form 66.8% of the total which includes daudi aini and ghaili Daudi aflaj make up 37.2% , aini 26.1%, and ghaili 36.7% of the total number in the Dakhliyah region.

Most dead aflaj in the region were originally of the ghaili type, which forms 50.6% of total dead aflaj. This group is followed by daudi and aini aflaj which make up 38.6% and 10.8% of the total dead aflaj in the Dakhliyah region.

أنواع وحالات الأفلاج

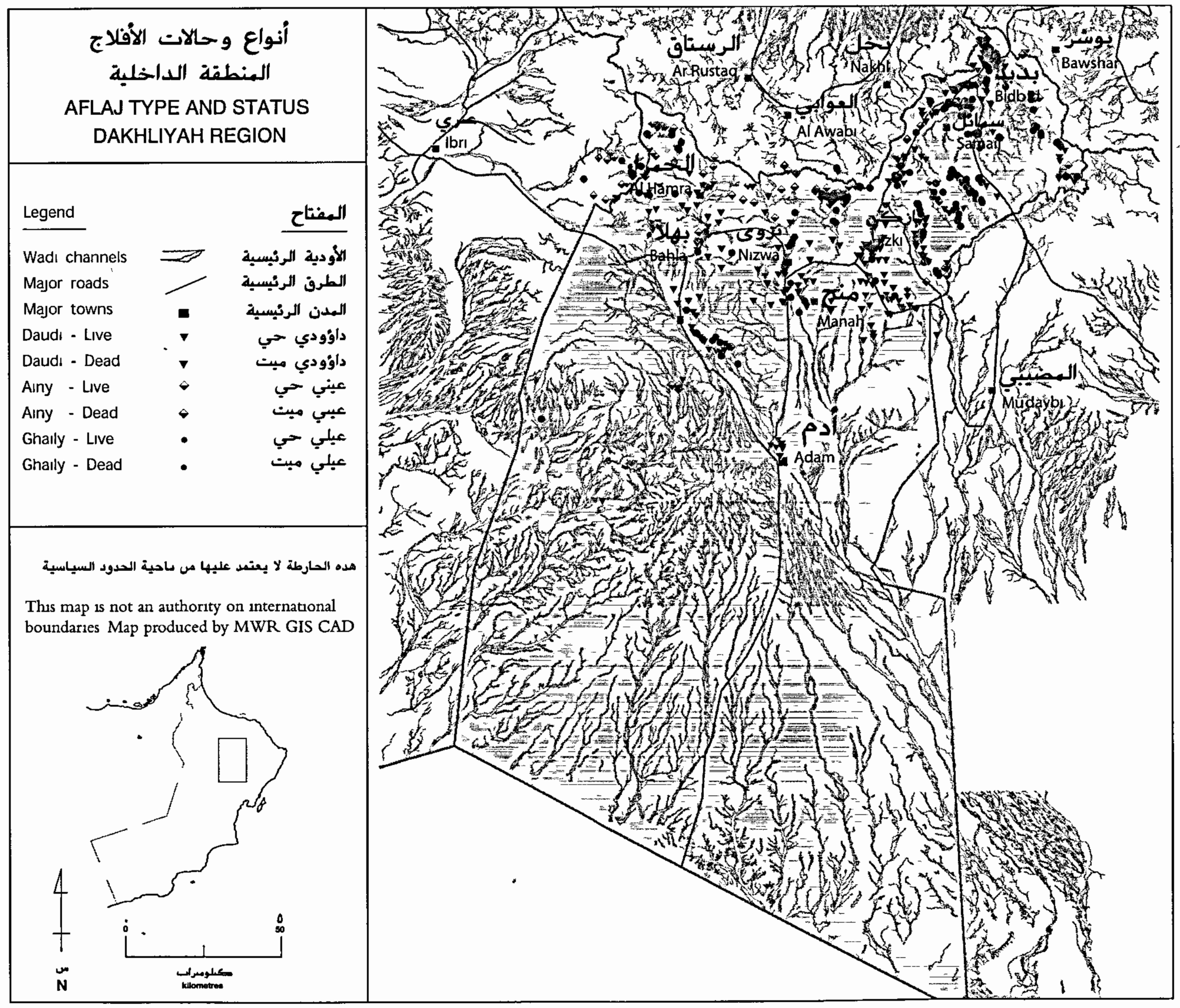
تأتي المنطقة الداخلية في المرتبة الثالثة من حيث عدد الأفلاج المحصورة فيها، حيث تم حصر ٧٥٠ فلجاً في هذه المنطقة. وتشكل الأفلاج الحية ٦٦,٨٪ من مجموع الأفلاج المحصورة، وتتوفر الأفلاج في المنطقة الداخلية بكافة أنواعها الداؤودية والعينية والعيلية. حيث بلغت نسبة الأفلاج الداؤودية ٣٧,٢٪ من مجموع الأفلاج في المنطقة، وبلغت نسبة الأفلاح العينية ٢٦,١٪ والأفلاج العيلية شكلت نسبة ٣٦,٧٪ من مجموع الأفلاح.

أكثر الأفلاج الميتة في المنطقة كانت أفلاجاً غيلية حيث بلغت نسبتها ٥٠,٦٪ من مجموع الأفلاج الميتة في المنطقة تلتها الأفلاح الميتة الداؤودية وشكلت نسبة ٣٨,٦٪ ثم الأفلاج الميتة العينية وكانت نسبتها ١٠,٨٪ من مجموع الأفلاج الميتة.



Aflaj Type and Status أنواع وحالات الأفلاج

Wilayat	Total المجموع Dead ميت	Live حي	Ghaili عيلي Dead ميت	Live حي	Aini عيني Dead ميت	Live حي	Daudi داؤودي Dead ميت	Live حي	الولاية
Samail	87	137	75	65	3	24	9	48	سمائل
Nizwa	23	111	1	25	'12	63	10	23	نزوى
Bidbid	28	90	21	30	1	31	6	29	بدبد
Izki	50	61	14	8	3	6	33	47	إزكي
Bahla	47	56	12	9	5	25	30	22	بهلاء
Al Hamra	5	33	2	10	3	19	0	4	الحمراء
Manah	6	9	1	2	0	1	5	6	منح
Adam	3	4	0	0	0	0	3	4	أدم
Total	**249**	**501**	**126**	**149**	**27**	**169**	**96**	**183**	المجموع

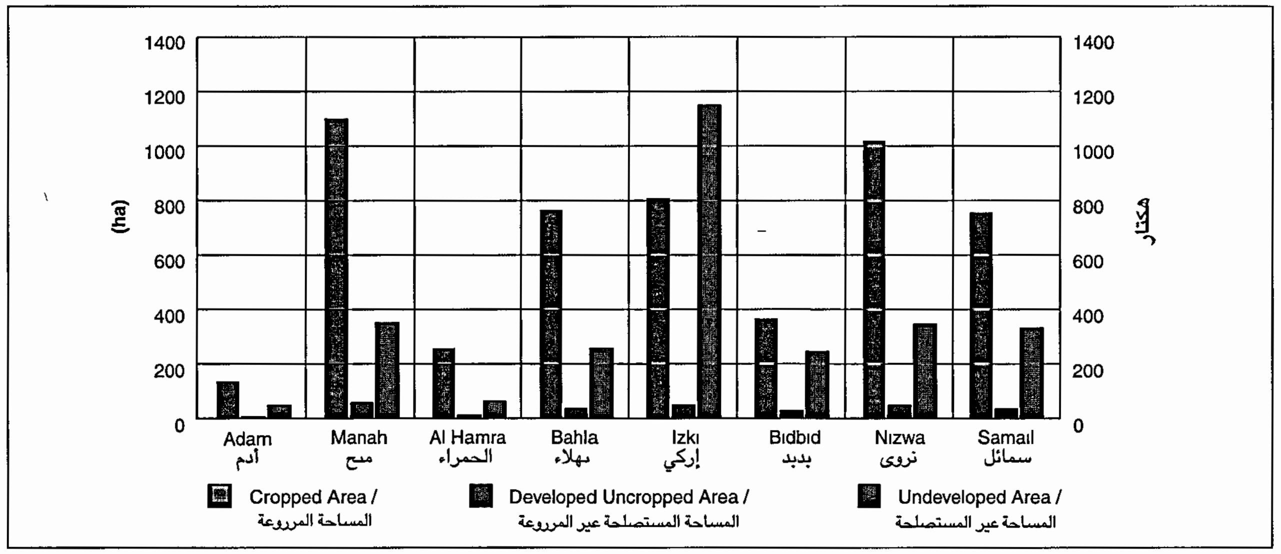


PART 7 :
DAKHLIYAH REGION AFLAJ STATISTICS

Aflaj Demand Areas

The area dependent on aflaj water in the Dakhliyah region totals 8132 hectares 62 5% of this area is cropped land; 3 5% is developed uncropped land; and 34% is undeveloped land.

The wilayat of Izki possesses the highest area of land dependent on aflaj water, representing 24.5% of the total in the region The districts of Manah, Nizwa, Samail and Bahla follow with figures of 18.7%, 17.4%,13.8% and 11.7% respectively.The districts of Bidbid, Al Hamra and Adam collectively make up 13 9% of the total Note that Manah forms the largest area of cropped land, with a figure of 21.5% of the total cropped land in the Dakhliyah region.



Demand Areas — **مناطق الاحتياج**

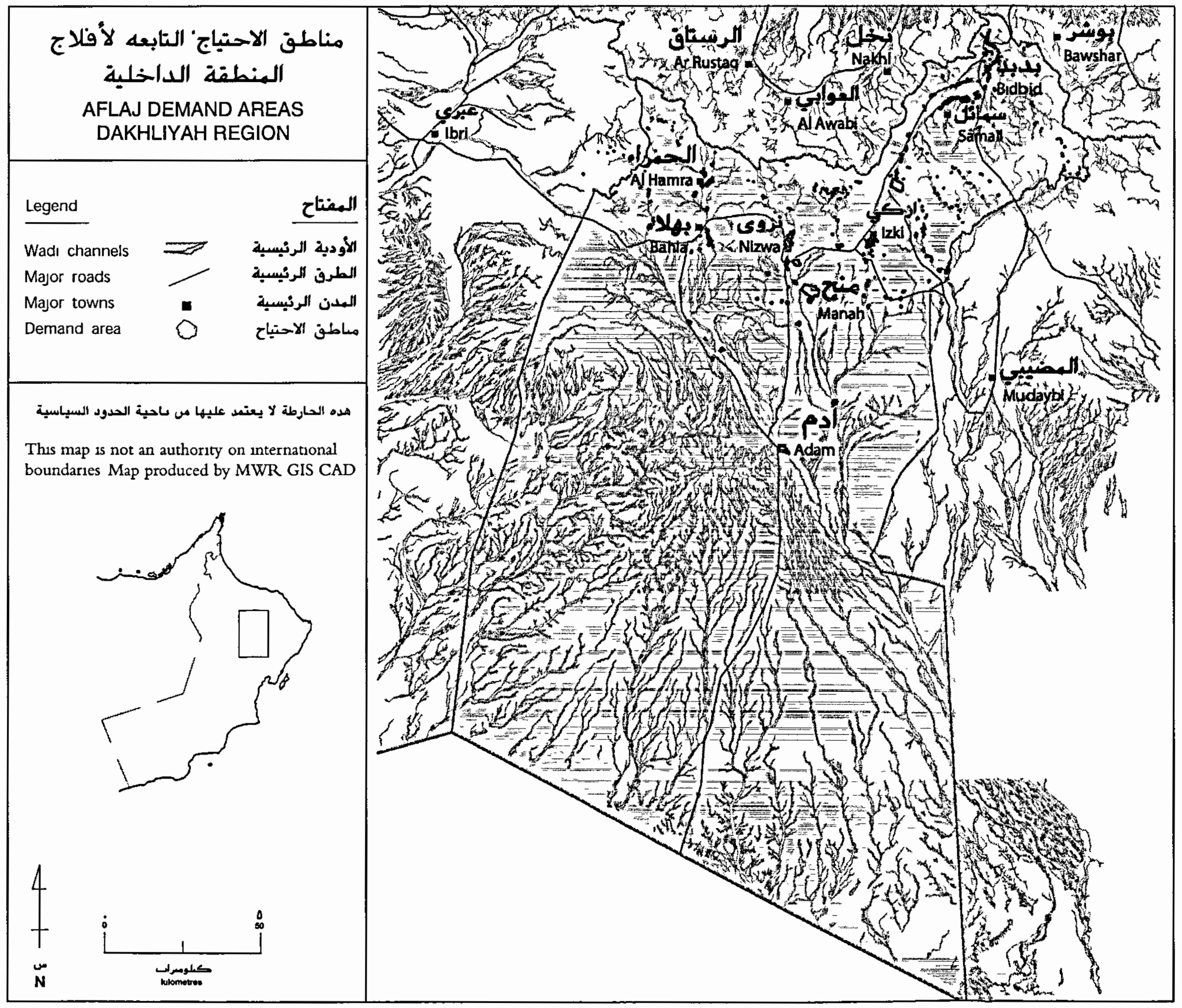
Wilayat	Total Area (ha) مجموع المساحة (هكتار)	Undeveloped Area (ha) المساحة غير المستصلحة (هكتار)	Developed Uncropped Area (ha) المساحة المستصلحة غير المزروعة (هكتار)	Cropped Area (ha) المساحة المزروعة (هكتار)	الولاية
Samail	1126 06	328 12	41 99	755 95	سمائل
Nizwa	1412 41	347 41	56 05	1008 95	نزوى
Bidbid	616 15	230 83	20 28	365 04	بدبد
Izki	1992 85	1146 39	44 55	801 91	إزكي
Bahla	953 20	228 77	38 12	686 31	بهلاء
Al Hamra	332 08	79 70	13 28	239 10	الحمراء
Manah	1517 22	364 13	60 68	1092 41	منح
Adam	182 00	43 68	7 28	131 04	أدم
Total	**8131.97**	**2769.03**	**282.23**	**5080.71**	المجموع

الجزء السابع :
إحصائيات أفلاج المنطقة الداخلية

المساحات المعتمدة على الأفلاج

بلعت مساحة المناطق المعتمدة على مياه الأفلاح في المطقة الداخلية ٨١٣٢ هكتاراً. مىها ٦٢,٥٪ مساحة مزروعة و٣,٥٪ مساحة مستصلحة عير مزروعــة و٣٤٪ مساحة عير مستصلحة.

جاءت ولاية ازكي في المرتبة الأولى من حيث محموع المساحة المعتمدة على مياه الأفلاج مشكلة ما نسبته ٢٤,٥٪ من محموع المساحة في المنطقة ثم ولاية منح بنسة ١٨,٧٪ وولاية نزوى ىنسبة ١٧,٤٪ ثم ولاية سمائل ىنسبة ١٣,٨٪ وولاية بهلاء ىنسبة ١١,٧٪ بيما شكلت ولايات ىدبد والحمراء وأدم مجتمعة نسبة ١٣,٩٪ من مجموع المساحة. وجاءت ولاية منح في المرتىة الأولى من حيث مجموع المساحة المزروعة بسبة ٢١,٥٪ من محموع المساحة المزروعة في المنطقة.



PART 7 :
DAKHLIYAH REGION AFLAJ STATISTICS

الجزء السابع :
إحصائيات أفلاج المنطقة الداخلية

Annual Water Demand

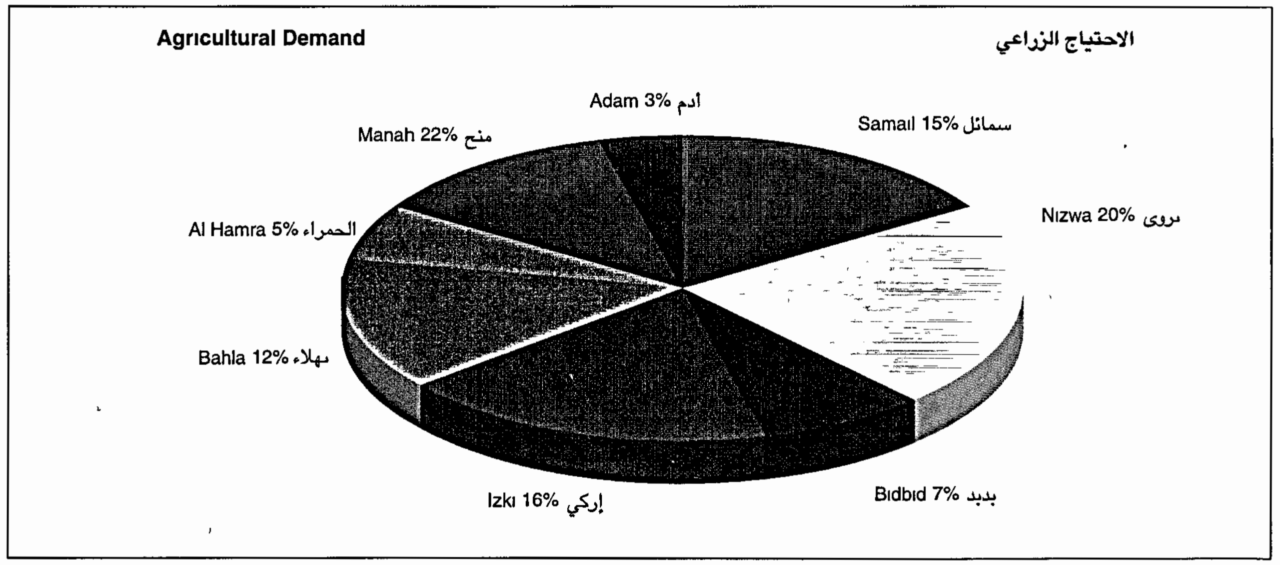
The annual demand for aflaj water in the Dakhliyah region is 135.17 million m³. Agricultural land accounts for 99.8% of this figure

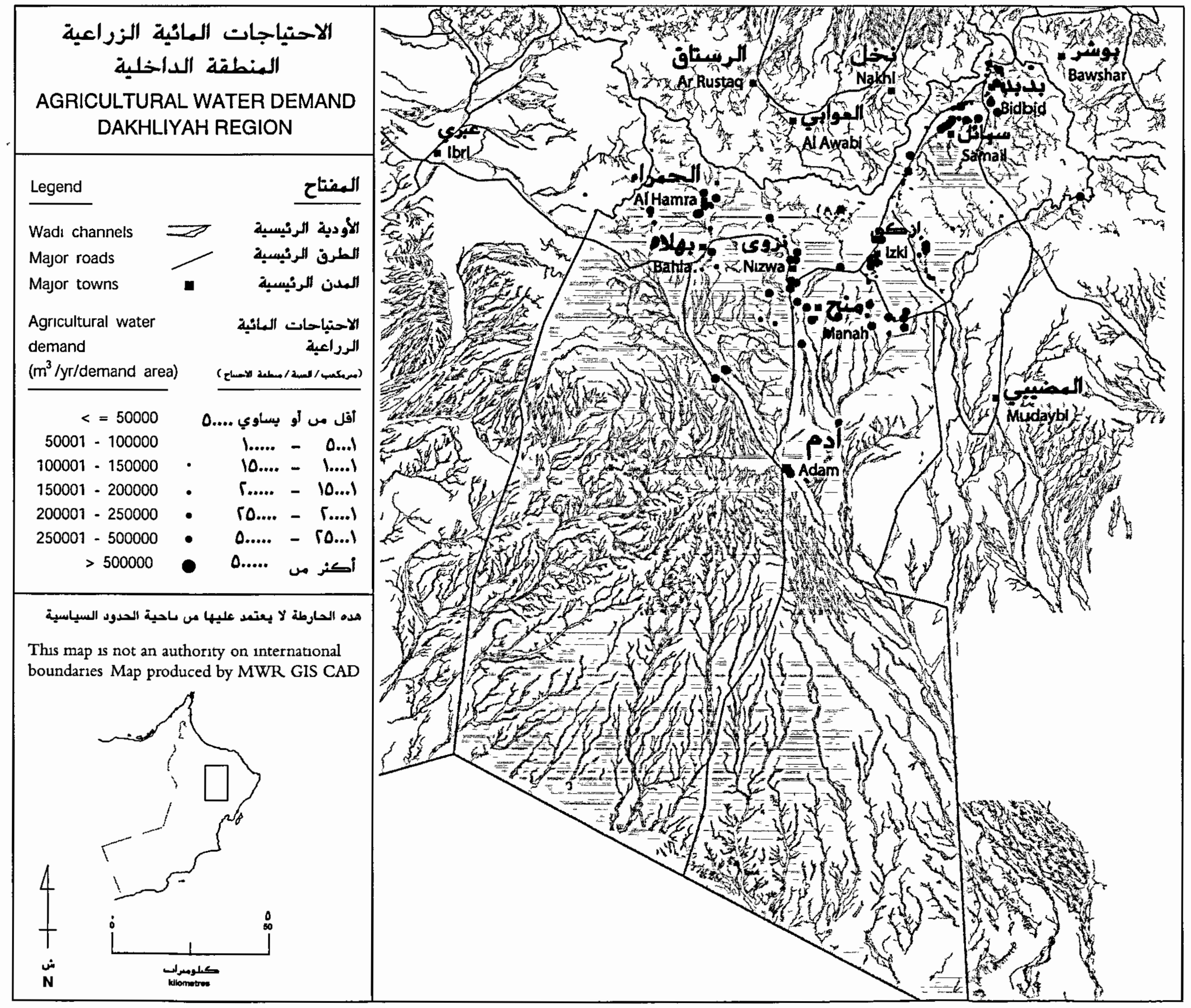
Manah has the highest annual demand for aflaj water with a figure of 30.06 million m³. The wilayats of Nizwa, Izki, Samail, Bahla, Bidbid, Al Hamra and Adam follow with figures of 26.41, 22.13, 20.22, 15.79, 10.17, 6.54 and 3.86 million m³ respectively.

الاحتياج المائي السنوي

بلغ مجموع الاحتياج السوي من مياه الأفلاج في المنطقة الداخلية ١٣٥,١٧ مليون متر مكعب. وكان للاحتياج الزراعي النصيب الأعظم منها حيث بلغ ٩٩,٨٪ من مجموع حجم الاحتياج.

جاءت ولاية منح في المرتبة الأولى من حيث حجم الاحتياج السنوي من مياه الأفلاج وبلغ حجم الاحتياج المائي السنوي في هذه الولاية ٣٠,٠٦ مليون متر مكعب تلتها ولاية نزوى بحجم ٢٦,٤١ مليون متر مكعب فولاية إزكي بحجم ٢٢,١٣ مليون متر مكعب ثم ولاية سمائل بحجم ٢٠,٢٢ مليون متر مكعب وولاية بهلاء بححم ١٥,٧٩ مليون متر مكعب ثم ولاية بدبد بحجم ١٠,١٦ مليون متر مكعب وولاية الحمراء بحجم ٦,٥٤ مليون متر مكعب وأخيراً ولاية أدم بحجم ٣,٨٦ مليون متر مكعب في السنة.





Annual Water Requirement — الاحتياج المائي السنوي

Wilayat	Total Water Demand (Mm³/yr) إجمالي الاحتياج المائي (م م³/سنة)	Livestock Demand (Mm³/yr) الاحتياج الحيواني (م م³/سنة)	Agricultural Demand (Mm³/yr) الاحتياج الزراعي (م م³/سنة)	الولاية
Samail	20 22	0 10	20 12	سمائل
Nizwa	26 41	0 00	26 41	نزوى
Bidbid	10 16	0 03	10 31	بدبد
Izki	22 13	0 18	21 95	إزكي
Bahla	15 79	0 00	15 79	بهلاء
Al Hamra	6 54	0 00	6 54	الحمراء
Manah	30 06	0 00	30 06	منح
Adam	3 86	0 00	3 86	أدم
Total	**135.17**	**0.31**	**134 86**	المجموع

PART 7 :
DAKHLIYAH REGION AFLAJ STATISTICS

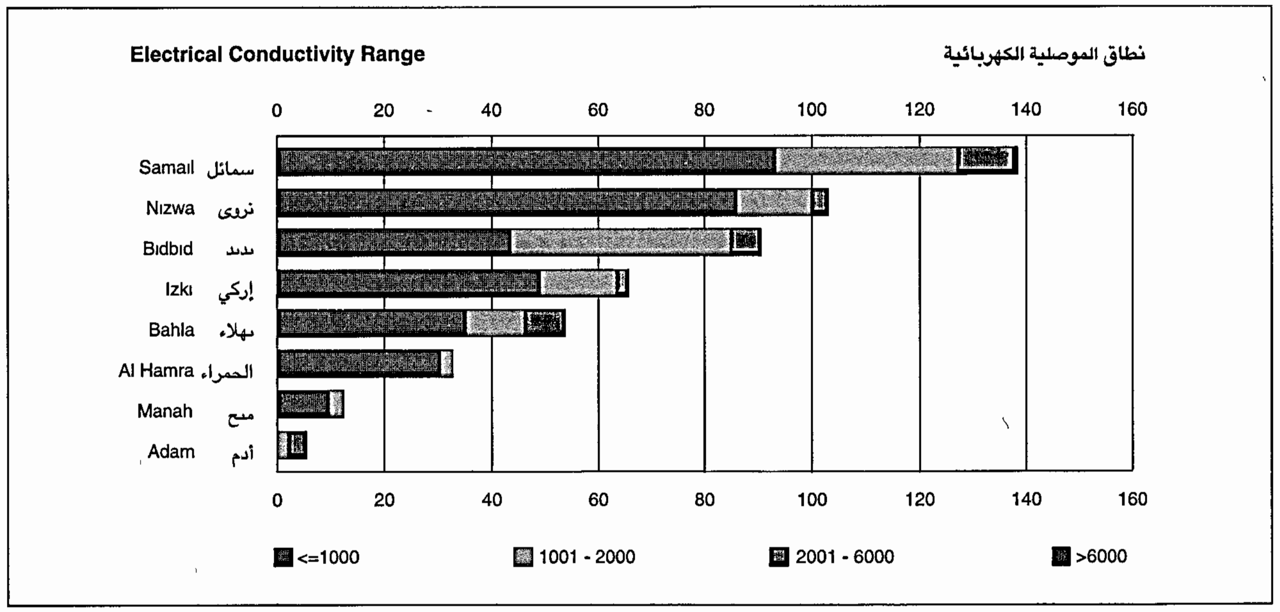
الجزء السابع :
إحصائيات أفلاج المنطقة الداخلية

Water Quality: Electrical Conductivity

Al Masdara falaj (F3084), Nizwa, gave the lowest Electrical Conductivity (EC) reading for aflaj water in the Dakhliyah region - a figure of 200 µS/cm. The highest EC reading for the Dakhliyah region was recorded at Dab's falaj (F0650) in Samail wilayat, which produced a reading of 11013 µS/cm The tests showed that the water of 466 aflaj in the region was suitable for all crops whilst the water of 30 aflaj was suitable for most. Only one falaj was relatively saline (>6000 µS/cm); such water is suitable only for certain crops, such as clover and date palms

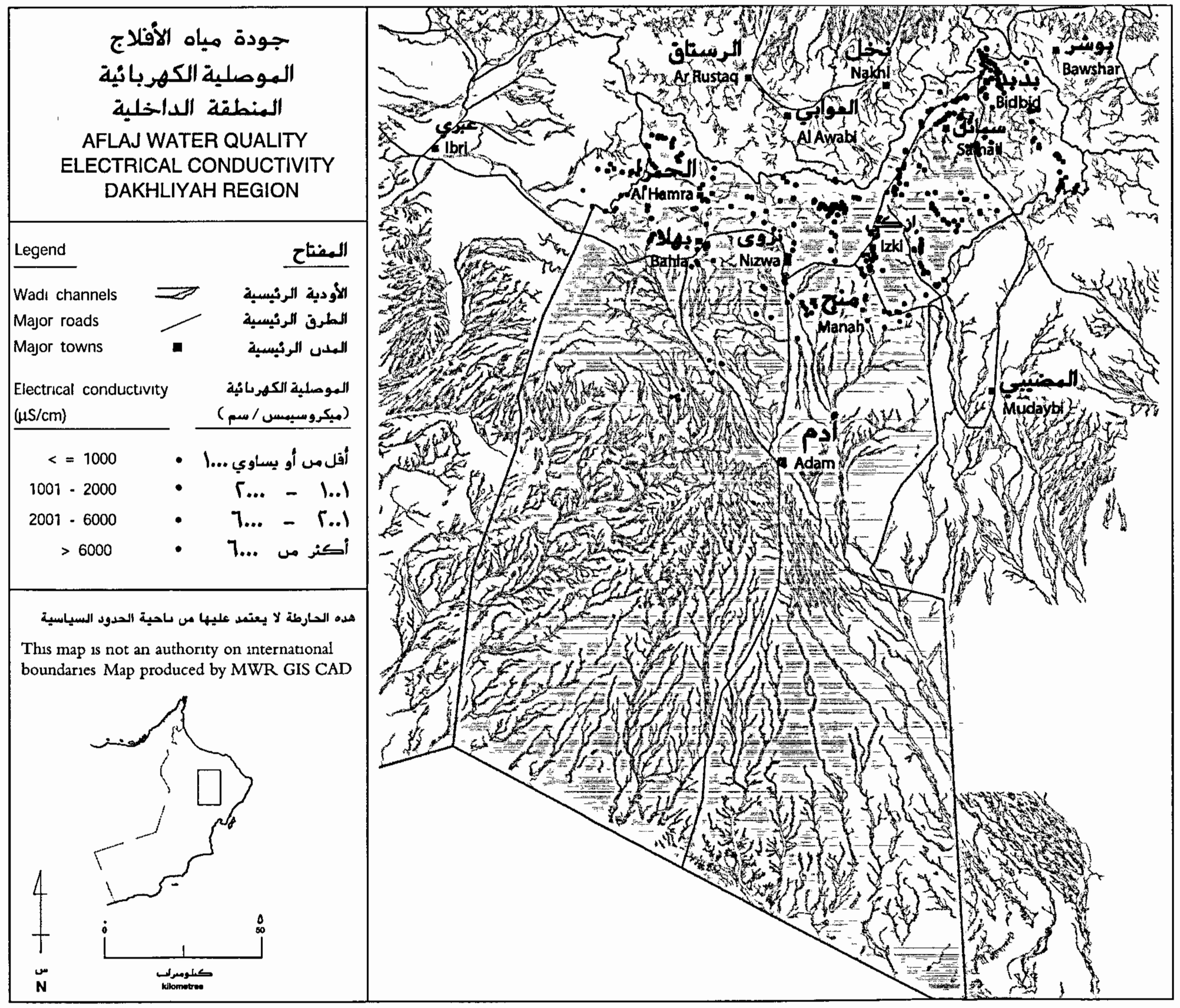
جودة المياه : الموصلية الكهربائية (EC)

سحلت أقل قراءة للموصلية الكهربية لمياه الأفلاج في المنطقة الداخلية بفلح المصدرة (ف٣٠٨٤) التابع لولاية نزوى وكانت ٢٠٠ مايكروسيمنس/سم بينما سجلت أكبر قراءة للموصلية الكهربية في المنطقة بفلح ضبعان (ف٠٦٥٠) التابع لولاية سمائل وقد بلغت ١١٠١٣ مايكروسيمنس/سم. ووجد أن مياه ٤٦٦ فلجاً في المنطقة مناسبة لجميع المحاصيل الزراعية ومياه ٣٠ فلجاً ملائمة لمعظم المحاصيل الزراعية بينما وحد أن مياه فلج واحد فقط كانت مالحة نسبياً (>٦٠٠٠ مايكروسيمنس/سم) وهذه الوعية من المياه لا تصلح إلا لزراعة بعض أنواع المحاصيل مثل البرسيم وأشحار النخيل.



Electrical Conductivity — **الموصلية الكهربائية**

Wilayat	Electrical Conductivity Range -µS/cm نطاق الموصلية الكهربائية – ميكروسيمنس/سم >6000	2001-6000	1001-2000	<=1000	الولاية
Samail	1	10	33	95	سمائل
Nizwa	0	3	14	86	نزوى
Bidbid	0	5	42	43	بدبد
Izki	0	2	16	48	إزكي
Bahla	0	7	11	35	بهلاء
Al Hamra	0	0	2	31	الحمراء
Manah	0	0	2	7	منح
Adam	0	3	1	0	أدم
Total	1	30	121	345	المجموع

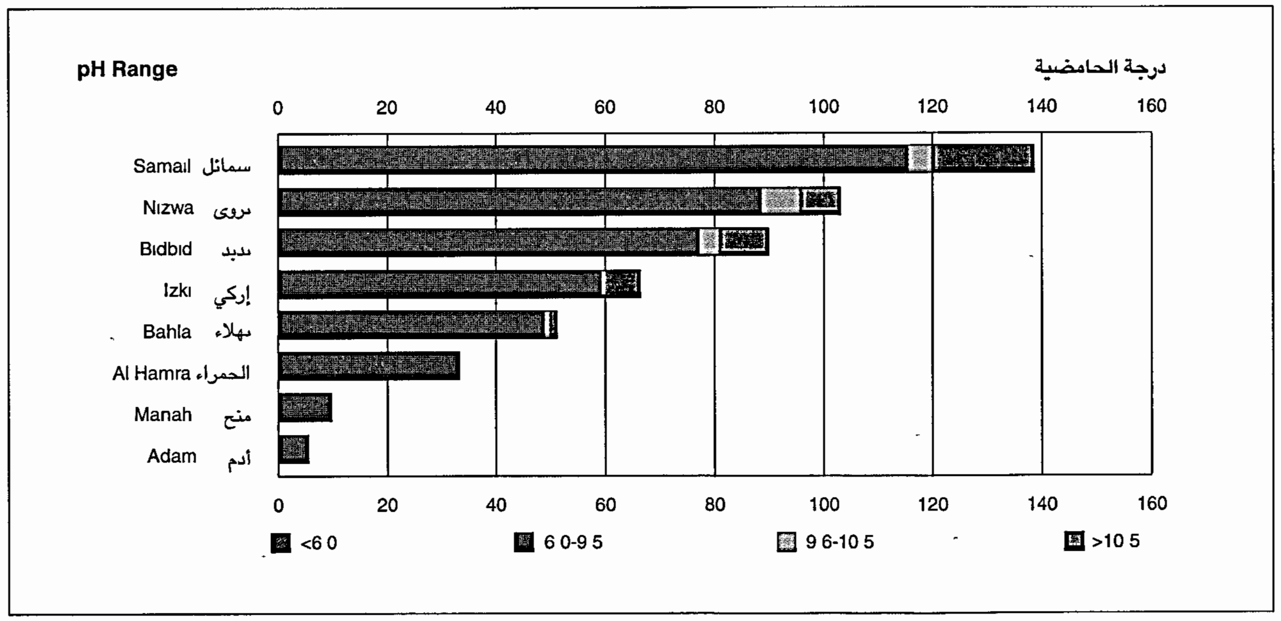


PART 7 :
DAKHLIYAH REGION AFLAJ STATISTICS

الجزء السابع :
إحصائيات أفلاج المنطقة الداخلية

Water Quality: pH Levels

Al Hadith falaj (F1601), Samail, gave the lowest pH reading recorded for aflaj water in the Dakhliyah region - a figure of 5.1. The highest reading occurred at Al Karib Al Hidri falaj (F2265), in the wilayat of Bidbid, where the pH value was found to be 12.0. Generally, the results showed that the water of 435 aflaj in the region was suitable for all crops (pH value ranging between 6 and 9.5). 16 aflaj had water that was slightly alkaline (pH ranging between 9.6 and 10.5) whilst the water of 43 aflaj in the region was significantly so (pH value greater than 10.5) Only one falaj had water that was acidic (pH value below 6), which is unsuitable for some crops

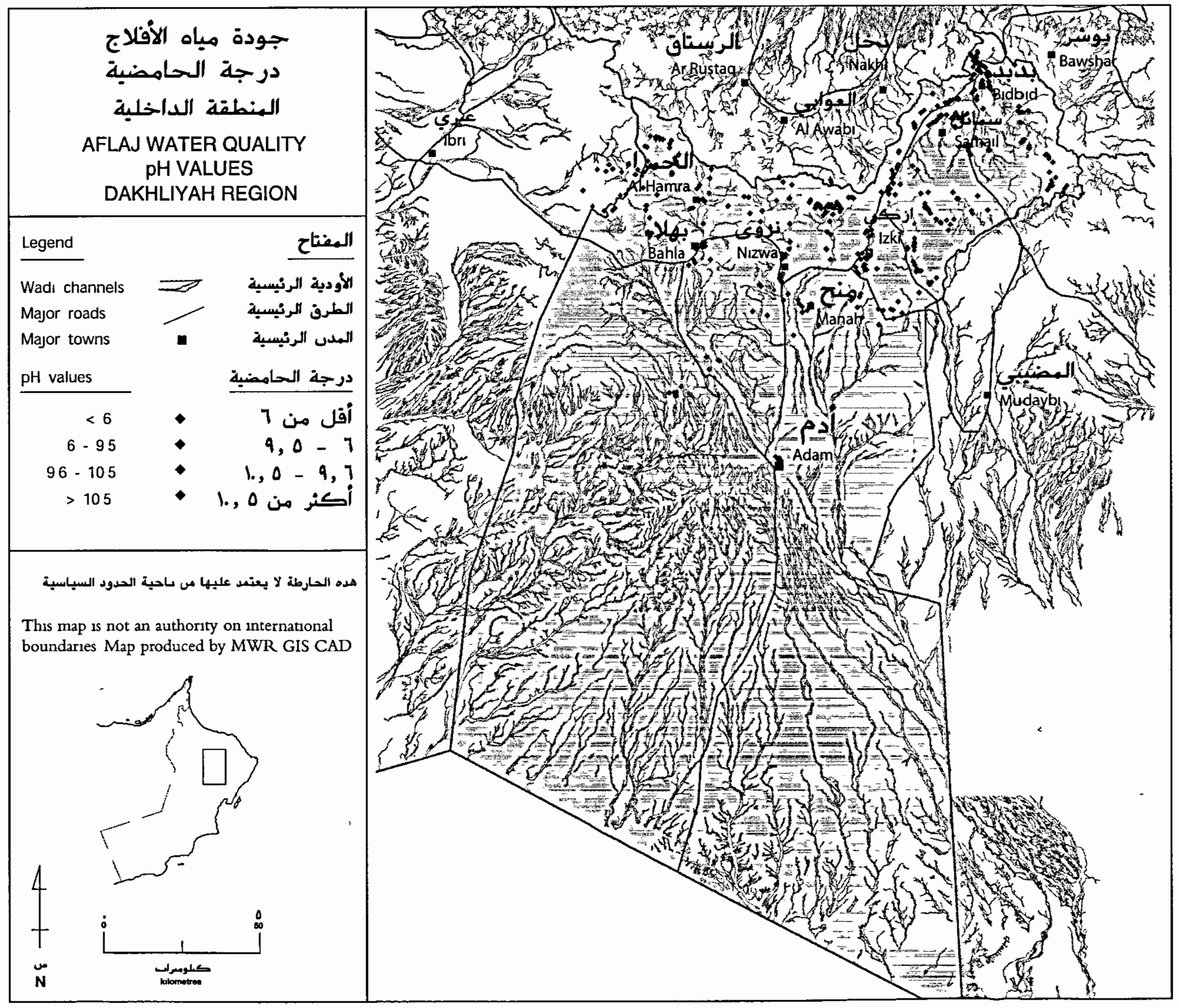


pH Level | **درجة الحامضية**

Wilayat	>10 5	9.6-10.5	6.0-9 5	<6.0	الولاية
		pH Range	درجة الحامضية		
Samail	19	4	115	1	سمائل
Nizwa	7	7	89	0	نزوى
Bidbid	9	4	77	0	بدبد
Izki	7	0	59	0	إزكي
Bahla	1	1	49	0	بهلاء
Al Hamra	0	0	33	0	الحمراء
Manah	0	0	9	0	منح
Adam	0	0	4	0	أدم
Total	**43**	**16**	**435**	**1**	المجموع

جودة المياه : درجة الحامضية (pH)

سجلت أقل قراءة للحامضية لمياه الأفلاج في المنطقة الداخلية بفلج الحديث (ف١٦٠١) التابع لولاية سمائل وكانت ٥,١ بينما سجلت أعلى قراءة للحامضية بفلح الكريب الحدري (ف٢٢٦٥) التابع لولاية بدبد وقد بلغت درجة حامضية مياهه ١٢,٠ وأظهرت النتائح أن مياه ٤٣٥ فلحاً في المنطقة صالحة لجميع المحاصيل الزراعية (تتراوح درجة الحامضية بين ٦ و٩,٥) ومياه ١٦ فلجاً مائلة إلى القلوية (تتراوح درجة الحامضية بين ٩,٦ و١٠,٥) بينما جاءت مياه ٤٣ فلحاً في المنطقة عالية القلوية (درجة الحامضية أكبر من ١٠,٥) ومياه فلحاً واحداً فقط حامصية (درجة الحامضية أقل من ٦) وبالتالي فهي عير صالحة لبعض المحاصيل الزراعية.



PART 8 :
SHARQIYAH REGION AFLAJ STATISTICS

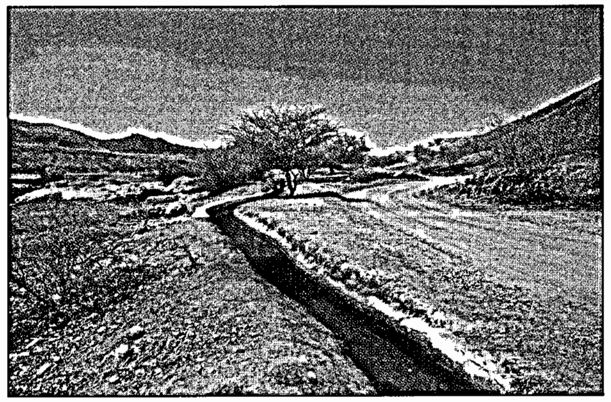
الجزء الثامن :
إحصائيات أفلاج المنطقة الشرقية

Aflaj Type and Status

Sharqiyah has the second largest number of inventoried aflaj of any Omani region with a figure of 846 Live aflaj form 78 1% of the total included in the inventory and the region includes aflaj from all categories. daudi, aini and ghaili. Daudi aflaj make up 37.6% of the total; aini aflaj represent 28.1%; and ghaili aflaj form 34.3% of the total number of aflaj in the Sharqiyah region.

Most dead aflaj in the region were originally of the daudi type, which forms 67.6% of the total This category is followed by ghaili and aini aflaj, which make up 20% and 12 4% of the total number of dead aflaj in the Sharqiyah region respectively

602 demand areas were included in the inventory, forming an area of 5818.7 hectares 644 samples of water were sent to the Ministry's Water Quality Laboratory for chemical analysis.

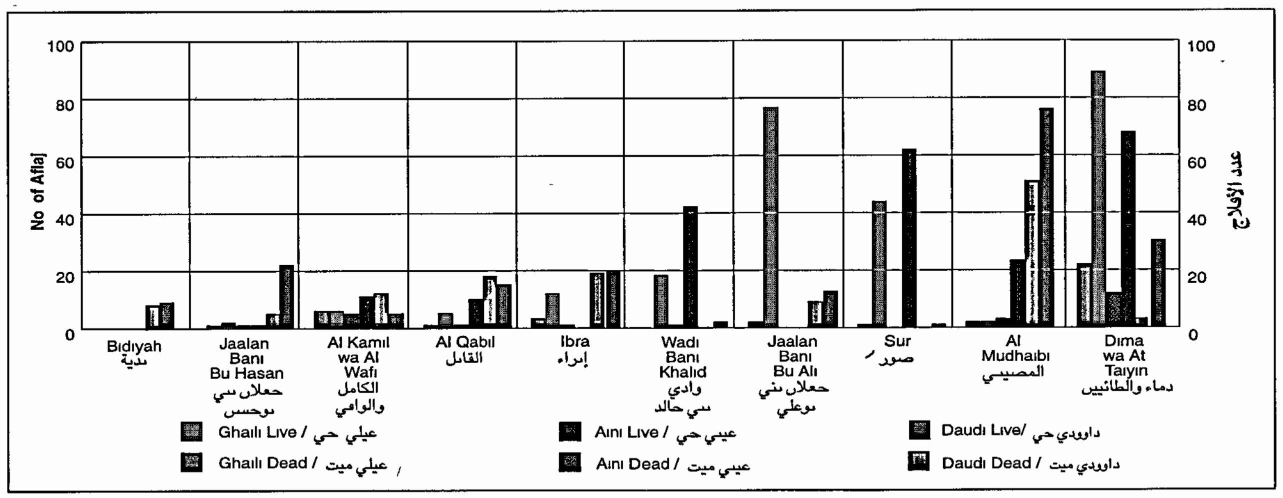


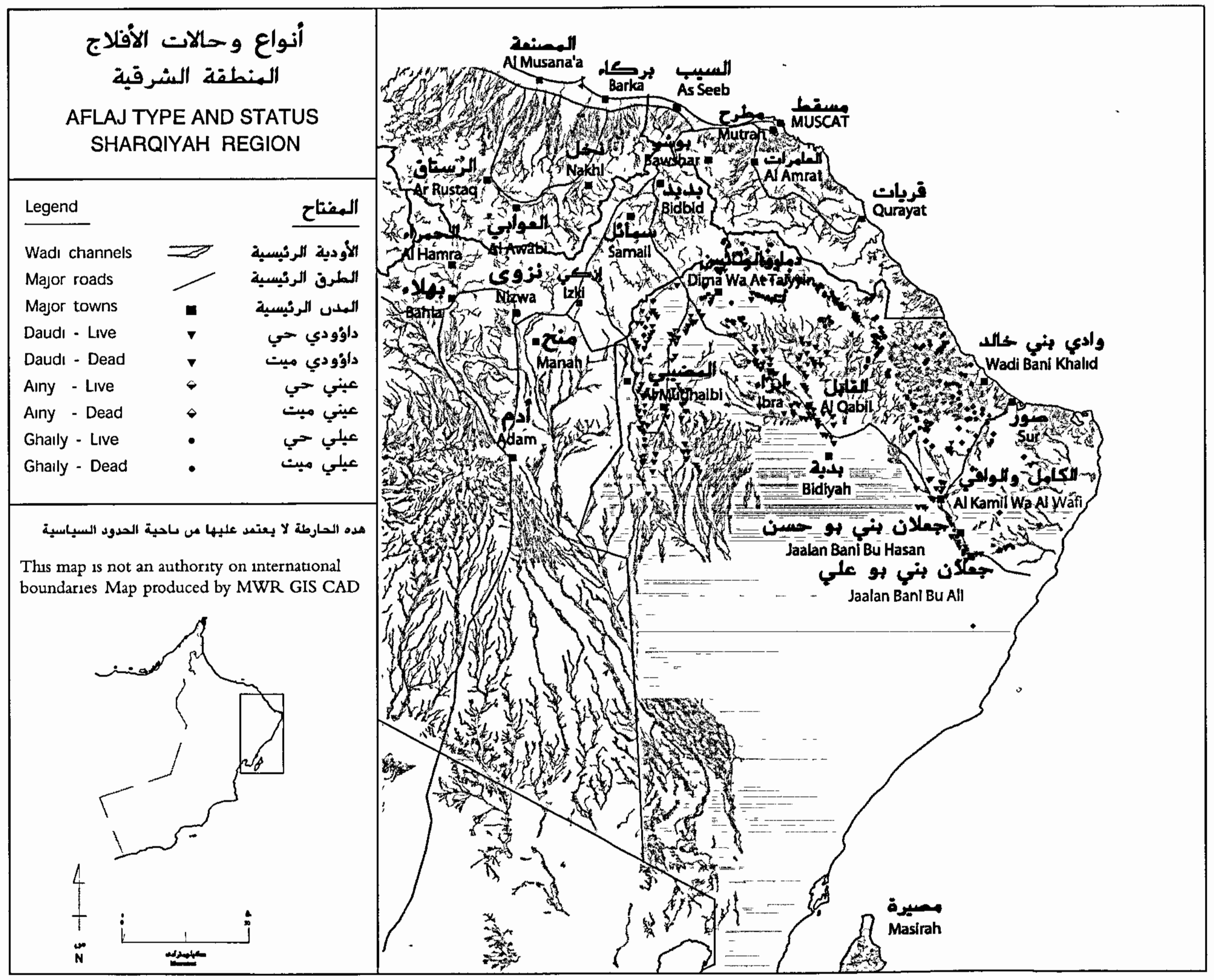
أنواع وحالات الأفلاج

تأتي المنطقة الشرقية في المرتبة الثانية من حيث عدد الأفلاج المحصورة فيها، حيث تم حصر ٨٤٦ فلجاً في هذه المنطقة. وتشكل الأفلاج الحية ٧٨,١٪ من مجموع الأفلاج المحصورة ، وتتوفر الأفلاج في المنطقة الشرقية بكافة أنواعها الداؤودية والعينية والغيلية، حيث بلغت نسبة الأفلاج الداؤودية ٣٧,٦٪ من مجموع الأفلاج في المنطقة، وبلغت نسبة الأفلاج العينية ٢٨,١٪ والأفلاج الغيلية شكلت نسبة ٣٤,٣٪ من مجموع الأفلاج.

أكثر الأفلاج الميتة في المنطقة كانت أفلاجاً داؤودية حيث بلغت نسبتها ٦٧,٦٪ من مجموع الأفلاج الميتة في المنطقة تلتها الأفلاج الميتة الغيلية وشكلت نسبة ٢٠٪ ثم الأفلاج الميتة العينية وكانت نسبتها ١٢,٤٪ من مجموع الأفلاج الميتة.

وقد تم حصر ٦٠٢ منطقة احتياج في المنطقة الشرقية شكلت مساحة إجمالية بلغت ٥٨١٨,٧ هكتاراً وقد تم جمع ٦٤٤ عينة مياه تم إرسالها إلى مختبر جودة المياه التابع للوزارة لإجراء التحليلات الكيميائية عليها.





Aflaj Type and Status
أنواع وحالات الأفلاج

Wilayat	Total Dead ميت	المجموع Live حي	Ghaili Dead ميت	عيلي Live حي	Aini Dead ميت	عيني Live حي	Daudi Dead ميت	داؤودي Live حي	الولاية
Dima wa At Taiyin	37	187	22	89	12	67	3	31	دماء والطائيين
Al Mudhaibi	56	100	2	2	3	23	51	75	المضيبي
Sur	1	106	1	44	0	61	0	1	صور
Jaalan Bani Bu Ali	11	90	2	77	0	0	9	13	جعلان بني بو علي
Wadi Bani Khalid	1	62	0	18	1	42	0	2	وادي بني خالد
Ibra	23	31	3	11	1	0	19	20	إبراء
Al Qabil	20	30	1	5	1	10	18	15	القابل
Al Kamil wa Al Wafi	21	21	5	5	4	11	12	5	الكامل والوافي
Jaalan Bani Bu Hasan	7	25	1	2	1	1	5	22	جعلان بني بو حسن
Bidiyah	8	9	0	0	0	0	8	9	بدية
Total	**185**	**661**	**37**	**253**	**23**	**215**	**125**	**193**	المجموع

PART 8 :
SHARQIYAH REGION AFLAJ STATISTICS

الجزء الثامن :
إحصائيات أفلاج المنطقة الشرقية

Aflaj Demand Areas

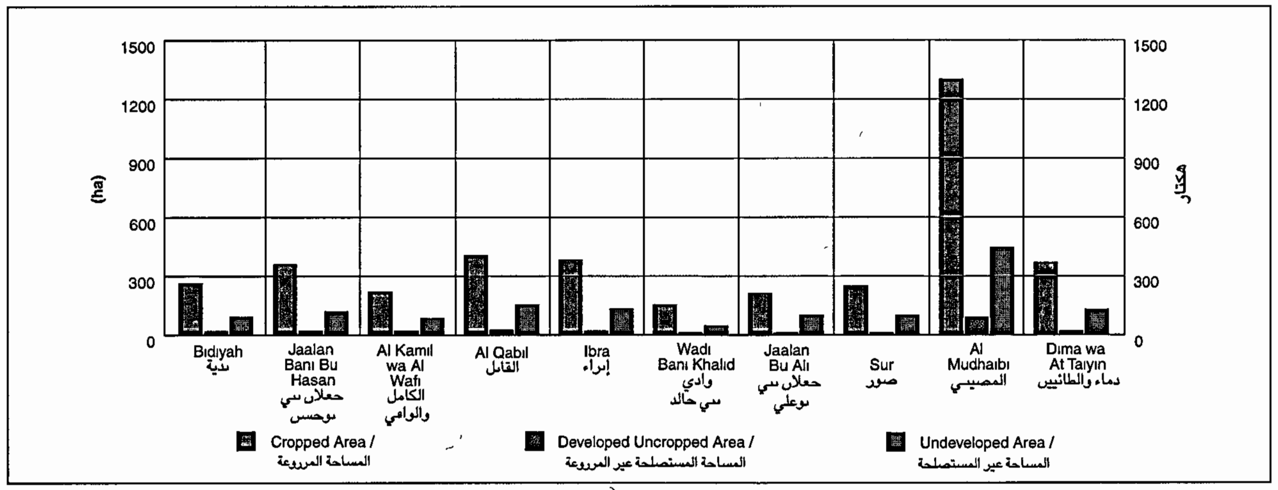
The area dependent on aflaj water in the Sharqiyah region totals 5818.7 hectares. 72% of this figure is cropped land, 4% is developed uncropped land; and 24% is undeveloped land.

The wilayat of Al Mudhaibi has the highest area of land dependent on aflaj water, representing 32.6% of the total in the region. The wilayats of Al Qabil, Ibra, Dima wa Al Taiyin and Jaalan Bani Bu Hasan follow with figures of 10.5%, 9.7%, 9.6% and 9.1% respectively. The wilayats of Bidiyah, Jaalan Bani Bu Ali, Al Kamil wa Al Wafi and Wadi Bani Khalid collectively make up 28.5% of the total. Note that Al Mudhaibi also forms the largest cropped area, with a figure of 32.6% of the total cropped area in the region.

المساحات المعتمدة على الأفلاج

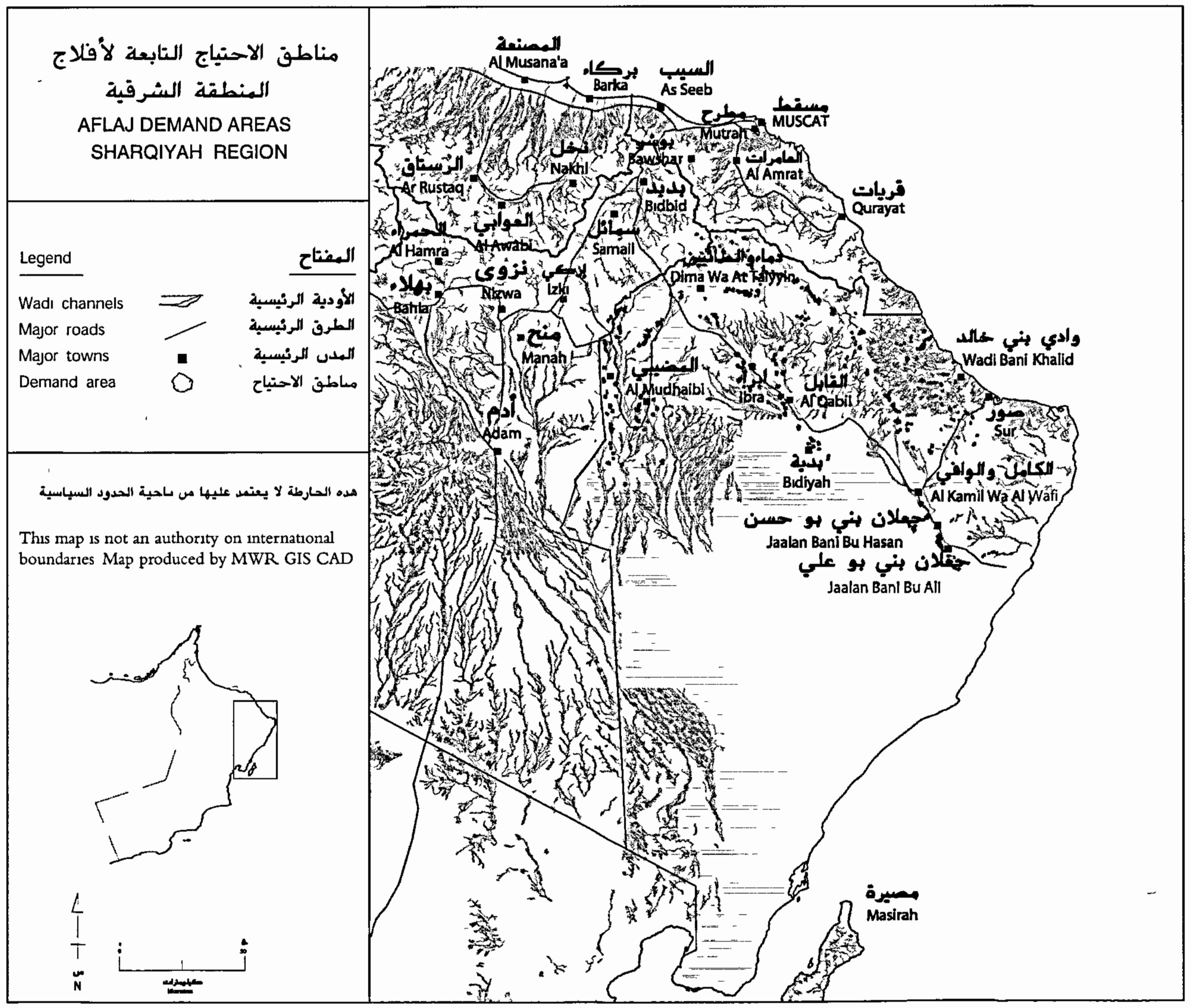
بلغت مساحة المناطق المعتمدة على مياه الأفلاج في المنطقة الشرقية ٥٨١٨,٧ هكتاراً. ٧٢٪ مساحة مزروعة و٤٪ مساحة مستصلحة غير مزروعة و٢٤٪ مساحة غير مستصلحة.

جاءت ولاية المضيبي في المرتبة الأولى من حيث مجموع المساحة المعتمدة على مياه الأفلاج مشكلة ما نسبته ٣٢,٦٪ من مجموع المساحة في المنطقة ثم ولاية القابل بنسبة ١٠,٥٪ وولاية إبراء بنسبة ٩,٧٪ ثم ولاية دماء والطائيين بنسبة ٩,٦٪ وولاية جعلان بني بوحسن ٩,١٪ بينما شكلت ولايات بدية وصور وجعلان بني بو علي والكامل والوافي ووادي بني خالد مجتمعة نسبة ٢٨,٥٪ من مجموع المساحة. وجاءت ولاية المضيبي أيضاً في المرتبة الأولى من حيث مجموع المساحة المزروعة بنسبة ٣٢,٦ من مجموع المساحة المزروعة في المنطقة.



Demand Areas مناطق الاحتياج

Wilayat	Total Area (ha) مجموع المساحة (هكتار)	Undeveloped Area (ha) المساحة غير المستصلحة (هكتار)	Developed Uncropped Area (ha) المساحة المستصلحة غير المزروعة (هكتار)	Cropped Area (ha) المساحة المزروعة (هكتار)	الولاية
Dima wa At Taiyin	559.89	134.82	22.37	402.70	دماء والطائيين
Al Mudhaibi	1896.87	455.25	75.87	1365.75	المضيبي
Sur	375.02	90.00	15.00	270.02	صور
Jaalan Bani Bu Ali	350.00	86.19	13.88	249.93	جعلان بني بو علي
Wadi Bani Khalid	205.27	49.27	8.21	147.79	وادي بني خالد
Ibra	563.10	135.14	22.52	405.44	إبراء
Al Qabil	610.51	146.52	24.42	439.57	القابل
Al Kamil wa Al Wafi	333.17	79.96	13.32	239.89	الكامل والوافي
Jaalan Bani Bu Hasan	528.51	126.84	21.14	380.53	جعلان بني بو حسن
Bidiyah	396.31	95.11	15.85	285.35	بدية
Total	**5818.65**	**1399.10**	**232.58**	**4186.97**	**المجموع**



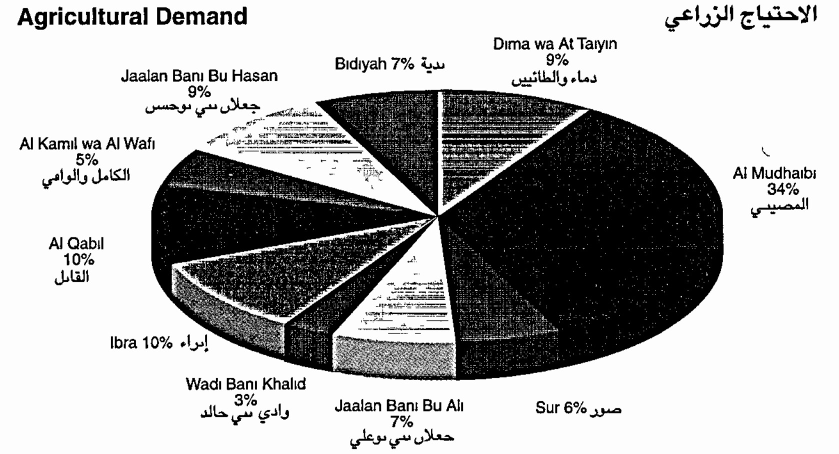
PART 8 :
SHARQIYAH REGION AFLAJ STATISTICS

Annual Water Demand

The annual demand for aflaj water in the Sharqiyah region is 115.45 million m³. No readings for livestock demand were recorded in the region.

Al Mudhaibi has the highest annual demand for aflaj water with a figure of 37.95 million m³. The wilayats of Al Qabil, Ibra, Dima wa Al Taiyin, Jaalan Bani Bu Hassan, Jaalan Bani Bu Ali, Badiya, Sur, Al Kamil wa Al Wafi and Wadi Bani Khalid follow with figures of 12.1, 11.36, 10.82, 10.5, 7.9, 7.54, 7.9, 6.31 and 3.88 million m³ respectively.

Agricultural Demand الاحتياج الزراعي



Annual Water Requirement الاحتياج المائي السنوي

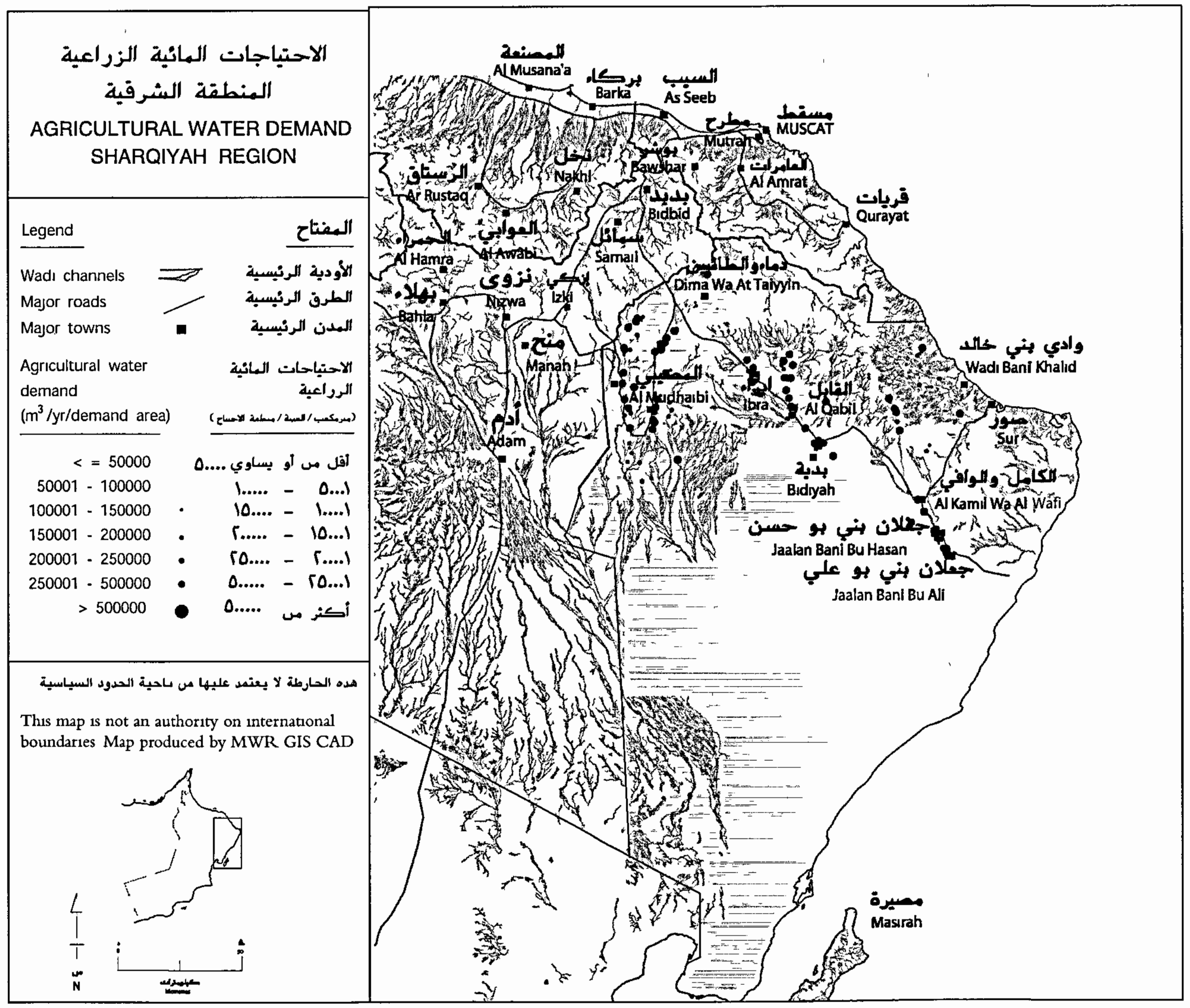
Wilayat	Total Water Demand (Mm³/yr) إجمالي الاحتياج المائي (م م³/سنة)	Livestock Demand (Mm³/yr) الاحتياج الحيواني (م م³/سنة)	Agricultural Demand (Mm³/yr) الاحتياج الزراعي (م م³/سنة)	الولاية
Dima wa At Taiyin	10.82	0.00	10.82	دماء والطائيين
Al Mudhaibi	37.95	0.00	37.95	المضيبي
Sur	7.09	0.00	7.09	صور
Jaalan Bani Bu Ali	7.9	0.00	7.9	جعلان بني بو علي
Wadi Bani Khalid	3.88	0.00	3.88	وادي بني خالد
Ibra	11.36	0.00	11.36	إبراء
Al Qabil	12.1	0.00	12.1	القابل
Al Kamil wa Al Wafi	6.31	0.00	6.31	الكامل والوافي
Jaalan Bani Bu Hasan	10.5	0.00	10.5	جعلان بني بو حسن
Bidiyah	7.54	0.00	7.54	بدية
Total	**115.45**	**0.00**	**115.45**	**المجموع**

الجزء الثامن :
إحصائيات أفلاج المنطقة الشرقية

الاحتياجات المائية السنوية

بلغ مجموع الاحتياج الزراعي السنوي من مياه الأفلاج في المنطقة الشرقية ١١٥,٤٥ مليون متر مكعب، و لم يتم تسجيل أي قراءة للاحتياج الحيواني في المنطقة.

جاءت ولاية المضيبي في المرتبة الأولى من حيث حجم الاحتياج السنوي من مياه الأفلاج وبلغ حجم الاحتياج المائي السنوي في هذه الولاية ٣٧,٩٥ مليون متر مكعب تلتها ولاية القابل بحجم ١٢,١ مليون متر مكعب وولاية إبراء بحجم ١١,٣٦ مليون متر مكعب ثم ولاية دماء والطائيين بحجم ١٠,٨٢ مليون متر مكعب وولاية جعلان بني بوحسن بحجم ١٠,٥ مليون متر مكعب ثم ولاية جعلان بني بوعلي بحجم ٧,٩ مليون متر مكعب وولاية بدية بحجم ٧,٥٤ مليون متر مكعب وولاية صور بحجم ٧,٩ مليون متر مكعب ثم ولاية الكامل والوافي بحجم ٦,٣١ مليون متر مكعب وأخيراً ولاية وادي بني خالد بحجم ٣,٨٨ مليون متر مكعب في السنة.



PART 8 : SHARQIYAH REGION AFLAJ STATISTICS

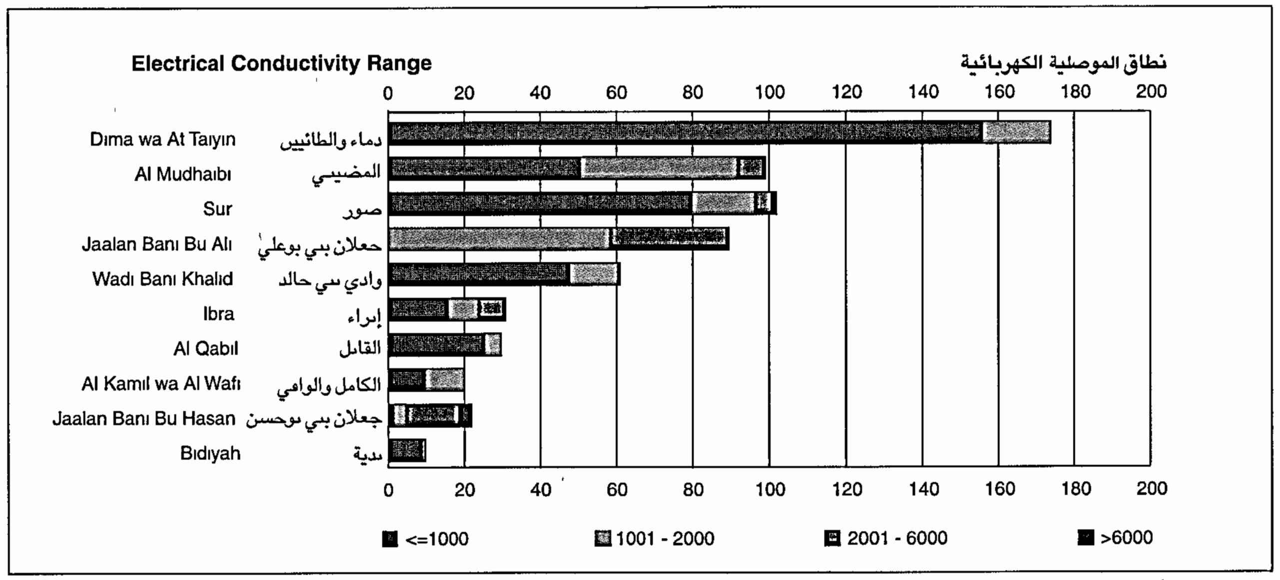
الجزء الثامن : إحصائيات أفلاج المنطقة الشرقية

Water Quality: Electrical Conductivity

Al Mansuri falaj (F1772), Al Mudhaibi, gave the lowest Electrical Conductivity (EC) reading for aflaj water in the Sharqiyah region - a figure of 258 µS/cm. The highest EC reading was recorded at Arhiyan falaj (F0916) in the Jaalan Bani Bu Ali wilayat, which produced a reading of 16700 µS/cm. The tests showed that the water of 506 aflaj in the region was suitable for all crops with the water of 93 suitable for most. 35 aflaj were relatively saline (>6000 µS/cm); such water is suitable only for certain crops, such as clover and date palms

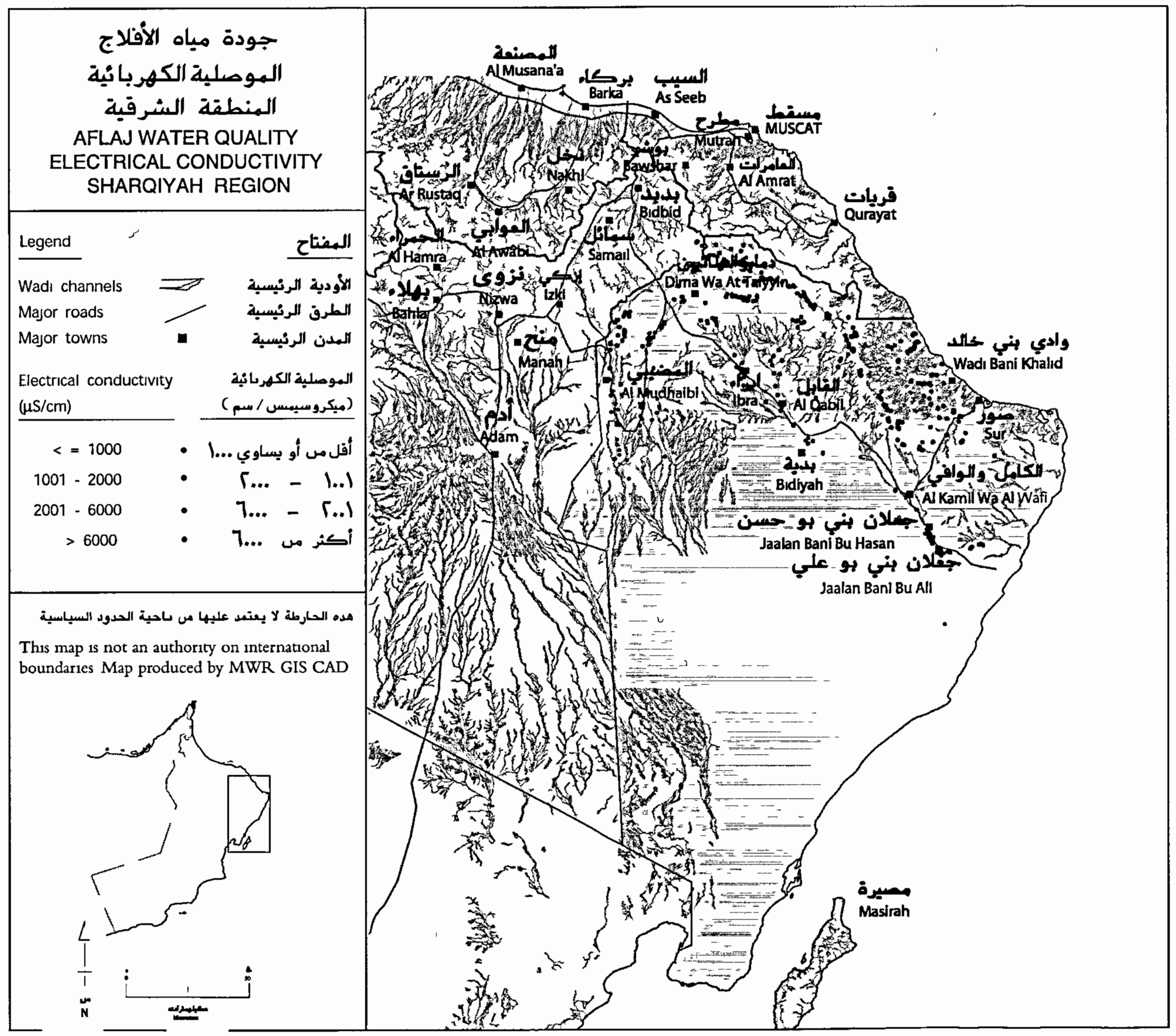
جودة المياه : الموصلية الكهربائية (EC)

سجلت أقل قراءة للموصلية الكهربية لمياه الأفلاج في المنطقة الشرقية بفلج المصوري (ف١٧٧٢) التابع لولاية المضيبي وكانت ٢٥٨ مايكروسيمنس/سم ، بينما سجلت أكبر قراءة للموصلية الكهربية في المنطقة بفلج أرحيان (ف٠٩١٦) التابع لولاية جعلان بني بوعلي وقد بلغت ١٦٧٠٠ مايكروسيمنس/سم. ووجد أن مياه ٥٠٦ فلجاً في المنطقة مناسبة لجميع المحاصيل الزراعية، ومياه ٩٣ فلجاً في المنطقة ملائمة لمعظم المحاصيل الزراعية بيما وجد أن مياه ٣٥ فلجاً كانت مالحة نسبياً (<٦٠٠٠ مايكروسيمنس/سم) وهذه النوعية من المياه لا تصلح إلا لزراعة بعض أنواع المحاصيل مثل الرسيم وأشجار النخيل.



Electrical Conductivity — **الموصلية الكهربائية**

Wilayat	>6000	2001-6000	1001-2000	<=1000	الولاية
	Electrical Conductivity Range - µS/cm		نطاق الموصلية الكهربائية – ميكروسيمنس/سم		
Dima wa At Taiyin	0	0	17	158	دماء والطائيين
Al Mudhaibi	0	8	40	51	المضيبي
Sur	1	4	16	80	صور
Jaalan Bani Bu Ali	31	59	0	0	جعلان بني بو علي
Wadi Bani Khalid	0	1	13	47	وادي بني خالد
Ibra	0	6	7	16	إبراء
Al Qabil	0	0	4	25	القابل
Al Kamil wa Al Wafi	0	0	9	11	الكامل والوافي
Jaalan Bani Bu Hasan	3	14	3	2	جعلان بني بو حسن
Bidiyah	0	1	0	7	بدية
Total	35	93	109	397	المجموع



PART 8 :
SHARQIYAH REGION AFLAJ STATISTICS

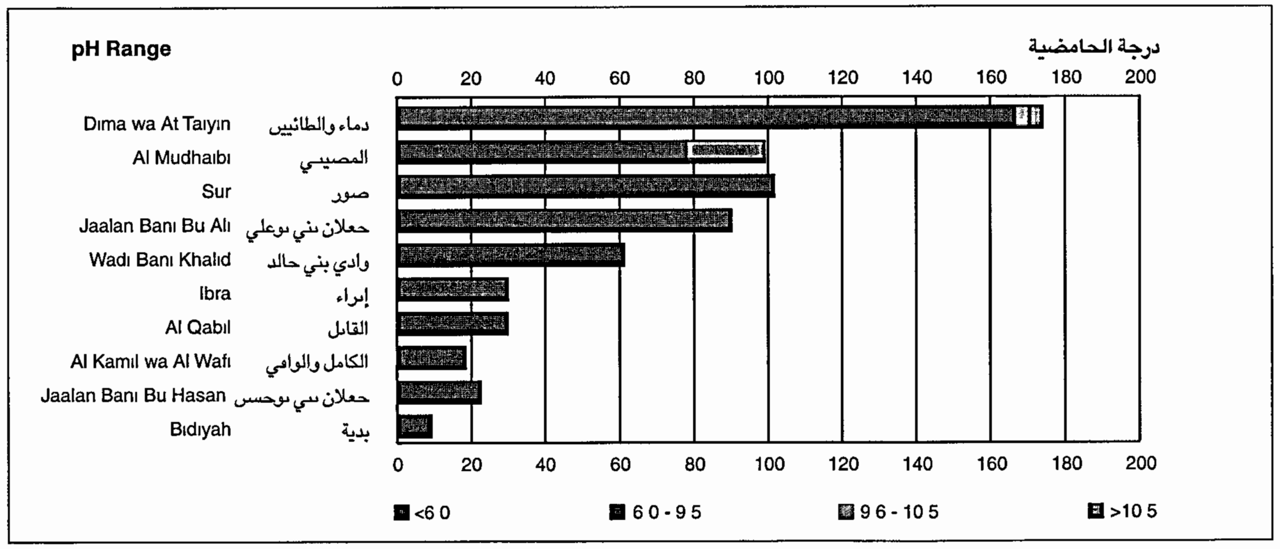
الجزء الثامن :
إحصائيات أفلاج المنطقة الشرقية

Water Quality: pH Levels

Jabiya Salim Hamad falaj (F0856), in the wilayat of Jaalan Bani Bu Ali, produced the lowest pH reading for aflaj water in the Sharqiyah region - a figure of 6.5. The highest reading occurred at Al Juwaibiya falaj (F2433), Al Mudhaibi, where the pH value was found to be 12.1. Generally, the results showed that the water of 603 aflaj in the region was suitable for all crops (pH value ranging between 6 and 9.5). 4 aflaj had water that was slightly alkaline (pH ranging between 9.6 and 10.5) whilst the water of 24 aflaj in the region was significantly so (pH value greater than 10.5), which is unsuitable for some crops.

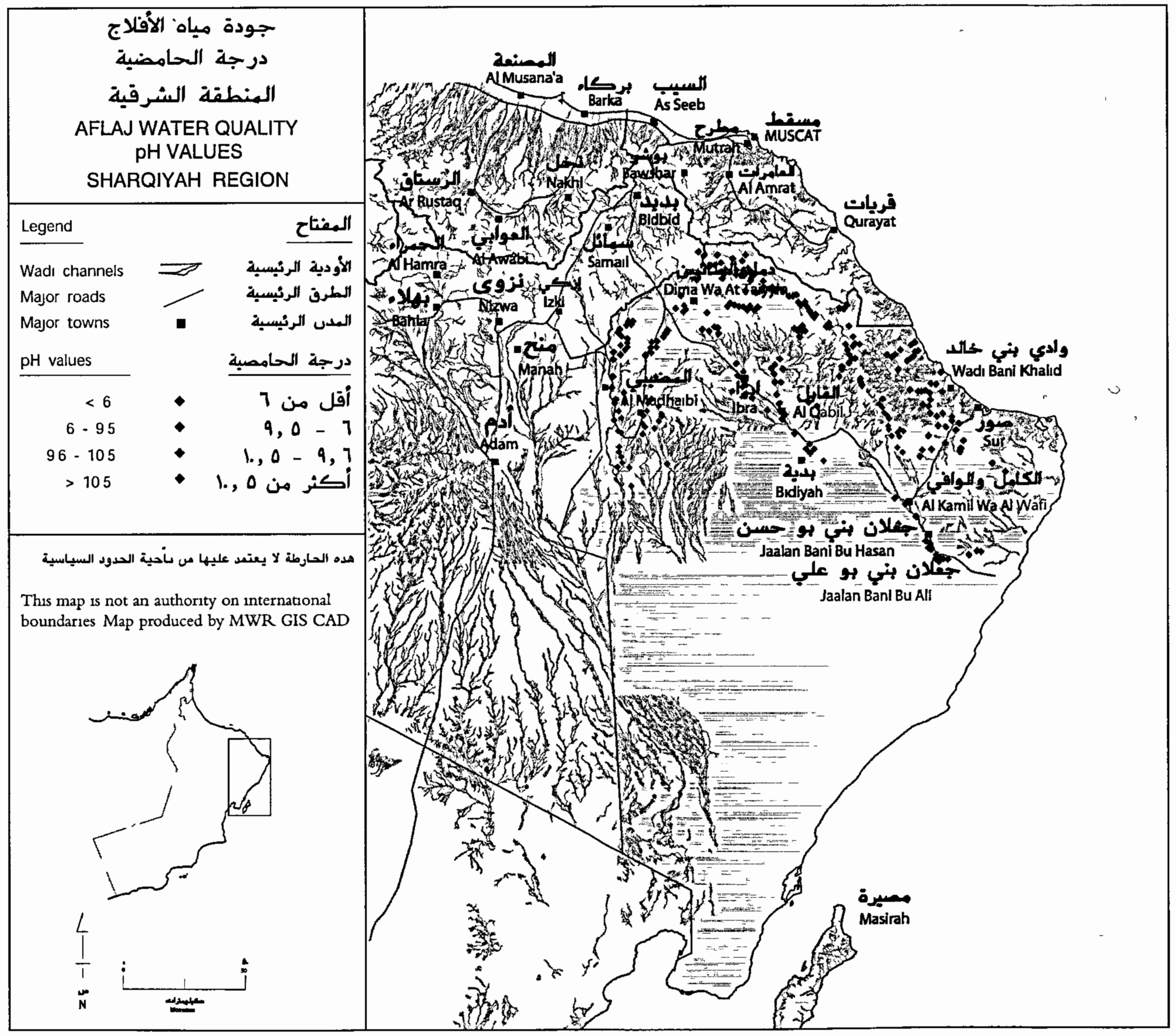
جودة المياه : درجة الحامضية (pH)

سجلت أقل قراءة للحامضية (pH) لمياه الأفلاج بالمنطقة الشرقية لفلج جابية سالم حمد (ف٠٨٥٦) التابع لولاية جعلان بني بوعلي وكانت ٦,٥، بيما سحلت أعلى قراءة للحامضية بفلج الجويبية (ف٢٤٣٣) التابع لولاية المضيبي وقد بلعت درجة حامصية مياهه ١٢,١ وأظهرت النتائج أن مياه ٦٠٣ فلجاً صالحة لجميع المحاصيل الزراعية (تتراوح درجة الحامضية بين ٦ و٩,٥) ومياه ٤ أفلاح مائلة إلى القلوية (تتراوح درجة الحامضية بين ٩,٦ و١٠,٥) بيسما جاءت مياه ٢٤ فلجاً في المطقة عالية القلوية (درجة الحامضية أكر من ١٠,٥) وبالتالي فهي غير صالحة لبعض المحاصيل الزراعية.



pH Level | **درجة الحامضية**

Wilayat	>10.5	pH Range 9.6-10.5	درجة الحامضية 6.0-9.5	<6.0	الولاية
Dima wa At Taiyin	4	4	166	0	دماء والطائيين
Al Mudhaibi	20	0	79	0	المضيبي
Sur	0	0	101	0	صور
Jaalan Bani Bu Ali	0	0	90	0	جعلان بني بو علي
Wadi Bani Khalid	0	0	61	0	وادي بني خالد
Ibra	0	0	29	0	إبراء
Al Qabil	0	0	29	0	القابل
Al Kamil wa Al Wafi	0	0	18	0	الكامل والوافي
Jaalan Bani Bu Hasan	0	0	22	0	جعلان بني بو حسن
Bidiyah	0	0	8	0	بدية
Total	**24**	**4**	**603**	**0**	**المجموع**




ملحق
Appendix

FALAJ SYSTEM REPORT
تقرير نظام الفلج

Falaj System Number / Falaj Inventory Number	:	S0500 / F0500	:	رقم نظام الفلج / رقم حصر الفلج
Other Connected Aflaj	:		:	أفلاج اخرى مرتبطة بالنظام
Total Number of Aflaj	:	1	:	مجموع الافلاج
Total Number of Demand Area	:	1	:	عدد مناطق الاحتياج

FALAJ DETAILS — بيانات الفلج

Falaj Name (s)	1 :	DARIS	١ : دارس	اسم (اسماء) الفلج
	2 :		٢ :	
	3 :		٣ :	
Village	:	AL ILAYAH	: العلايه	اسم القرية
Wadi	:	AL ABYADH	: الابيض	اسم الوادي
Catchment Name / No	:	058(ANDAM/HALF SYS)	: ٠٥٨(عندام/نظام حلفين)	إسم و رقم المستجمع
Wilayat	:	NIZWA	: نزوى	اسم الولاية
MWR Regional Office	:	NIZWA	: نزوى	مكتب موارد المياه الأقليمي
Falaj Inventory Date	:	01/11/1997	: ١٩٩٧/١١/٠١	تاريخ حصر الفلج

FALAJ OBSERVATIONS — مواصفات الفلج

Falaj Type	:	DA'UDI	: داؤودي	نوع الفلج
Falaj Status	:	LIVE	: حي	حالة الفلج
All Measurements Taken at				موقع أخذ القياسات
Feature Type	:	Sharia	: الشريعة	نوع المعلم
MWR Site ID	:		:	رقم الموقع حسب تصنيف الوزارة

MEASUREMENTS - WATER QUALITY — قياسات جودة المياه

EC (µS/cm) (Lab)	:	477	٤٧٧ :	الموصلية الكهربائية (ميكروسيمنز/سم) (مخ)
pH (Lab)	:	7.30	٧,٣٠ :	الرقم الهيدروجيني (مخ)
Water Temperature (°C)	:	37.0	٣٧,٠ :	درجة حرارة الماء(٥م)
Air Temperature (°C)	:	33.0	٣٣,٠ :	درجة حرارة الهواء(٥م)
Water Sample No	:	F0500/11	F0500/11 :	رقم عينة الماء

MEASUREMENTS - FLOW — قياسات التدفق

Discharge Rate				معدل التدفق
-gauge (m^3/sec)	:		:	جهاز قياس التدفق(م٣/الثانية)
-float (m^3/sec)	:		:	جهاز الطفو (م٣/الثانية)
-currrent meter (m^3/sec)	:	0.6321	٠,٦٣٢١ :	عداد قياس التدفق(م٣/الثانية)

SURVEY - CHANNEL LENGTHS — مسح قنوات الفلج

Total length below ground (m)	:	6,480	٦،٤٨٠ :	الطول الكلي- تحت الارض (م)
Total length at ground surface (m)	:	1,510	١،٥١٠ ·	الطول الكلي- سطحي (م)
Total channel length of falaj (m)	:	7,990	٧،٩٩٠ :	الطول الكلي للقنوات (م)

SUPPORT WELLS — الآبار المساعدة

: :

BRANCH DETAILS — بيانات السواعد

Branch Name	1 :	AL KABEER	١ : الكبير	إسم الساعد
Source Type	:	Da'udi	: داؤودي	نوع المصدر
Source Total Depth (m)	:		:	العمق الكلي للمصدر (م)
Source Depth to Water (m)	:		:	العمق الى سطح الماء عند المصدر(م)
Branch Name	2 :	A'SHARQI	٢ : الشرقي	إسم الساعد
Source Type	:	Da'udi	: داؤودي	نوع المصدر
Source Total Depth (m)	:		:	العمق الكلي للمصدر (م)
Source Depth to Water (m)	.		:	العمق الى سطح الماء عند المصدر(م)
Branch Name	3 .	AL GHARBI	٣ : الغربي	إسم الساعد
Source Type	:	Da'udi	: داؤودي	نوع المصدر
Source Total Depth (m)	:		:	العمق الكلي للمصدر (م)
Source Depth to Water (m)	.		:	العمق الى سطح الماء عند المصدر(م)

DEMAND AREA DETAILS — بيانات منطقة الاحتياج

Demand Area Name D01	:	AL ILAYAH	D01 : العلايه	إسم منطقة الاحتياج
Cropped Area (m^2) *	:	1,715,502	١،٧١٥،٥٠٢ :	المساحة المزروعة (م٢) *
Dev./Uncropped Area (m^2) *	:	95,306	٩٥،٣٠٦ ·	المساحة المستصلحة / غير المزروعة (م٢)*
Undeveloped Area (m^2) *	:	571,834	٥٧١،٨٣٤ :	المساحة غير المستصلحة (م٢) *
Total Demand Area (m^2)	:	2,382,642	٢،٣٨٢،٦٤٢ :	المساحة الكلية لمنطقة الاحتياج (م٢)

WATER DEMAND DETAILS — بيانات الاحتياجات المائية

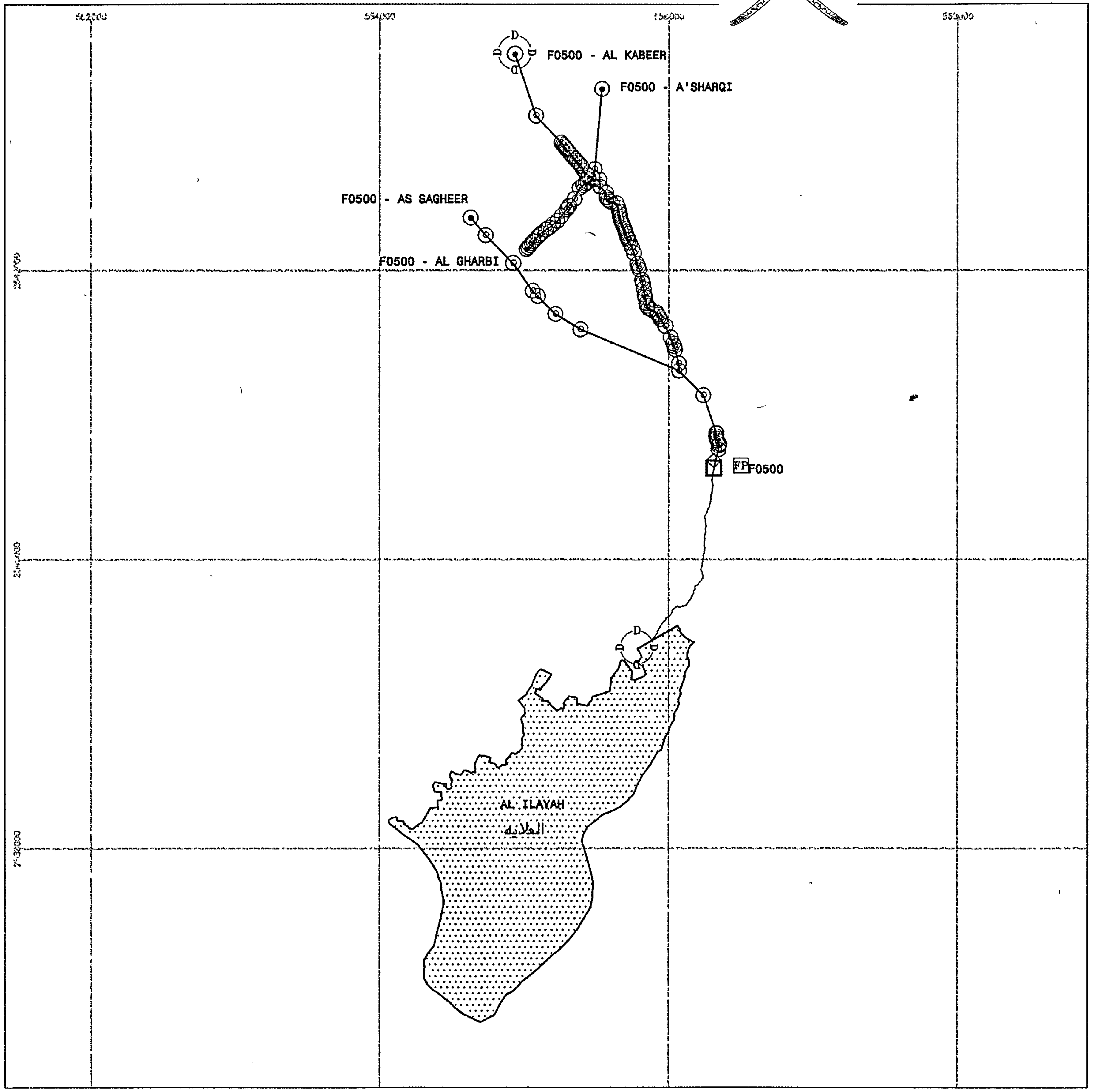
Demand Area Name D01	:	AL ILAYAH	D01 : العلايه	إسم منطقة الاحتياج
Crop Net Water Demand (m^3/yr) *	:	4,682,410	٤،٦٨٢،٤١٠ *	صافي الاحتياج المائي السنوي للمحاصيل (م٣/سنة)
Livestock Water Demand (m^3/yr)		0	٠ :	الإحتياج السنوي لسقي الحيوانات (م٣/سنة)
Total Annual Water Demand (m^3/yr) *		4,682,410	٤،٦٨٢،٤١٠ *	مجموع الإحتياج السنوي من المياه (م٣/سنة)

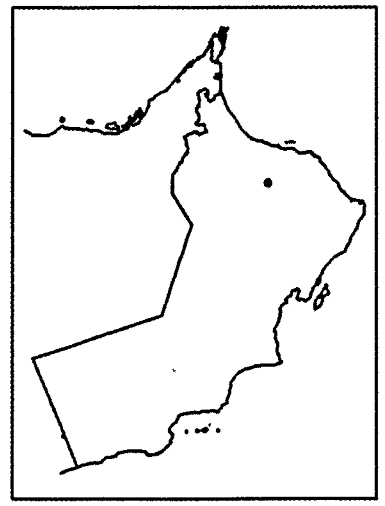
Caution: * Values not based on direct field measurements, but are estimates based on the results of the agricultural sample survey of the demand areas

تنبيه: * القيم غير مبنية على قياسات حقلية مباشرة ، ولكنها مقدرة اعتمادا على نتائج المسح الزراعي التفصيلي لعينة من مناطق الاحتياج

Report Generated On : 19/Feb/2001

S0500 - F0500





سلطنة عمان
وزارة موارد المياه
دائرة الإحصاء والبيانات الحقلية
مشروع حصر الأفلاج

SULTANATE OF OMAN
Ministry of Water Resources
Department of Statistics and Field Data
FALAJ INVENTORY PROJECT

Falaj System	S0500	نظام الفلج	
Falaj No.	F0500	رقم الفلج	
Falaj Name	DARIS	دارس	الفلج
Wadi	AL ABYADH	الابيص	الوادي
Village	AL ILAYAH	العلاية	القرية
Wilayat	NIZWA	نزوى	الولاية

Legend

Underground channel
Covered surface channel
Open surface channel – wet
Open surface channel – dry
Open surface channel – unknown
Agricultural demand area
Point location fixed by "Differential" GPS
Point location fixed by 3 minute "Averaged" GPS
Point location fixed by "Single fix" GPS
Source – Daudi: wet, dry, unknown
Source – Ghaily: wet, dry
Source – Ainy: wet, dry
Source – Dam: wet, dry
Access hole: wet, dry, unknown
Sharia: wet, dry, unknown
Collector/Storage basin: wet, dry, unknown
Supporting well
Location of falaj inventory plate
Source – Unknown type
Measurement / sample point

Note The siting of the falaj is based on the location of the falaj sources found by taking a GPS fix (as indicated on the map and in the legend)
Location of support wells subject to a maximum of 300m inaccuracy from true position

N

0 0.50 1.00 1.50 2.00
km

Datum . WGS 84 Projection : Transverse Mercator
Map compiled by MWR GIS CAD
W:/G173/S0500 17-10-98 11:11

S0500

FALAJ SYSTEM REPORT

تقرير نظام الفلج

Falaj System Number / Falaj Inventory Number	: S0606 / F0606	:	رقم نظام الفلج / رقم حصر الفلج
Other Connected Aflaj	:	:	أفلاج اخرى مرتبطة بالنظام
Total Number of Aflaj	: 1	:	مجموع الافلاج
Total Number of Branches	: 17	:	عدد السواعد
Total Number of Demand Area	: 2	:	عدد مناطق الاحتياج

FALAJ DETAILS — بيانات الفلج

Falaj Name (s) 1	: AL MALKI	١ : الملكي	إسم (أسماء) الفلج
2	:	٢ :	
3	:	٣ :	
Village	: AN NIZAR+ AL YAMAN	: النزار ، اليمن	إسم القرية
Wadi	: HALFIN + IMTY	: حلفين-امطي	اسم الوادي
Catchment Name / No	: 058 (ADAM-HALFIN)	: ٠٥٨ (ادم - حلفين)	إسم و رقم المستجمع
Wilayat	: IZKI	: ازكي	اسم الولاية
MWR Regional Office	: SAMAIL	: سمائل	مكتب موارد المياه الاقليمي
Falaj Inventory Date	: 26/05/1997	: ١٩٩٧/٠٥/٢٦	تاريخ حصر الفلج

FALAJ OBSERVATIONS — مواصفات الفلج

Falaj Type	. DA'UDI	: داوودي	نوع الفلج
Falaj Status	: LIVE	: حي	حالة الفلج
All Measurements Taken at			موقع أخذ القياسات
Feature Type	: Sharia	: الشريعة	نوع المعلم
MWR Site ID	:	:	رقم الموقع حسب تصنيف الوزارة

MEASUREMENTS - WATER QUALITY — قياسات جودة المياه

EC (µS/cm) (Lab)	: 764 5	٧٦٤,٥ :	الموصلية الكهربائية (ميكروسيمنز/سم) (مخ)
pH (Lab)	: 7 82	٧,٨٢ :	الرقم الهيدروجيني (مخ)
Water Temperature (°C)	: 30 0	٣٠,٠ :	درجة حرارة الماء(م٥)
Air Temperature (°C)	: 37.0	٣٧,٠ :	درجة حرارة الهواء(م٥)
Water Sample No	: F0606/11	F0606/11 :	رقم عينة الماء

MEASUREMENTS - FLOW — قياسات التدفق

Discharge Rate			معدل التدفق
-gauge (m^3/sec)	:	:	جهاز قياس التدفق(م٣/الثانية)
-float (m^3/sec)	:	:	جهاز الطفو (م٣/الثانية)
-currrent meter (m^3/sec)	: 0 2264	٠,٢٢٦٤ :	عداد قياس التدفق(م٣/الثانية)

SURVEY - CHANNEL LENGTHS — مسح قنوات الفلج

Total length below ground (m)	: 14,088	١٤،٠٨٨ :	الطول الكلي- تحت الارض (م)
Total length at ground surface (m)	: 787	٧٨٧ :	الطول الكلي- سطحي (م)
Total channel length of falaj (m)	. 14,875	١٤،٨٧٥ :	الطول الكلي للقنوات (م)

SUPPORT WELLS — الآبار المساعدة

: 010/586, 010/592 — ٠١٠/٥٩٢ ,٠١٠/٥٨٦ :

BRANCH DETAILS — بيانات السواعد

Branch Name	1 . AR RAESI	: الريسي ١	إسم الساعد
Source Type	: Da'udi	: داوودي	نوع المصدر
Source Total Depth (m)	:	:	العمق الكلي للمصدر (م)
Source Depth to Water (m)	:	:	العمق الى سطح الماء عند المصدر(م)
Branch Name	2 : AL AKHDAR	: الاخضر ٢	اسم الساعد
Source Type	: Da'udi	: داوودي	نوع المصدر
Source Total Depth (m)	:	:	العمق الكلي للمصدر (م)
Source Depth to Water (m)	:	:	العمق الى سطح الماء عند المصدر(م)
Branch Name	3 : AL ASWAD	: الاسود ٣	إسم الساعد
Source Type	: Da'udi	: داوودي	نوع المصدر
Source Total Depth (m)	:	:	العمق الكلي للمصدر (م)
Source Depth to Water (m)	:	:	العمق الى سطح الماء عند المصدر(م)

DEMAND AREA DETAILS — بيانات منطقة الاحتياج

Demand Area Name D01	: AN NIZAR	D01 . النزار	اسم منطقة الاحتياج
Cropped Area (m^2) *	: 740,170	٧٤٠،١٧٠ :	المساحة المزروعة (م٢) *
Dev./Uncropped Area (m^2) *	: 41,121	٤١،١٢١ :	المساحة المستصلحة / غير المزروعة (م٢)*
Undeveloped Area (m^2) *	: 246,723	٢٤٦،٧٢٣ :	المساحة غير المستصلحة (م٢) *
Total Demand Area (m^2)	: 1,028,014	١،٠٢٨،٠١٤ :	المساحة الكلية لمنطقة الاحتياج (م٢)
Demand Area Name D02	: AL YAMAN	D02 : اليمن	إسم منطقة الاحتياج
Cropped Area (m^2) *	: 392,202	٣٩٢،٢٠٢ :	المساحة المزروعة (م٢) *
Dev./Uncropped Area (m^2) *	: 21,789	٢١،٧٨٩ :	المساحة المستصلحة / غير المزروعة (م٢)*
Undeveloped Area (m^2) *	: 130,734	١٣٠،٧٣٤ :	المساحة غير المستصلحة (م٢) *
Total Demand Area (m^2)	: 544,725	٥٤٤،٧٢٥ :	المساحة الكلية لمنطقة الاحتياج (م٢)

WATER DEMAND DETAILS — بيانات الاحتياجات المائية

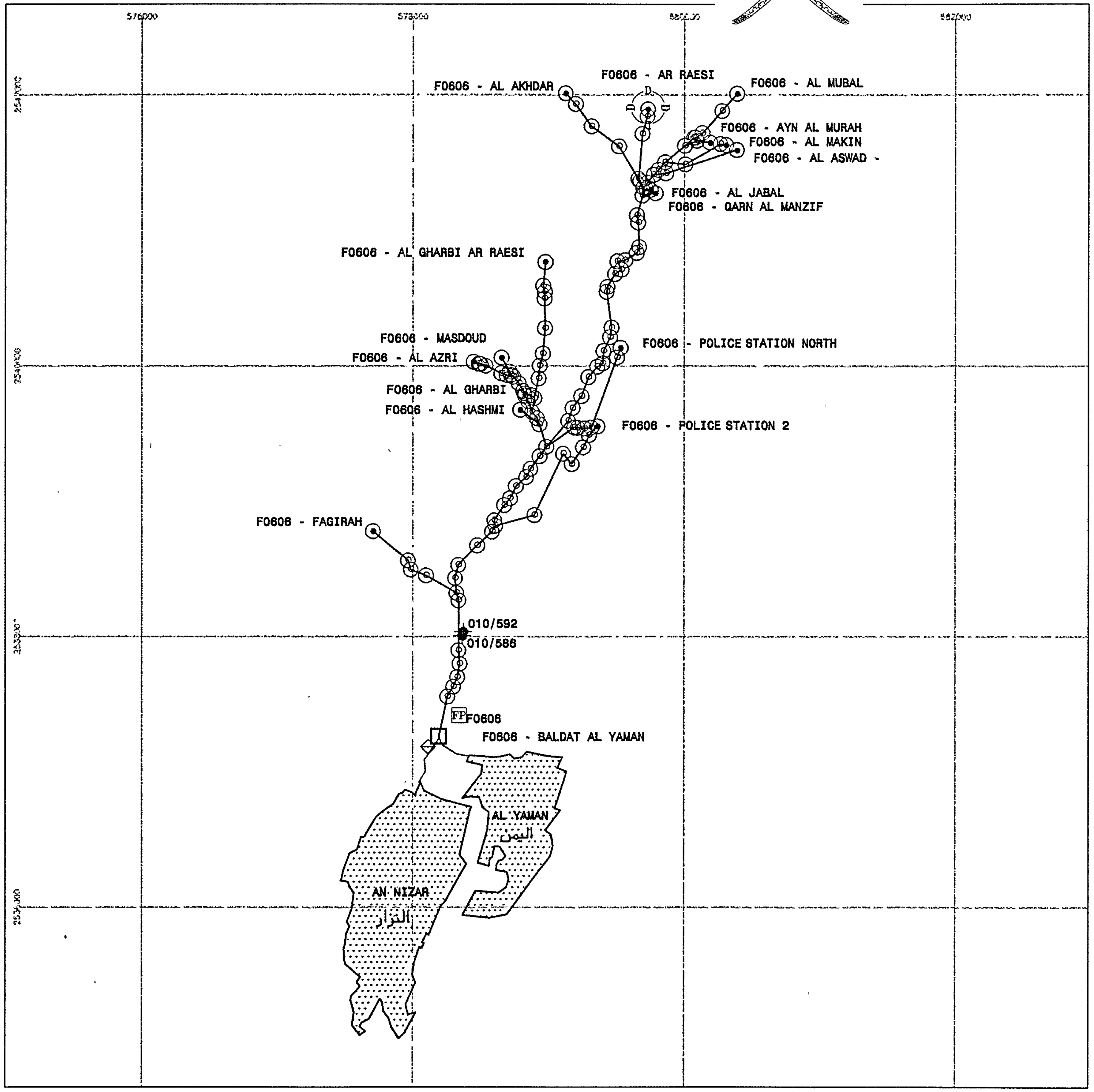
Demand Area Name D01	: AN NIZAR	D01 : النزار	إسم منطقة الاحتياج
Crop Net Water Demand (m^3/yr) *	: 2,037,919	٢،٠٣٧،٩١٩ : *	صافي الاحتياج المائي السنوي للمحاصيل (م٣/سنة)
Livestock Water Demand (m^3/yr)	: 15,576	١٥،٥٧٦ :	الإحتياج السنوي لسقي الحيوانات (م٣/سنة)
Total Annual Water Demand (m^3/yr) *	: 2,053,495	٢،٠٥٣،٤٩٥ : *	مجموع الإحتياج السنوي من المياه (م٣/سنة)
Demand Area Name D02	: AL YAMAN	D02 : اليمن	إسم منطقة الاحتياج
Crop Net Water Demand (m^3/yr) *	: 1,079,855	١،٠٧٩،٨٥٥ : *	صافي الاحتياج المائي السنوي للمحاصيل (م٣/سنة)
Livestock Water Demand (m^3/yr)	: 0	٠ .	الإحتياج السنوي لسقي الحيوانات (م٣/سنة)
Total Annual Water Demand (m^3/yr) *	: 1,079,855	١،٠٧٩،٨٥٥ *	مجموع الإحتياج السنوي من المياه (م٣/سنة)

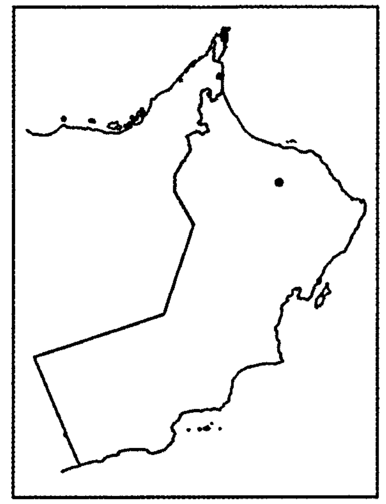
Caution: * Values not based on direct field measurements, but are estimates based on the results of the agricultural sample survey of the demand areas

تنبيه: * القيم عير مبنية على قياسات حقلية مباشرة , ولكنها مقدرة اعتمادا على نتائج المسح الزراعي التفصيلي لعينة من مناطق الاحتياج

Report Generated On : 02/Apr/2001

S0606 - F0606





سلطنة عمان
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SULTANATE OF OMAN
Ministry of Water Resources
Department of Statistics and Field Data
FALAJ INVENTORY PROJECT

	Falaj System	S0606	نظام الفلج	
	Falaj No.	F0606	رقم الفلج	
Falaj Name	AL MALKI		الملكي	الفلج
Wadi	HALFIN + IMTY		حلفين - إمطي	الوادي
Village	AN NIZAR+ AL YAMAN		النزار - اليمن	القرية
Wilayat	IZKI		إزكي	الولاية

Legend

Underground channel
Covered surface channel
Open surface channel – wet
Open surface channel – dry
Open surface channel – unknown
Agricultural demand area

Point location fixed by "Differential" GPS
Point location fixed by 3 minute "Averaged" GPS
Point location fixed by "Single fix" GPS

Source – Daudi: wet, dry, unknown
Source – Ghaily: wet, dry
Source – Ainy: wet, dry
Source – Dam: wet, dry

Access hole: wet, dry, unknown
Sharia: wet, dry, unknown
Collector/Storage basin: wet, dry, unknown

Supporting well
FP Location of falaj inventory plate
Source – Unknown type
Measurement / sample point

Note The siting of the falaj is based on the location of the falaj sources found by taking a GPS fix (as indicated on the map and in the legend)
Location of support wells subject to a maximum of 300m inaccuracy from true position

N

0 0.50 1.00 1.50 2.00
km

Datum : WGS 84 Projection . Transverse Mercator
Map compiled by MWR GIS CAD
W:/G173/S0606 17-05-99 09 03

S0606

FALAJ SYSTEM REPORT
تقرير نظام الفلج

Falaj System Number / Falaj Inventory Number	: S1301 / F1301	:	رقم نظام الفلج / رقم حصر الفلج
Other Connected Aflaj	:	:	أفلاج اخرى مرتبطة بالنظام
Total Number of Aflaj	: 1	:	مجموع الافلاج
Total Number of Demand Area	: 1	:	عدد مناطق الاحتياج

FALAJ DETAILS — بيانات الفلج

Falaj Name (s)	1 : ADH DHAHIR	الظاهر : ١		إسم (أسماء) الفلج
	2 :	: ٢		
	3 :	: ٣		
Village	: ADH DHAHIR	الظاهر :		إسم القرية
Wadi	: BAIYA/ AN NAJD	بايع _ النجد :		إسم الوادي
Catchment Name / No.	: 060 (WADI AL BATHA)	٠٦٠ (وادي البطحاء) :		اسم و رقم المستجمع
Wilayat	: BIDIYAH	بديه :		إسم الولاية
MWR Regional Office	: IBRA	ابراء :		مكتب موارد المياه الاقليمي
Falaj Inventory Date	: 08/03/1997	١٩٩٧/٠٣/٠٨ :		تاريخ حصر الفلج

FALAJ OBSERVATIONS — مواصفات الفلج

Falaj Type	: DA'UDI	داؤودي :	نوع الفلج
Falaj Status	: LIVE	حي .	حالة الفلج
All Measurements Taken at			موقع أخذ القياسات
Feature Type	:	:	نوع المعلم
MWR Site ID	:	:	رقم الموقع حسب تصنيف الوزارة

MEASUREMENTS - WATER QUALITY — قياسات جودة المياه

EC (µS/cm) (Lab)	:	421	٤٢١ :	الموصلية الكهربائية (ميكروسيمنز/سم) (مخ)
pH (Lab)	:	8.21	٨,٢١ :	الرقم الهيدروجيني (مخ)
Water Temperature (°C)	:	34.0	٣٤,٠ :	درجة حرارة الماء(م°)
Air Temperature (°C)	:	30 0	٣٠,٠ :	درجة حرارة الهواء(م°)
Water Sample No.	:	F1301/11	F1301/11 :	رقم عينة الماء

MEASUREMENTS - FLOW — قياسات التدفق

Discharge Rate				معدل التدفق
-gauge (m^3/sec)	:		:	جهاز قياس التدفق(م٣/الثانية)
-float (m^3/sec)	:	0 1476	٠,١٤٧٦ :	جهاز الطفو (م٣/الثانية)
-currrent meter (m^3/sec)	:		:	عداد قياس التدفق(م٣/الثانية)

SURVEY - CHANNEL LENGTHS — مسح قنوات الفلج

Total length below ground (m)	:	4,964	٤،٩٦٤ :	الطول الكلي- تحت الارض (م)
Total length at ground surface (m)	:	390	٣٩٠ :	الطول الكلي- سطحي (م)
Total channel length of falaj (m)	:	5,354	٥،٣٥٤ :	الطول الكلي للقنوات (م)

SUPPORT WELLS — الآبار المساعدة

: :

BRANCH DETAILS — بيانات السواعد

Branch Name	1 : ADH DHAHIR	الظاهر : ١	إسم الساعد
Source Type	: Da'udi	داؤودي :	نوع المصدر
Source Total Depth (m)	:	:	العمق الكلي للمصدر (م)
Source Depth to Water (m)	:	:	العمق الى سطح الماء عند المصدر(م)

DEMAND AREA DETAILS — بيانات منطقة الاحتياج

Demand Area Name	D01 : ADH DHAHIR		الظاهر : D01	إسم منطقة الاحتياج
Cropped Area (m^2) *	:	569,545	٥٦٩،٥٤٥ :	المساحة المزروعة (م٢) *
Dev./Uncropped Area (m^2) *	:	31,641	٣١،٦٤١ :	المساحة المستصلحة / غير المزروعة (م٢)*
Undeveloped Area (m^2) *	:	189,848	١٨٩،٨٤٨ :	المساحة غير المستصلحة (م٢) *
Total Demand Area (m^2)	:	791,034	٧٩١،٠٣٤ :	المساحة الكلية لمنطقة الاحتياج (م٢)

WATER DEMAND DETAILS — بيانات الاحتياجات المائية

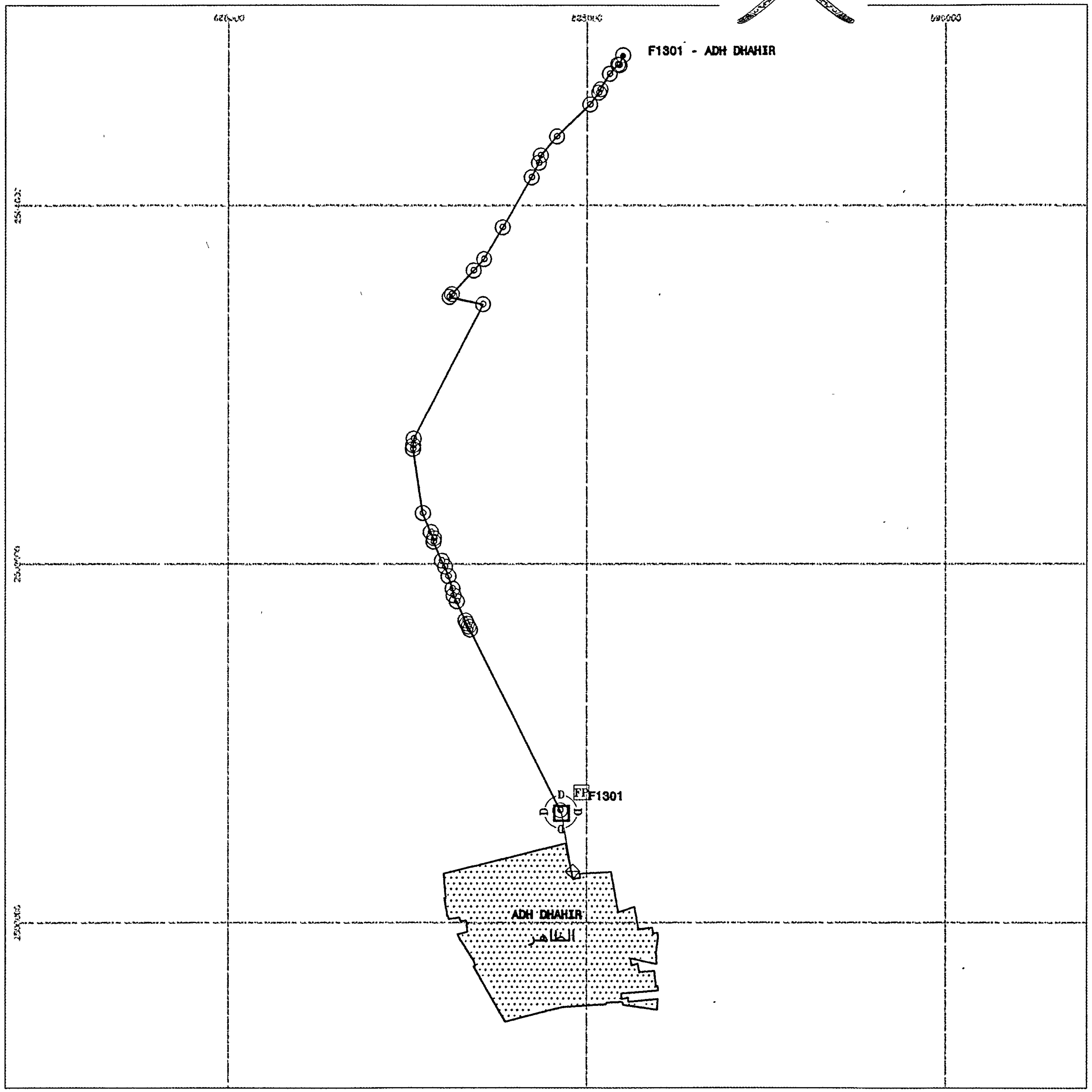
Demand Area Name	D01 : ADH DHAHIR		الظاهر . D01	اسم منطقة الاحتياج
Crop Net Water Demand (m^3/yr) *	:	1,552,106	١،٥٥٢،١٠٦ : *	صافي الاحتياج المائي السنوي للمحاصيل (م٣/سنة)
Livestock Water Demand (m^3/yr)	:	0	٠ :	الإحتياج السنوي لسقي الحيوانات (م٣/سنة)
Total Annual Water Demand (m^3/yr) *	·	1,552,106	١،٥٥٢،١٠٦ : *	مجموع الإحتياج السنوي من المياه (م٣/سنة)

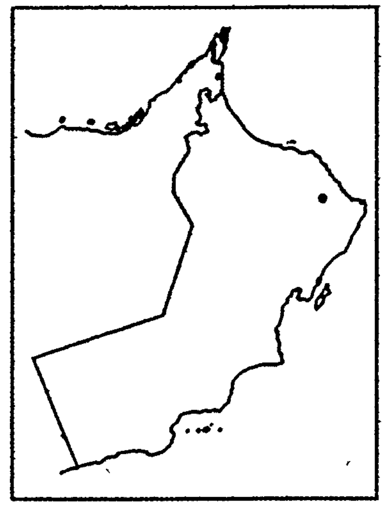
Caution: * Values not based on direct field measurements, but are estimates based on the results of the agricultural sample survey of the demand areas

تنبيه: * القيم عير مبنية على قياسات حقلية مباشرة ، ولكنها مقدرة اعتمادا على نتائج المسح الرراعي التفصيلي لعينة من مناطق الاحتياج

Report Generated On : 19/Feb/2001

S1301 - F1301





سلطنة عمان
وزارة موارد المياه
دائرة الإحصاء والبيانات الحقلية
مشروع حصر الأفلاج

SULTANATE OF OMAN
Ministry of Water Resources
Department of Statistics and Field Data
FALAJ INVENTORY PROJECT

	Falaj System	S1301	نظام الفلج	
	Falaj No.	F1301	رقم الفلج	
Falaj Name	ADH DHAHIR		الظاهر	الفلج
Wadi	BAIYA/ AN NAJD		بايع - النجد	الوادي
Village	ADH DHAHIR		الظاهر	القرية
Wilayat	BIDIYAH		بديه	الولاية

Legend

- Underground channel
- Covered surface channel
- Open surface channel – wet
- Open surface channel – dry
- Open surface channel – unknown
- Agricultural demand area
- Point location fixed by "Differential" GPS
- Point location fixed by 3 minute "Averaged" GPS
- Point location fixed by "Single fix" GPS

Source – Daudi: wet, dry, unknown
Source – Ghaily: wet, dry
Source – Any: wet, dry
Source – Dam: wet, dry

Access hole: wet, dry, unknown
Sharia: wet, dry, unknown
Collector/Storage basin: wet, dry, unknown

- Supporting well
- FP Location of falaj inventory plate
- Source – Unknown type
- Measurement / sample point

Note The siting of the falaj is based on the location of the falaj sources found by taking a GPS fix (as indicated on the map and in the legend)
Location of support wells subject to a maximum of 300m inaccuracy from true position

0 0.50 1.00 1.50 2.00
km

N

Datum : WGS 84 Projection : Transverse Mercator
Map compiled by MWR GIS CAD
W./G173/S1301 26-02-01 10:15

S1301

FALAJ SYSTEM REPORT
تقرير نظام الفلج

Falaj System Number / Falaj Inventory Number	: S2119 / F2119	:	رقم نظام الفلج / رقم حصر الفلج
Other Connected Aflaj	:	:	أفلاج اخرى مرتبطة بالنظام
Total Number of Aflaj	: 1	:	مجموع الافلاج
Total Number of Demand Area	: 1	:	عدد مناطق الاحتياج

FALAJ DETAILS — بيانات الفلج

Falaj Name (s) 1	: MA'UL	معول : ١	اسم (اسماء) الفلج
2	:	: ٢	
3	:	: ٣	
Village	: MA'UL	معول :	إسم القرية
Wadi	: MA'UL	معول :	إسم الوادي
Catchment Name / No.	: 077(WADI MIJLAS)	٠٧٧(وادي مجلاس) :	اسم و رقم المستجمع
Wilayat	: QURAYYAT	قريات :	اسم الولاية
MWR Regional Office	: AS SEEB	السيب :	مكتب موارد المياه الاقليمي
Falaj Inventory Date	: 08/09/1997	١٩٩٧/٠٩/٠٨ :	تاريخ حصر الفلج

FALAJ OBSERVATIONS — مواصفات الفلج

Falaj Type	: DA'UDI	داوودي	نوع الفلج
Falaj Status	: LIVE	حي	حالة الفلج
All Measurements Taken at			موقع أخذ القياسات
Feature Type	: Sharia	الشريعة :	نوع المعلم
MWR Site ID	:		رقم الموقع حسب تصنيف الوزارة

MEASUREMENTS - WATER QUALITY — قياسات جودة المياه

EC (µS/cm) (Lab)	:	514	٥١٤ :	الموصلية الكهربائية (ميكروسيمنز/سم) (مخ)
pH (Lab)	:	7.71	٧٫٧١ :	الرقم الهيدروجيني (مخ)
Water Temperature (°C)	:	33 4	٣٣٫٤ :	درجة حرارة الماء(°م)
Air Temperature (°C)	:	42 9	٤٢٫٩ :	درجة حرارة الهواء(°م)
Water Sample No	:	F2119/11	F2119/11 :	رقم عينة الماء

MEASUREMENTS - FLOW — قياسات التدفق

Discharge Rate				معدل التدفق
-gauge (m^3/sec)	:		:	جهاز قياس التدفق(م٣/الثانية)
-float (m^3/sec)	:	0 0062	٠٫٠٠٦٢ .	جهاز الطفو (م٣/الثانية)
-currrent meter (m^3/sec)	:		.	عداد قياس التدفق(م٣/الثانية)

SURVEY - CHANNEL LENGTHS — مسح قنوات الفلج

Total length below ground (m)	:	310	٣١٠ .	الطول الكلي- تحت الارض (م)
Total length at ground surface (m)	:	100	١٠٠ :	الطول الكلي- سطحي (م)
Total channel length of falaj (m)	:	410	٤١٠ :	الطول الكلي للقنوات (م)

SUPPORT WELLS — الآبار المساعدة

: :

BRANCH DETAILS — بيانات السواعد

Branch Name	1 : MA'UL AL FOUQI	معول الفوقي : ١	اسم الساعد
Source Type	: Da'udi	داوودي :	نوع المصدر
Source Total Depth (m)	:	:	العمق الكلي للمصدر (م)
Source Depth to Water (m)	:	:	العمق الى سطح الماء عند المصدر(م)

DEMAND AREA DETAILS — بيانات منطقة الاحتياج

Demand Area Name	D01 MA'UL		معول : D01	إسم منطقة الاحتياج
Cropped Area (m^2) *	:	22,124	٢٢٫١٢٤ :	المساحة المزروعة (م٢) *
Dev /Uncropped Area (m^2) *	:	1,229	١٫٢٢٩ :	المساحة المستصلحة / غير المزروعة (م٢)*
Undeveloped Area (m^2) *	:	7,375	٧٫٣٧٥ :	المساحة غير المستصلحة (م٢) *
Total Demand Area (m^2)	.	30,728	٣٠٫٧٢٨ :	المساحة الكلية لمنطقة الاحتياج (م٢)

WATER DEMAND DETAILS — بيانات الاحتياجات المائية

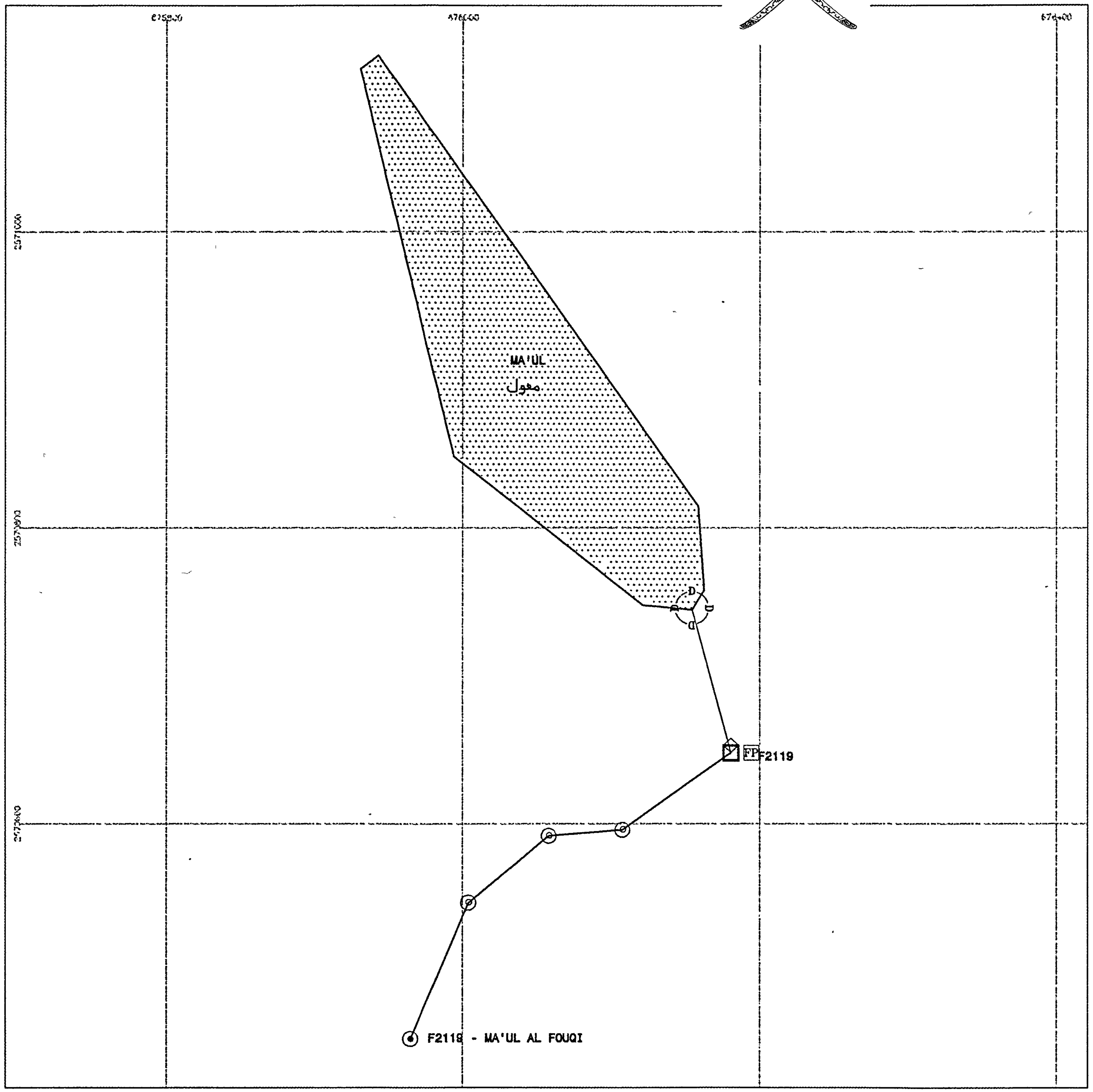
Demand Area Name	D01 : MA'UL		معول : D01	إسم منطقة الاحتياج
Crop Net Water Demand (m^3/yr) *	:	58,024	٥٨٫٠٢٤ : *	صافي الاحتياج المائي السنوي للمحاصيل (م٣/سنة)
Livestock Water Demand (m^3/yr)	:	0	٠ :	الإحتياج السنوي لسقي الحيوانات (م٣/سنة)
Total Annual Water Demand (m^3/yr) *	:	58,024	٥٨٫٠٢٤ : *	مجموع الإحتياج السنوي من المياه (م٣/سنة)

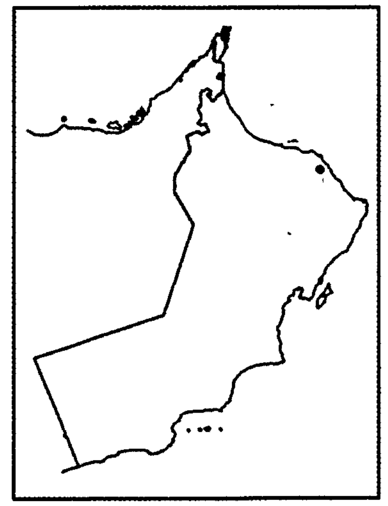
Caution: * Values not based on direct field measurements, but are estimates based on the results of the agricultural sample survey of the demand areas

تنبيه: * القيم غير مبنية على قياسات حقلية مباشرة ، ولكنها مقدرة اعتمادا على نتائج المسح الزراعي التفصيلي لعينة من مناطق الاحتياج

Report Generated On : 19/Feb/2001

S2119 - F2119





سلطنة عمان
وزارة موارد المياه
دائرة الإحصاء والبيانات الحقلية
مشروع حصر الأفلاج

SULTANATE OF OMAN
Ministry of Water Resources
Department of Statistics and Field Data
FALAJ INVENTORY PROJECT

Falaj System	S2119		نظام الفلج
Falaj No.	F2119		رقم الفلج
Falaj Name	MA'UL	معول	الفلج
Wadi	MA'UL	معول	الوادي
Village	MA'UL	معول	القرية
Wilayat	QURAYYAT	قريات	الولاية

Legend

- Underground channel
- Covered surface channel
- Open surface channel - wet
- Open surface channel - dry
- Open surface channel - unknown
- Agricultural demand area
- Point location fixed by "Differential" GPS
- Point location fixed by 3 minute "Averaged" GPS
- Point location fixed by "Single fix" GPS

Source - Daudi	Source - Ghaily	Source - Ainy	Source - Dam
wet	wet	wet	wet
dry	dry	dry	dry
unknown			

Access hole	Sharia	Collector/Storage basin
wet	wet	wet
dry	dry	dry
unknown	unknown	unknown

- Supporting well
- FP Location of falaj inventory plate
- Source - Unknown type
- Measurement / sample point

Note The siting of the falaj is based on the location of the falaj sources found by taking a GPS fix (as indicated on the map and in the legend)
Location of support wells subject to a maximum of 300m inaccuracy from true position

N

0 0.050 0.100 0.150 0.200
km

Datum : WGS 84 Projection Transverse Mercator
Map complied by MWR GIS CAD
W./G173/S2119 02-11-98 07:56

S2119

FALAJ SYSTEM REPORT

تقرير نظام الفلج

Falaj System Number / Falaj Inventory Number	: S2157 / F2157	:	رقم نظام الفلج / رقم حصر الفلج
Other Connected Aflaj	:	:	أفلاج اخرى مرتبطة بالنظام
Total Number of Aflaj	: 1	:	مجموع الافلاج
Total Number of Demand Area	: 1	:	عدد مناطق الاحتياج

FALAJ DETAILS — بيانات الفلج

Falaj Name (s)	1	: AL HAYL	الحيل : ١	اسم (اسماء) الفلج
	2	:	: ٢	
	3	:	: ٣	
Village		: AL HAYL	الحيل :	إسم القرية
Wadi		: AL AYN	العين :	إسم الوادي
Catchment Name / No.		: 052(W SALAMAH/AL AYN	٠٥٢(وادي سلمى/العين) :	إسم و رقم المستجمع
Wilayat		: IBRI	عبري :	إسم الولاية
MWR Regional Office		: IBRI	عبري :	مكتب موارد المياه الأقليمي
Falaj Inventory Date		: 07/12/1997	١٩٩٧/١٢/٠٧ :	تاريخ حصر الفلج

FALAJ OBSERVATIONS — مواصفات الفلج

Falaj Type	: DA'UDI	داوودي :	نوع الفلج
Falaj Status	: LIVE	حي :	حالة الفلج
All Measurements Taken at			موقع أخذ القياسات
Feature Type	: Sharia	الشريعة :	نوع المعلم
MWR Site ID	: EA061659AB	EA061659AB :	رقم الموقع حسب تصنيف الوزارة

MEASUREMENTS - WATER QUALITY — قياسات جودة المياه

EC (µS/cm) (Lab)	: 793	٧٩٣ :	الموصلية الكهربائية (ميكروسيمنز/سم) (مخ)
pH (Lab)	: 7.35	٧,٣٥ :	الرقم الهيدروجيني (مخ)
Water Temperature (°C)	: 26.0	٢٦,٠ :	درجة حرارة الماء(٥م)
Air Temperature (°C)	: 24.0	٢٤,٠ :	درجة حرارة الهواء(٥م)
Water Sample No	: F2157/11	F2157/11 :	رقم عينة الماء

MEASUREMENTS - FLOW — قياسات التدفق

Discharge Rate			معدل التدفق
-gauge (m^3/sec)	:	:	جهاز قياس التدفق(م٣/الثانية)
-float (m^3/sec)	:	:	جهاز الطفو (م٣/الثانية)
-currrent meter (m^3/sec)	: 0.07	٠,٠٧ :	عداد قياس التدفق(م٣/الثانية)

SURVEY - CHANNEL LENGTHS — مسح قنوات الفلج

Total length below ground (m)	: 1,614	١٠٦١٤ :	الطول الكلي- تحت الارض (م)
Total length at ground surface (m)	:	:	الطول الكلي- سطحي (م)
Total channel length of falaj (m)	: 1,614	١٠٦١٤ :	الطول الكلي للقنوات (م)

SUPPORT WELLS — الآبار المساعدة

: :

BRANCH DETAILS — بيانات السواعد

Branch Name	1 : AL HADAYTH	الحديث : ١	إسم الساعد
Source Type	: Da'udi	داوودي :	نوع المصدر
Source Total Depth (m)	:	:	العمق الكلي للمصدر (م)
Source Depth to Water (m)	:	:	العمق الى سطح الماء عند المصدر(م)
Branch Name	2 : AL QADEM	القديم : ٢	إسم الساعد
Source Type	: Da'udi	داوودي :	نوع المصدر
Source Total Depth (m)	:	:	العمق الكلي للمصدر (م)
Source Depth to Water (m)	:	:	العمق الى سطح الماء عند المصدر(م)

DEMAND AREA DETAILS — بيانات منطقة الاحتياج

Demand Area Name	D01 AL HAYL	الحيل : D01	إسم منطقة الاحتياج
Cropped Area (m^2) *	: 166,024	١٦٦٠٠٢٤ :	المساحة المزروعة (م٢) *
Dev./Uncropped Area (m^2) *	: 9,224	٩٠٢٢٤ :	المساحة المستصلحة / غير المزروعة (م٢)*
Undeveloped Area (m^2) *	: 55,341	٥٥٠٣٤١ :	المساحة غير المستصلحة (م٢) *
Total Demand Area (m^2)	: 230,589	٢٣٠٠٥٨٩ :	المساحة الكلية لمنطقة الاحتياج (م٢)

WATER DEMAND DETAILS — بيانات الاحتياجات المائية

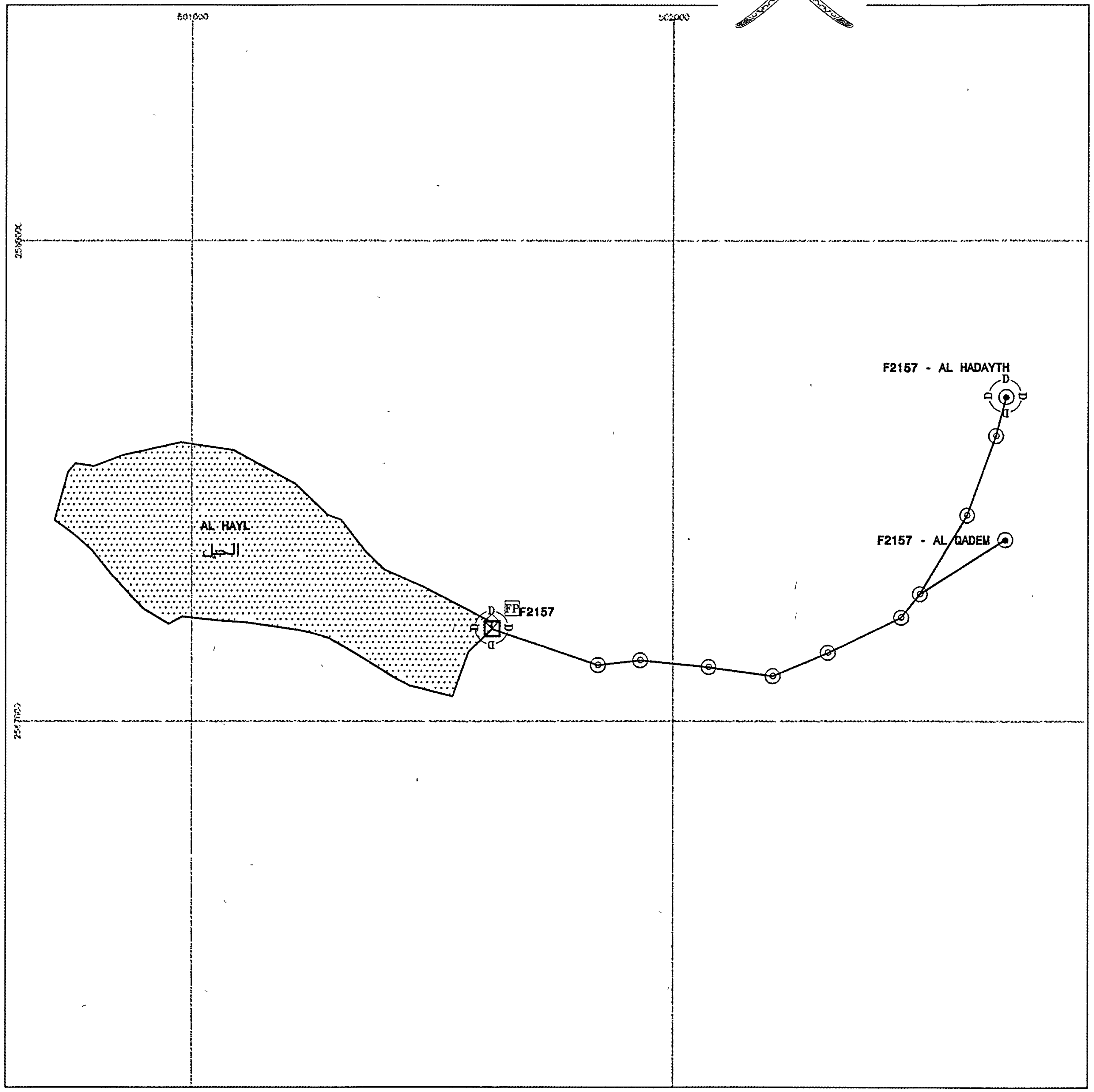
Demand Area Name	D01 : AL HAYL	الحيل : D01	إسم منطقة الاحتياج
Crop Net Water Demand (m^3/yr) *	: 457,265	٤٥٧٠٢٦٥ : *	صافي الاحتياج المائي السنوي للمحاصيل (م٣/سنة)
Livestock Water Demand (m^3/yr)	: 469	٤٦٩ :	الإحتياج السنوي لسقي الحيوانات (م٣/سنة)
Total Annual Water Demand (m^3/yr) *	: 457,734	٤٥٧٠٧٣٤ : *	مجموع الإحتياج السنوي من المياه (م٣/سنة)

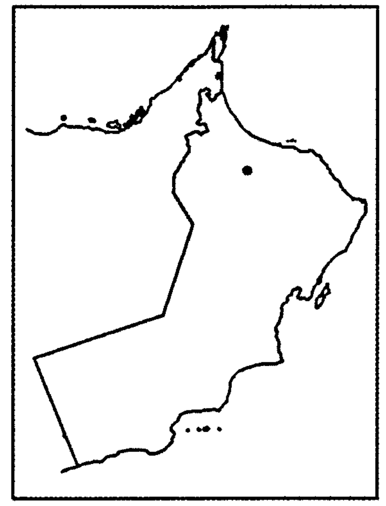
Caution: * Values not based on direct field measurements, but are estimates based on the results of the agricultural sample survey of the demand areas

تنبيه: * القيم غير مبنية على قياسات حقلية مباشرة ، ولكنها مقدرة اعتمادا على نتائج المسح الزراعي التفصيلي لعينة من مناطق الاحتياج

Report Generated On : 19/Feb/2001

S2157 - F2157





سلطنة عمان
وزارة موارد المياه
دائرة الإحصاء والبيانات الحقلية
مشروع حصر الأفلاج

SULTANATE OF OMAN
Ministry of Water Resources
Department of Statistics and Field Data
FALAJ INVENTORY PROJECT

	Falaj System	S2157	نظام الفلج	
	Falaj No.	F2157	رقم الفلج	
Falaj Name	AL HAYL		الحيل	الفلج
Wadi	AL AYN		العين	الوادي
Village	AL HAYL		الحيل	القرية
Wilayat	IBRI		عبري	الولاية

Legend

Underground channel
Covered surface channel
Open surface channel – wet
Open surface channel – dry
Open surface channel – unknown
Agricultural demand area

Point location fixed by "Differential" GPS
Point location fixed by 3 minute "Averaged" GPS
Point location fixed by "Single fix" GPS

Source – Daudi: wet, dry, unknown
Source – Ghaily: wet, dry
Source – Any: wet, dry
Source – Dam: wet, dry

Access hole: wet, dry, unknown
Sharia: wet, dry, unknown
Collector/Storage basin: wet, dry, unknown

Supporting well
Location of falaj inventory plate
Source – Unknown type
Measurement / sample point

Note. The siting of the falaj is based on the location of the falaj sources found by taking a GPS fix (as indicated on the map and in the legend)
Location of support wells subject to a maximum of 300m inaccuracy from true position.

N

0 0 25 0 50 0 75
km

Datum : WGS 84 Projection : Transverse Mercator
Map compiled by MWR GIS CAD
W:/G173/S2157 16-09-98 12:18

S2157

SULTANATE OF OMAN

FALAJ FLOW DATA

VOLUME 3

NORTH BATINAH & MUSANDAM AREA

1983 - 2002

MINISTRY OF REGIONAL MUNICIPALITIES,
ENVIRONMENT & WATER RESOURCES
DIRECTORATE GENERAL OF WATER
RESOURCES AFFAIRS

DECEMBER 2003

CONTENTS

CONTENTS- *Continued*

FALAJ FLOW RECORDS

VOLUME 3: NORTH BATINAH & MUSANDAM ASSESSMENT AREA

1983-2002

ABSTRACT

This report is a compilation of falaj flow records for the North Batinah & Musandam Assessment area for the entire period of record through 30 September 2002. It includes tables of discharge for 30 falaj-gauging stations, together with water quality data

Volume 3 is one of a series of seven volumes, 1 - Muscat; 2 - South Batinah; 3 - North Batinah and Musandam, 4 – Ad' Dhahirah; 5 – Ad' Dakhliyah, 6 – As' Sharqiyah; 7 – Dhofar. That volumes include aflaj flow records collected in the Sultanate of Oman for the entire period of record. Each volume contains a text that explains the terminology and procedures used in compiling the data, tables of discharges and water quality by hydrologic year (01 October to 30 September), and a description of each station The data can also be provided in computer readable format.

Most of the data that have been collected at falaj sites consist of (a) field measurements of flow using floats to determine the velocity of flow; (b) field measurements of flow using current meters to determine the velocity of flow, and (c) readings of the falaj stage at the time of the measurements At most sites, water temperature, and electrical conductivity are also taken when the flow is measured At less regular intervals water quality samples have also been taken for laboratory analysis.

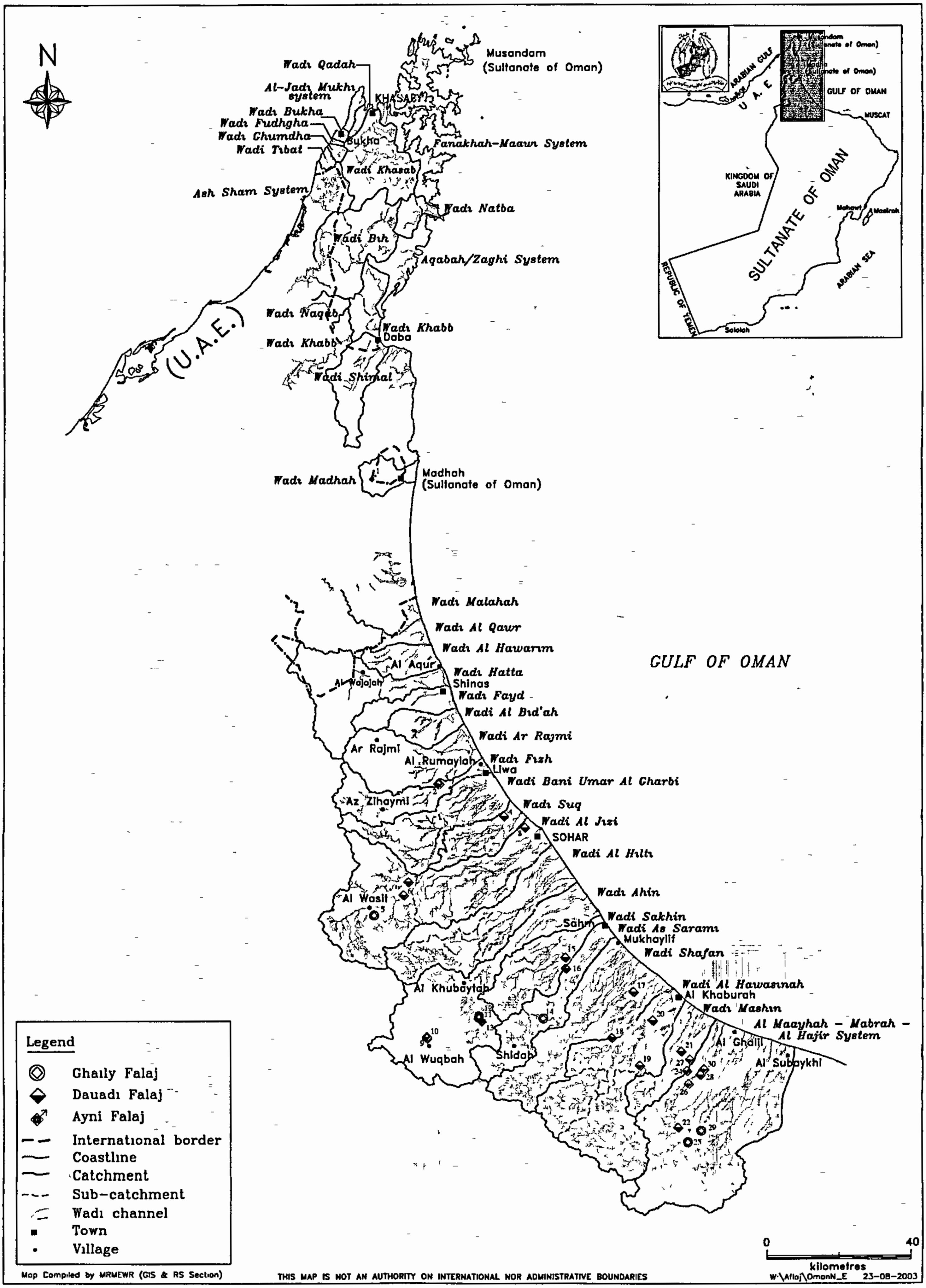
Introduction

The Ministry of Regional Municipalities & Environment and Water Resources is concerned with the orderly development of water resources in the Sultanate of Oman and its conservation in coordination with other ministries and government units. To this end, it is necessary to collect, analyze, compile, store, and publish information on falaj flows that can be used in undertaking research, and analyses, aimed at addressing water and water related issues in the Sultanate. The data in this report are the result of the operation of a network of falaj gauging stations that have been strategically located to establish a base of information on falaj flow. The data presented herein will help water managers, government ministries, and private entities make informed decisions about utilization and conservation of water resources.

Falaj flows are a substantial proportion of the groundwater discharge in most major drainage basins in Oman Assessment of water resource availability in these basins requires estimates of falaj flows, based on monitoring data. The variation of falaj water quality can give valuable information about regional hydrology and it can have social and public health implications

A major purpose for monitoring aflaj is to provide a scientific basis for identifying and quantifying important changes or long term trends in falaj flow and water quality. Long term downward trends in falaj flows or water quality can be critical for falaj communities. Advanced warning can provide time to plan measures to overcome such problems

This report is one of a series of seven, which compiles discharge and water quality data monitored at selected aflaj by various governmental and other agencies in the Sultanate of Oman since systematic monitoring began. The reports are presented in the following volumes: 1 - Muscat, 2 - South Batinah; 3 - North Batinah and Musandam; 4 – Ad' Dhahirah, 5 – Ad' Dakhliyah; 6 – As' Sharqiyah; 7 - Dhofar. Map 1 is showing falaj monitoring stations in the North Batinah & Musandam Assessment area



MAP 1 : LOCATION OF AFLAJ STATIONS AT BATINAH NORTH & MUSANDAM

Table 1. Falaj gauging station index to Map 1, North Batinah & Musandam Area

Number on Map	Station No	Station Name	Page No
1	CB996855AB	Falaj Mahdha at Mahdha	20
2	DN413005AB	Falaj Al Murabbah at Al Murabbah	26
3	DN413037AB	Falaj Al Awa'hin at Al Awa'hin	31
4	DC600173AB	Falaj Al Qabail at Falaj Al Qabail	36
5	DM275523AB	Falaj Al Wasit at Al Wasit	45
6	DM373955AB	Falaj Al Khan at Al Khan	49
7	DB384269AB	Falaj Suhailah at Suhailah	55
8	DB696852AB	Falaj Al Awhi at Al Awhi	61
9	DB349082AB	Falaj Al Baidha at Al Waqbah	68
10	DB349095AB	Falaj Al Hail at Al Waqbah	71
11	DM544619AB	Falaj Hail at Hail Nseel	74
12	DM544636AB	Falaj Al Hijjal at Al Hijjal	79
13	DM544498AB	Falaj Hibi at Haibi	86
14	DM741678AB	Falaj Hail Rasah at Hail Rasah	93
15	DB767284AB	Falaj Al Harth Near Saham	99
16	DB757972AB	Falaj Al Rawdah at Al Rawdah	106
17	DB957411AB	Falaj Al Hijari at Al Hijari	112
18	DB940051AB	Falaj Al Diqal at Diqal	119
19	DB938244AB	Falaj Al Ghuzayn at Al Ghuzayn	126
20	EB042429AB	Falaj Al Qasf at Al Qasf	134
21	EB130602AB	Falaj Bani Rabiah at Bani Rabiah	141
22	EM019505AB	Falaj Bidat at Bidat	149
23	EM111210AB	Falaj Hail Al Gharbi at Hail Haylayn	153
24	EB131026AB	Falaj Al Khizam at Al Khizam	157
25	EM111178AB	Falaj Hail Al Sharqi at Haylayn	164
26	EB121783AB	Falaj Al Qulayyah at Al Qulayyah	168
27	EB132329AB	Falaj Al Fardah at Al Fardah	175
28	EB124974AB	Falaj Al Sih'hah at Al Sih'hah	181
29	EM113497AB	Falaj Al Mabrah at Al Mabrah	186
30	EB136121AB	Falaj Mashayiq at Mashayiq	190

DESCRIPTION OF FALAJ GAUGING STATION OPERATION

Location of Gauging Site

The measuring point of a falaj is ideally located at the first opening from the mother well, where the channel is straight, uniform and far away from any human disturbances, so that the relationship of discharge to stage is not affected Not all of the first openings of aflaj are located far away from human disturbances, since some are located near villages, where the relationship of discharge to stage is sometimes not satisfactory. In a falaj where current meter measurements are made, there should be a fixed measuring point, a benchmark, and a staff gauge. Regularly scheduled visits, generally at monthly intervals, are made to the falaj sites to take measurements

Falaj Stage Discharge Relationships

It is generally not advisable to assume a stage-discharge relationship in a falaj due to changes in the hydraulics brought by human activities mainly associated with water division and use. It's necessary that a reference mark is established to allow a measurement to water surface to obtain the gauge height

Assessment of Data

The assessment of data quality includes rigorous checks on the field data wherever this is possible. It's necessarily to keep in mind that as discharges given are for a particular time (snapshot concept), therefore a simple linear relationship cannot be assumed between the observations and the data sets presented must be seen simply as a series of discharges, at particular times, for set locations, which provide a time-series of discharges. Also, falaj discharge records may be affected by falaj support from pumped wells, or diversion of flow. In addition, during droughts falaj communities may try to increase the efficiency of their falaj by clearing the channels, extending the Motherwell, etc., as well as utilizing an active program of falaj reconstruction The result is that some increases or decreases in discharge are not responses to climatic factors alone

Unfortunately, historic data poses a particular problem where there is no documentation regarding the conditions under which measurements were taken, leading to uncertainty in the quality of the data. Also the float method of velocity estimation and poorly observed stage readings led to wide error bounds

Generally, as the length of falaj records increases and quality control procedures become routine, then greater confidence in the record set should be expected

AFLAJ FLOW RECORDS

The falaj flow records published in this report are collected from falaj gauging stations located in the North Batinah & Musandam assessment area for the period of record ending 30 September 2002

Station Identification Numbers

Each gauging station is assigned a unique identification number. The station-numbering system is based on the Universal Transverse Mercator (UTM) grid printed on all Ministry of Defense (MOD) 1:100,000 and 1:250,000 scale maps The coordinates of the station are determined to the nearest 100 meters (m) and converted into the station identification number. The coordinates mark the southwest corner of each successive smaller square. The 100 m square identified by UTM coordinates 04143E 28859N is used in figure 1 as an example

The site location part of the number is DP184539. The letters DP are printed on the maps and identify the 100-km square containing the site. The 18 identifies the 10 km square within the 100 km square (figure 1A), 45 identifies the 1 km square within the 10 km square (figure 1B), and 39 identifies the 100 m square within the 1 km square (figure 1C).

The addition of a two-letter suffix (AB, in this example) completes the site-identification number. The letter A uniquely identifies the site within the 100-m square. In case of a station having more than one falaj gauge, the gauge installed first is given the letter A, the second B, and so on. The last letter identifies the type of data collected at the station In the example given, the B designates that it is a falaj station. Letters used in identifying the types of stations are as follows.

A - well	D - wadi
B - falaj	E - lake
C - spring	F - rainfall

The station-identification number should not be used to convert back to a geographical location The UTM grid is subject to change on MOD maps, whereas the station identification number will not change, even if the MOD grid changes

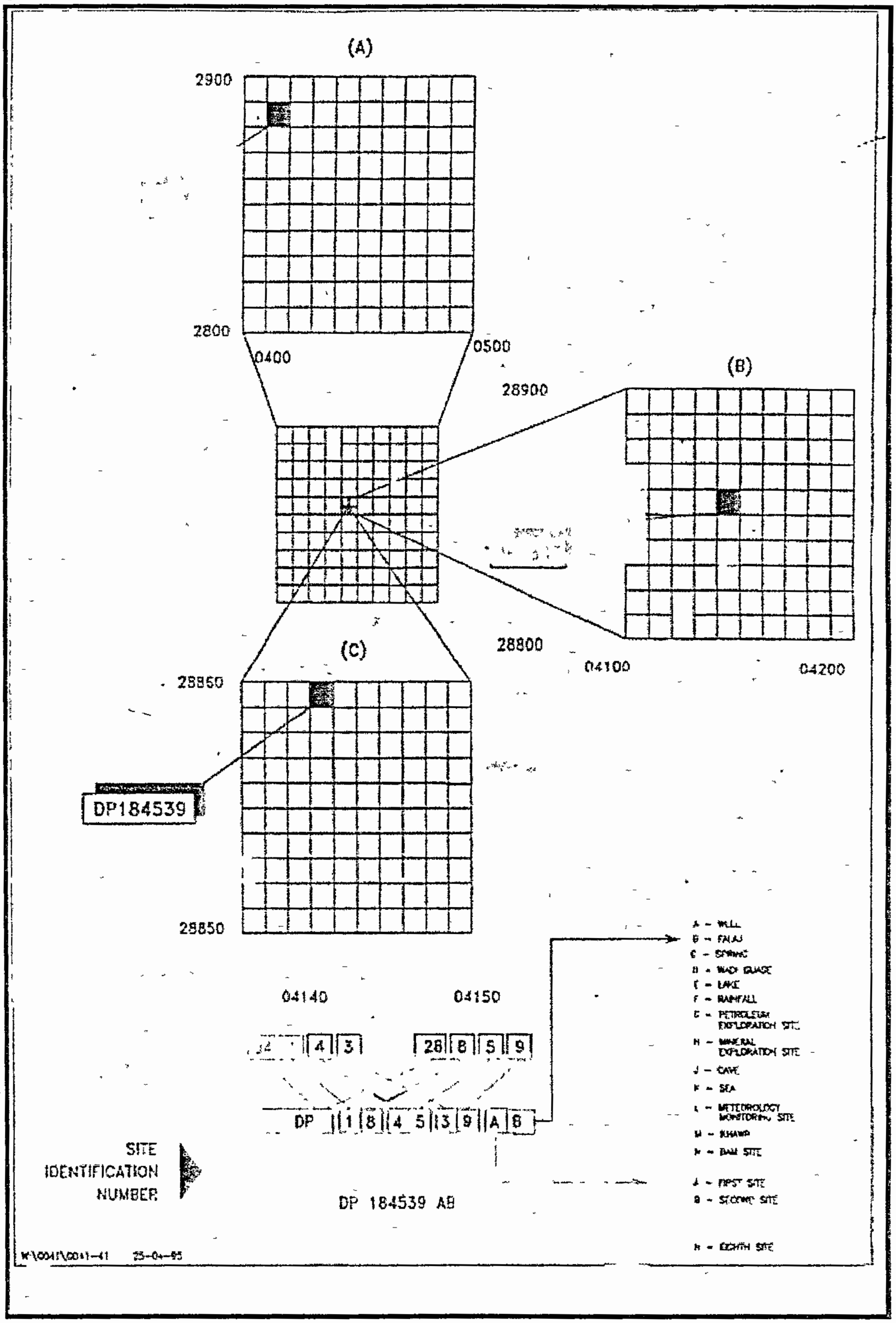


Figure 1 Site identification number design

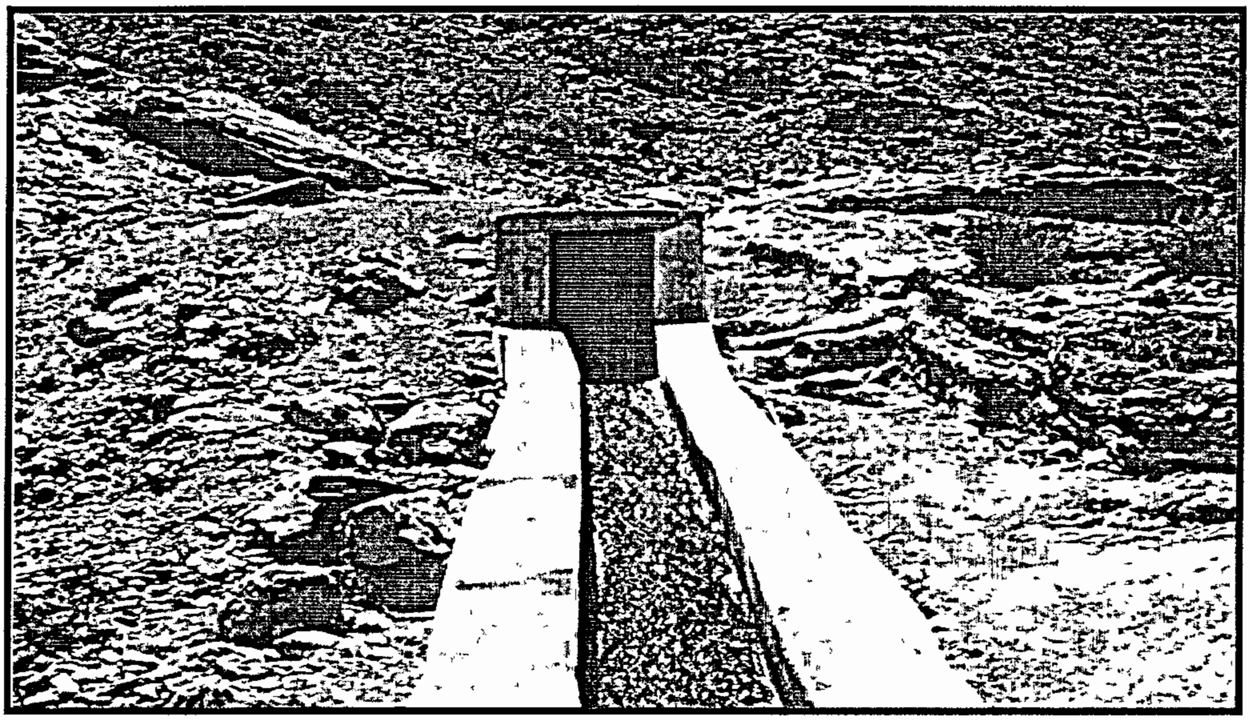


Figure 2 : The first opening :Discharge measurements are made in the vicinity of the first opening.

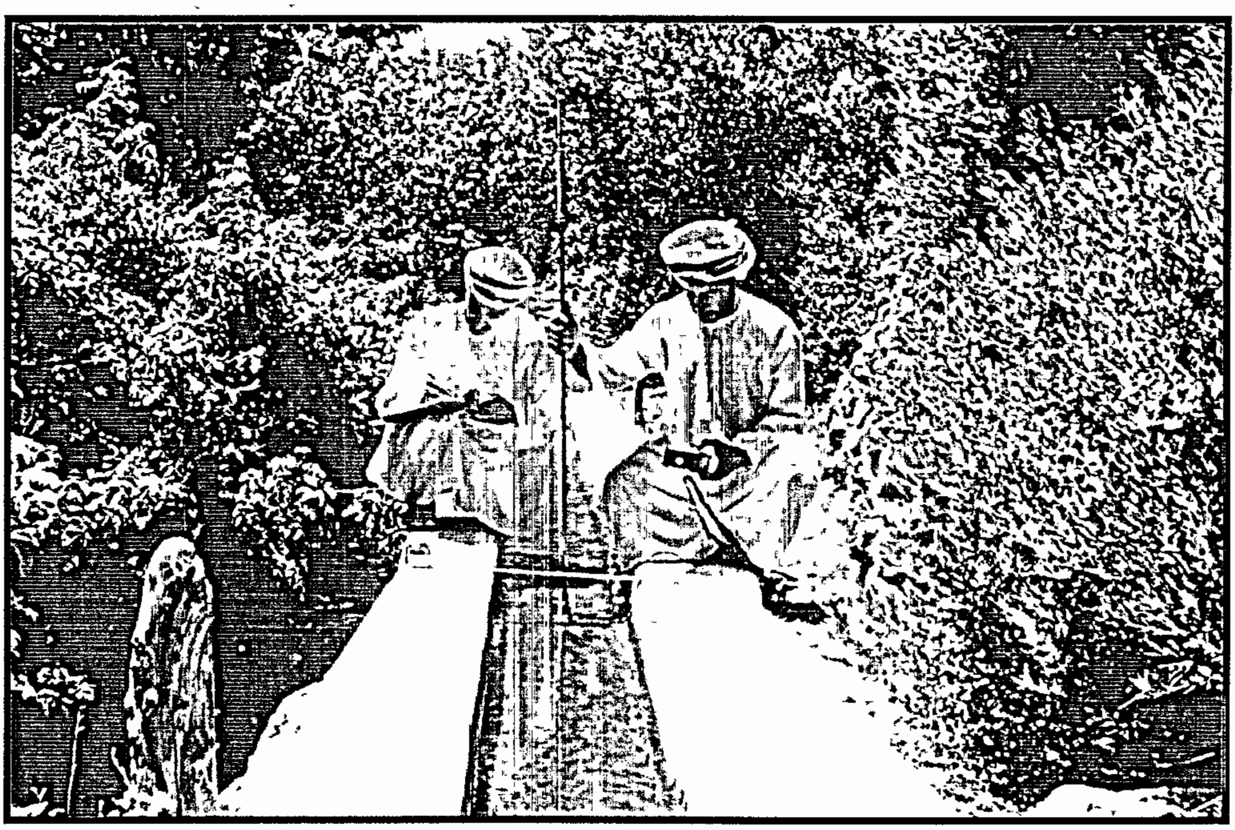


Figure 3 : A discharge measurements being carried out with a Pygmy meter.

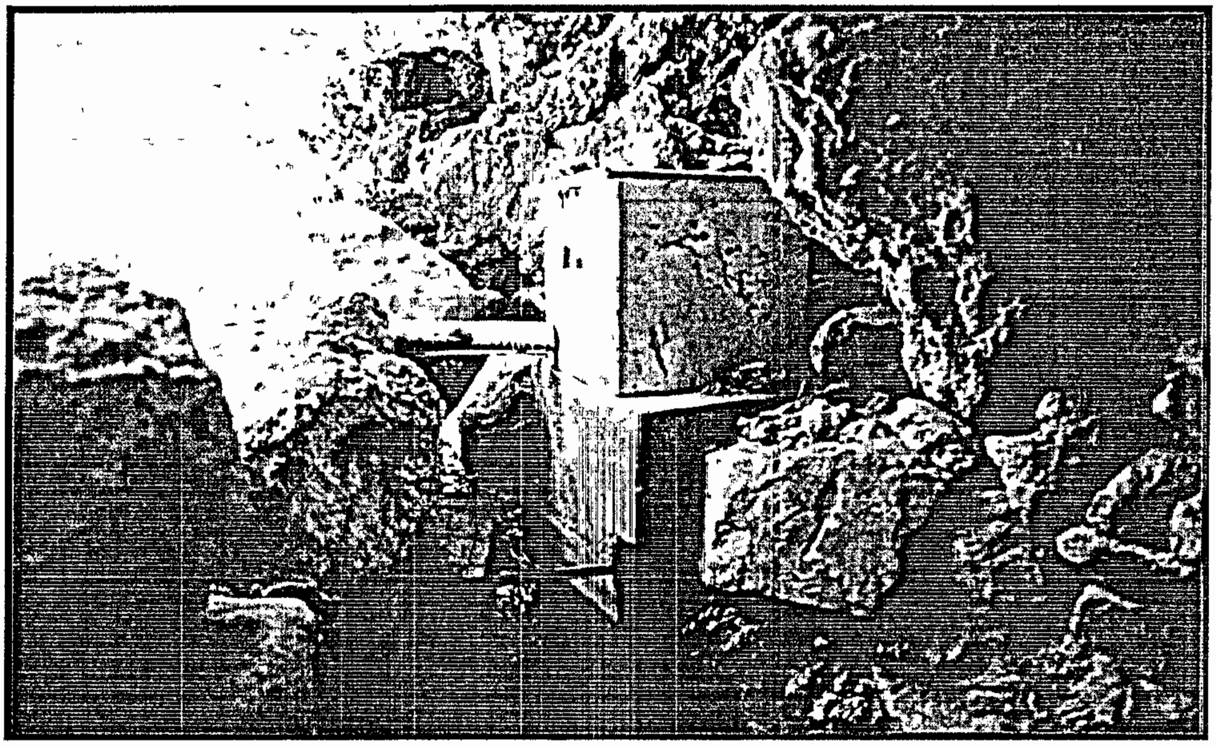


Figure 4 : A small flume measurng discharge on Al Ayn spring At Saiq (Jabal Al Akhdar).

Figure 5 : The continuous water level data logger on the Al Ayn spring.

AFLAJ RECESSION - A SIMPLE MODEL

In a no rain period falaj flow could be expected to recede exponentially at a rate dependent upon the aquifer parameters (in the case of wadi through flow - the wadi through flow parameters) based on an assumption of Darcian flow.

An equation of the form: - $Q_t = Q_0 e^{-\alpha t}$ is appropriate for this type of flow recession

Where: Q_0 = Discharge at starting time
Q_t = Discharge at finish time.
t = Time between start and finish.
α = The coefficient of depletion

Start and finish times refer to arbitrary points selected on the recession curve, or "snapshot" gauging taken "t" days apart during a no-rain period. The model is only suitable for non-pump supported aflaj and aflaj with mother wells in homogeneous source rocks or wadi gravels. The model can be used to predict the likely discharge from a falaj in the future and therefore should find use in the management of water resources. For example: On a particular falaj discharges have been recorded on the falling limb of a hydrograph 30 days apart (t = 30 days), a discharge of 100 l/sec. was recorded after a period of 10 days without rain (Q_0 = 100 l/sec). Another discharge, this time of 50 l/sec, was recorded after a continuous period of 40 days without rain (Q_t = 50 l/sec.) What is the likely discharge after 120 days, 200, 250, 300, and 365 days without rain?

Solution

First Calculate α, the coefficient of depletion, from $Q_t = Q_0 e^{-\alpha t}$ given that

$$Q_0 = 100 \text{ l/sec.}$$
$$Q_t = 50 \text{ l/sec}$$
$$t = 30 \text{ days}$$
$$\therefore \quad 50 = 100\, e^{-\alpha 30}$$
$$\ln(50/100) = -\alpha 30$$

$\therefore$ α = 0 023104 The depletion curve equation for this example is . $Q_t = Q_0 e^{-0\ 023104t}$

To calculate the expected discharge after 120 days without rain:

$$Q_t = Q_0 e^{-0\ 023104*110} \cong 8 \text{ l/sec.}$$

Similarly.

		Q_t(l/sec)
After	200 days	1.20
	250 days	0.40
	300 days	0 10
	365 days	0 03

DATA PRESENTATION

Falaj flow records for the Nouth Batinah & Musandam Assessment area are published in this report The records published for each gauging station consist of two parts, the manuscript or station description and data tables for the period of record through the 2002 hydrologic year (ends 30 September 2002) in addition to data tables for water quality results for each falaj. The accuracy of these results depends on the instrument calibrations and the analytical methods applied. The manuscript provides, under various headings, descriptive information, such as station location; period of record measured extremes and remarks.

HYDROLOGIC YEAR

It is desirable to treat annual rainfall, wadi and falaj data on a hydrologic year basis in order to avoid the division of the rainy or flood season between successive calendar years. Therefore, the end of the hydrologic year should coincide with the time when basin natural recharge is most often at an annual minimum, avoiding correction for carry-over storage.

The choice of the end of the hydrologic year in Oman was based on rainfall records, assuming that the period of minimum basin and aquifer storage coincides with that of the minimum rainfall. An examination of the average monthly rainfall data for long term stations shows that September is generally the driest month in Oman. Therefore, 01 October to 30 September was selected as the hydrologic year for presentation of aflaj flow data For one part of the Sultanate, the Salalah Governorate with a very different climatic regime the optimum hydrologic year is different, and coincides there with the calendar year.

DEFINITION OF TERMS

Terms relating to the preparation and publication of data in this report are defined below.

Control of Flow in an open channel means the establishment of a definitive flow condition in the channel to give a relationship between stage and discharge. The control section controls the flow in such a way that it restricts the transmission of the effect of changes in flow condition either in upstream direction or in a downstream direction The slope of falaj channels can be mild (subcritical), critical, and steep (supercritical). In the case of mild (subcritical) flow control is exercised downstream, in the case of critical and steep (supercritical) flow control is exercised upstream. The control feature may be a natural constriction of the channel, artificial structures such as weirs or flumes, or a uniform cross-section over a long reach of channel.
Most aflaj have mild (sub-critical) slopes, however some mountain aflaj have steep (supercritical) slopes

Current Meter Measurement is an accurate measurement of discharge at a site using an instrument called a current meter to measure the falaj velocity. Both the cross-sectional area and velocity distribution are determined by a sampling method of measuring depth and velocities at a number of points across the falaj channel from which incremental flows are calculated and summed to give total discharge.

Continuous Record Station is a particular station where falaj stage data are collected by means of an automatic recorder. A theoretical relationship for a control structure (weir, or flume) or a stage -discharge relationship, discharge being established by current meter, relates stage to discharge either There are no continuous recorders listed in this report.

Discharge is the volume of water that passes a given point (gauging station) in the falaj within a given period of time. For this report, discharge is presented in liters per second

Float Gauging is a method of obtaining the mean velocity in a falaj by timing floating objects over a known distance This is an approximate method.

Gauge is a device or combination of devices used to record the stage of the water surface in aflaj.

Gauge Datum is an arbitrary horizontal plane (datum) selected at each gauging station to which all gauge heights are referenced, and is for the convenience of using gauge heights of relatively low readings for operating purposes. Once established, this datum must be maintained for the life of the site, and gauges are periodically checked to maintain the same datum.

Gauge Height is the water-surface elevation referred to some arbitrary datum (gauge datum) Gauge height is often used interchangeably with the more general term "stage", although gauge height is more appropriate when used with a reading on a gauge.

Gauging Station is a particular site on a wadi or a falaj where systematic observations of hydrologic data are obtained

Hydrologic Year is the 12-month period beginning 01 October and ending 30 September. The hydrologic year is designated by the calendar year, in which it ends, and includes 9 of the 12 months (January through September) of that calendar year. Thus, the year ending 30 September 1990 is called the "1990 hydrologic year". See section "Hydrologic Year" for more information.

Partial-record Station is a particular site where limited falaj flow data are collected systematically over a period of years for use in hydrologic analysis. Most records in the falaj data set are from partial-record stations usually measured on a monthly basis.

Rating Curve is a line defined by a stage-discharge relationship based on measurements of flow and stage and is normally plotted on a paper with rectilinear and log coordinate scales. Each rating curve is unique for each gauging station and is subject to revision with any physical change in falaj-channel control conditions

Stage-discharge Relation (rating curve) is the relation between gauge height (stage) and the volume of water, per unit of time, flowing in a channel. Stage-discharge relations are based on measurements of stage and discharge in the field and some technique to average these measurements.

Aflaj are subject to human disturbances during the water conveyance and distribution phases; maintenance is necessary, changes in cross-sectional area may be made to improve conveyance or remove the build-up of bed-load or algae.
A falaj is a "living" system, in constant use, and this presents special problems in the interpretation of data. Consequently stage-discharge relationships are not readily available, unless the station is located outside these influences

OTHER PUBLICATIONS

There are numerous books and reports which document aspects of aflaj in Oman. Various agencies and consultants carried out most of this work. The Ministry of Regional Municipalities & Environment and Water Resources (and its predecessors) continued to monitor many stations set up by them. The listing given here is not exhaustive Many of the reports may not now be readily available and advice should be sought from the Ministry of Regional Municipalities & Environment and Water Resources about this.

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- SALIM BIN MOHAMED AL BEHLANI, National Health Survey, Dec. 1986 to May 1987, Ministry of Health, Oman
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WATER QUALITY NOTES

Introduction

These notes have been prepared to assist in the understanding of water analysis results contained ın this report.

The principal features of water qualıty in aflaj may be considered ın three main groups -- physıcal, chemical, and biological Only physical and chemical features are considered here. Under the auspice of H.E the Mınister of Health, the National Inter- Ministerial Technical Committee for Water Supply and Sanitation were charged with the task of evaluating the environmental health condıtions and the quality/quantity of drınking water supply in selected regions of Oman. Thıs survey, inter alia, covered many bacterıological qualities of water in aflaj. The Committee reported in June, 1987; (21)

Water qualıty is affected by point and non-point sources of contaminants, which are dependent on spatially distributed attributes of the surface water catchments and aquifers. Some of these attributes are natural, for example, ground waters tend to be rich in mınerals dependent upon theır host geology. Dolomite areas produce Mg/HCO_3 rich waters, limestone Ca/HCO_3 and ophiolitic areas Na/Cl rich water, all of which are subject to modıficatıon on contact with the atmosphere and the receiving waters. Other attributes are introduced by human activities, for example, domestıc and farming practices introduce phosphates, nitrates, pestcides, herbicides and bacteriological contaminants The latter from the traditional use of falaj water for washing and from wind-borne dust, which may contain faecal bacterıa blown from adjacent gardens which, are often used as latrines. Another source is from faulty septic and holdıng tank septage leakage. Because contaminants are transported by runoff to surface water and by ınfiltration and deeper percolation to groundwater, hydrologic processes are often at the core of water quality concerns

A major ındıcator used in water resources analyses is electrıcal conductıvity (EC), which indıcates the degree of salinity in any sampled aquifer or falaj source Upward trends in EC warn of deteriorating water qualıty

The tabulated results in the report are arranged in the order of major anions (positıvely charged ions e.g. Ca^{++}) and major cations (negatively charged ions e.g Cl^-), then some minor components, dissolved gases and finally some physical components.

Water Quality Measurement and Analysis

Physical Features. Some of the physical measurements, such as water temperature and electrıcal conductivity (EC), are carried out ın the field at the time of sampling; for others more sophisticated laboratory methods are necessary.

Chemical Features. Although there are instruments to measure some chemical properties dırectly, for example the pH meter, most measures of the chemical contents of water must be made by laboratory analyses of samples. The analytical methods may be grouped under four headings· titrimetric, colorimetric, spectral and potentiometrıc.

ACKNOWLEDGMENTS

The Ministry of Regional Municipalities & Environment and Water Resources acknowledges all individuals who participated in the preparation of this report

FALAJ FLOW RECORDS

VOLUME 3

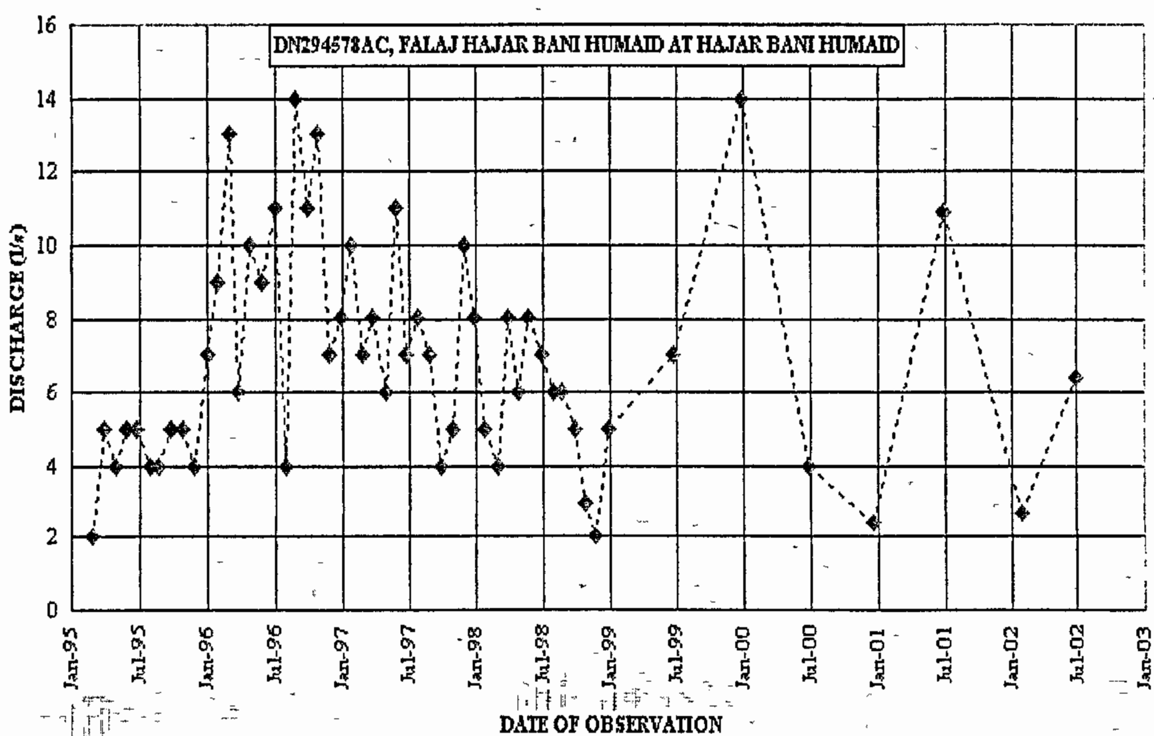
NORTH BATINAH & MUSANDAM ASSESSMENT AREA

1983-2002

WADI MADHA BASIN
DN294578AC, AIN HAJAR BANI HUMAID AT HAJAR

LOCATION

UTM	424607 E, 2795847 N
LATITUDE	25° 16' 37"
LONGITUDE	56° 15' 04"
FALAJ TYPE	Ainy
PERIOD OF RECORD	February 1995 to September 2002
REMARKS	55 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 14 l\s, 27 December 1999 Minimum measured discharge, 2 l\s, 26 February 1995



WADI MADHA BASIN
DN294578AC, AIN HAJAR BANI HUMAID AT HAJAR
DISCHARGE MEASUREMENTS, Feb 1995 to Jun 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
26-02-95	2	541	30 0	23 0
26-02-95	2	541	30 0	23 0
27-03-95	5	533	30 5	23 1
27-03-95	5	533	30 5	23 1
29-04-95	4	530	24 5	31 1
29-04-95	4	530	24 5	31 1
28-05-95	5	560	31 7	33 5
28-05-95	5	560	31 7	33 5
25-06-95	5	531	32 1	35 4
25-06-95	5	531	32 1	35 4
29-07-95	4	529	32 3	32 0
29-07-95	4	529	32 3	32 0
20-08-95	4	531	32 0	37 6
20-08-95	4	531	32 0	37 6
24-09-95	5	534	32 0	29 4
24-09-95	5	534	32 0	29 4
24-10-95	5	535	31 3	26 7
24-10-95	5	535	31 3	26 7
26-11-95	4	--	--	--
26-11-95	4	--	--	--
31-12-95	7	524	30 8	23 5
31-12-95	7	524	30 8	23 5
30-01-96	9	526	30 4	22 4
30-01-96	9	526	30 4	22 4
28-02-96	13	528	30 5	22 7
28-02-96	13	528	30 5	22 7
25-03-96	6	527	31 0	--
25-03-96	6	527	31 0	--
23-04-96	10	537	31 5	27 4
23-04-96	10	537	31 5	27 4
26-05-96	9	543	31 9	37 6
26-05-96	9	543	31 9	37 6
30-06-96	11	542	31 7	37 5
30-06-96	11	542	31 7	37 5
27-07-96	4	788	--	36 0
27-07-96	4	788	--	36 0
26-08-96	14	600	31 9	33 1
26-08-96	14	600	31 9	33 1
28-09-96	11	545	31 8	30 0
28-09-96	11	545	31 8	30 0
26-10-96	13	534	31.5	24 9
26-10-96	13	534	31 5	24 9
25-11-96	7	535	31 0	22 5
25-11-96	7	535	31 0	22 5
28-12-96	8	530	30 8	23 6
28-12-96	8	530	30 8	23 6
25-01-97	10	581	28 6	20 5
25-01-97	10	581	28 6	20 5

WADI MADHA BASIN
DN294578AC, AIN HAJAR BANI HUMAID AT HAJAR
DISCHARGE MEASUREMENTS, Feb 1995 to Jun 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
24-02-97	7	540	31 1	25 0
24-02-97	7	540	31 1	25 0
23-03-97	8	533	30 6	23 0
23-03-97	8	533	30 6	23 0
30-04-97	6	540	31 1	28 2
30-04-97	6	540	31 1	28 2
25-05-97	11	560	31 6	39 4
25-05-97	11	560	31 6	39 4
25-06-97	7	512	31 7	32 5
25-06-97	7	512	31 7	32 5
27-07-97	8	538	31 9	31 4
27-07-97	8	538	31 9	31 4
26-08-97	7	540	31 9	33 7
26-08-97	7	540	31 9	33 7
27-09-97	4	540	32 0	31 9
27-09-97	4	540	32 0	31 9
29-10-97	5	560	31 5	28 5
29-10-97	5	560	31.5	28 5
30-11-97	10	550	32 3	27 3
30-11-97	10	550	32 3	27 3
28-12-97	8	547	30 7	21 2
28-12-97	8	547	30 7	21 2
24-01-98	5	--	--	--
24-01-98	5	--	--	--
28-02-98	4	557	--	--
28-02-98	4	557	--	--
29-03-98	8	547	31 4	27 4
29-03-98	8	547	31 4	27 4
25-04-98	6	571	31 5	28 0
25-04-98	6	571	31 5	28 0
24-05-98	8	549	31 7	32 0
24-05-98	8	549	31 7	32 0
28-06-98	7	550	33 8	43 0
28-06-98	7	550	33 8	43 0
29-07-98	6	562	--	41 2
29-07-98	6	562	--	41 2
23-08-98	6	535	31 7	30 3
23-08-98	6	535	31 7	30 3
29-09-98	5	542	32 3	34 5
29-09-98	5	542	32 3	34 5
26-10-98	3	630	33 4	36 6
26-10-98	3	630	33 4	36 6
23-11-98	2	720	--	35 1
23-11-98	2	720	--	35 1
26-12-98	5	544	31 2	26 3
26-12-98	5	544	31 2	26 3
23-06-99	7	540	31 9	35 7

WADI MADHA BASIN
DN294578AC, AIN HAJAR BANI HUMAID AT HAJAR
DISCHARGE MEASUREMENTS, Feb 1995 to Jun 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
23-06-99	7	540	31 9	35 7
27-12-99	14	600	31 0	25 0
27-12-99	14	600	31 0	25 0
26-06-00	4	530	32 3	--
26-06-00	4	530	32 3	--
18-12-00	2	530	--	--
18-12-00	2	530	--	--
26-06-01	11	523	32 3	33 3
26-06-01	11	523	32 3	33 3
30-01-02	3	566	30 9	25 2
30-01-02	3	566	30 9	25 2
30-06-02	6	394	32 3	30 0
30-06-02	6	394	32 3	30 0

WADI MADHA BASIN
DN294578AC, AIN HAJAR BANI HUMAID AT HAJAR
WATER QUALITY DATA, Apr 1994 to Dec 2000

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
25-04-94	130	--	3 27	63	0 10	--	0 3	49
31-12-95	112	--	0 10	60	0 19	--	1 1	46
28-09-96	135	--	--	59	0 10	--	0 4	50
28-12-96	133	--	--	61	0 10	--	0 4	41
28-12-97	137	--	--	64	0 10	--	0 4	42
25-04-98	131	--	--	64	0 10	--	0 5	42
26-12-98	140	--	--	61	0 10	--	0 5	45
23-06-99	126	--	--	62	0 10	--	0 5	45
26-06-00	137	--	--	61	0 10	--	0 5	35
18-12-00	117	--	--	54	0 10	--	2 1	71
Mean	**130**	**--**	**1.69**	**61**	**0.11**	**--**	**0.7**	**47**
Min	**112**	**--**	**0.10**	**54**	**0.10**	**--**	**0.3**	**35**
Max	**140**	**--**	**3.27**	**64**	**0.19**	**--**	**2.1**	**71**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
25-04-94	23	0 04	4 3	0 1	22	0 03	43	--
31-12-95	19	0 05	2 1	-0 4	34	0 05	32	--
28-09-96	19	0 05	2 0	0 1	33	0 05	40	--
28-12-96	18	0 05	2 2	0 3	33	0 05	42	--
28-12-97	22	0 05	2 3	0 3	33	0 05	42	--
25-04-98	19	0 05	2 4	0 0	34	0 05	42	--
26-12-98	18	0 05	2 6	0 2	33	0 05	43	--
23-06-99	19	0 05	2 4	-0 4	35	0 05	41	--
26-06-00	16	0 05	2 2	-1 6	30	0 05	37	--
18-12-00	15	0 07	2 8	-0 4	37	0 05	41	--
Mean	**19**	**0 05**	**2.5**	**-0.2**	**32**	**0.05**	**40**	**--**
Min	**15**	**0 04**	**2.0**	**-1.6**	**22**	**0.03**	**32**	**--**
Max	**23**	**0 07**	**4.3**	**0.3**	**37**	**0.05**	**43**	**--**

WADI MADHA BASIN
DN294578AC, AIN HAJAR BANI HUMAID AT HAJAR
WATER QUALITY DATA, Apr 1994 to Dec 2000

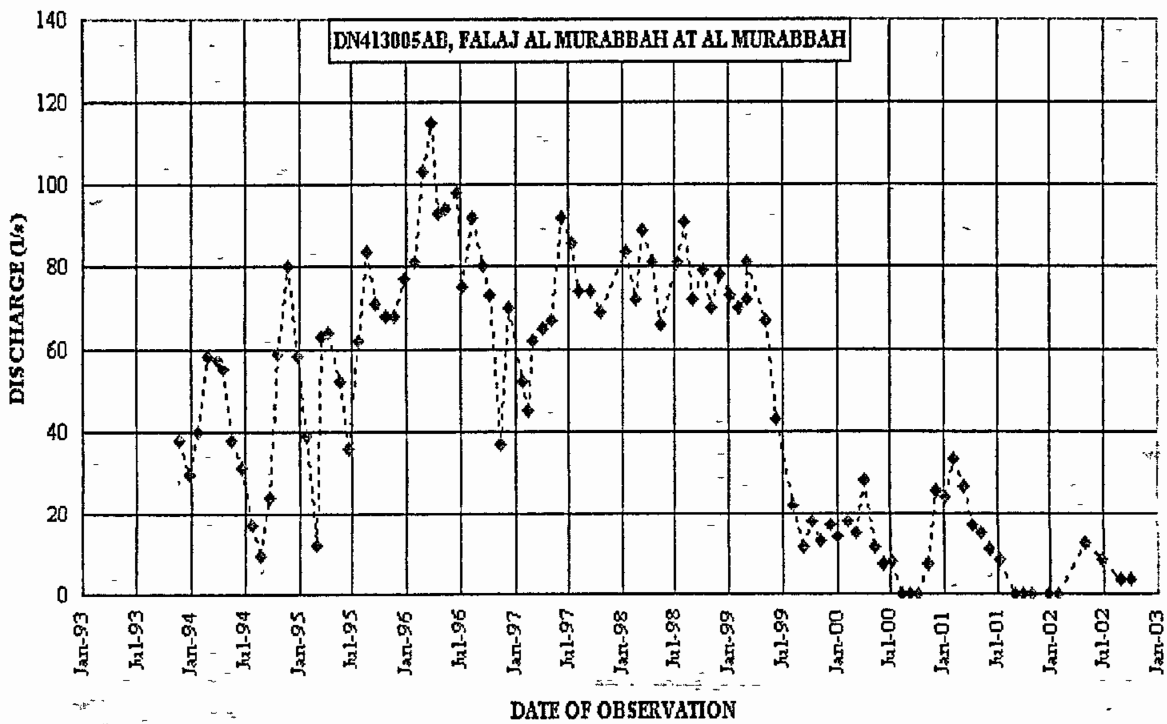
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
25-04-94	130	148	--	5	5	289	545	8 0
31-12-95	112	185	--	5	5	267	509	7 6
28-09-96	135	181	--	5	5	288	534	8 0
28-12-96	133	182	--	5	6	282	528	8 3
28-12-97	138	190	--	5	6	294	530	8 3
25-04-98	131	186	--	5	6	287	528	7 9
26-12-98	140	182	--	5	6	293	542	8 0
23-06-99	126	192	--	5	6	285	537	7 6
26-06-00	137	164	--	5	5	269	544	6 5
18-12-00	117	189	--	5	6	303	426	7 6

WADI FIZH BASIN
DN413005AB, FALAJ AL MURABBAH AT AL MURABBAH

LOCATION

UTM	442873 E, 2710539 N
LATITUDE	24° 30' 27"
LONGITUDE	56° 26' 10"
FALAJ TYPE	Daudi
PERIOD OF RECORD	January 1993 to September 2002
REMARKS	103 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 115 l\s, 25 March 1996 Minimum measured discharge, 4 l\s, 26 August 2002



WADI FIZH BASIN
DN413005AB, FALAJ AL MURABBAH AT AL MURABBAH
DISCHARGE MEASUREMENTS, Nov 1993 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
20-11-93	38	709	32 0	27 0
22-12-93	30	719	31 2	28 0
24-01-94	40	709	29 8	23 3
27-02-94	58	715	28 9	24 5
29-03-94	57	702	29 5	--
19-04-94	55	715	29 0	24 0
17-05-94	38	720	31 0	32 0
22-06-94	31	719	33 3	31 7
25-07-94	17	730	33 0	31 9
24-08-94	9	757	34 7	32 0
21-09-94	24	674	33 6	33 0
22-10-94	59	585	37 4	29 4
21-11-94	80	720	30 9	24 1
25-12-94	58	657	30 8	22 4
25-01-95	39	683	30 3	26 0
26-02-95	12	726	29 1	19 5
21-03-95	63	610	28 0	24 9
11-04-95	64	621	28 0	26 3
21-05-95	52	660	30 5	30 5
21-06-95	36	679	31 9	38 8
25-07-95	62	532	32 5	31 2
20-08-95	84	528	33 3	32 1
19-09-95	71	584	33 0	31 1
22-10-95	68	725	32 0	31 5
22-11-95	68	627	29 9	23 4
28-12-95	77	588	28 1	21 5
31-01-96	81	521	23 1	20 5
28-02-96	103	646	24 0	21 0
25-03-96	115	640	24 0	24 2
21-04-96	93	630	26 7	25 3
11-05-96	94	670	28 3	27 5
19-06-96	98	683	31 5	29 0
09-07-96	75	686	32 0	31 5
12-08-96	92	585	30 0	30 9
14-09-96	80	648	31 9	30 0
08-10-96	73	699	31 2	26 0
12-11-96	37	720	30 0	28 2
10-12-96	70	690	28 5	25 3
28-01-97	52	--	26 7	23 6
12-02-97	45	675	26 6	23 5
04-03-97	62	--	26 5	25 7
08-04-97	65	510	26 0	27 5
06-05-97	67	592	28 0	26 0
08-06-97	92	690	29 8	30 3
12-07-97	86	681	32 2	36 1
05-08-97	74	662	33 0	37 0
13-09-97	74	668	33 4	37 9
19-10-97	69	650	32 4	30 7
11-01-98	84	794	25 8	22 0

WADI FIZH BASIN
DN413005AB, FALAJ AL MURABBAH AT AL MURABBAH
DISCHARGE MEASUREMENTS, Nov 1993 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
15-02-98	72	500	24 7	23 6
14-03-98	89	637	23 5	24 1
12-04-98	81	716	26 7	34 6
12-05-98	66	751	28 2	24 1
12-07-98	81	693	32 4	32 7
03-08-98	91	746	33 1	35 0
01-09-98	72	710	33 4	31 7
03-10-98	79	750	32 9	32 2
04-11-98	70	757	31 8	28 2
02-12-98	78	755	30 3	31 2
02-01-99	73	760	29 3	29 8
02-02-99	70	744	27 6	24 2
01-03-99	72	812	28 2	30 7
04-03-99	81	791	25 9	28 9
05-05-99	67	785	30 5	33 1
07-06-99	43	786	31 8	32 8
04-08-99	22	796	33 0	34 2
07-09-99	11	799	33 3	35 5
06-10-99	18	771	33 1	33 9
07-11-99	13	770	32 0	29 2
11-12-99	17	510	32 0	27 0
05-01-00	14	780	31 0	25 0
07-02-00	18	776	30 0	22 0
06-03-00	15	760	30 0	28 0
05-04-00	28	775	30 1	36 1
07-05-00	11	776	31 0	34 0
07-06-00	7	740	32 4	--
08-07-00	8	730	32 3	--
07-08-00	--	785	32 8	33 3
06-09-00	--	820	31 3	36 0
07-10-00	--	--	--	--
07-11-00	7	770	32 4	328 4
09-12-00	26	750	32 2	26 9
07-01-01	24	773	31 6	23 0
04-02-01	33	797	30 4	24 5
11-03-01	26	730	29 7	--
08-04-01	17	793	26 9	30 0
06-05-01	15	800	31 2	37 0
03-06-01	11	817	32 0	36 0
08-07-01	8	818	32 9	38 3
27-08-01	--	858	33 3	29 6
25-09-01	--	--	--	--
29-10-01	--	835	34 0	32 6
25-12-01	--	--	--	--
27-01-02	--	--	--	--
29-04-02	12	737	31 3	35 2
25-06-02	8	740	33 6	37 0
26-08-02	4	752	34 6	34 0
29-09-02	4	742	33 5	36 0

WADI FIZH BASIN
DN413005AB, FALAJ AL MURABBAH AT AL MURABBAH
WATER QUALITY DATA, Jun 1995 to Dec 2000

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
21-06-95	168	--	--	86	0 10	--	1 0	43
19-09-95	154	--	--	67	0 10	--	1 0	47
28-12-95	143	--	0 09	61	0 12	--	1 0	51
14-09-96	154	--	--	74	0 10	--	1 6	69
10-12-96	163	--	--	80	0 10	--	1 4	64
12-07-97	145	--	--	76	0 13	--	1.1	64
04-08-97	152	--	--	75	0 10	--	1.1	57
12-04-98	147	--	--	80	0 13	--	1 1	86
02-12-98	195	--	--	86	0 10	--	1 0	78
07-06-99	165	--	--	99	0 10	--	0 7	87
07-06-00	173	--	--	112	0 10	--	0 8	63
09-12-00	166	--	--	100	0 10	--	0 9	59
Mean	**160**	**--**	**0.09**	**83**	**0.11**	**--**	**1.1**	**64**
Min	**143**	**--**	**0 09**	**61**	**0 10**	**--**	**0.7**	**43**
Max	**195**	**--**	**0.09**	**112**	**0.13**	**--**	**1.6**	**87**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
21-06-95	20	0 05	5 0	-0 2	43	0 05	49	--
19-09-95	21	0 05	2 4	-0 4	46	0 05	38	--
28-12-95	18	0 05	2 1	0 1	46	0 05	32	--
14-09-96	22	0 05	2 6	0 3	44	0 05	45	--
10-12-96	23	0 05	2 5	0 5	52	0 05	49	--
12-07-97	21	0 05	2 7	0 3	40	0 05	53	--
04-08-97	19	0 05	2 5	0 3	37	0 05	44	--
12-04-98	23	0 05	3 4	0 5	41	0 05	63	--
02-12-98	25	0 05	3 0	0 3	49	0 05	63	--
07-06-99	27	0 05	3 0	-0 2	53	0 05	66	--
07-06-00	26	0 07	2 7	-1 0	53	0 07	50	--
09-12-00	26	0 07	3 0	-0 6	54	0 06	48	--
Mean	**23**	**0.05**	**2.9**	**0.0**	**46**	**0.05**	**50**	**--**
Min	**18**	**0 05**	**2.1**	**-1.0**	**37**	**0.05**	**32**	**--**
Max	**27**	**0.07**	**5 0**	**0.5**	**54**	**0 07**	**66**	**--**

WADI FIZH BASIN
DN413005AB, FALAJ AL MURABBAH AT AL MURABBAH
WATER QUALITY DATA, Jun 1995 to Dec 2000

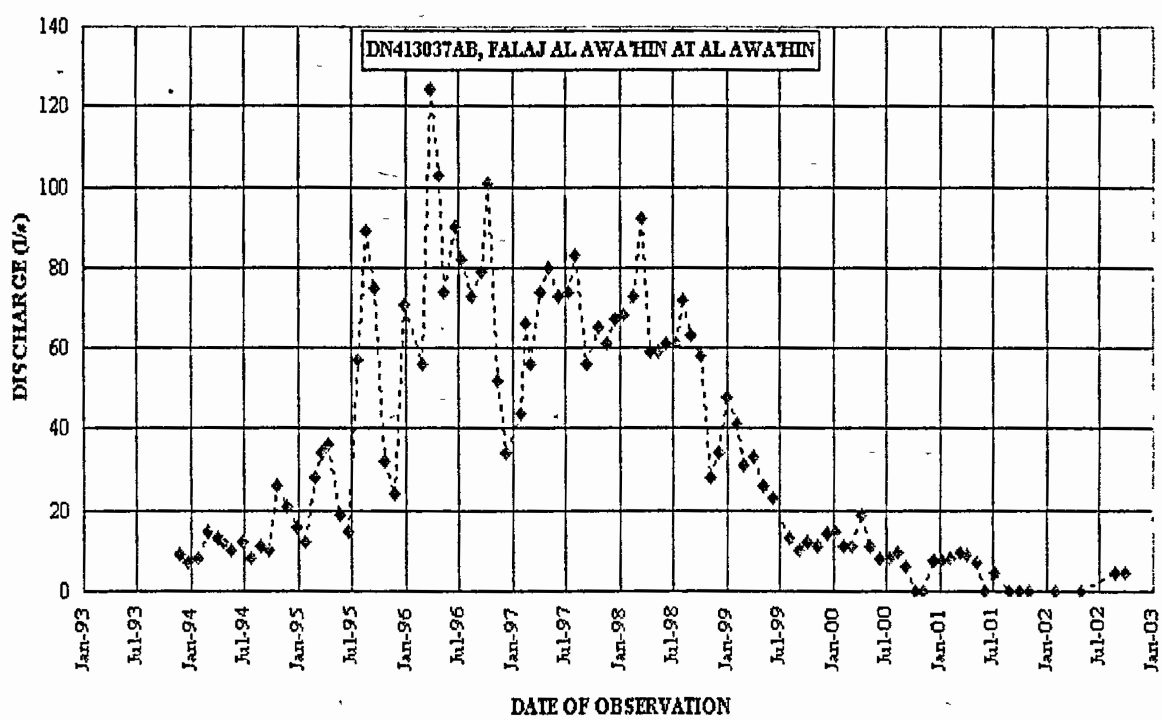
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
21-06-95	168	226	--	7	7	354	683	7.7
19-09-95	154	243	--	6	7	322	609	7.4
28-12-95	143	236	--	6	6	304	568	8.0
21-04-96	149	226	--	6	6	339	615	8.5
14-09-96	154	238	--	7	7	360	641	8.1
10-12-96	165	271	--	7	8	379	677	8.3
12-07-97	145	217	--	6	7	352	662	8.2
04-08-97	152	201	--	6	6	334	648	8.2
12-04-98	158	225	--	7	7	399	681	8.4
02-12-98	195	264	--	8	8	430	745	8.0
07-06-99	165	285	--	8	9	441	800	7.6
07-06-00	173	283	--	8	8	417	792	6.7
09-12-00	166	289	--	7	8	398	440	7.0

WADI FIZH BASIN
DN413037AB, FALAJ AL AWA'HIN AT AL AWA'HIN

LOCATION

UTM	443316 E, 2710610 N
LATITUDE	24° 15' 37"
LONGITUDE	56° 21' 28"
FALAJ TYPE	Daudi
PERIOD OF RECORD	January 1993 to September 2002
REMARKS	103 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 124 l\s, 25 March 1996 Minimum measured discharge, 5 l\s, 08 Jul 01 and 29 Sep 02



WADI FIZH BASIN
DN413037AB, FALAJ AL AWA'HIN AT AL AWA'HIN
DISCHARGE MEASUREMENTS, Nov 1993 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
20-11-93	9	732	33 0	28 5
22-12-93	7	745	31 2	25 5
24-01-94	8	732	29 2	24 5
27-02-94	15	816	28 7	26 0
29-03-94	13	735	28 8	--
19-04-94	12	810	29 0	27 0
17-05-94	10	760	31 5	33 0
22-06-94	12	763	33 3	33 1
23-07-94	8	760	--	--
24-08-94	11	724	33 4	34 0
21-09-94	10	703	34 3	34 0
22-10-94	26	660	31 9	31 3
21-11-94	21	814	30 2	27 5
25-12-94	16	689	29 8	25 8
25-01-95	12	712	29 0	25 7
26-02-95	28	701	30 1	23 6
21-03-95	34	661	26 3	25 5
11-04-95	36	661	26 5	25 6
21-05-95	19	710	30 2	36 5
21-06-95	15	709	32 3	43 8
25-07-95	57	565	32 9	29 0
20-08-95	89	558	33 5	37 2
19-09-95	75	586	32 8	31 4
22-10-95	32	756	31 5	31 0
22-11-95	24	638	28 3	25 6
28-12-95	71	603	--	19 3
28-02-96	56	653	24 1	21 5
25-03-96	124	688	24 6	25 1
21-04-96	103	780	29 9	42 3
11-05-96	74	680	28 9	30 7
19-06-96	90	721	31 7	31 3
09-07-96	82	734	32 9	32 0
12-08-96	73	626	33 6	36 1
14-09-96	79	696	33 3	30 9
08-10-96	101	710	31 5	26 1
12-11-96	52	713	29 4	25 6
10-12-96	34	720	26 5	24 3
28-01-97	44	740	24 2	22 3
12-02-97	66	714	25 0	23 3
04-03-97	56	--	25 1	24 3
08-04-97	74	540	26 8	26 4
06-05-97	80	640	28 0	30 0
08-06-97	73	780	30 7	29 4
12-07-97	74	759	32 6	35 2
05-08-97	83	775	33 8	29 8
13-09-97	56	755	33 5	31 4
19-10-97	65	730	31 4	32 7
16-11-97	61	742	32 6	29 8
13-12-97	67	850	26 1	19 9
11-01-98	68	913	24 7	19 1

WADI FIZH BASIN
DN413037AB, FALAJ AL AWA'HIN AT AL AWA'HIN
DISCHARGE MEASUREMENTS, Nov 1993 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
15-02-98	73	560	23 9	23 0
14-03-98	92	674	23 8	22 6
12-04-98	59	789	26 8	28 6
12-05-98	59	810	28 6	28 0
09-06-98	61	850	34 8	33 6
12-07-98	61	732	32 3	32 5
03-08-98	72	892	33 5	34 8
01-09-98	63	810	33 6	32 3
03-10-98	58	860	32 7	33 7
04-11-98	28	867	30 9	33 0
02-12-98	34	857	28 7	27 2
02-01-99	48	862	27 1	26 3
02-02-99	41	878	25 7	26 5
01-03-99	31	946	26 9	28 2
03-04-99	33	955	27 8	30 4
05-05-99	26	890	30 2	33 3
07-06-99	23	893	32 0	34 0
04-08-99	13	886	33 7	34 0
07-09-99	10	854	34 1	34 0
06-10-99	12	831	33 7	26 5
07-11-99	11	800	--	--
11-12-99	14	680	32 0	26 0
05-01-00	15	810	31 0	23 0
07-02-00	11	800	30 0	24 0
06-03-00	11	793	29 6	27 3
05-04-00	19	811	29 9	36 0
07-05-00	11	822	31 0	33 0
07-06-00	8	830	32 4	--
08-07-00	8	840	30 1	--
07-08-00	10	822	33 8	34 6
06-09-00	6	900	31 6	33 5
07-10-00	--	--	--	--
07-11-00	--	805	32 9	30 5
09-12-00	8	790	31 9	29 0
07-01-01	8	807	30 0	22 8
04-02-01	8	833	29 5	24 9
11-03-01	10	824	29 6	30 2
02-04-01	9	827	30 0	28 0
06-05-01	7	840	31 3	41 0
03-06-01	--	852	32 6	38 0
08-07-01	5	854	33 9	36 3
27-08-01	--	895	34 7	29 6
25-09-01	--	915	32 6	29 2
29-10-01	--	890	33 3	35 0
27-01-02	--	--	--	--
29-04-02	--	773	32 4	--
26-08-02	5	788	34 6	29 9
29-09-02	5	770	34 2	36 0

WADI FIZH BASIN
DN413037AB, FALAJ AL AWA'HIN AT AL AWA'HIN
WATER QUALITY DATA, Sep 1995 to Dec 2000

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
19-09-95	151	--	--	60	0 10	--	1 1	44
28-12-95	149	--	0 09	61	0 23	--	1 1	52
14-09-96	162	--	--	77	0 13	--	1 6	75
10-12-96	169	--	--	83	0 16	--	1 2	72
12-07-97	151	--	--	81	0 13	--	1 1	84
04-08-97	154	--	--	82	0 25	--	1 1	84
13-09-97	153	--	--	110	0 10	--	1 0	74
12-04-98	167	--	--	87	0 10	--	1 2	78
02-12-98	200	--	--	103	0 10	--	0 9	97
07-06-99	180	--	--	112	0 10	--	0 8	104
09-12-00	176	--	--	108	0 10	--	1 0	64
Mean	**165**	--	**0 09**	**88**	**0.14**	--	**1.1**	**75**
Min	**149**	--	**0 09**	**60**	**0.10**	--	**0.8**	**44**
Max	**200**	--	**0 09**	**112**	**0.25**	--	**1.6**	**104**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
19-09-95	18	0 05	2 2	-0 3	42	0 05	32	--
28-12-95	20	0 05	2 0	-0 1	48	0 05	32	--
14-09-96	25	0 05	2 6	0 4	47	0 05	51	--
10-12-96	24	0 05	2 4	0 3	50	0 05	52	--
12-07-97	24	0 05	2 8	0 3	41	0 05	62	--
04-08-97	23	0 07	2 9	0 4	41	0 05	63	--
13-09-97	25	0 06	3 0	0 4	43	0 05	69	--
12-04-98	24	0 05	3 6	0 3	41	0 05	72	--
02-12-98	27	0 05	3 0	0 2	48	0 05	82	--
07-06-99	33	0 05	3 2	0 0	55	0 05	80	--
09-12-00	29	0 06	2 9	-0 3	56	0 05	53	--
Mean	**25**	**0.05**	**2.8**	**0.1**	**47**	**0 05**	**59**	--
Min	**18**	**0 05**	**2.0**	**-0.3**	**41**	**0.05**	**32**	--
Max	**33**	**0.07**	**3 6**	**0 4**	**56**	**0 05**	**82**	--

WADI FIZH BASIN
DN413037AB, FALAJ AL AWA'HIN AT AL AWA'HIN
WATER QUALITY DATA, Sep 1995 to Dec 2000

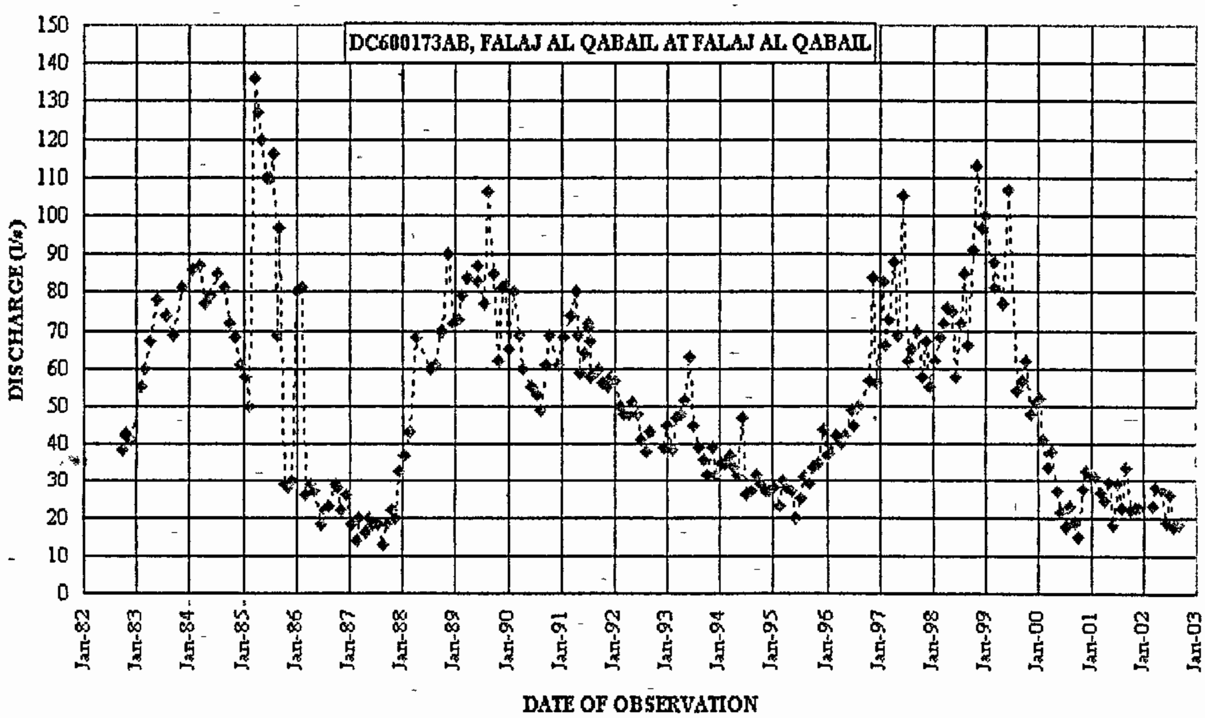
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
19-09-95	151	220	--	6	6	298	580	7.5
28-12-95	149	246	--	6	6	311	580	7.9
21-04-96	159	253	--	6	7	351	995	8.3
14-09-96	162	257	--	7	7	385	686	8.1
10-12-96	169	265	--	7	8	394	697	8.2
12-07-97	151	228	--	7	7	393	741	8.1
04-08-97	154	228	--	7	7	398	769	8.1
13-09-97	153	240	--	8	8	424	738	8.1
12-04-98	167	230	--	8	8	416	747	8.2
02-12-98	200	265	--	9	9	489	855	7.9
07-06-99	180	310	--	9	10	503	901	7.2
09-12-00	176	303	--	8	8	427	626	7.3

WADI SUQ BASIN
DC600173AB, FALAJ AL QABAIL AT FALAJ AL QABAIL

LOCATION

UTM	461029 E, 2701584 N
LATITUDE	24° 25' 38"
LONGITUDE	56° 36' 56"
FALAJ TYPE	Daudı
PERIOD OF RECORD	September 1982 to September 2002
REMARKS	230 measurements have been made at the sıte
MEASURED EXTREMES	Maxımum measured dıscharge, 136 l\s, 18 March 1985 Mınımum measured dıscharge, 13 l\s, 17 August 1987



WADI SUQ BASIN
DC600173AB, FALAJ AL QABAIL AT FALAJ AL QABAIL
DISCHARGE MEASUREMENTS, Sep 1982 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
26-09-82	39	885	35 0	--
12-10-82	42	--	--	--
13-10-82	43	--	--	--
25-11-82	41	880	32 0	--
30-01-83	55	--	--	--
05-03-83	60	950	30 0	--
02-04-83	67	--	--	--
18-05-83	78	950	32 0	--
19-07-83	74	900	36 0	--
08-09-83	69	950	31 5	--
10-11-83	81	870	31 0	--
17-01-84	86	840	32 0	--
04-03-84	87	830	32 0	--
15-04-84	77	--	--	--
24-05-84	79	875	30 5	--
12-07-84	85	860	34 0	--
25-08-84	81	850	34 0	--
30-09-84	72	840	34 0	--
06-11-84	68	890	31 0	--
15-12-84	61	920	30 0	--
12-01-85	58	--	--	--
16-02-85	50	--	--	--
18-03-85	136	850	32 0	--
14-04-85	127	870	32 0	--
06-05-85	120	880	32 0	--
10-06-85	110	880	32 0	--
10-07-85	110	900	32 0	--
04-08-85	116	900	32 0	--
21-08-85	69	950	30 0	--
07-09-85	97	890	35 0	--
12-10-85	29	900	32 0	--
06-11-85	28	900	32 0	--
04-12-85	30	850	31 0	--
06-01-86	80	900	30 0	--
05-02-86	81	600	28 0	--
09-03-86	26	880	31 0	--
06-04-86	29	850	32 0	--
07-05-86	27	845	32 0	--
22-06-86	18	740	32 0	--
13-07-86	22	820	31 0	--
11-08-86	23	--	--	--
27-09-86	29	--	--	--
12-10-86	28	--	--	--
08-11-86	22	910	29 0	--
07-12-86	26	900	28 0	--
10-01-87	18	970	33 0	--
16-02-87	14	950	35 0	--
04-03-87	20	850	30 0	--
15-04-87	16	--	35 0	--
11-05-87	20	775	34 0	--

WADI SUQ BASIN
DC600173AB, FALAJ AL QABAIL AT FALAJ AL QABAIL
DISCHARGE MEASUREMENTS, Sep 1982 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
10-06-87	18	1200	35 0	--
12-07-87	18	--	--	--
17-08-87	13	700	32 0	--
14-09-87	18	930	33 0	--
13-10-87	22	1250	29 5	--
14-11-87	20	1100	32 0	--
08-12-87	33	--	--	--
09-01-88	37	1000	34 0	--
19-02-88	43	900	35 0	--
05-04-88	68	--	--	--
12-07-88	60	1030	36 0	--
18-08-88	61	1000	33 0	--
21-09-88	70	1050	33 0	--
05-10-88	70	940	34 0	--
12-11-88	90	950	31 0	--
17-12-88	72	--	--	--
15-01-89	73	850	33 0	--
15-02-89	79	820	34 0	--
23-03-89	84	700	31 0	--
30-05-89	87	950	35 0	--
06-06-89	83	940	34 0	--
19-07-89	77	900	30 0	--
16-08-89	106	840	30 0	--
18-09-89	85	920	34 0	--
23-10-89	62	980	33 0	--
15-11-89	81	900	34 0	--
16-12-89	82	880	31 0	--
03-01-90	65	850	31 0	--
14-02-90	80	940	29 0	--
20-03-90	69	930	--	--
10-04-90	60	--	--	--
11-06-90	55	900	36 0	--
15-07-90	53	--	--	--
18-08-90	49	980	--	--
15-09-90	61	880	--	--
13-10-90	69	--	--	--
08-12-90	61	--	34 0	--
15-01-91	68	--	35 0	--
11-03-91	74	1008	33 5	--
09-04-91	80	1011	29 4	--
23-04-91	69	1055	33 0	--
07-05-91	59	--	--	--
10-06-91	64	996	--	--
09-07-91	71	915	35 0	--
10-07-91	72	746	35 0	--
14-07-91	67	--	35 4	--
15-07-91	58	991	34 2	--
17-08-91	59	985	34 3	--

WADI SUQ BASIN
DC600173AB, FALAJ AL QABAIL AT FALAJ AL QABAIL
DISCHARGE MEASUREMENTS, Sep 1982 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
10-09-91	60	978	34 2	33 0
09-10-91	56	985	34 0	--
11-11-91	55	972	34 0	--
08-12-91	58	973	25 6	--
05-01-92	57	970	34 0	--
04-02-92	50	970	33 0	--
09-03-92	48	980	33 5	--
11-04-92	48	985	33 5	--
06-05-92	51	985	33 0	--
11-06-92	48	957	30 0	--
05-07-92	41	975	34 0	--
03-08-92	38	992	34 0	--
01-09-92	43	975	34 1	--
05-12-92	39	980	33 6	--
05-01-93	45	999	33 4	--
08-02-93	39	991	33 3	--
06-03-93	47	991	33 5	--
10-04-93	48	1002	33 7	28 8
04-05-93	52	1009	33 6	--
06-06-93	63	1008	33 9	39 4
05-07-93	45	1001	34 2	35 0
04-08-93	39	997	34 0	33 3
06-09-93	36	998	34 2	32 8
04-10-93	32	999	33 8	35 1
06-11-93	39	996	33 6	--
05-12-93	32	1000	33 3	30 0
04-01-94	35	994	33 4	26 9
02-02-94	35	995	33 2	28 8
06-03-94	37	999	33 1	30 9
04-04-94	34	994	33 3	27 9
04-05-94	32	997	33 6	38 0
06-06-94	47	1008	33 9	39 3
03-07-94	26	991	34 1	33 6
03-08-94	27	995	34 1	34 2
14-09-94	32	1001	33 8	30 0
03-10-94	29	994	33 9	34 0
07-11-94	27	1004	33 6	33 3
04-12-94	27	1003	33 3	27 6
09-01-95	28	1010	32 9	28 4
07-02-95	23	1074	33 1	24 5
08-03-95	30	1142	32 8	36 1
04-04-95	28	1130	32 0	29 0
06-05-95	27	1011	25 6	39 9
06-06-95	20	1015	33 7	32 0
05-07-95	25	1000	34 0	41 8
05-08-95	31	1003	34 2	34 9
03-09-95	29	1019	33 9	38 6
04-10-95	34	1018	33 8	26 3
05-11-95	35	1027	33 6	39 7

WADI SUQ BASIN
DC600173AB, FALAJ AL QABAIL AT FALAJ AL QABAIL
DISCHARGE MEASUREMENTS, Sep 1982 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
10-12-95	44	1026	33 5	28 3
08-01-96	37	1052	28 8	30 5
04-02-96	38	1115	32 6	26 0
03-03-96	42	1040	33 0	29 4
07-04-96	40	1138	32 7	36 9
11-05-96	42	1050	33 6	43 3
23-06-96	49	1056	34 1	34 7
09-07-96	45	--	33 9	39 1
12-08-96	50	1043	34 0	34 3
20-10-96	57	1052	28 0	33 0
12-11-96	84	1030	30 0	26 2
10-12-96	56	1030	29 5	26 2
28-01-97	83	1021	33 3	25 0
12-02-97	66	1014	33 5	28 4
04-03-97	73	--	32 9	30 4
08-04-97	88	960	33 7	34 5
06-05-97	69	924	34 0	33 0
08-06-97	105	910	34 1	28 4
12-07-97	62	876	33 9	35 6
05-08-97	65	863	34 0	39 9
13-09-97	70	840	34 1	43 9
19-10-97	58	830	33 8	31 8
16-11-97	67	853	33 6	29 2
13-12-97	55	850	33 4	26 0
11-01-98	62	852	33 4	30 1
15-02-98	68	820	33 5	26 2
14-03-98	72	843	33 5	23 6
12-04-98	76	862	33 7	35 6
12-05-98	75	830	33 9	32 6
09-06-98	58	820	34 3	37 0
12-07-98	72	837	34 2	33 4
03-08-98	85	843	34 1	40 1
01-09-98	66	860	34.2	32 6
03-10-98	91	866	34 1	31 4
02-11-98	113	870	34 0	32 4
02-12-98	97	893	33 6	27 3
02-01-99	100	882	29 8	26 6
02-02-99	--	882	33 7	28 7
01-03-99	81	866	32 9	37 1
04-03-99	88	911	28 8	29 3
05-05-99	77	865	35 0	32 6
07-06-99	107	846	33 9	35 2
04-08-99	54	892	34 2	40 0
07-09-99	57	879	33 9	31.3
06-10-99	62	888	33 4	35 2
07-11-99	48	900	33 2	31 9
11-12-99	51	720	33 0	30 0
05-01-00	52	950	33 0	27 0
07-02-00	41	953	32 0	22 0

WADI SUQ BASIN
DC600173AB, FALAJ AL QABAIL AT FALAJ AL QABAIL
DISCHARGE MEASUREMENTS, Sep 1982 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
06-03-00	34	949	32 4	28 0
05-04-00	38	983	32 7	36 7
07-05-00	27	1008	33 0	35 0
07-06-00	21	980	33 1	--
08-07-00	18	965	33 0	--
07-08-00	23	1056	34 2	40 4
06-09-00	19	990	29 3	32 1
02-10-00	15	1058	32 9	34 2
04-11-00	28	1100	32 2	28 0
03-12-00	33	1130	--	--
02-01-01	32	1162	29 9	18 7
04-02-01	31	1196	30 2	27 8
11-03-01	27	1164	32 9	29 5
02-04-01	25	1175	32 8	29 0
06-05-01	30	1200	33 4	40 4
03-06-01	18	1210	33 5	35 4
08-07-01	29	1221	34 1	39 9
01-08-01	22	1208	33 7	35 3
02-09-01	34	--	34 1	31 1
02-10-01	22	--	--	--
05-11-01	22	1282	33 1	26 9
02-12-01	22	--	33 1	--
03-03-02	23	1387	30 7	26 9
03-04-02	28	1150	24 6	39 6
04-05-02	27	1165	33.4	36.2
08-06-02	19	1400	--	--
02-07-02	26	--	34 3	--
03-08-02	18	--	34 2	37 4
01-09-02	18	1240	34 2	35 5

WADI SUQ BASIN
DC600173AB, FALAJ AL QABAIL AT FALAJ AL QABAIL
WATER QUALITY DATA, Aug 1987 to Jun 2001
ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
22-08-87	216	0 38	--	122	1 30	0 01	2 6	95
06-06-95	173	--	--	145	0 10	--	2 3	109
04-09-95	173	--	--	158	0 10	--	2 5	117
04-10-95	170	--	--	144	0 12	--	2 3	119
10-12-95	148	--	0 19	154	0 12	--	2.9	127
25-02-96	170	--	0 29	173	0 27	--	2 4	128
14-09-96	172	--	--	131	0 16	--	3 0	143
10-12-96	188	--	--	114	0 21	--	2 9	121
09-03-97	188	--	--	126	0 25	--	2 9	112
12-07-97	162	--	--	95	0 13	--	2 9	108
13-09-97	161	--	--	87	0 10	--	3 1	101
12-04-98	161	--	--	96	0 20	--	3 2	106
07-06-99	150	--	--	111	0 10	--	2 9	125
07-06-00	163	--	--	160	0 10	--	2 9	126
03-06-01	133	--	--	201	0 38	--	2 8	111
Mean	**169**	**0.38**	**0.24**	**134**	**0.24**	**0.01**	**2.8**	**117**
Min	**133**	**0.38**	**0.19**	**87**	**0.10**	**0.01**	**2.3**	**95**
Max	**216**	**0 38**	**0.29**	**201**	**1.30**	**0.01**	**3.2**	**143**

WADI SUQ BASIN
DC600173AB, FALAJ AL QABAIL AT FALAJ AL QABAIL
WATER QUALITY DATA, Aug 1987 to Jun 2001

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
22-08-87	36	0 03	4 5	-1 0	35	0 02	115	--
06-06-95	36	0 05	7 0	0 6	40	0 05	97	--
04-09-95	33	0 05	3 6	0 6	45	0 05	103	--
04-10-95	35	0 05	2 9	0 3	53	0 05	89	--
10-12-95	28	0 05	3 4	1 0	58	0 05	95	--
25-02-96	42	0 05	3 1	1 0	48	0 05	98	--
14-09-96	41	0 05	3 4	0 9	56	0 05	107	--
10-12-96	35	0 05	3 3	0 8	52	0 05	106	--
09-03-97	33	0 05	3 0	0 5	49	0 05	94	--
12-07-97	30	0 05	3 1	0 4	38	0 05	96	--
13-09-97	31	0 05	3 0	0 6	38	0 05	92	--
12-04-98	29	0 05	3 7	0 7	38	0 05	75	--
07-06-99	31	0 05	3 2	-0 2	44	0 05	91	--
07-06-00	34	0 07	3 3	-1 1	49	0 07	92	--
03-06-01	42	0 05	4 0	-0 1	63	0 05	101	--
Mean	**34**	**0.05**	**3.6**	**0.3**	**47**	**0.05**	**97**	**--**
Min	**28**	**0.03**	**2.9**	**-1.1**	**35**	**0.02**	**75**	**--**
Max	**42**	**0.07**	**7 0**	**1.0**	**63**	**0 07**	**115**	**--**

WADI SUQ BASIN
DC600173AB, FALAJ AL QABAIL AT FALAJ AL QABAIL
WATER QUALITY DATA, Aug 1987 to Jun 2001

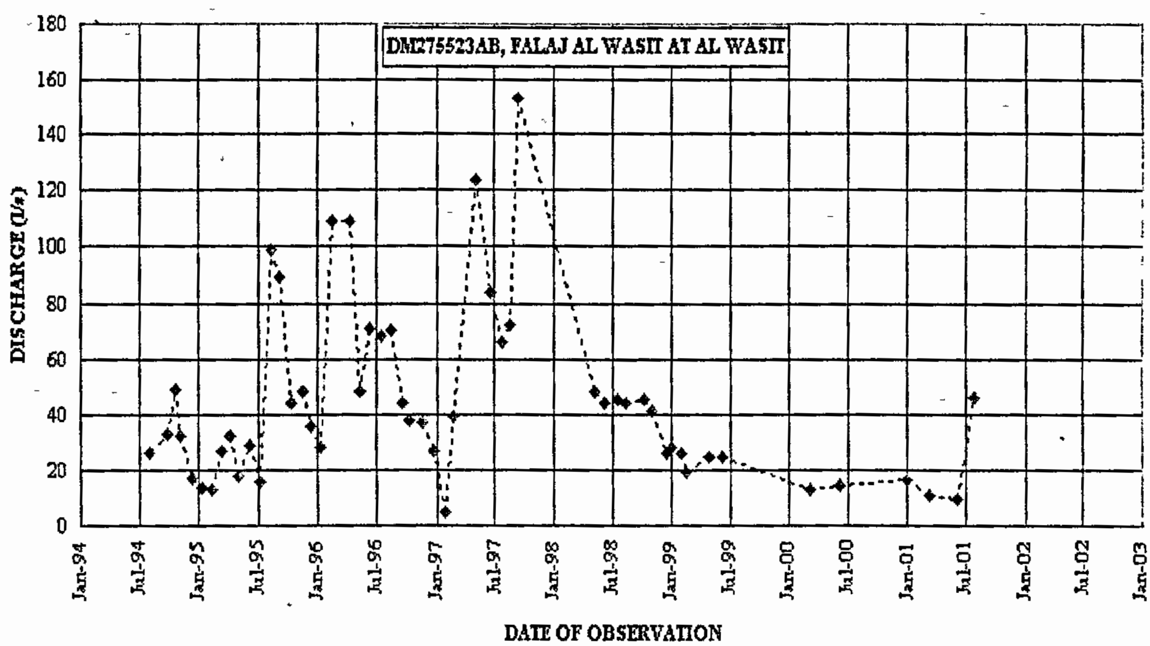
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
22-08-87	230	235	--	--	--	--	1008	8 5
06-06-95	173	252	--	10	9	551	1029	8 2
04-09-95	173	268	--	11	10	578	1010	8 3
04-10-95	170	305	--	10	10	559	1001	7 8
10-12-95	166	308	--	11	10	581	1030	8 6
25-02-96	186	304	--	11	10	619	1037	8 5
14-09-96	185	332	--	11	11	609	1055	8 4
10-12-96	188	301	--	10	11	561	1007	8 3
09-03-97	188	283	--	10	10	546	935	8 2
12-07-97	162	233	--	8	9	484	855	8 1
13-09-97	161	233	--	8	9	465	833	8 2
12-04-98	168	230	--	9	8	466	823	8 3
07-06-99	150	259	--	9	9	512	881	7 5
07-06-00	163	286	--	11	10	578	1028	6 5
03-06-01	133	365	--	11	12	618	1257	7 6

WADI AL JIZZI BASIN
DM275523AB, FALAJ AL WASIT AT AL WASIT

LOCATION

UTM	425238 E, 2675333 N
LATITUDE	24° 11' 20"
LONGITUDE	56° 15' 50"
FALAJ TYPE	Ghaily
PERIOD OF RECORD	August 1994 to September 2002
REMARKS	56 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 153 l\s, 10 September 1997 Minimum measured discharge, 5 l\s, 28 January 1997



WADI AL JIZZI BASIN
DM275523AB, FALAJ AL WASIT AT AL WASIT
DISCHARGE MEASUREMENTS, Aug 1994 to Jul 2001

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
03-08-94	26	461	30 9	--
25-09-94	33	446	26 6	--
23-10-94	49	429	25 1	--
06-11-94	32	442	24 9	--
11-12-94	17	461	19 6	--
08-01-95	14	--	--	--
08-02-95	13	--	--	--
11-03-95	27	--	--	--
05-04-95	32	--	--	--
03-05-95	18	--	--	--
06-06-95	29	--	--	--
04-07-95	16	--	--	--
12-08-95	99	421	30 8	--
05-09-95	89	436	29 3	--
08-10-95	44	440	27 5	--
12-11-95	48	448	25 3	--
10-12-95	36	448	22 0	20 0
09-01-96	28	451	21 7	--
12-02-96	109	456	21 1	--
08-04-96	109	456	23 7	--
08-05-96	48	477	27 0	38 0
11-06-96	71	482	29 7	--
13-07-96	68	--	30 6	--
14-08-96	70	--	--	31 3
16-09-96	44	--	31 1	--
08-10-96	38	459	26 7	--
16-11-96	37	260	21 8	--
22-12-96	27	473	21 1	--
28-01-97	5	415	18 3	--
24-02-97	39	467	23 7	--
03-05-97	124	475	26 7	--
18-06-97	84	465	29 9	--
23-07-97	66	471	30 8	--
17-08-97	72	444	30 7	--
10-09-97	153	462	29 1	--
10-05-98	48	466	26 7	--
07-06-98	44	465	30 4	--
18-07-98	45	466	30 2	--
11-08-98	44	464	30 5	--
05-10-98	45	443	29 1	--
02-11-98	41	444	29 1	--
15-12-98	26	463	20 6	19 2
03-01-99	28	462	19 3	21 7
02-02-99	26	471	19 6	21 6
14-02-99	19	--	--	--
27-04-99	25	470	--	--
06-06-99	25	469	28 1	--

WADI AL JIZZI BASIN

DM275523AB, FALAJ AL WASIT AT AL WASIT

DISCHARGE MEASUREMENTS, Aug 1994 to Jul 2001

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
05-03-00	13	--	--	--
05-06-00	14	484	31 1	36 5
31-12-00	16	--	--	--
11-03-01	11	458	22 6	32 0
03-06-01	10	493	29 5	36 9
23-07-01	46	486	29 8	--

WADI AL JIZZI BASIN
DM275523AB, FALAJ AL WASIT AT AL WASIT
WATER QUALITY DATA, Jun 1995 to Jul 1997

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
06-06-95	107	--	--	44	0 10	--	1 8	39
26-07-97	54	--	--	40	0 10	--	1 0	39
Mean	**80**	**--**	**--**	**42**	**0.10**	**--**	**1.4**	**39**
Min	**54**	**--**	**--**	**40**	**0.10**	**--**	**1.0**	**39**
Max	**107**	**--**	**--**	**44**	**0.10**	**--**	**1.8**	**39**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
06-06-95	22	0 05	2 5	0 6	34	0 05	23	--
26-07-97	15	0 05	1 5	0 6	41	0 05	17	--
Mean	**18**	**0.05**	**2 0**	**0.6**	**38**	**0.05**	**20**	**--**
Min	**15**	**0.05**	**1.5**	**0.6**	**34**	**0.05**	**17**	**--**
Max	**22**	**0 05**	**2.5**	**0.6**	**41**	**0.05**	**23**	**--**

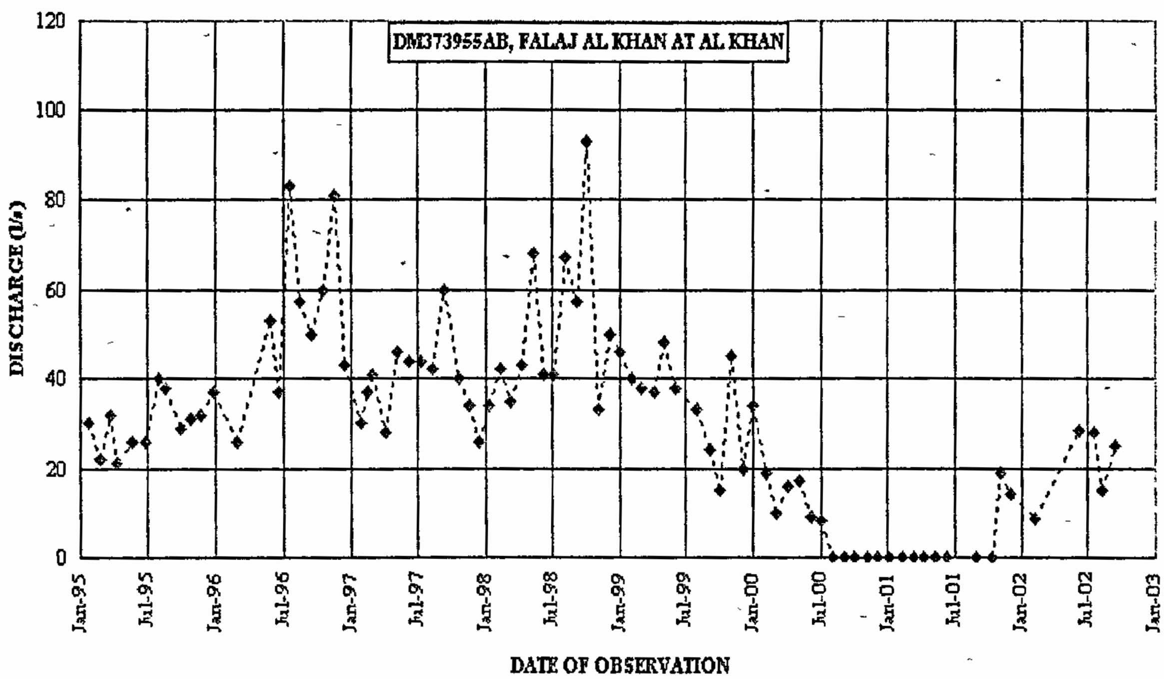
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
06-06-95	118	195	--	5	5	246	462	8 6
26-07-97	133	206	--	5	5	239	454	9 0

WADI AL JIZZI BASIN
DM373955AB, FALAJ AL KHAN AT AL KHAN

LOCATION

UTM	433456 E, 2679510 N
LATITUDE	24° 13' 37"
LONGITUDE	56° 20' 40"
FALAJ TYPE	Daudi
PERIOD OF RECORD	January 1995 to September 2002
REMARKS	89 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 93 l\s, 05 October 1998 Minimum measured discharge, 8 l\s, 02 July 2000



WADI AL JIZZI BASIN
DM373955AB, FALAJ AL KHAN AT AL KHAN
DISCHARGE MEASUREMENTS, Jan 1995 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
25-01-95	30	761	29 0	30 0
22-02-95	22	857	28 9	22 4
21-03-95	32	777	28 7	23 7
11-04-95	21	775	28 9	29 0
20-05-95	26	769	29 7	26 1
25-06-95	26	890	31 0	25 0
31-07-95	40	524	31 7	30 6
19-08-95	38	535	31 3	29 3
26-09-95	29	644	31 0	28 2
24-10-95	31	685	30 1	26 6
21-11-95	32	712	28 4	23 9
27-12-95	37	678	26 8	30 0
28-02-96	26	703	23 0	19 0
29-05-96	53	748	28 2	27 9
19-06-96	37	762	29 7	28 2
21-07-96	83	755	31 0	40 0
18-08-96	57	720	31 7	31 0
18-09-96	50	728	31 0	37 0
16-10-96	60	735	29 8	29 0
17-11-96	81	--	27 9	24 9
17-12-96	43	762	30 0	23 0
28-01-97	30	783	33 5	30 2
15-02-97	37	680	22 7	20 1
03-03-97	41	--	23 3	21 5
06-04-97	28	590	23 6	23 4
07-05-97	46	640	25 8	28 0
09-06-97	44	723	28 5	26 4
12-07-97	44	752	30 2	33 5
10-08-97	42	719	31 3	35 7
13-09-97	60	771	31 2	32 0
20-10-97	40	735	29 5	24 5
16-11-97	34	757	27 7	25 0
15-12-97	26	762	25 4	21 1
11-01-98	34	750	24 1	20 1
11-02-98	42	740	23 3	22 0
11-03-98	35	730	22 3	27 9
12-04-98	43	720	26 5	29 0
10-05-98	68	726	28 2	40 3
08-06-98	41	750	33 2	39 5
04-07-98	41	744	30 6	31 3
04-08-98	67	670	31 6	34 1
05-09-98	57	690	31 6	29 2
05-10-98	93	660	31 1	33 0
02-11-98	33	701	29 0	31 3
05-12-98	50	720	27 3	25 0
03-01-99	46	730	26 3	26 7
03-02-99	40	726	25 6	22 6
02-03-99	38	732	25 7	24 6

WADI AL JIZZI BASIN
DM373955AB, FALAJ AL KHAN AT AL KHAN
DISCHARGE MEASUREMENTS, Jan 1995 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
05-04-99	37	660	25 6	42 5
02-05-99	48	808	30 5	34 5
02-06-99	38	720	29 9	44.4
02-08-99	33	735	32 4	38 6
04-09-99	24	750	30 9	35 5
01-10-99	15	700	31 9	31 8
02-11-99	45	660	34 0	32 0
06-12-99	20	700	26 0	29 0
02-01-00	34	747	29 0	24 0
05-02-00	19	800	28 0	23 0
04-03-00	10	776	28 6	22 9
02-04-00	16	770	28 0	32 8
03-05-00	17	730	30 0	39 0
04-06-00	9	760	30 2	--
02-07-00	8	780	31.2	--
02-08-00	--	--	--	--
04-09-00	--	--	--	--
02-10-00	--	--	--	--
04-11-00	--	760	31 4	30 2
03-12-00	--	760	--	--
02-01-01	--	--	--	--
07-02-01	--	--	--	--
12-03-01	--	--	--	--
07-04-01	--	--	--	--
09-05-01	--	--	--	--
09-06-01	--	--	--	--
29-08-01	--	--	--	--
13-10-01	--	480	34 4	34 0
07-11-01	19	553	32 4	30 4
04-12-01	14	436	31 7	29 3
09-02-02	9	804	29 6	22 0
09-06-02	29	--	--	--
20-07-02	28	--	--	--
10-08-02	15	413	33 1	37 6
14-09-02	25	--	--	--

WADI AL JIZZI BASIN
DM373955AB, FALAJ AL KHAN AT AL KHAN
WATER QUALITY DATA, Jun 1995 to Dec 2000
ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
24-06-95	180	--	--	92	0.10	--	2.4	57
19-08-95	128	--	--	56	0.10	--	2.0	50
26-09-95	149	--	--	70	0.10	--	2.3	56
19-06-96	167	--	--	97	0.24	--	2.3	74
18-09-96	171	--	--	82	0.10	--	2.1	74
17-12-96	167	--	--	97	0.10	--	2.0	70
12-07-97	134	--	--	90	0.14	--	1.7	49
13-09-97	131	--	--	91	0.10	--	1.9	75
12-04-98	153	--	--	82	0.10	--	1.6	72
05-12-98	170	--	--	84	0.10	--	1.7	71
02-06-99	180	--	--	87	0.10	--	1.8	69
04-06-00	202	--	--	94	0.10	--	2.2	66
03-12-00	177	--	--	102	0.10	--	2.5	78
Mean	**162**	**--**	**--**	**86**	**0.11**	**--**	**2.0**	**66**
Min	**128**	**--**	**--**	**56**	**0.10**	**--**	**1.6**	**49**
Max	**202**	**--**	**--**	**102**	**0.24**	**--**	**2.5**	**78**

WADI AL JIZZI BASIN
DM373955AB, FALAJ AL KHAN AT AL KHAN
WATER QUALITY DATA, Jun 1995 to Dec 2000

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
24-06-95	15	0 05	5 0	0 4	46	0 05	60	--
19-08-95	12	0 05	2 5	-0 4	36	0 05	32	--
26-09-95	16	0 05	2 8	0 2	51	0 05	40	--
19-06-96	19	0 06	2 9	0 3	56	0 05	48	--
18-09-96	18	0 05	3 1	0 4	56	0 05	52	--
17-12-96	16	0 05	2 9	0 3	59	0 05	53	--
12-07-97	17	0 05	3 1	0 2	49	0 05	53	--
13-09-97	17	0 06	3 5	0 4	50	0 05	60	--
12-04-98	16	0 09	3 2	0 4	57	0 05	54	--
05-12-98	15	0 07	3 4	0 2	55	0 05	56	--
02-06-99	17	0 05	3 5	0 3	61	0 05	55	--
04-06-00	15	0 05	3 4	-1 2	58	0 07	51	--
03-12-00	16	0 06	3 6	-0 2	62	0 05	52	--
Mean	**16**	**0.06**	**3.3**	**0.1**	**54**	**0.05**	**51**	**--**
Min	**12**	**0 05**	**2.5**	**-1.2**	**36**	**0 05**	**32**	**--**
Max	**19**	**0 09**	**5.0**	**0 4**	**62**	**0.07**	**60**	**--**

WADI AL JIZZI BASIN
DM373955AB, FALAJ AL KHAN AT AL KHAN
WATER QUALITY DATA, Jun 1995 to Dec 2000

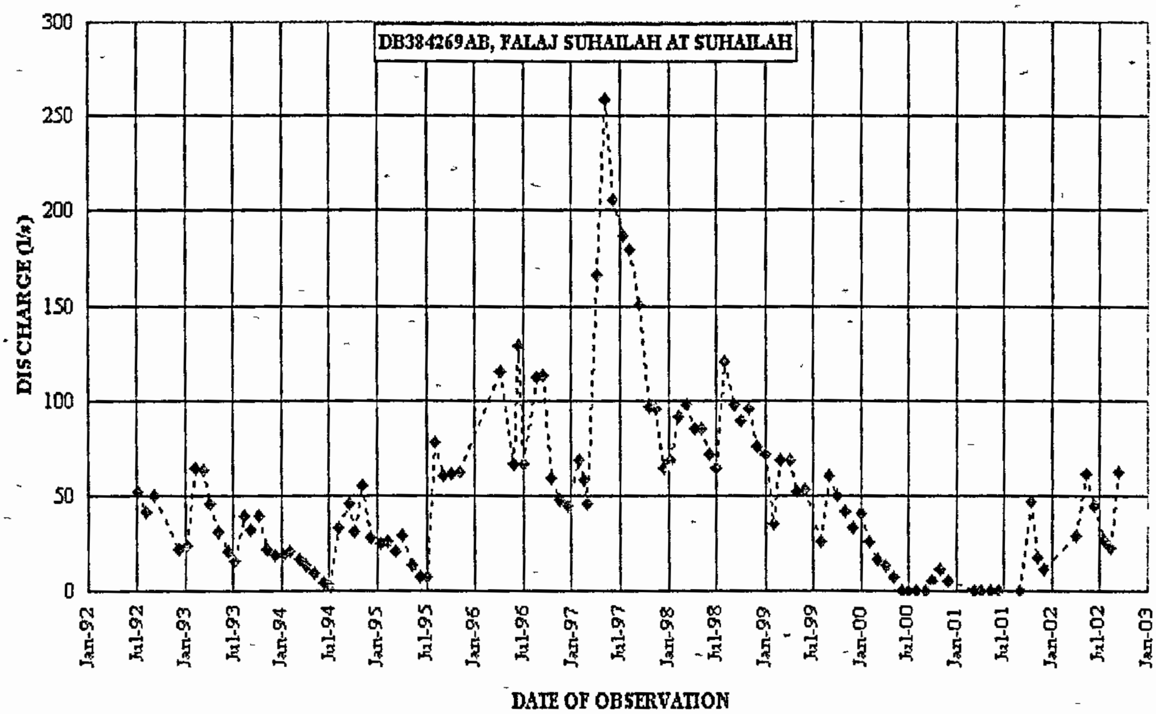
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
24-06-95	180	225	--	8	7	397	765	8 3
19-08-95	128	177	--	5	5	276	535	7 7
26-09-95	149	251	--	6	7	339	641	8 2
22-04-96	166	258	--	7	7	375	717	8 6
19-06-96	167	278	--	8	8	411	744	8 2
18-09-96	171	276	--	7	8	400	721	8 3
17-12-96	173	284	--	8	8	415	748	8 3
12-07-97	153	246	--	7	7	363	695	8 3
13-09-97	154	249	--	7	8	400	738	8 4
12-04-98	175	277	--	7	8	400	707	8 5
05-12-98	170	265	--	7	8	398	719	8 2
02-06-99	180	294	--	8	8	412	737	8 2
04-06-00	202	277	--	8	8	423	776	6 7
03-12-00	177	297	--	8	8	436	593	7 7

WADI AL JIZZI BASIN
DB384269AB, FALAJ SUHAILAH AT SUHAILAH

LOCATION

UTM	434798 E, 2683206 N
LATITUDE	24° 15' 37"
LONGITUDE	56° 21' 28"
FALAJ TYPE	Daudi
PERIOD OF RECORD	April 1983 to September 2002
REMARKS	112 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 258 l\s, 07 May 1997 Minimum measured discharge, 2 l\s, 03 July 1994



WADI AL JIZZI BASIN

DB384269AB, FALAJ SUHAILAH AT SUHAILAH

DISCHARGE MEASUREMENTS, Jul 1992 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
05-07-92	52	--	30 0	36 0
03-08-92	42	--	31 2	37 0
02-09-92	50	--	31 5	40 0
05-12-92	22	874	26 4	30 3
05-01-93	24	893	25 0	33 0
08-02-93	64	760	24 5	20 0
06-03-93	63	846	23 8	34 5
04-04-93	46	869	24 3	28 0
04-05-93	31	880	26 5	33 3
06-06-93	21	880	29 7	34 6
05-07-93	16	880	31 8	36 9
07-08-93	39	891	32 6	31 2
06-09-93	32	890	33 1	32 0
04-10-93	39	890	31 6	34 0
06-11-93	22	889	30 2	31 3
05-12-93	19	897	28 9	30 2
04-01-94	19	903	27 6	28 5
02-02-94	21	912	26 2	32 3
06-03-94	17	915	26 1	28 2
04-04-94	13	916	26 0	27.9
04-05-94	9	920	29 0	38 0
06-06-94	4	915	30 5	38 0
03-07-94	2	917	31 1	31 4
03-08-94	33	874	30 5	32 7
14-09-94	46	843	32 5	32 0
03-10-94	31	910	30 8	29 0
07-11-94	55	858	28 0	33 4
04-12-94	28	875	26 9	28 8
09-01-95	25	888	24 2	21 1
07-02-95	26	995	24 4	24 0
08-03-95	21	1013	24 3	28 0
04-04-95	29	1029	25 2	26 8
06-05-95	14	908	27 8	41 9
06-06-95	7	911	29 9	41 5
05-07-95	7	902	32 2	40 0
05-08-95	78	694	31 9	40 1
04-09-95	60	687	31 0	39 3
04-10-95	61	737	28 9	25 7
05-11-95	62	775	26 3	33 3
07-04-96	115	811	23 3	35 3
29-05-96	66	772	28 2	36 4
16-06-96	129	778	30 0	44 0
02-07-96	66	792	30 7	40 0
19-08-96	112	742	31 9	43 0
17-09-96	113	--	31 7	32 3
16-10-96	59	785	28 9	25 6
17-11-96	48	--	25 2	26 1
17-12-96	45	820	31 2	22 6
28-01-97	69	758	32 5	29 6

WADI AL JIZZI BASIN
DB384269AB, FALAJ SUHAILAH AT SUHAILAH
DISCHARGE MEASUREMENTS, Jul 1992 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
15-02-97	58	--	20 8	18 1
03-03-97	46	--	22 0	22 8
06-04-97	166	590	33 7	30 3
07-05-97	258	642	24 6	28 0
09-06-97	206	738	28 5	44 5
12-07-97	187	764	27 6	35 7
10-08-97	180	730	31 6	33 0
13-09-97	151	772	31 0	32 5
20-10-97	97	775	28 1	32 1
16-11-97	96	763	26 0	32 2
15-12-97	64	790	23 4	21 9
11-01-98	68	789	21 7	18 5
11-02-98	91	739	23 2	25 0
11-03-98	98	730	21 2	28 3
12-04-98	85	740	25 0	24 0
10-05-98	85	736	26 6	40 2
08-06-98	72	790	32 2	39 2
04-07-98	64	799	31 2	35 9
04-08-98	120	650	32 2	34 8
05-09-98	98	750	31 9	37 5
05-10-98	89	680	30 2	32 9
02-11-98	95	765	27 7	31 8
05-12-98	76	795	24 7	25 0
03-01-99	72	800	24 5	25 0
03-02-99	35	801	22 8	34 7
02-03-99	69	809	24 7	29 7
05-04-99	68	781	25 5	41 4
02-05-99	52	373	30 0	35 5
02-06-99	53	810	28 8	39 6
02-08-99	26	843	34 5	39 2
04-09-99	60	850	28 9	34 2
01-10-99	50	820	31 0	31 7
02-11-99	42	700	34 0	35 0
06-12-99	33	900	26 0	29 0
02-01-00	41	875	26 0	28 0
05-02-00	26	820	24 0	28 0
04-03-00	17	881	23 4	21 3
02-04-00	14	890	26 9	31 0
03-05-00	7	860	29 0	38 0
04-06-00	--	--	--	34 3
02-07-00	--	--	--	39 0
02-08-00	--	--	--	38 6
04-09-00	--	--	--	--
02-10-00	5	866	32 0	34 0
04-11-00	11	886	31 4	30 0
03-12-00	5	900	--	--
02-01-01	--	918	26 8	24 8

WADI AL JIZZI BASIN
DB384269AB, FALAJ SUHAILAH AT SUHAILAH
DISCHARGE MEASUREMENTS, Jul 1992 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
07-02-01	--	900	26 7	25 0
12-03-01	--	--	--	--
07-04-01	--	--	--	--
09-05-01	--	--	--	--
09-06-01	--	--	--	--
29-08-01	--	--	--	--
13-10-01	47	870	30 0	34 0
07-11-01	17	690	28 5	33 1
04-12-01	11	520	28 9	33 5
07-04-02	29	804	28 5	35 0
11-05-02	61	--	--	--
09-06-02	45	--	--	--
17-07-02	27	--	--	--
10-08-02	23	752	34 4	40 0
14-09-02	62	--	--	--

WADI AL JIZZI BASIN
DB384269AB, FALAJ SUHAILAH AT SUHAILAH
WATER QUALITY DATA, Jun 1995 to Dec 2000

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
06-06-95	210	--	--	132	0 23	--	1 7	67
04-09-95	167	--	--	70	0 10	--	1 8	64
04-10-95	186	--	--	78	0 10	--	2 0	70
10-12-95	177	--	0 13	93	0 10	--	3 0	82
16-06-96	174	--	--	88	0 86	--	1 8	79
17-09-96	184	--	--	82	0 10	--	1 8	75
17-12-96	178	--	--	102	0 10	--	1 6	76
12-07-97	134	--	--	80	0 10	--	1 4	70
13-09-97	130	--	--	97	0 10	--	1 6	76
12-04-98	160	--	--	82	0 13	--	1 3	69
05-12-98	220	--	--	90	0 10	--	1 3	74
02-06-99	207	--	--	97	0 10	--	1 3	80
03-12-00	212	--	--	112	0 10	--	2 2	90
Mean	**180**	**--**	**0.13**	**93**	**0 17**	**--**	**1 8**	**75**
Min	**130**	**--**	**0.13**	**70**	**0.10**	**--**	**1.3**	**64**
Max	**220**	**--**	**0.13**	**132**	**0.86**	**--**	**3.0**	**90**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
06-06-95	18	0 05	7 2	0 8	72	0 05	75	--
04-09-95	16	0 05	3 1	0 4	47	0 05	46	--
04-10-95	18	0 06	2 6	0 3	61	0 05	40	--
10-12-95	20	0 05	3 2	0 5	61	0 05	49	--
16-06-96	20	0 05	2 9	0 4	58	0 05	48	--
17-09-96	20	0 05	2 9	0 6	59	0 05	52	--
17-12-96	19	0 05	3 1	0 8	68	0 05	56	--
12-07-97	20	0 05	3 2	0 5	54	0 05	55	--
13-09-97	20	0 05	3 6	0 5	53	0 05	61	--
12-04-98	18	0 05	3 1	0 5	59	0 05	52	--
05-12-98	18	0 05	3 4	0 4	63	0 05	59	--
02-06-99	19	0 05	3 6	0 5	70	0 05	60	--
03-12-00	19	0 06	4 0	0 2	72	0 05	66	--
Mean	**19**	**0 05**	**3.5**	**0 5**	**61**	**0.05**	**55**	**--**
Min	**16**	**0 05**	**2.6**	**0.2**	**47**	**0 05**	**40**	**--**
Max	**20**	**0.06**	**7.2**	**0.8**	**72**	**0.05**	**75**	**--**

WADI AL JIZZI BASIN
DB384269AB, FALAJ SUHAILAH AT SUHAILAH
WATER QUALITY DATA, Jun 1995 to Dec 2000

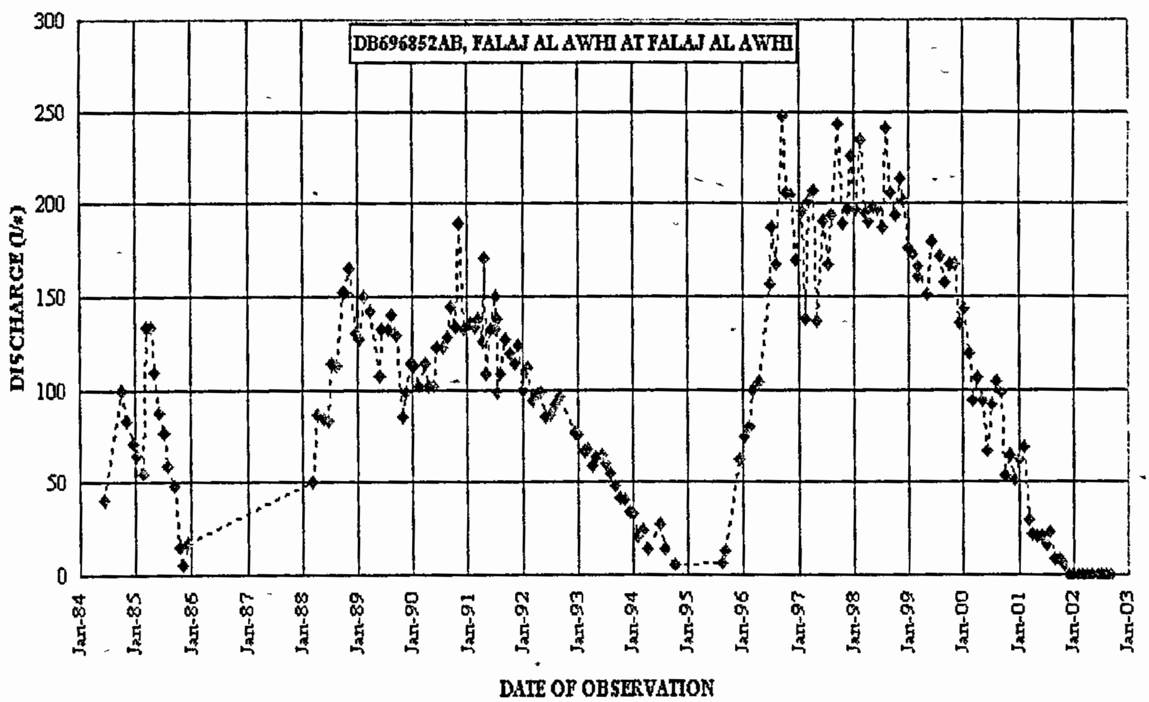
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
06-06-95	225	344	--	10	10	519	935	8 6
04-09-95	172	236	--	7	7	362	684	8 4
04-10-95	186	298	--	8	8	395	730	8 1
10-12-95	187	302	--	8	8	438	790	8 4
16-06-96	179	290	--	8	8	416	761	8 3
17-09-96	189	292	--	8	8	416	757	8 3
17-12-96	198	326	--	9	9	453	800	8 5
12-07-97	174	272	--	7	8	396	728	8 5
13-09-97	169	265	--	8	8	421	754	8 5
12-04-98	185	290	--	8	8	404	713	8 5
05-12-98	220	307	--	9	9	451	782	8 2
02-06-99	207	337	--	9	9	465	822	8 3
03-12-00	212	343	--	9	10	504	771	8 0

WADI AL JIZZI BASIN
DB696852AB, FALAJ AL AWHI AT AL AWHI

LOCATION

UTM	466734 E, 2698474 N
LATITUDE	24° 23' 57"
LONGITUDE	56° 40' 19"
FALAJ TYPE	Daudı
PERIOD OF RECORD	June 1984 to September 2002
REMARKS	182 measurements have been made at the site
MEASURED EXTREMES	Maxımum measured dıscharge, 247 l\s, 14 September 1996 Minimum measured dıscharge, 5 l\s, 03 October 1994



WADI AL JIZZI BASIN
DB696852AB, FALAJ AL AWHI AT AL AWHI
DISCHARGE MEASUREMENTS, Jun 1984 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
11-06-84	41	550	32.0	--
30-09-84	100	550	32.0	--
06-11-84	83	570	27.0	--
22-12-84	71	560	30.0	--
12-01-85	65	--	--	--
16-02-85	55	--	--	--
18-03-85	134	550	31.0	--
13-04-85	134	520	30.0	--
06-05-85	110	580	31.0	--
10-06-85	88	550	32.0	--
10-07-85	77	550	31.0	--
04-08-85	59	890	31.0	--
07-09-85	48	525	31.0	--
12-10-85	15	550	30.0	--
06-11-85	6	550	30.0	--
04-12-85	17	600	29.0	--
08-03-88	50	520	34.0	--
05-04-88	87	--	--	--
24-05-88	84	600	35.0	--
19-06-88	83	600	34.0	--
12-07-88	114	600	35.0	--
18-08-88	113	600	34.0	--
21-09-88	152	580	32.0	32.0
05-10-88	152	570	32.0	32.0
12-11-88	165	500	31.0	--
17-12-88	130	--	--	--
15-01-89	127	520	32.0	--
15-02-89	150	520	31.0	--
23-03-89	142	450	28.0	--
30-05-89	107	580	33.0	--
06-06-89	133	570	30.0	--
19-07-89	132	490	31.0	--
16-08-89	140	465	30.0	--
18-09-89	129	585	31.0	--
23-10-89	85	580	34.0	39.0
15-11-89	98	570	33.0	--
16-12-89	114	540	30.0	--
03-01-90	113	565	31.0	--
14-02-90	102	560	26.0	--
20-03-90	114	570	--	--
10-04-90	102	--	--	--
16-05-90	102	550	25.0	--
11-06-90	123	550	35.0	--
15-07-90	123	--	--	--
18-08-90	128	560	--	--
15-09-90	144	500	--	--
13-10-90	134	--	--	--
05-11-90	189	--	--	--
08-12-90	133	--	32.0	28.0

WADI AL JIZZI BASIN
DB696852AB, FALAJ AL AWHI AT AL AWHI
DISCHARGE MEASUREMENTS, Jun 1984 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
15-01-91	136	450	32 0	25 0
16-02-91	134	570	32 8	--
11-03-91	138	570	32 8	--
09-04-91	126	572	29 3	--
23-04-91	171	--	33 0	37 0
07-05-91	108	570	32 0	--
10-06-91	133	573	32 0	--
09-07-91	150	--	34 0	34 0
10-07-91	133	--	33 0	33 0
14-07-91	138	--	34 0	38 0
15-07-91	98	574	32 4	31 0
07-08-91	108	574	32 0	34 0
10-09-91	127	576	32 0	31 0
09-10-91	119	582	32 0	36 0
11-11-91	114	--	--	--
08-12-91	124	586	26 0	28 0
05-01-92	100	580	32 0	22 0
04-02-92	112	580	32 0	25 0
09-03-92	94	587	32 0	30 0
11-04-92	97	591	32 0	--
06-05-92	99	591	32 0	35 0
06-06-92	85	586	32 0	37 0
05-07-92	86	568	32 0	38 0
03-08-92	92	593	32 0	37 0
02-09-92	96	585	32 4	36 0
06-12-92	77	590	31 8	33 9
05-01-93	75	601	31 5	26 5
09-02-93	67	600	31 1	23 6
06-03-93	68	595	31 6	28 8
10-04-93	59	599	31 7	30 0
04-05-93	64	603	28 8	34 0
06-06-93	65	601	32 3	39 0
05-07-93	60	601	32 5	34 0
07-08-93	55	595	32 3	36 1
06-09-93	48	600	32 2	32 6
04-10-93	42	--	31 7	32 0
06-11-93	40	600	31 4	28 0
05-12-93	34	600	30 7	22 4
04-01-94	33	600	30 6	27 7
02-02-94	21	601	30 0	24 5
06-03-94	24	602	29 6	29 1
04-04-94	14	601	30 2	26 3
03-07-94	27	595	31 7	31 7
03-08-94	14	599	32 1	32 6
03-10-94	5	600	30 6	34 7
05-08-95	7	593	32 0	33 7
04-09-95	13	606	31 4	37 5
10-12-95	62	617	31 1	23 8
08-01-96	74	622	28 6	30 5

WADI AL JIZZI BASIN
DB696852AB, FALAJ AL AWHI AT AL AWHI
DISCHARGE MEASUREMENTS, Jun 1984 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
04-02-96	80	630	31.0	25.1
03-03-96	100	610	31.5	29.3
07-04-96	104	--	31.6	41.1
23-06-96	157	608	32.2	33.7
09-07-96	187	617	32.5	40.1
12-08-96	168	597	33.6	34.5
14-09-96	247	577	32.7	35.8
14-10-96	206	585	32.4	39.4
12-11-96	205	582	29.9	25.8
10-12-96	170	590	29.1	25.6
28-01-97	196	--	32.2	30.0
12-02-97	138	591	32.2	25.5
04-03-97	202	--	31.7	27.7
08-04-97	207	584	32.4	31.6
06-05-97	137	584	32.0	32.0
08-06-97	190	580	32.5	45.4
12-07-97	167	581	32.4	34.8
05-08-97	194	568	32.5	38.6
13-09-97	243	573	32.5	42.7
19-10-97	189	570	32.5	30.3
16-11-97	197	563	31.2	28.5
13-12-97	226	582	32.5	24.6
11-01-98	197	690	32.2	29.3
15-02-98	234	420	32.0	25.1
14-03-98	195	569	32.4	23.5
12-04-98	191	579	32.4	36.9
12-05-98	198	566	32.5	41.6
09-06-98	197	560	32.6	31.2
12-07-98	187	567	32.8	34.9
04-08-98	241	570	32.6	39.2
01-09-98	206	570	32.9	34.3
03-10-98	194	570	32.5	30.6
02-11-98	213	570	32.5	33.9
02-12-98	202	579	32.4	28.8
02-01-99	176	582	34.0	31.6
02-02-99	173	576	32.2	29.0
01-03-99	161	535	30.6	28.7
04-03-99	166	913	28.2	28.9
05-05-99	151	585	30.9	32.6
07-06-99	180	587	32.7	37.8
04-08-99	172	586	32.6	31.5
07-09-99	158	586	32.5	34.0
06-10-99	168	534	31.9	32.0
07-11-99	168	550	31.8	32.0
11-12-99	136	590	32.0	30.0
05-01-00	143	610	31.0	26.0
07-02-00	119	554	21.0	32.0
06-03-00	94	584	31.7	30.0

WADI AL JIZZI BASIN
DB696852AB, FALAJ AL AWHI AT AL AWHI
DISCHARGE MEASUREMENTS, Jun 1984 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
05-04-00	106	600	31 9	38 6
07-05-00	94	590	32 0	35 0
07-06-00	67	629	32 4	--
08-07-00	92	630	32 0	--
07-08-00	104	588	32 4	36 4
06-09-00	98	690	30 2	31 7
02-10-00	53	578	34 4	37 0
04-11-00	64	580	31.1	30 5
03-12-00	52	580	--	--
02-01-01	62	594	27 8	20 2
04-02-01	69	596	29 1	26 1
11-03-01	30	577	30 5	32 1
02-04-01	22	581	33 1	28 0
06-05-01	21	588	31 5	40 9
03-06-01	21	587	31.7	39 0
08-07-01	16	584	32 1	38 3
01-08-01	23	589	32 3	40 1
02-09-01	8	375	31 7	31 4
02-10-01	9	--	--	--
05-11-01	6	602	28 6	26 2
02-12-01	--	--	--	--
25-12-01	--	--	--	--
04-02-02	--	--	--	--
03-03-02	--	565	--	--
03-04-02	--	540	--	--
04-05-02	--	543	29 0	--
08-06-02	--	600	--	--
02-07-02	--	388	30 6	--
03-08-02	--	307	31 6	--
01-09-02	--	410	31 5	30 4

WADI AL JIZZI BASIN
DB696852AB, FALAJ AL AWHI AT AL AWHI
WATER QUALITY DATA, Jun 1995 to Jun 2001

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
06-06-95	124	--	--	79	0 10	--	1 3	50
04-09-95	123	--	--	77	0 10	--	1 7	55
04-10-95	126	--	--	79	0 10	--	1 6	80
10-12-95	104	--	0 12	82	0 15	--	1 6	63
14-09-96	127	--	--	70	0 10	--	1 6	63
12-07-97	113	--	--	66	0 10	--	11 6	34
13-09-97	113	--	--	57	0 10	--	1 6	65
12-04-98	130	--	--	66	0 10	--	2 1	63
02-12-98	155	--	--	67	0 10	--	1.7	58
07-06-99	127	--	--	66	0 10	--	1 7	61
07-06-00	129	--	--	71	0 10	--	1 8	62
03-12-00	124	--	--	67	0 10	--	2 0	74
03-06-01	127	--	--	75	0 22	--	1 9	63
Mean	**125**	**--**	**0.12**	**71**	**0.11**	**--**	**2.5**	**61**
Min	**104**	**--**	**0 12**	**57**	**0.10**	**--**	**1.3**	**34**
Max	**155**	**--**	**0.12**	**82**	**0.22**	**--**	**11.6**	**80**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
06-06-95	13	0 05	7 0	-0 6	36	0 05	50	--
04-09-95	13	0 05	2 8	-0 1	38	0 05	45	--
04-10-95	14	0 05	2 3	-0 1	46	0 05	37	--
10-12-95	14	0 05	2 5	0 6	47	0 05	37	--
14-09-96	17	0 05	2 4	0 1	43	0 05	42	--
12-07-97	13	0 05	2 5	0 0	37	0 05	41	--
13-09-97	14	0 05	2 6	0 0	39	0 05	44	--
12-04-98	26	0 13	2 5	0 1	38	0 05	40	--
02-12-98	13	0 05	2 9	-0 4	43	0 05	43	--
07-06-99	14	0 05	2 8	-0 1	45	0 05	42	--
07-06-00	14	0 08	2 6	-1 5	40	0 05	38	--
03-12-00	13	0 07	2 9	-0 7	45	0 05	41	--
03-06-01	13	0 05	3 1	-0 7	47	0 05	44	--
Mean	**15**	**0 06**	**3.0**	**-0 3**	**42**	**0 05**	**42**	**--**
Min	**13**	**0.05**	**2.3**	**-1 5**	**36**	**0 05**	**37**	**--**
Max	**26**	**0.13**	**7.0**	**0 6**	**47**	**0 05**	**50**	**--**

WADI AL JIZZI BASIN
DB696852AB, FALAJ AL AWHI AT AL AWHI
WATER QUALITY DATA, Jun 1995 to Jun 2001

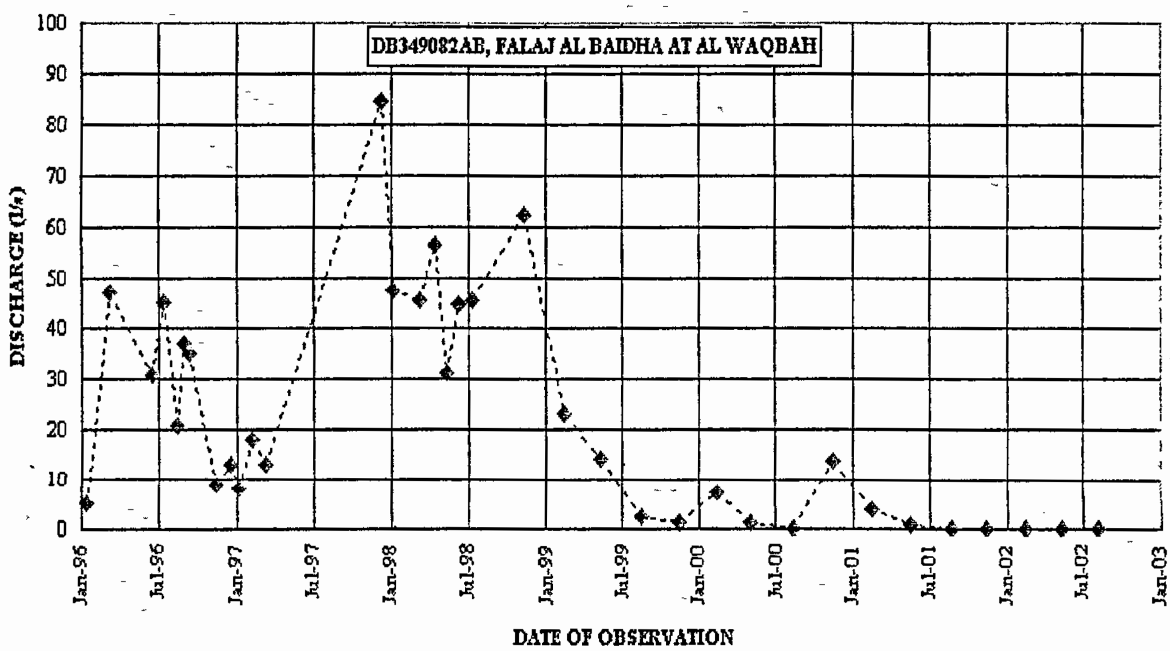
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
06-06-95	124	180	--	6	6	318	618	7 6
04-09-95	123	189	--	6	6	315	608	8 1
04-10-95	126	225	--	7	6	344	617	7 9
10-12-95	124	229	--	6	6	330	603	8 7
14-09-96	127	219	--	6	6	323	589	8 1
12-07-97	113	183	--	6	5	314	562	8 2
13-09-97	113	196	--	5	6	299	559	8 2
12-04-98	130	221	--	6	6	326	569	8 0
02-12-98	155	209	--	6	6	331	577	7 6
07-06-99	127	220	--	6	6	318	585	8 0
07-06-00	129	201	--	6	6	316	608	6 5
03-12-00	124	218	--	6	6	329	432	7 4
03-06-01	127	226	--	6	6	333	606	7 5

WADI AHIN BASIN
DB349082AB, FALAJ AL BAIDHA AT AL WAQBAH

LOCATION

UTM	439863 E, 2640043 N
LATITUDE	23° 52' 19"
LONGITUDE	56° 24' 31"
FALAJ TYPE	Daudi
PERIOD OF RECORD	January 1996 to September 2002
REMARKS	35 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 85 l\s, 10 December 1997 Minimum measured discharge, 1 l\s, 14 Nov 99 and 12 May 01



WADI AHIN BASIN
DB349082AB, FALAJ AL BAIDHA AT AL WAQBAH
DISCHARGE MEASUREMENTS, Jan 1996 to Aug 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
13-01-96	5	758	27.0	20.0
09-03-96	47	736	25.3	26.0
12-06-96	31	777	29.9	28.3
13-07-96	45	780	30.6	29.0
12-08-96	21	791	30.1	28.7
28-08-96	37	733	30.2	31.8
10-09-96	35	766	30.5	36.8
09-11-96	9	811	29.5	29.4
14-12-96	13	840	28.5	22.4
06-01-97	8	842	28.0	17.1
05-02-97	18	799	26.9	22.2
08-03-97	13	850	27.8	29.0
10-12-97	85	928	26.2	21.1
07-01-98	48	936	26.9	21.0
09-03-98	45	930	23.0	20.0
15-04-98	56	901	27.4	26.5
10-05-98	31	920	28.6	35.0
08-06-98	45	903	29.4	33.5
11-07-98	45	892	29.8	35.6
10-11-98	62	886	28.0	32.1
09-02-99	23	942	28.2	28.2
09-05-99	14	966	29.9	32.3
15-08-99	2	985	30.9	33.5
14-11-99	1	975	29.8	25.2
12-02-00	7	1008	27.4	21.0
01-05-00	1	1017	30.4	31.8
12-08-00	--	--	--	--
12-11-00	14	901	30.0	27.1
11-02-01	4	946	28.0	24.5
12-05-01	1	950	--	--
19-08-01	--	--	--	--
11-11-01	--	--	--	--
12-02-02	--	--	--	--
12-05-02	--	--	--	--
05-08-02	--	--	--	--

WADI AHIN BASIN
DB349082AB, FALAJ AL BAIDHA AT AL WAQBAH
WATER QUALITY DATA, Mar 1996 to Jun1997

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
09-03-96	183	--	--	59	0 10	--	4 0	102
12-06-96	190	--	--	68	0 12	--	4 0	109
10-09-96	194	--	--	66	0 11	--	3 7	103
08-03-97	211	--	--	79	0 13	--	3 6	110
12-05-97	163	--	--	85	0 10	--	4 9	124
11-06-97	167	--	--	89	0 10	--	5 2	424
Mean	**185**	**--**	**--**	**74**	**0.11**	**--**	**4.2**	**162**
Min	**163**	**--**	**--**	**59**	**0.10**	**--**	**3.6**	**102**
Max	**211**	**--**	**--**	**89**	**0.13**	**--**	**5.2**	**424**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
09-03-96	47	0 05	2 4	0 6	46	0 05	35	--
12-06-96	45	0 05	2 4	0 5	50	0 05	39	--
10-09-96	50	0 05	2 4	0 5	50	0 05	39	--
08-03-97	48	0 05	2 5	0 5	65	0 05	40	--
12-05-97	55	0 07	3 0	0 7	55	0 05	46	--
11-06-97	56	0 05	3 0	0 7	49	0 05	47	--
Mean	**50**	**0.05**	**2.6**	**0 6**	**52**	**0.05**	**41**	**--**
Min	**45**	**0.05**	**2.4**	**0.5**	**46**	**0.05**	**35**	**--**
Max	**56**	**0 07**	**3.0**	**0.7**	**65**	**0.05**	**47**	**--**

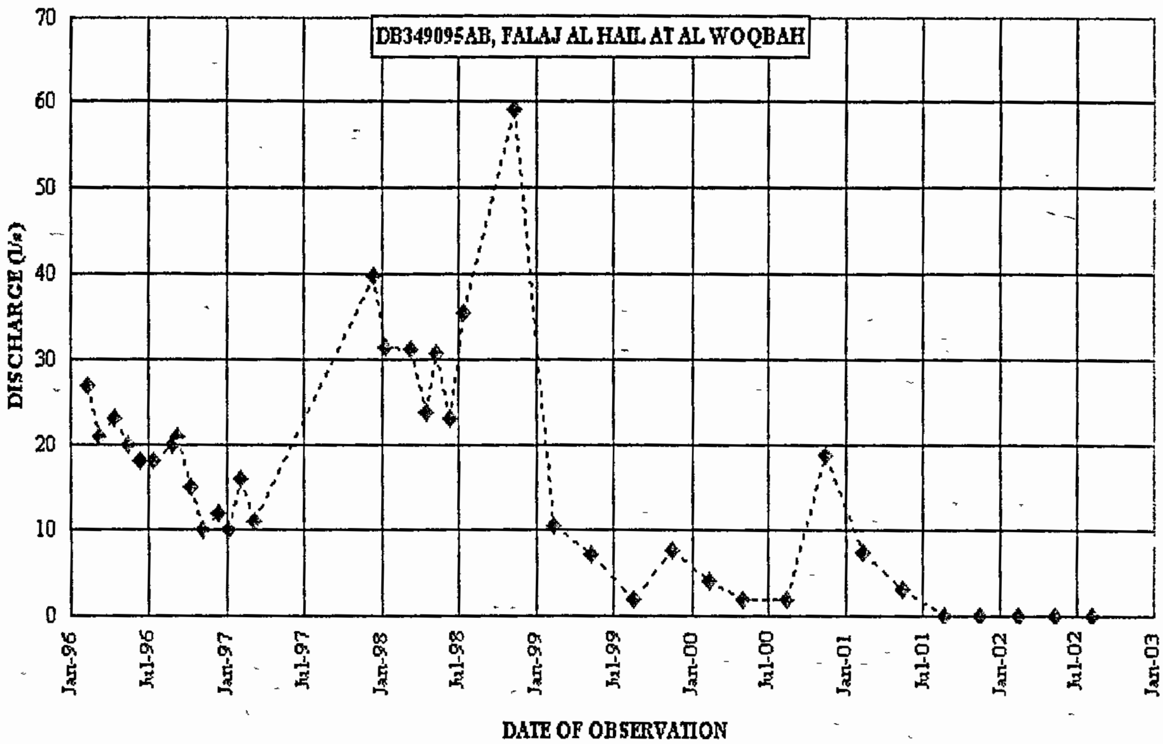
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
09-03-96	183	307	--	8	8	422	718	8 1
12-06-96	190	316	--	8	8	448	762	7 9
10-09-96	194	331	--	8	8	447	760	7 9
08-03-97	211	388	--	9	10	492	828	7 9
12-05-97	163	363	--	9	9	491	815	8 1
11-06-97	167	341	--	9	9	504	866	8 1

WADI AHIN BASIN
DB349095AB, FALAJ AL HAIL AT AL WAQBAH

LOCATION

UTM	439865 E, 2640450 N
LATITUDE	23° 52' 27"
LONGITUDE	56° 24' 34"
FALAJ TYPE	Daudi
PERIOD OF RECORD	February 1996 to September 2002
REMARKS	37 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 59 l\s, 10 November 1998 Minimum measured discharge, 2 l\s, 15 Aug 99 and 12 Aug 00



WADI AHIN BASIN
DB349095AB, FALAJ AL HAIL AT AL WAQBAH
DISCHARGE MEASUREMENTS, Feb 1996 to Aug 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
10-02-96	27	639	22 7	31 9
09-03-96	21	752	23 8	26 0
13-04-96	23	787	24 8	27 0
15-05-96	20	846	26 6	31 2
12-06-96	18	878	27 7	28 3
13-07-96	18	486	28 6	29 0
28-08-96	20	789	29 6	31 8
10-09-96	21	800	29 5	36 8
12-10-96	15	812	29 4	28 7
09-11-96	10	826	28 7	29 4
14-12-96	12	848	27 4	22 4
06-01-97	10	859	25 4	20 1
05-02-97	16	794	25.1	22 2
08-03-97	11	871	25 0	29 0
10-12-97	40	963	25 2	21 0
07-01-98	31	1016	25 0	21 0
09-03-98	31	1020	25 0	21 0
15-04-98	24	970	25 2	36 5
10-05-98	31	1015	29 5	34 0
08-06-98	23	1010	27 6	37 0
11-07-98	35	992	28 5	37 4
10-11-98	59	1010	27 7	31 8
09-02-99	10	948	26 7	28 2
09-05-99	7	991	28 2	32 3
15-08-99	2	977	30 6	33 5
14-11-99	8	--	28 2	25 2
12-02-00	4	--	26 1	21 8
01-05-00	2	983	28 1	31 8
12-08-00	2	928	30 8	31 3
12-11-00	19	875	28 9	27 1
11-02-01	7	931	26 4	28 9
12-05-01	3	952	34 0	--
19-08-01	--	--	--	--
11-11-01	--	--	--	--
12-02-02	--	--	--	--
12-05-02	--	--	--	--
05-08-02	--	--	--	--

WADI AHIN BASIN
DB349095AB, FALAJ AL HAIL AT AL WAQBAH
WATER QUALITY DATA, Mar 1996 to Jun 1997

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
09-03-96	214	--	--	57	0 10	--	2 9	94
12-06-96	148	--	--	67	0 23	--	3 8	120
10-09-96	223	--	--	62	0 11	--	2 7	107
08-03-97	237	--	--	74	0 14	--	3 0	114
13-05-97	163	--	--	91	0 10	--	4 5	131
11-06-97	172	--	--	91	0 17	--	5 1	129
Mean	**193**	**--**	**--**	**74**	**0.14**	**--**	**3.7**	**116**
Min	**148**	**--**	**--**	**57**	**0.10**	**--**	**2.7**	**94**
Max	**237**	**--**	**--**	**91**	**0.23**	**--**	**5.1**	**131**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
09-03-96	57	0 05	1 8	0 4	45	0 05	33	--
12-06-96	46	0 05	1 9	0 9	52	0 05	41	--
10-09-96	61	0 05	2 0	0 4	48	0 05	40	--
08-03-97	66	0 05	2 0	0 4	57	0 05	41	--
13-05-97	57	0 05	2 7	0 4	50	0 05	45	--
11-06-97	62	0 05	2 8	0 5	47	0 05	48	--
Mean	**58**	**0.05**	**2.2**	**0.5**	**50**	**0.05**	**41**	**--**
Min	**46**	**0.05**	**1.8**	**0.4**	**45**	**0.05**	**33**	**--**
Max	**66**	**0.05**	**2.8**	**0.9**	**57**	**0.05**	**48**	**--**

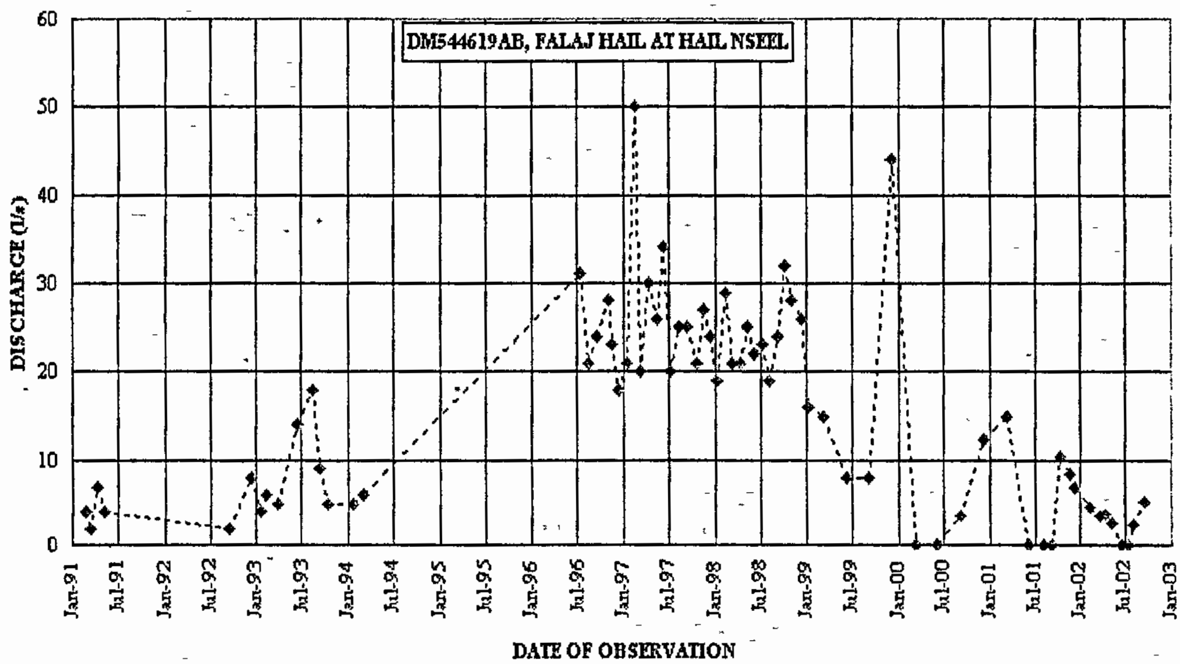
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
09-03-96	214	326	--	8	8	433	733	7 8
12-06-96	154	326	--	8	8	440	735	8 4
10-09-96	223	349	--	9	9	471	789	7 6
08-03-97	237	401	--	9	10	515	848	7 7
13-05-97	163	347	--	9	9	497	803	7 9
11-06-97	172	349	--	9	9	508	892	7 9

WADI AHIN BASIN
DM544619AB, FALAJ HAIL AT HAIL NSEEL

LOCATION

UTM	454100 E, 2646886 N
LATITUDE	23° 55' 59"
LONGITUDE	56° 32' 56"
FALAJ TYPE	Ghaily
PERIOD OF RECORD	February 1991 to September 2002
REMARKS	75 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 50 l\s, 16 February 1997 Minimum measured discharge, 2 l\s, 13 Mar 91 and 04 Aug 02



WADI AHIN BASIN
DM544619AB, FALAJ HAIL AT HAIL NSEEL
DISCHARGE MEASUREMENTS, Feb 1991 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
25-02-91	4	--	27 0	--
13-03-91	2	1428	24 0	--
10-04-91	7	1518	26 2	--
06-05-91	4	--	--	--
15-09-92	2	1479	33 8	35 0
06-12-92	8	1342	25 8	28 7
19-01-93	4	1412	24 3	23 0
09-02-93	6	1381	23 5	28 0
28-03-93	5	1480	26 0	28 0
13-06-93	14	1132	31 8	41 3
15-08-93	18	1023	32 7	32 4
11-09-93	9	--	31 5	35 5
13-10-93	5	1402	29 3	27 5
19-01-94	5	--	24 2	21 0
28-02-94	6	1440	21 6	29 6
13-07-96	31	1050	31 6	41 6
14-08-96	21	1044	32 1	45 0
16-09-96	24	1058	30 4	43 0
30-10-96	28	1121	--	--
18-11-96	23	1048	29 2	21 6
14-12-96	18	1109	26 5	--
11-01-97	21	1115	27 4	24 3
16-02-97	50	1150	27 7	30 0
05-03-97	20	--	27 6	21 0
08-04-97	30	1000	27 4	27 0
11-05-97	26	1030	28 0	30 0
11-06-97	34	1070	30 3	36 0
09-07-97	20	1028	31 4	38 0
06-08-97	25	1042	32 1	30 5
10-09-97	25	1068	32 4	36 0
19-10-97	21	1090	30 8	34 1
15-11-97	27	1020	28 5	25 5
13-12-97	24	1050	28 0	25 5
12-01-98	19	1050	27 0	23 5
14-02-98	29	1050	25.7	20 0
14-03-98	21	1050	26 3	32 3
13-04-98	21	1045	28 1	28 6
11-05-98	25	1033	29 4	40 5
08-06-98	22	1095	30 7	32 5
06-07-98	23	1110	32 3	35 2
05-09-98	24	1057	32 6	34 0
06-10-98	32	930	31 6	25 3
03-11-98	28	948	30 0	29 0
07-12-98	26	1060	28 2	27 8
04-01-99	16	--	27 5	20 5
07-03-99	15	1368	28 5	23 6
05-06-99	8	1080	34 1	39 8
05-09-99	8	1120	32 8	35 0
04-08-98	19	1093	32 5	37 0

WADI AHIN BASIN
DM544619AB, FALAJ HAIL AT HAIL NSEEL
DISCHARGE MEASUREMENTS, Feb 1991 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
07-12-99	44	1136	31 0	28 0
05-03-00	--	--	--	--
05-06-00	--	--	--	--
03-09-00	4	990	29 2	34 0
04-12-00	12	933	31 3	29 8
13-03-01	15	--	28 0	--
05-06-01	--	--	--	--
04-08-01	--	--	--	--
05-09-01	--	--	33 7	--
08-10-01	10	660	33 4	37 8
18-11-01	9	570	32 2	28 1
10-12-01	7	--	31 6	30 8
11-02-02	4	1135	32 2	32 0
23-03-02	3	--	--	--
10-04-02	4	955	32 3	31 1
07-05-02	2	--	--	--
12-06-02	--	--	--	--
10-07-02	--	--	--	--
04-08-02	2	720	33 6	38 8
16-09-02	5	--	--	--

WADI AHIN BASIN
DM544619AB, FALAJ HAIL AT HAIL NSEEL
WATER QUALITY DATA, Oct 1995 to Jun 2001

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
11-10-95	295	--	--	190	0 44	--	1 3	71
16-09-96	287	--	--	131	0 56	--	1 4	50
14-12-96	309	--	--	142	0 57	--	1 4	46
13-04-98	260	--	--	160	0 54	--	1 7	34
07-12-98	260	--	--	146	0 10	--	1 8	43
05-06-99	286	--	--	167	0 71	--	1 9	41
05-06-00	275	--	--	167	0 10	--	2 3	45
04-12-00	255	--	--	92	0 43	--	2 7	31
05-06-01	298	--	--	198	0 69	--	2 1	51
Mean	**281**	**--**	**--**	**155**	**0.46**	**--**	**1.8**	**46**
Min	**255**	**--**	**--**	**92**	**0.10**	**--**	**1.3**	**31**
Max	**309**	**--**	**--**	**198**	**0.71**	**--**	**2.7**	**71**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
11-10-95	49	0 05	3 5	0 5	73	0 05	98	--
16-09-96	51	0 08	3 3	0 5	60	0 05	89	--
14-12-96	51	0 05	3 0	0 4	61	0 05	90	--
13-04-98	45	0 06	3 1	0 3	58	0 05	88	--
07-12-98	50	0 05	3 2	0 1	57	0 05	89	--
05-06-99	59	0 05	3 3	0 2	61	0 05	92	--
05-06-00	51	0 06	3 2	-0 1	55	0 05	90	--
04-12-00	31	0 06	3 6	-0 2	35	0 05	76	--
05-06-01	60	0 05	3 5	0 5	60	0 05	95	--
Mean	**50**	**0 06**	**3.3**	**0.2**	**58**	**0.05**	**90**	**--**
Min	**31**	**0.05**	**3.0**	**-0 2**	**35**	**0.05**	**76**	**--**
Max	**60**	**0.08**	**3.6**	**0.5**	**73**	**0.05**	**98**	**--**

WADI AHIN BASIN
DM544619AB, FALAJ HAIL AT HAIL NSEEL
WATER QUALITY DATA, Oct 1995 to Jun 2001

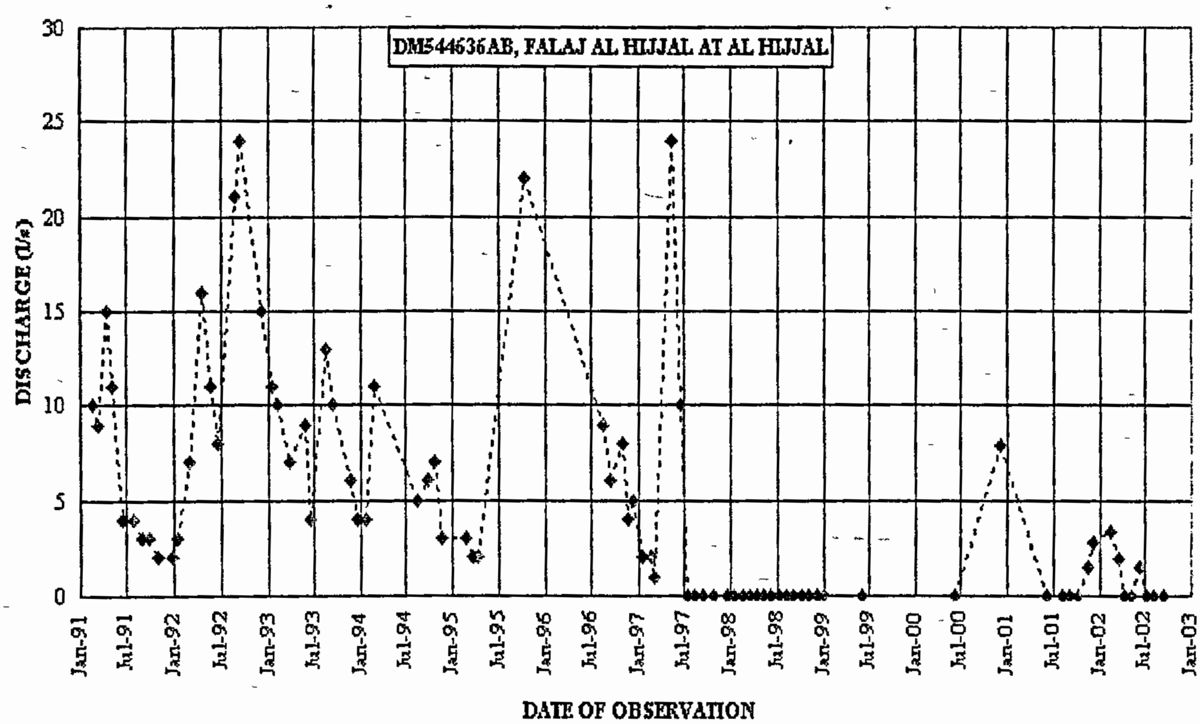
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
11-10-95	295	424	--	13	13	674	1230	7.6
16-09-96	287	377	--	11	12	570	1038	7.7
14-12-96	309	380	--	11	12	592	1087	7.7
13-04-98	260	353	--	11	11	558	992	7.6
07-12-98	260	363	--	10	11	559	1062	7.4
05-06-99	286	402	--	11	12	612	1097	7.3
05-06-00	275	354	--	11	11	594	1128	7.0
04-12-00	255	222	--	9	8	440	743	7.2
05-06-01	298	400	--	13	12	665	1142	7.6

WADI AHIN BASIN
DM544636AB, FALAJ AL HIJJAL AT AL HIJJAL

LOCATION

UTM	454115 E, 2647321 N
LATITUDE	23° 56' 13"
LONGITUDE	56° 32' 56"
FALAJ TYPE	Ghaily
PERIOD OF RECORD	February 1991 to September 2002
REMARKS	88 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 24 l\s, 11 May 1997 Minimum measured discharge, 1 l\s, 05 March 1997



WADI AHIN BASIN
DM544636AB, FALAJ AL HIJJAL AT AL HIJJAL
DISCHARGE MEASUREMENTS, Feb 1991 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
15-02-91	10	--	29.0	--
15-02-91	10	--	29.0	--
13-03-91	9	1474	26.0	--
13-03-91	9	1474	26.0	--
10-04-91	15	1549	27.9	30.0
10-04-91	15	1549	27.9	30.0
06-05-91	11	--	--	--
06-05-91	11	--	--	--
16-06-91	4	1493	30.6	39.0
16-06-91	4	1493	30.6	39.0
23-07-91	4	1490	30.0	39.0
23-07-91	4	1490	30.0	39.0
25-08-91	3	1490	31.0	39.0
25-08-91	3	1490	31.0	39.0
24-09-91	3	1480	31.0	43.0
24-09-91	3	1480	31.0	43.0
26-10-91	2	1502	28.0	33.0
26-10-91	2	1502	28.0	33.0
23-12-91	2	1560	26.0	30.0
23-12-91	2	1560	26.0	30.0
13-01-92	3	1583	24.6	30.0
13-01-92	3	1583	24.6	30.0
02-03-92	7	1644	25.0	19.0
02-03-92	7	1644	25.0	19.0
18-04-92	16	1241	29.1	42.0
18-04-92	16	1241	29.1	42.0
18-05-92	11	1170	30.0	33.0
18-05-92	11	1170	30.0	33.0
15-06-92	8	1132	31.3	31.0
15-06-92	8	1132	31.3	31.0
23-08-92	21	1025	32.6	40.0
23-08-92	21	1025	32.6	40.0
15-09-92	24	1125	32.0	34.0
15-09-92	24	1125	32.0	34.0
06-12-92	15	1182	30.4	25.4
06-12-92	15	1182	30.4	25.4
19-01-93	11	1226	29.4	21.0
19-01-93	11	1226	29.4	21.0
09-02-93	10	1210	29.0	30.0
09-02-93	10	1210	29.0	30.0
28-03-93	7	1256	29.6	28.0
28-03-93	7	1256	29.6	28.0
25-05-93	9	1562	31.4	31.1
25-05-93	9	1562	31.4	31.1
13-06-93	4	1590	31.5	40.7
13-06-93	4	1590	31.5	40.7
15-08-93	13	1530	31.3	29.1
15-08-93	13	1530	31.3	29.1
11-09-93	10	1509	31.0	30.0

WADI AHIN BASIN
DM544636AB, FALAJ AL HIJJAL AT AL HIJJAL
DISCHARGE MEASUREMENTS, Feb 1991 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
11-09-93	10	1509	31 0	30 0
20-11-93	6	1380	27 6	29 3
20-11-93	6	1380	27 6	29 3
21-12-93	4	1421	26 4	31 1
21-12-93	4	1421	26 4	31 1
19-01-94	4	1419	26 0	21 8
19-01-94	4	1419	26 0	21 8
26-02-94	11	1250	29 8	28 2
26-02-94	11	1250	29 8	28 2
15-08-94	5	1485	34 3	32 4
15-08-94	5	1485	34.3	32 4
25-09-94	6	1559	30 9	32 3
25-09-94	6	1559	30 9	32 3
24-10-94	7	1520	29 8	31 5
24-10-94	7	1520	29 8	31 5
19-11-94	3	1604	29 2	30 3
19-11-94	3	1604	29 2	30 3
20-02-95	3	1464	25 0	22 2
20-02-95	3	1464	25 0	22 2
22-03-95	2	1535	26 1	23 7
22-03-95	2	1535	26 1	23 7
09-04-95	2	1473	26 7	28 3
09-04-95	2	1473	26 7	28 3
11-10-95	22	1511	30 4	25 7
11-10-95	22	1511	30 4	25 7
14-08-96	9	1178	32 9	48 0
14-08-96	9	1178	32 9	48 0
16-09-96	6	1224	30 4	46 0
16-09-96	6	1224	30 4	46 0
30-10-96	8	1200	--	--
30-10-96	8	1200	--	--
18-11-96	4	1220	28 8	--
18-11-96	4	1220	28 8	--
14-12-96	5	1220	27 2	--
14-12-96	5	1220	27 2	--
11-01-97	2	1240	25 7	21 1
11-01-97	2	1240	25 7	21 1
16-02-97	2	1280	25 0	--
16-02-97	2	1280	25 0	--
05-03-97	1	1580	24 7	--
05-03-97	1	1580	24 7	--
11-05-97	24	1100	27 6	--
11-05-97	24	1100	27 6	--
11-06-97	10	1130	30 2	--
11-06-97	10	1130	30 2	--
09-07-97	--	1040	32 7	--
09-07-97	--	1040	32 7	--
06-08-97	--	--	--	--
06-08-97	--	--	--	--

WADI AHIN BASIN
DM544636AB, FALAJ AL HIJJAL AT AL HIJJAL
DISCHARGE MEASUREMENTS, Feb 1991 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
10-09-97	--	1147	31 0	34 1
10-09-97	--	1147	31 0	34 1
19-10-97	--	1215	30 2	36 4
19-10-97	--	1215	30 2	36 4
13-12-97	--	1071	24 5	22 6
13-12-97	--	1071	24 5	22 6
12-01-98	--	1073	24 2	--
12-01-98	--	1073	24 2	--
14-02-98	--	--	21 9	24 2
14-02-98	--	--	21 9	24 2
14-03-98	--	--	--	--
14-03-98	--	--	--	--
13-04-98	--	--	--	--
13-04-98	--	--	--	--
11-05-98	--	--	--	--
11-05-98	--	--	--	--
08-06-98	--	1342	28 3	--
08-06-98	--	1342	28 3	--
06-07-98	--	1215	35 3	--
06-07-98	--	1215	35 3	--
04-08-98	--	1306	32 6	--
04-08-98	--	1306	32 6	--
05-09-98	--	1305	31 7	27 8
05-09-98	--	1305	31 7	27 8
06-10-98	--	1130	30 2	32 4
06-10-98	--	1130	30 2	32 4
03-11-98	--	1109	27 6	29 2
03-11-98	--	1109	27 6	29 2
07-12-98	--	1150	25 7	23 0
07-12-98	--	1150	25 7	23 0
04-01-99	--	1150	25 5	24 3
04-01-99	--	1150	25 5	24 3
05-06-99	--	--	--	--
05-06-99	--	--	--	--
05-06-00	--	--	--	--
05-06-00	--	--	--	--
04-12-00	8	1300	28 7	30 6
04-12-00	8	1300	28 7	30 6
05-06-01	--	--	--	--
05-06-01	--	--	--	--
04-08-01	--	--	--	--
04-08-01	--	--	--	--
05-09-01	--	--	--	--
05-09-01	--	--	--	--
08-10-01	--	--	--	--
08-10-01	--	--	--	--

WADI AHIN BASIN
DM544636AB, FALAJ AL HIJJAL AT AL HIJJAL
DISCHARGE MEASUREMENTS, Feb 1991 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
18-11-01	2	--	--	--
18-11-01	2	--	--	--
10-12-01	3	1360	27 7	31 4
10-12-01	3	1360	27 7	31 4
11-02-02	3	1256	26 5	32 3
11-02-02	3	1256	26 5	32 3
23-03-02	2	--	--	--
23-03-02	2	--	--	--
10-04-02	--	1125	37 5	37 0
10-04-02	--	1125	37 5	37 0
07-05-02	--	--	--	--
07-05-02	--	--	--	--
12-06-02	2	--	--	--
12-06-02	2	--	--	--
10-07-02	--	--	--	--
10-07-02	--	--	--	--
04-08-02	--	788	31 9	38 2
04-08-02	--	788	31 9	38 2
16-09-02	--	--	--	--
16-09-02	--	--	--	--

WADI AHIN BASIN
DM544636AB, FALAJ AL HIJJAL AT AL HIJJAL
WATER QUALITY DATA, Jun1995 to Jun 2000

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
19-06-95	330	--	--	243	0 70	--	0.5	43
13-12-95	274	--	0 21	207	0 66	--	1 0	58
16-09-96	333	--	--	172	0 46	--	0 6	63
17-12-96	324	--	--	154	0 55	--	0 7	50
09-07-97	230	--	--	144	0 86	--	1.5	23
13-04-98	296	--	--	183	0 40	--	1 1	45
05-06-99	340	--	--	206	0 67	--	1 6	57
05-06-00	278	--	--	208	0 10	--	0 5	54
Mean	**301**	**–**	**0.21**	**190**	**0.55**	**–**	**0.9**	**49**
Min	**230**	**–**	**0 21**	**144**	**0 10**	**–**	**0.5**	**23**
Max	**340**	**–**	**0.21**	**243**	**0.86**	**–**	**1.6**	**63**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
19-06-95	45	0 05	8 0	0 0	61	0 05	164	--
13-12-95	44	0 05	3 4	0 7	74	0 05	102	--
16-09-96	52	0 05	3 8	0 6	72	0 05	107	--
17-12-96	47	0 05	3 4	0 5	71	0 05	105	--
09-07-97	45	0 05	2 8	0 5	48	0 05	87	--
13-04-98	46	0 08	3 6	0 5	71	0 05	100	--
05-06-99	62	0 06	3 9	0 2	80	0 05	113	--
05-06-00	43	0 05	4 0	-0 4	69	0 08	108	--
Mean	**48**	**0 06**	**4.1**	**0.3**	**68**	**0 05**	**111**	**–**
Min	**43**	**0 05**	**2.8**	**-0 4**	**48**	**0.05**	**87**	**–**
Max	**62**	**0.08**	**8 0**	**0.7**	**80**	**0 08**	**164**	**–**

WADI AHIN BASIN

DM544636AB, FALAJ AL HIJJAL AT AL HIJJAL

WATER QUALITY DATA, Jun1995 to Jun 2000

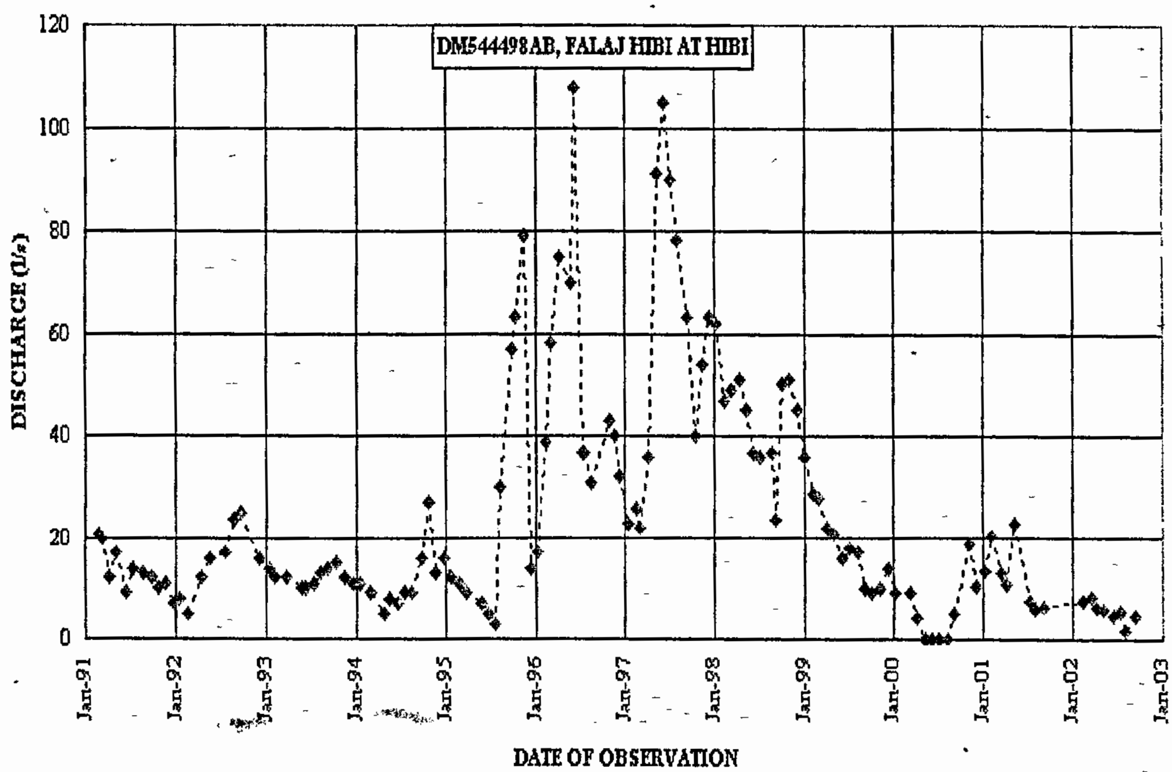
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
19-06-95	330	366	--	14	15	772	1390	7.2
13-12-95	274	416	--	13	13	664	1170	8 0
16-09-96	333	426	--	13	13	680	1200	7 8
17-12-96	324	409	--	12	13	635	1180	7 7
09-07-97	230	308	--	9	10	499	1000	7.8
13-04-98	296	406	--	12	13	638	1114	7 8
05-06-99	340	485	--	14	15	743	1316	7 3
05-06-00	278	392	--	13	13	662	1273	6 8

WADI AHIN BASIN
DM544498AB, FALAJ HIBI AT HIBI

LOCATION

UTM	454806 E, 2644780 N
LATITUDE	23° 54' 50"
LONGITUDE	56° 33' 22"
FALAJ TYPE	Daudi
PERIOD OF RECORD	February 1991 to September 2002
REMARKS	132 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 108 l\s, 08 June 1996 Minimum measured discharge, 2 l\s, 04 August 2002



WADI AHIN BASIN
DM544498AB, FALAJ HIBI AT HIBI
DISCHARGE MEASUREMENTS, Feb 1991 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
25-02-91	21	--	34 0	--
13-03-91	20	803	32 1	--
10-04-91	12	803	32 1	--
06-05-91	17	--	--	--
16-06-91	9	805	32 0	39 0
16-07-91	14	805	32 0	42 0
25-08-91	13	805	32 0	--
24-09-91	12	803	32 0	--
26-10-91	10	802	31 7	32 5
23-11-91	11	802	31 2	--
23-12-91	7	866	31 0	--
13-01-92	8	800	30 0	22 0
18-02-92	5	773	29 0	30 0
18-04-92	12	835	31 0	40 0
18-05-92	16	832	31 6	30 0
19-07-92	17	838	31 3	40 0
23-08-92	24	833	32 2	34 0
19-09-92	25	832	32 0	34 0
06-12-92	16	815	31 8	24 4
19-01-93	14	820	31 0	15 0
09-02-93	12	815	31 2	26 0
28-03-93	12	818	31 4	26 8
25-05-93	10	814	31 8	35 2
13-06-93	10	819	32 0	43 2
13-07-93	11	811	31 8	26 1
15-08-93	13	814	32 0	34 0
11-09-93	14	808	32 0	34 0
13-10-93	15	810	31 7	29 0
20-11-93	12	797	31 7	27 0
21-12-93	11	791	31 3	19 8
19-01-94	11	792	31 0	24 0
28-02-94	9	832	30 9	26 0
25-04-94	5	792	31 3	27 0
16-05-94	8	793	31 5	28 2
21-06-94	7	795	31 7	36 3
19-07-94	9	797	31 9	--
15-08-94	9	808	30 4	32 1
25-09-94	16	795	31 8	26 7
24-10-94	27	798	31 8	23 8
19-11-94	13	871	31 6	32 0
24-12-94	16	796	31 2	28 2
18-01-95	12	797	30 8	19 7
20-02-95	11	794	30 7	18.2
22-03-95	9	799	31 1	23 8
21-05-95	7	859	31 2	29 6
19-06-95	5	890	31.7	35 0
17-07-95	3	943	32 1	34 6
06-08-95	30	815	32 3	33 0

WADI AHIN BASIN
DM544498AB, FALAJ HIBI AT HIBI
DISCHARGE MEASUREMENTS, Feb 1991 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
23-09-95	57	803	32 4	37 9
11-10-95	63	936	32 2	33 8
15-11-95	79	779	32 4	25 4
13-12-95	14	781	32 2	23 3
09-01-96	17	785	26 3	21 0
11-02-96	39	835	32 1	31 0
03-03-96	58	824	32.2	23 5
07-04-96	75	855	26 7	28 9
25-05-96	70	835	32 3	31 7
08-06-96	108	844	32 3	31 8
13-07-96	37	839	32 3	43 3
16-07-96	37	843	30 1	44 0
14-08-96	31	843	32 5	46 5
30-10-96	43	938	--	--
18-11-96	40	838	32 0	19 9
14-12-96	32	843	27 4	--
11-01-97	23	840	31.9	20 1
16-02-97	26	870	31 8	26 2
05-03-97	22	--	31 2	23 3
08-04-97	36	926	32 1	29 0
11-05-97	91	900	32 1	30 0
11-06-97	105	860	32 3	31 2
09-07-97	90	875	32 2	36 5
06-08-97	78	881	32 3	30 9
10-09-97	63	897	32 4	34 7
19-10-97	40	893	32 4	35 6
15-11-97	54	932	32 3	25 4
13-12-97	63	915	32 2	26 4
12-01-98	62	884	32 2	25 2
14-02-98	47	830	31 9	22 8
14-03-98	49	930	32 1	30 7
13-04-98	51	902	32 1	39 7
11-05-98	45	883	32 2	36 9
08-06-98	37	906	32 6	33 8
06-07-98	36	943	32 1	34 3
23-08-98	37	885	32 5	28 5
05-09-98	24	801	32 5	31 6
06-10-98	50	870	32 4	26 8
03-11-98	51	855	32 3	35 3
07-12-98	45	860	32 3	25 2
04-01-99	36	843	32 0	20 5
06-02-99	29	844	31 9	22 8
02-03-99	28	865	32 1	--
05-04-99	22	876	30 2	32 2
03-05-99	21	885	30 4	32 2
05-06-99	16	870	35 6	40 3
05-07-99	18	880	30 0	38 0
03-08-99	17	873	32 3	37 5
05-09-99	10	870	32 0	35 0
03-10-99	9	580	31 8	29 2
03-11-99	10	760	33 4	28 0
07-12-99	14	887	32 0	27 0

WADI AHIN BASIN
DM544498AB, FALAJ HIBI AT HIBI
DISCHARGE MEASUREMENTS, Feb 1991 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
03-01-00	9	900	32 0	27 0
05-03-00	9	894	30 8	21 7
03-04-00	4	905	31 1	28 1
07-05-00	--	--	--	--
05-06-00	--	--	--	--
03-07-00	--	--	--	--
05-08-00	--	--	--	--
04-09-00	5	900	29.2	33 5
03-11-00	19	1150	31 9	26 6
04-12-00	10	880	26 8	32 0
06-01-01	13	877	26 4	28 0
05-02-01	21	879	26 0	27 5
13-03-01	13	857	31 8	29 0
03-04-01	11	848	32 2	3 0
08-05-01	23	857	32 1	35 0
09-07-01	8	874	32 5	35 3
04-08-01	6	890	32 2	32 0
05-09-01	6	890	32 3	40 4
11-02-02	8	930	30 7	29 2
20-03-02	9	--	--	--
10-04-02	6	776	31 5	32 7
07-05-02	6	--	--	--
12-06-02	5	--	--	--
10-07-02	5	--	--	--
04-08-02	2	702	32 3	41 2
16-09-02	4	--	--	--

WADI AHIN BASIN
DM544498AB, FALAJ HIBI AT HIBI
WATER QUALITY DATA, Jun 1995 to Dec 2000
ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
19-06-95	163	--	--	132	0 53	--	1 8	40
11-10-95	186	--	--	111	0 57	--	2 1	44
13-12-95	162	--	0 12	115	0 70	--	2 1	37
08-06-96	173	--	--	123	0 71	--	2 2	43
16-09-96	175	--	--	123	0 10	--	2 1	41
14-12-96	173	--	--	141	0 76	--	2 1	35
09-07-97	159	--	--	127	0 69	--	2 1	34
13-04-98	173	--	--	143	0 65	--	2 1	49
07-12-98	180	--	--	134	0 10	--	2 2	36
05-06-99	170	--	--	142	0 59	--	2 2	39
05-06-00	172	--	--	153	0 10	--	2 3	32
04-12-00	169	--	--	147	0 33	--	2 3	39
Mean	**171**	--	**0.12**	**133**	**0.49**	--	**2.1**	**39**
Min	**159**	--	**0.12**	**111**	**0.10**	--	**1.8**	**32**
Max	**186**	--	**0.12**	**153**	**0.76**	--	**2.3**	**49**

WADI AHIN BASIN
DM544498AB, FALAJ HIBI AT HIBI
WATER QUALITY DATA, Jun 1995 to Dec 2000

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
19-06-95	32	0 05	5 0	0 7	30	0 05	77	--
11-10-95	38	0 06	2 0	0 3	38	0 05	60	--
13-12-95	37	0 05	2 2	-0 1	37	0 05	60	--
08-06-96	42	0 05	2 2	0 2	38	0 05	65	--
16-09-96	43	0 05	2 5	0 2	39	0 05	73	--
14-12-96	40	0 05	2 3	0 4	37	0 05	69	--
09-07-97	44	0 05	2 5	0 0	34	0 05	74	--
13-04-98	44	0 06	2 7	0.2	39	0 05	81	--
07-12-98	41	0 05	2 9	0.1	37	0 05	80	--
05-06-99	44	0 05	2 6	-0 2	39	0 05	77	--
05-06-00	39	0 08	2 7	-0 6	38	0 06	73	--
04-12-00	41	0 05	2 9	-0 3	42	0 05	72	--
Mean	**40**	**0 05**	**2.7**	**0.1**	**37**	**0.05**	**72**	**--**
Min	**32**	**0.05**	**2.0**	**-0.6**	**30**	**0.05**	**60**	**--**
Max	**44**	**0 08**	**5 0**	**0.7**	**42**	**0.06**	**81**	**--**

WADI AHIN BASIN
DM544498AB, FALAJ HIBI AT HIBI
WATER QUALITY DATA, Jun 1995 to Dec 2000

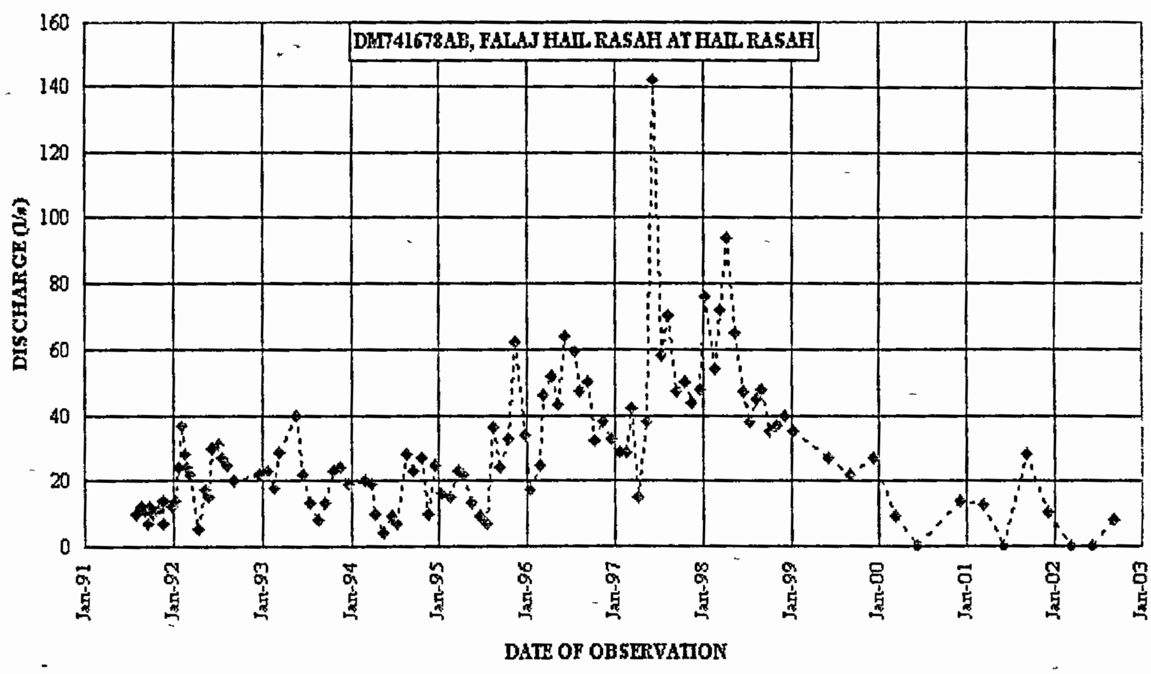
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
19-06-95	167	205	--	8	8	428	819	8 4
11-10-95	186	250	--	8	8	418	782	7 7
13-12-95	162	245	--	7	8	398	759	7 4
08-06-96	173	260	--	8	8	430	815	7 7
16-09-96	175	268	--	8	9	439	834	7 8
14-12-96	173	250	--	8	8	440	828	8 0
09-07-97	159	248	--	8	8	424	854	7 5
13-04-98	173	268	--	9	9	475	862	7.7
07-12-98	180	257	--	8	9	454	871	7 6
05-06-99	170	272	--	8	9	461	867	7 4
05-06-00	172	257	--	9	8	456	907	6 9
04-12-00	169	277	--	9	9	461	666	7 2

WADI SARAMI BASIN
DM741678AB, FALAJ HAIL RASAH AT HAIL RASAH

LOCATION

UTM	471743 E, 2646787 N
LATITUDE	23° 55' 56"
LONGITUDE	56° 55' 56"
FALAJ TYPE	Ghaily
PERIOD OF RECORD	August 1991 to September 2002
REMARKS	112 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 142 l\s, 10 June 1997 Minimum measured discharge, 4 l\s, 15 May 1994



WADI SARAMI BASIN

DM741678AB, FALAJ HAIL RASAH AT HAIL RASAH

DISCHARGE MEASUREMENTS, Aug 1991 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
06-08-91	10	902	30 0	--
21-08-91	12	930	32 8	36 0
03-09-91	11	929	33 0	34 0
18-09-91	7	932	32 0	31 0
30-09-91	12	944	32 0	--
14-10-91	10	958	31 0	26 0
29-10-91	11	980	30 0	34 0
19-11-91	7	990	26 5	34 0
24-11-91	14	963	26 3	--
24-12-91	12	905	23 0	29 0
07-01-92	14	905	20 5	24 0
21-01-92	24	895	22 0	27 0
08-02-92	37	861	22 0	27 0
22-02-92	28	891	31 0	30 0
23-02-92	24	854	34 0	32 0
10-03-92	22	889	22 0	26 4
18-04-92	5	--	25 9	42 0
09-05-92	17	--	--	--
24-05-92	15	799	30 0	35 0
08-06-92	30	749	31 0	42 0
06-07-92	31	880	33 7	35 0
22-07-92	27	981	32 8	38 0
10-08-92	25	903	33 9	34 0
07-09-92	20	960	31 5	34 0
22-12-92	22	836	23 2	28 0
24-01-93	23	858	21 8	22 0
21-02-93	18	889	24 8	30 9
10-03-93	29	881	26 8	29 6
23-05-93	40	847	26 2	26 8
14-06-93	22	834	33 6	32 0
14-07-93	13	867	33 1	31 5
21-08-93	8	898	33 6	34 0
13-09-93	13	919	34 3	33 5
18-10-93	23	1013	28 5	26 6
14-11-93	24	1008	26 0	28 1
19-12-93	19	977	23 5	20 3
27-02-94	20	885	24 4	26 5
30-03-94	19	862	26 4	28 1
12-04-94	10	885	27 9	--
15-05-94	4	884	31 4	37 0
18-06-94	9	941	32 5	31 7
19-06-94	9	941	32 5	31 7
13-07-94	7	922	33 3	39 9
20-08-94	28	1002	33 6	38 9
19-09-94	23	981	30 9	31 1
19-10-94	27	962	28 6	30 1
15-11-94	10	929	27 5	24 7
17-12-94	25	920	23 7	31 1
15-01-95	16	964	21 3	21 6

WADI SARAMI BASIN
DM741678AB, FALAJ HAIL RASAH AT HAIL RASAH
DISCHARGE MEASUREMENTS, Aug 1991 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
14-02-95	15	1057	22 7	19 2
21-03-95	23	973	24 5	26 9
10-04-95	22	910	26 0	20 6
16-05-95	13	921	29 1	26 8
17-06-95	9	930	32 2	41 3
15-07-95	7	946	33 5	33 9
14-08-95	36	616	32 6	38 0
11-09-95	24	680	34 4	34 7
14-10-95	33	822	30 9	29 5
12-11-95	62	754	26 2	34 0
25-12-95	34	748	24 2	27 7
14-01-96	17	757	23 6	22 0
26-02-96	25	656	24 1	22 6
10-03-96	46	636	24 4	24 1
14-04-96	52	660	29 6	26 9
13-05-96	43	703	31 9	37 0
08-06-96	64	631	33 8	40 0
20-07-96	59	--	33 5	40 7
10-08-96	47	673	35 8	43 5
11-09-96	50	670	35 5	40 2
12-10-96	32	752	27 1	26 6
12-11-96	38	810	26 1	24 1
18-12-96	33	809	27 6	--
22-01-97	29	--	--	--
17-02-97	29	--	--	--
08-03-97	42	849	23 6	24 6
09-04-97	15	600	27 4	32 0
11-05-97	38	589	30 5	31 2
10-06-97	142	640	31 4	37 0
15-07-97	58	672	31 2	31 7
11-08-97	70	670	32 4	39 7
14-09-97	47	735	33 6	37 0
20-10-97	50	700	29 4	24 0
18-11-97	44	588	29 6	33 2
16-12-97	48	633	23 5	22 3
12-01-98	76	639	22 2	21 0
16-02-98	54	600	21 0	24 0
15-03-98	72	616	25.7	24 2
12-04-98	94	630	28 3	35 4
11-05-98	65	674	31 8	41 7
15-06-98	47	744	35 6	38 0
14-07-98	38	750	33 5	32 5
08-08-98	45	760	36 0	42 2
02-09-98	48	756	34 2	32 6
03-10-98	35	766	33 1	31 2
03-11-98	37	781	30 0	31 8
09-12-98	40	796	32 3	31 6
09-01-99	35	806	25 5	27 6
02-06-99	27	793	30 7	32 5

WADI SARAMI BASIN
DM741678AB, FALAJ HAIL RASAH AT HAIL RASAH
DISCHARGE MEASUREMENTS, Aug 1991 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
04-09-99	22	800	34 4	40 0
06-12-99	27	938	26 0	34 0
04-03-00	9	900	25 6	27 7
04-06-00	--	--	--	--
03-12-00	14	946	25 7	30 0
10-03-01	13	930	26 0	27 5
03-06-01	--	980	32 4	35 8
05-09-01	28	1072	33 0	37 0
04-12-01	10	1071	25 9	29 5
09-03-02	--	1070	26 7	25 6
08-06-02	--	1030	31 5	36 0
08-09-02	8	--	--	--

WADI SARAMI BASIN
DM741678AB, FALAJ HAIL RASAH AT HAIL RASAH
WATER QUALITY DATA, Jun 1995 to Jun 2001

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
17-06-95	306	--	--	99	0 10	--	0 5	39
11-09-95	214	--	--	58	0 10	--	0 9	32
25-12-95	222	--	0 10	103	0 10	--	1 0	43
08-06-96	216	--	--	72	0 53	--	0 6	50
18-12-96	236	--	--	82	0 10	--	0 2	44
15-07-97	144	--	--	63	0 16	--	0 8	38
14-09-97	150	--	--	93	0 10	--	1 0	38
12-04-98	206	--	--	64	0 10	--	0 9	46
04-06-00	261	--	--	122	0 10	--	0 5	55
03-06-01	235	--	--	130	0 24	--	0 5	56
Mean	**219**	--	**0.10**	**89**	**0.16**	--	**0.7**	**44**
Min	**144**	--	**0.10**	**58**	**0.10**	--	**0.2**	**32**
Max	**306**	--	**0.10**	**130**	**0.53**	--	**1.0**	**56**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
17-06-95	17	0 05	6 0	0 8	72	0 05	62	--
11-09-95	18	0 05	2 5	1 0	61	0 05	31	--
25-12-95	23	0 05	2 9	1 0	68	0 05	36	--
08-06-96	22	0 05	2 8	0 9	68	0 05	33	--
18-12-96	25	0 05	3 0	1 0	82	0 05	41	--
15-07-97	20	0 05	2 6	0 8	55	0 05	31	--
14-09-97	22	0 05	3 1	1 0	64	0 05	37	--
12-04-98	19	0 05	2 4	0 4	59	0 05	33	--
04-06-00	19	0 06	3 9	-0 3	87	0 06	55	--
03-06-01	21	0 05	4 1	0 8	90	0 05	61	--
Mean	**21**	**0 05**	**3.3**	**0.7**	**71**	**0.05**	**42**	--
Min	**17**	**0.05**	**2.4**	**-0.3**	**55**	**0.05**	**31**	--
Max	**25**	**0.06**	**6.0**	**1.0**	**90**	**0 06**	**62**	--

WADI SARAMI BASIN
DM741678AB, FALAJ HAIL RASAH AT HAIL RASAH
WATER QUALITY DATA, Jun 1995 to Jun 2001

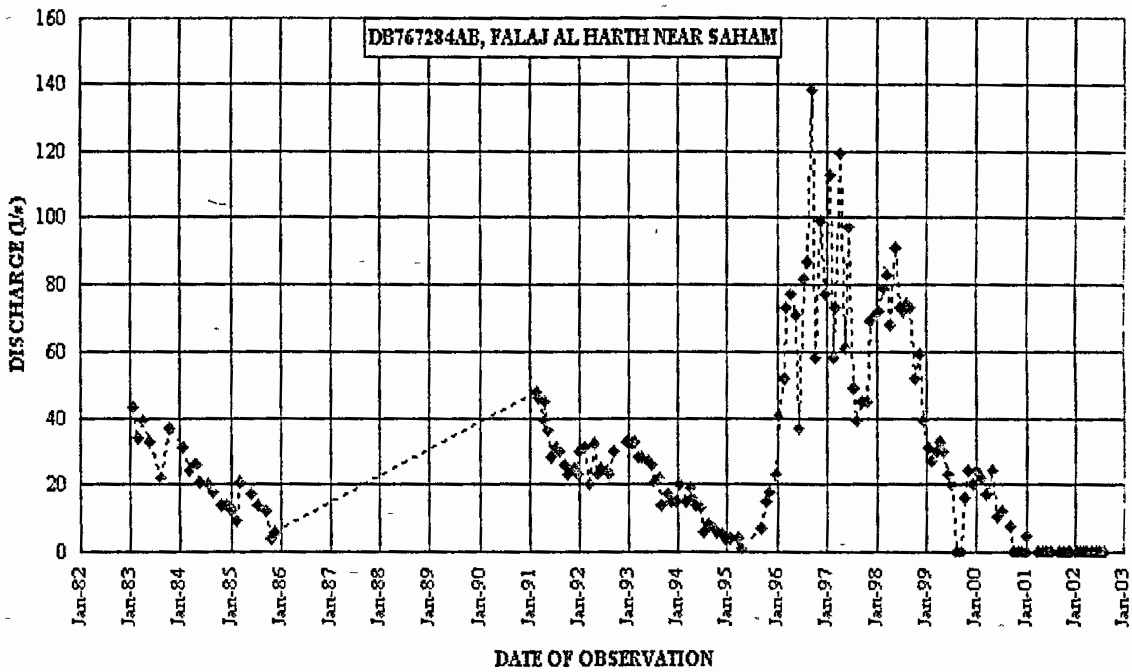
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
17-06-95	313	338	--	10	10	491	941	8 4
11-09-95	241	296	--	7	7	356	676	8 7
25-12-95	263	338	--	9	8	443	729	8 7
14-04-96	214	284	--	7	7	355	644	8 9
08-06-96	238	336	--	8	8	399	721	8 5
18-12-96	278	399	--	9	10	450	793	8 6
15-07-97	198	276	--	7	7	335	649	8 7
14-09-97	221	317	--	8	8	397	705	8 8
12-04-98	206	292	--	7	7	357	628	8 2
04-06-00	261	406	--	10	11	506	964	7 3
03-06-01	276	423	--	10	11	535	991	8 5

WADI SARAMI BASIN
DB767284AB, FALAJ AL HARTH NEAR SAHAM

LOCATION

UTM	477833 E, 2662459 N
LATITUDE	24° 04' 27"
LONGITUDE	56° 04' 27"
FALAJ TYPE	Daudi
PERIOD OF RECORD	January 1983 to September 2002
REMARKS	156 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 138 l\s, 11 September 1996 Minimum measured discharge, 1 l\s, 10 Apr 1995



WADI SARAMI BASIN
DB767284AB, FALAJ AL HARTH NEAR SAHAM
DISCHARGE MEASUREMENTS, Jan 1983 to Aug 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
19-01-83	43	650	32 0	--
26-02-83	34	600	32 0	--
04-04-83	39	680	30 0	--
23-05-83	33	650	38 0	--
14-08-83	22	660	35 0	--
19-10-83	37	660	32 5	--
25-01-84	31	640	30 5	--
07-03-84	24	640	32 0	--
17-04-84	26	--	--	--
21-04-84	26	670	35 0	--
22-05-84	21	650	34 0	--
17-07-84	20	650	35 0	--
27-08-84	18	650	34 0	--
21-10-84	14	745	23 0	--
04-12-84	14	695	30 0	--
22-12-84	13	650	31 0	--
10-01-85	12	--	--	--
11-02-85	9	--	--	--
13-03-85	21	600	30 0	--
29-05-85	17	670	35 0	--
13-07-85	14	--	--	--
14-09-85	12	600	35 0	--
19-10-85	4	--	--	--
13-11-85	6	--	--	--
24-02-91	48	520	34 0	--
12-03-91	46	650	34 0	--
22-04-91	39	646	34 0	--
23-04-91	45	--	35 0	40 0
20-05-91	36	648	34 0	--
12-06-91	28	651	34 2	--
14-07-91	31	650	34 0	--
12-08-91	30	652	34 0	34 0
16-09-91	26	654	34 0	--
15-10-91	23	656	34 0	35 0
24-11-91	25	655	33 8	31 0
24-12-91	23	661	34 0	33 0
07-01-92	30	652	33 3	27 0
08-02-92	31	651	34 0	31 0
18-03-92	20	658	34 0	39 0
25-04-92	32	661	33 9	39 0
09-05-92	23	663	34 0	38 0
08-06-92	25	652	33 9	44 0
22-07-92	24	654	34 0	42 0
10-08-92	23	653	34 2	37 0
07-09-92	30	661	33 8	40 0
22-12-92	33	666	33 8	29 0
24-01-93	32	659	33 6	34 0
21-02-93	33	660	33 8	33 2
10-03-93	28	667	33 5	35 0

WADI SARAMI BASIN
DB767284AB, FALAJ AL HARTH NEAR SAHAM
DISCHARGE MEASUREMENTS, Jan 1983 to Aug 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
12-04-93	28	665	33 9	35 0
23-05-93	27	661	33 8	47 9
14-06-93	26	672	33 0	34 0
14-07-93	21	666	33 9	33 4
21-08-93	22	662	34 0	35 0
02-09-93	14	665	34 0	34 5
18-10-93	17	670	33 2	30 9
14-11-93	15	669	33 2	30 0
19-12-93	15	665	32 7	26 5
12-01-94	20	673	31 2	27 8
27-02-94	15	--	32 7	22 7
30-03-94	19	655	33 4	34 8
12-04-94	16	668	33 5	27 7
15-05-94	14	656	33 8	37 8
18-06-94	13	661	33 7	33 3
13-07-94	6	664	34 1	40.0
20-08-94	8	663	34 4	38 0
19-09-94	7	660	29 0	33 5
19-10-94	6	660	33 0	32 9
15-11-94	5	663	32 6	26 8
17-12-94	4	662	31 8	25 2
15-01-95	4	711	31 2	25 9
21-03-95	4	718	31 8	29 8
10-04-95	1	657	31 7	34 7
11-09-95	7	670	34 0	35 3
14-10-95	15	752	33 7	46 1
12-11-95	18	658	33 6	38 8
25-12-95	23	661	33 8	28 3
14-01-96	41	679	26 3	21 0
26-02-96	52	702	33 7	23 5
10-03-96	73	689	30 5	27 8
14-04-96	77	657	33 5	--
13-05-96	71	629	34 0	37 9
08-06-96	37	739	33 7	30 5
20-07-96	82	660	33 6	32 7
10-08-96	87	626	32 2	44 6
11-09-96	138	626	34 6	32 3
12-10-96	58	513	27 3	25 2
12-11-96	99	616	35 0	26 6
18-12-96	77	623	31 3	--
22-01-97	113	--	--	--
17-02-97	58	--	--	--
08-03-97	73	643	34 3	30 2
09-04-97	119	640	34 3	34 8
11-05-97	61	621	31 1	32 3
10-06-97	97	630	34 2	44 1
15-07-97	49	633	33 9	40 8
11-08-97	39	620	34 2	41 7

WADI SARAMI BASIN
DB767284AB, FALAJ AL HARTH NEAR SAHAM
DISCHARGE MEASUREMENTS, Jan 1983 to Aug 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
14-09-97	45	633	34 3	33 5
20-10-97	45	620	34 4	32 8
18-11-97	69	632	34 3	36 2
16-12-97	71	634	34 5	27 4
12-01-98	72	629	34 6	32 1
16-02-98	79	626	34 3	26 8
15-03-98	83	631	34 2	31 0
12-04-98	68	611	34 0	35 8
11-05-98	91	611	33 9	38 5
15-06-98	73	620	33 8	39 7
14-07-98	72	620	34 3	36 2
08-08-98	74	620	34 4	40 1
02-09-98	73	612	34 8	47 0
06-10-98	52	618	34 7	36 7
08-11-98	59	630	34 7	33 2
09-12-98	39	630	34 8	29 6
09-01-99	31	337	24 2	34 7
08-02-99	27	639	34 7	29 4
08-03-99	30	628	34 4	27 7
07-04-99	33	634	34 6	34 8
02-05-99	30	640	34 6	32 5
02-06-99	23	655	34 5	32 2
04-07-99	20	639	34 6	38 9
02-08-99	--	626	34 7	36 6
04-09-99	--	--	--	--
03-10-99	16	649	31 9	34 2
02-11-99	24	630	34 6	31 6
06-12-99	20	630	34 0	25 0
02-01-00	24	656	32 0	27 0
01-02-00	22	640	34 0	29 0
04-03-00	17	636	34 0	27 0
02-04-00	18	630	34 3	34 1
02-05-00	24	650	34 0	35 0
04-06-00	10	690	34 5	--
02-07-00	12	650	34 3	--
03-09-00	7	650	30 0	36 0
02-10-00	--	--	--	--
01-11-00	--	629	32 4	30 0
03-12-00	--	--	--	--
02-01-01	5	630	30 8	26 7
04-01-01	--	630	38 2	25 0
03-04-01	--	627	30 5	29 0
02-05-01	--	624	31 2	36 0
03-06-01	--	630	32 4	39 0
06-07-01	--	--	--	--
05-09-01	--	629	33 0	33 0

WADI SARAMI BASIN
DB767284AB, FALAJ AL HARTH NEAR SAHAM
DISCHARGE MEASUREMENTS, Jan 1983 to Aug 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
06-10-01	--	622	32 2	30 0
11-11-01	--	--	--	--
04-12-01	--	--	--	--
12-01-02	--	654	29 4	26 4
13-02-02	--	640	27 6	--
09-03-02	--	600	29 2	--
03-04-02	--	590	29 4	--
05-05-02	--	610	31 1	35 0
08-06-02	--	600	35 4	32 7
08-07-02	--	620	32 0	36 3
05-08-02	--	--	--	--

WADI SARAMI BASIN
DB767284AB, FALAJ AL HARTH NEAR SAHAM
WATER QUALITY DATA, Dec 1990 to Jun 2001

ANION

Date	Bicarbonate AsHCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
09-12-90	190	--	--	69	0.10	--	1.9	52
17-06-95	160	--	--	90	0.10	--	1.6	43
11-09-95	171	--	--	76	0.10	--	1.7	50
25-12-95	158	--	0.11	96	0.10	--	1.9	53
14-04-96	160	--	--	64	0.37	--	2.0	50
18-12-96	160	--	--	68	0.17	--	2.1	53
14-09-97	144	--	--	65	0.10	--	1.9	51
04-07-99	169	--	--	68	0.10	--	1.9	53
03-12-00	166	--	--	72	0.10	--	2.1	49
03-01-01	151	--	--	67	0.17	--	2.1	53
Mean	**163**	**--**	**0.11**	**74**	**0.14**	**--**	**1.9**	**51**
Min	**144**	**--**	**0.11**	**64**	**0.10**	**--**	**1.6**	**43**
Max	**190**	**--**	**0.11**	**96**	**0.37**	**--**	**2.1**	**53**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
09-12-90	21	0.05	2.7	-0.4	44	0.05	48	--
11-09-95	23	0.05	2.5	0.5	50	0.05	47	--
25-12-95	22	0.05	2.4	0.0	44	0.05	46	--
18-12-96	20	0.05	2.3	0.2	42	0.05	44	--
14-09-97	22	0.05	2.5	0.1	40	0.05	48	--
04-07-99	22	0.05	2.9	0.0	46	0.01	48	--
03-12-00	21	0.07	2.9	-0.1	48	0.05	46	--
03-06-01	19	0.05	2.9	0.4	45	0.05	43	--
Mean	**21**	**0.05**	**2.6**	**0.1**	**45**	**0.05**	**46**	**--**
Min	**19**	**0.05**	**2.3**	**-0.4**	**40**	**0.01**	**43**	**--**
Max	**23**	**0.07**	**2.9**	**0.5**	**50**	**0.05**	**48**	**--**

WADI SARAMI BASIN
DB767284AB, FALAJ AL HARTH NEAR SAHAM
WATER QUALITY DATA, Dec 1990 to Jun 2001

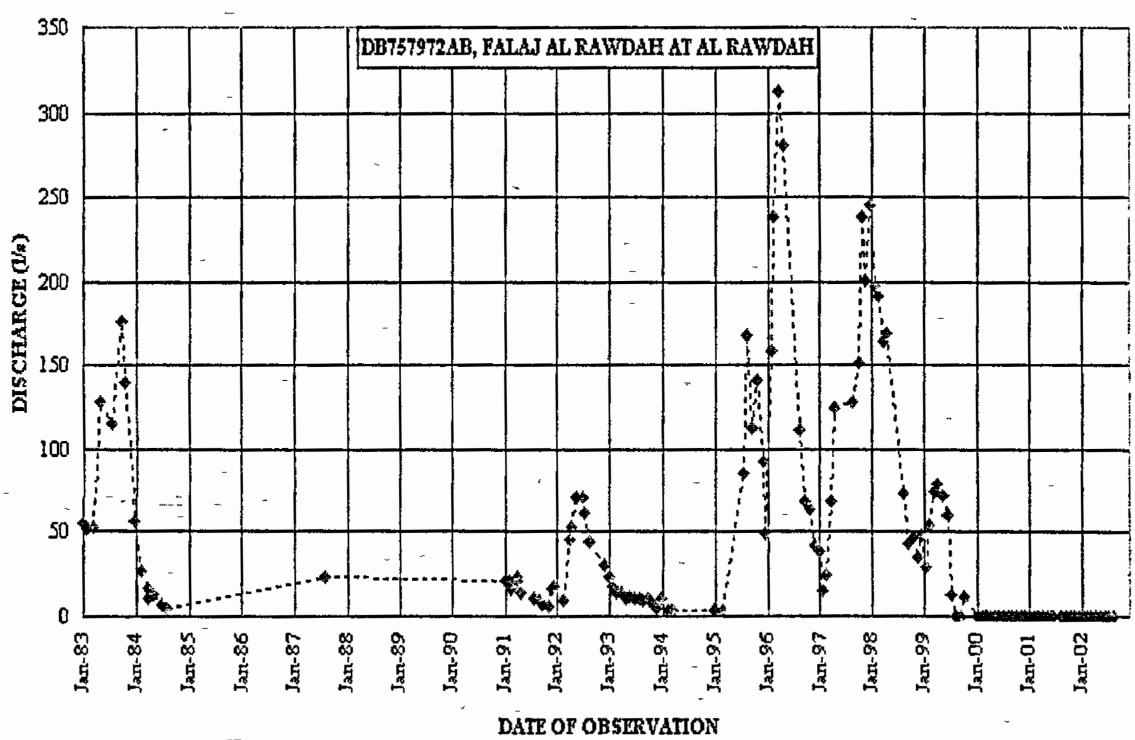
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
09-12-09	190	234	--	7	7	363	629	7 3
17-06-95	160	190	--	7	7	366	709	8 3
11-09-95	171	262	--	7	7	362	675	8 2
25-12-95	158	236	--	7	7	370	645	7 8
14-04-96	160	218	--	6	6	331	623	8 0
18-12-96	160	223	--	6	6	338	606	8 0
14-09-97	144	218	--	6	6	326	607	7 9
04-07-99	169	244	--	7	7	353	632	7 9
03-12-00	166	251	--	7	7	352	482	7 6
03-06-01	157	233	--	6	7	337	638	8 3

WADI SARAMI BASIN
DB757972AB, FALAJ AL RAWDAH AT AL RAWDAH

LOCATION

UTM	477977 E, 2659376 N
LATITUDE	24° 02' 47"
LONGITUDE	56° 47' 00"
FALAJ TYPE	Daudi
PERIOD OF RECORD	January 1983 to September 2002
REMARKS	134 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 313 l\s, 14 April 1996 Minimum measured discharge, 3 l\s, 30 Marr 1994



WADI SARAMI BASIN

DB757972AB, FALAJ AL RAWDAH AT AL RAWDAH

DISCHARGE MEASUREMENTS, Jan 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
29-01-83	55	--	--	--
26-02-83	52	600	32 0	--
04-04-83	53	620	29 0	--
23-05-83	128	550	35 0	--
14-08-83	115	545	34 0	--
19-10-83	176	575	30 0	--
13-11-83	140	570	33 0	--
25-01-84	56	550	32 0	--
07-03-84	27	550	32 0	--
17-04-84	16	--	--	--
21-04-84	11	600	36 0	--
22-05-84	13	590	34 0	--
17-07-84	7	550	33 5	--
27-08-84	5	550	32 0	--
19-08-87	24	--	35 0	--
08-02-91	21	637	33 0	23 0
24-02-91	21	500	33 0	--
12-03-91	17	640	33 0	--
22-04-91	21	639	33 0	--
23-04-91	24	--	33 0	37 0
20-05-91	14	641	33 1	--
12-08-91	11	640	33 0	34 0
16-09-91	9	635	33 3	37 0
15-10-91	7	647	32 0	35 0
24-11-91	6	650	32 8	30 0
24-12-91	17	643	33 0	28 0
07-01-92	18	635	32 5	25 0
15-03-92	9	653	33 0	28 0
25-04-92	46	619	32 7	34 0
09-05-92	53	630	32 0	35 0
08-06-92	71	634	33 0	39 0
22-07-92	71	635	33 0	35 0
10-08-92	61	636	33.1	34 0
07-09-92	45	644	33 3	38 0
22-12-92	31	644	33.2	32 0
24-01-93	24	636	32 9	28 0
21-02-93	18	630	33 2	45 4
10-03-93	14	634	33 1	--
12-04-93	14	628	33 0	28 0
23-05-93	10	625	33 0	43 6
14-06-93	12	637	33 3	36 1
14-07-93	10	631	33 2	36 3
21-08-93	11	634	33 4	36 4
13-09-93	9	633	33 1	34 0
18-10-93	10	635	33 1	38 7
14-11-93	8	643	32 8	28 1
19-12-93	5	650	32 4	26 6
12-01-94	10	650	32 4	39 0
27-02-94	3	646	23 5	24 4

WADI SARAMI BASIN
DB757972AB, FALAJ AL RAWDAH AT AL RAWDAH
DISCHARGE MEASUREMENTS, Jan 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
30-03-94	4	642	33 0	27 9
12-04-94	3	650	32 8	31 5
15-01-95	4	711	31 2	35 9
21-03-95	4	718	31 8	29 8
14-08-95	86	--	33 4	37 0
11-09-95	168	600	34 2	35 0
14-10-95	113	648	34 7	34 9
12-11-95	141	564	34 7	36 7
25-12-95	93	569	34 0	24 0
14-01-96	49	573	25 3	21 0
26-02-96	158	602	30 7	24 0
10-03-96	239	572	30 9	27 7
14-04-96	313	593	30 3	28 0
13-05-96	281	574	31 3	36 6
11-09-96	112	620	32 6	30 6
12-10-96	68	622	27 0	25 6
12-11-96	64	618	32 9	24 8
18-12-96	42	618	30 5	--
22-01-97	39	--	--	--
17-02-97	15	--	--	--
08-03-97	25	623	32 7	28 9
09-04-97	68	--	31 4	35 8
11-05-97	124	611	33 8	32 9
14-09-97	128	620	32 6	34 8
20-10-97	151	600	33 4	35 9
18-11-97	239	568	33 2	36 2
16-12-97	201	577	32 5	27 1
12-01-98	245	577	32 2	27 0
16-02-98	197	581	31 0	26 4
15-03-98	191	588	30 1	29 3
12-04-98	164	575	29 9	38 5
11-05-98	169	576	30 1	39 0
02-09-98	73	591	31 5	33 4
06-10-98	43	590	31 8	33 2
08-11-98	47	580	31 9	27 5
09-12-98	35	600	32 0	28 5
09-01-99	48	596	32 0	24 0
07-02-99	29	598	32 1	27 9
08-03-99	54	575	31 8	26 9
07-04-99	74	591	32 5	34 3
02-05-99	79	610	32 5	34 4
02-06-99	72	--	32 7	30 1
04-07-99	60	606	32 8	40 2
02-08-99	13	606	32 5	39 7
04-09-99	--	--	--	--
03-10-99	--	--	--	--
02-11-99	12	600	32 5	27 6
01-02-00	--	840	31 6	24 7
04-03-00	--	--	--	--

WADI SARAMI BASIN
DB757972AB, FALAJ AL RAWDAH AT AL RAWDAH
DISCHARGE MEASUREMENTS, Jan 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
02-04-00	--	--	--	--
06-04-00	--	--	--	--
02-05-00	--	--	--	--
04-06-00	--	652	35 0	40 0
02-07-00	--	610	31 6	36 0
02-08-00	--	--	--	--
03-09-00	--	--	--	--
02-10-00	--	--	--	--
01-11-00	--	--	--	--
03-12-00	--	--	--	--
02-01-01	--	--	--	--
04-02-01	--	--	--	--
10-03-01	--	--	--	--
03-04-01	--	--	--	--
02-05-01	--	--	--	--
03-06-01	--	--	--	--
05-07-01	--	--	--	--
06-07-01	--	--	--	--
05-09-01	--	--	--	--
06-10-01	--	--	--	--
10-11-01	--	--	--	--
12-12-01	--	--	--	--
12-01-02	--	--	--	--
13-02-02	--	--	--	--
09-03-02	--	--	--	--
03-04-02	--	--	--	--
05-05-02	--	--	--	--
08-06-02	--	--	--	--
08-07-02	--	--	--	--
05-08-02	--	--	--	--
08-09-02	--	--	--	--

WADI SARAMI BASIN
DB757972AB, FALAJ AL RAWDAH AT AL RAWDAH
WATER QUALITY DATA, Sep 1995 to Jun 2000

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
11-09-95	162	--	--	70	0 10	--	2.1	51
25-12-95	148	--	0 09	68	0 10	--	1 9	51
18-12-96	160	--	--	62	0 10	--	2.0	60
15-07-97	142	--	--	55	0 16	--	1 6	51
14-09-97	132	--	--	95	0.10	--	1 8	59
24-11-97	139	--	--	58	0 10	--	1 8	48
12-04-98	156	--	--	59	0 33	--	2 0	51
04-07-99	165	--	--	64	0 10	--	1 9	62
04-06-00	196	--	--	60	0 10	--	2 1	51
Mean	**156**	**--**	**0.09**	**66**	**0.13**	**--**	**1.9**	**54**
Min	**132**	**--**	**0.09**	**55**	**0.10**	**--**	**1.6**	**48**
Max	**196**	**--**	**0 09**	**95**	**0.33**	**--**	**2.1**	**62**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
11-09-95	22	0 05	2 5	0 1	47	0 05	38	--
25-12-95	19	0 05	2 3	0 4	37	0 05	36	--
18-12-96	23	0 05	2 5	0 4	42	0 05	41	--
15-07-97	23	0 05	2 4	0 1	34	0 05	41	--
14-09-97	27	0 05	2 6	0 2	36	0 05	45	--
24-11-97	23	0 05	2 5	-0 1	38	0 05	38	--
12-04-98	22	0 05	3 2	-0 1	37	0 05	45	--
04-07-99	25	0 05	2 8	0 2	45	0 01	45	--
04-06-00	21	0 05	2 6	-1 0	43	0 05	36	--
Mean	**23**	**0.05**	**2.6**	**0.0**	**40**	**0 05**	**41**	**--**
Min	**19**	**0.05**	**2.3**	**-1.0**	**34**	**0.01**	**36**	**--**
Max	**27**	**0 05**	**3.2**	**0 4**	**47**	**0 05**	**45**	**--**

WADI SARAMI BASIN
DB757972AB, FALAJ AL RAWDAH AT AL RAWDAH
WATER QUALITY DATA, Sep 1995 to Jun 2000

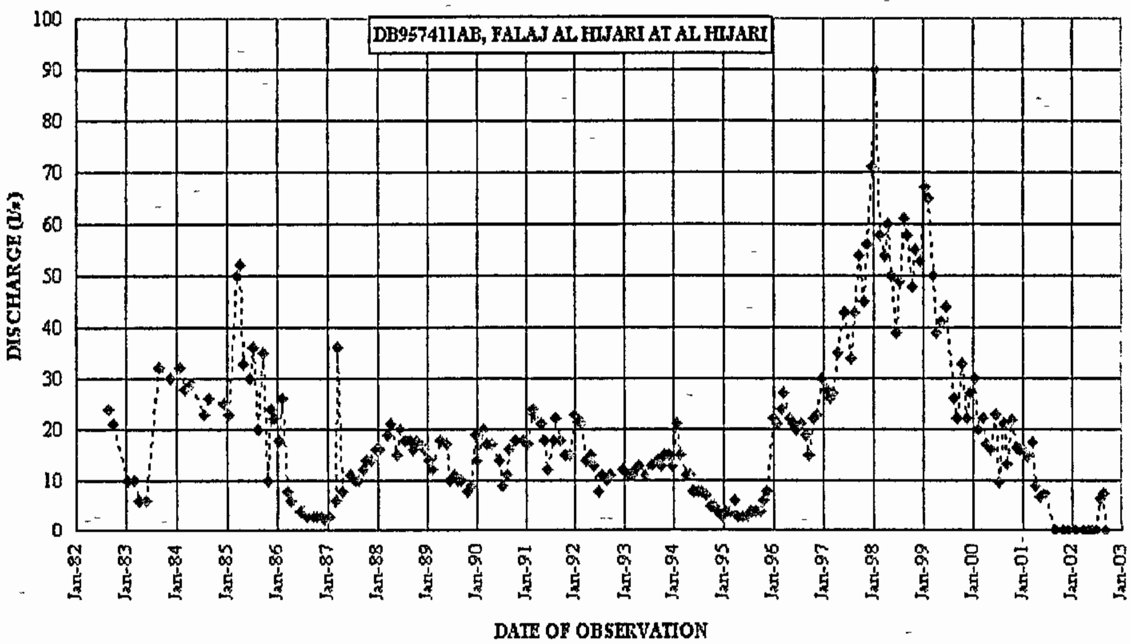
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
11-09-95	162	247	--	6	7	340	596	7 9
25-12-95	148	202	--	6	6	315	554	8 2
14-04-96	142	198	--	6	6	305	565	8 1
18-12-96	160	231	--	6	6	339	605	8 2
15-07-97	142	199	--	6	6	302	562	7.9
14-09-97	132	214	--	7	6	355	589	8 0
24-11-97	139	215	--	6	6	303	566	7 8
12-04-98	156	207	--	6	6	323	570	7 8
04-07-99	165	248	--	7	7	355	602	8 0
04-06-00	196	232	--	7	6	345	620	6 7

WADI SHAFAN BASIN
DB957411AB, FALAJ AL HIJARI AT AL HIJARI

LOCATION

UTM	496615 E, 2652984 N
LATITUDE	23° 59' 20"
LONGITUDE	56° 58' 00"
FALAJ TYPE	Daudı
PERIOD OF RECORD	August 1982 to September 2002
REMARKS	218 measurements have been made at the sıte
MEASURED EXTREMES	Maxımum measured dıscharge, 90 l\s, 13 January 1998 Mınımum measured dıscharge, 2 l\s, 13 December 1986



WADI SHAFAN BASIN
DB957411AB, FALAJ AL HIJARI AT AL HIJARI
DISCHARGE MEASUREMENTS, Aug 1982 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
25-08-82	24	1455	35 0	--
25-09-82	21	1450	36 0	--
11-01-83	10	1550	27 0	--
26-02-83	10	1600	29 0	--
04-04-83	6	1550	26 0	--
23-05-83	6	1620	35 0	--
22-08-83	32	--	--	--
14-11-83	30	1700	32 0	--
21-01-84	32	1680	29 5	--
03-03-84	28	--	--	--
14-04-84	29	--	--	--
15-07-84	23	1700	38 0	--
26-08-84	26	1450	34 0	--
04-12-84	25	--	29 0	--
10-01-85	23	--	--	--
13-03-85	50	1400	30 0	--
08-04-85	52	--	--	--
05-05-85	33	1400	35 0	--
12-06-85	30	1390	32 0	--
13-07-85	36	--	--	--
13-08-85	20	--	--	--
14-09-85	35	1400	39 0	--
19-10-85	10	--	--	--
12-11-85	24	--	--	--
10-12-85	22	1300	25 0	--
11-01-86	18	1300	28 0	--
11-02-86	26	1300	25 0	--
10-03-86	8	1200	25 0	--
13-04-86	6	1220	23 0	--
21-06-86	4	--	--	--
09-07-86	4	--	--	--
09-08-86	3	--	--	--
22-09-86	3	--	31 0	--
08-10-86	3	--	--	--
12-11-86	3	--	--	--
13-12-86	2	--	--	--
17-01-87	3	1325	25 0	--
08-03-87	6	1050	29 0	--
15-03-87	36	1600	26 0	--
23-04-87	8	1025	32 0	--
16-06-87	11	1700	40 0	--
20-07-87	10	1150	32 0	--
19-08-87	10	--	38 0	--
16-09-87	12	2000	--	--
17-10-87	14	1720	28 0	--
15-11-87	14	1600	30 0	--
18-12-87	16	--	--	--
19-01-88	16	1620	30 0	--
14-03-88	19	1650	--	--
09-04-88	21	1300	36 0	--
25-05-88	15	1650	35 0	--
22-06-88	20	1600	35 0	--
18-07-88	18	1630	35 0	--

WADI SHAFAN BASIN
DB957411AB, FALAJ AL HIJARI AT AL HIJARI
DISCHARGE MEASUREMENTS, Aug 1982 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
23-08-88	18	1300	34 0	--
19-09-88	16	1250	32 0	--
12-10-88	18	1600	--	--
15-11-88	17	1550	29 0	--
17-12-88	16	--	--	--
11-01-89	14	1625	24 0	--
13-02-89	12	1700	32 0	--
08-04-89	18	1550	31 0	--
27-05-89	17	1600	32 0	--
14-06-89	10	1500	36 0	--
22-07-89	11	--	--	--
19-08-89	10	1600	34 0	--
13-09-89	10	--	--	--
24-10-89	8	1600	33 0	--
21-11-89	9	1625	32 0	--
19-12-89	19	2050	26 0	--
08-01-90	14	1680	29 0	--
17-02-90	20	1750	30 0	--
17-03-90	17	--	--	--
16-04-90	17	--	--	--
18-06-90	14	1400	37 0	--
19-07-90	9	--	--	--
19-08-90	11	1605	38 0	--
02-09-90	16	--	--	--
20-10-90	18	1650	--	--
10-12-90	18	--	32 0	26 0
21-01-91	17	--	32 0	29 0
24-02-91	24	1450	35 0	--
12-03-91	23	1720	25 0	--
22-04-91	21	1685	32 5	40 0
20-05-91	18	--	--	--
12-06-91	12	1655	33 0	--
22-07-91	18	1659	33 0	42 0
11-08-91	22	1656	33 5	--
15-09-91	18	1649	33 3	39 0
15-10-91	15	1646	33 0	35 0
23-11-91	15	1651	33 0	30 0
21-12-91	23	1756	32 0	--
20-01-92	22	1636	32 0	26 0
17-02-92	21	1638	32 0	28 0
17-03-92	14	1635	32 1	--
19-04-92	15	1637	32 0	34 0
11-05-92	13	1570	32 0	32 0
23-06-92	8	1533	33 2	39 0
18-07-92	11	1563	33 4	38 0
22-08-92	10	1242	34 0	37 0
12-09-92	11	1551	33 4	35 0
16-12-92	12	1575	32 2	28 0
30-01-93	11	1580	31 4	30 0
20-02-93	11	1559	31 7	34 0
15-03-93	12	1569	31 9	26 8
17-04-93	13	1560	32 4	30 0
25-05-93	11	1560	33 0	30 0
16-06-93	11	1596	33 3	35 0
20-07-93	13	1584	33 8	32 4
27-08-93	14	1584	33 3	44 0

WADI SHAFAN BASIN
DB957411AB, FALAJ AL HIJARI AT AL HIJARI
DISCHARGE MEASUREMENTS, Aug 1982 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
20-09-93	13	--	--	--
19-10-93	15	1141	32 7	35 0
17-11-93	15	1616	33 0	30 5
18-12-93	13	1654	31 9	34 5
23-01-94	21	1649	32 2	29 0
07-02-94	15	1636	--	--
26-03-94	11	1583	32 7	30 0
27-04-94	11	1579	35 9	38 5
16-05-94	8	1573	33 3	46 9
19-06-94	8	1561	34 0	47 0
19-07-94	8	1575	34 0	41 0
24-08-94	7	1587	34 2	36 2
26-09-94	5	1582	33 6	36 0
16-10-94	5	1566	33 5	31 0
14-11-94	4	1588	32 8	27 7
20-12-94	3	1559	31 7	24 1
14-01-95	4	1760	30 4	24 9
13-02-95	4	1728	29 8	26 2
20-03-95	6	1720	31 3	27 0
18-04-95	3	1719	31 1	30 5
24-05-95	3	1537	33 5	31 0
19-06-95	3	1531	33 6	41 8
17-07-95	4	1487	34 4	32 7
15-08-95	4	1514	33 9	42 3
20-09-95	4	1528	33 7	29 5
21-10-95	6	1900	32 9	30 4
14-11-95	8	1665	32.5	33 1
29-12-95	22	1862	32 1	25 4
17-01-96	21	1838	31 8	26 8
27-02-96	24	1940	31 9	31 1
13-03-96	27	1950	32 0	23 9
21-04-96	22	2100	32 1	33 3
14-05-96	21	1910	32 7	37 9
11-06-96	20	1825	32 9	34 0
15-07-96	21	1854	33 3	39 9
17-08-96	19	1860	33 5	33 9
16-09-96	15	1854	33 6	36 1
21-10-96	22	1865	--	--
13-11-96	23	1840	32 9	30 3
15-12-96	30	1885	31 6	24 2
25-01-97	28	--	31 8	26 0
19-02-97	26	1990	32 0	30 0
10-03-97	27	--	32 6	28 7
09-04-97	35	2100	32 0	28 5
04-06-97	43	2160	32 2	34 4
15-07-97	34	1970	31 2	33 4
13-08-97	43	2030	33 0	31 2
16-09-97	54	2005	33 5	32 1
21-10-97	45	1964	33 5	36 0
17-11-97	56	1923	33 2	28 8
14-12-97	71	1943	32 3	29 2
13-01-98	90	1869	31 4	24 9
16-02-98	58	1789	31 0	34 5
17-03-98	54	1788	30 7	33 6
14-04-98	60	1746	31 0	45 9

WADI SHAFAN BASIN
DB957411AB, FALAJ AL HIJARI AT AL HIJARI
DISCHARGE MEASUREMENTS, Aug 1982 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
12-05-98	50	1725	31 8	35 6
13-06-98	39	1704	27 6	39 4
11-07-98	49	1650	33 2	42 0
08-08-98	61	1645	33 5	38 0
07-09-98	58	1633	33 9	38 0
07-10-98	48	1620	33 9	35 6
07-11-98	55	1820	34 3	33 9
08-12-98	53	1630	33 5	27 0
06-01-99	67	1630	32 8	25 2
07-02-99	65	1661	32 4	32 3
10-03-99	50	1637	31 9	30 3
06-04-99	39	1630	32 2	34 2
08-05-99	41	1672	32 5	34 7
09-06-99	44	1671	33 0	39 9
09-08-99	26	1660	33 4	31 6
08-09-99	22	1650	30 0	32 5
09-10-99	33	1122	33 7	32 2
08-11-99	22	1480	--	--
08-12-99	27	1400	33 0	31 0
15-01-00	30	1600	28 0	30 0
06-02-00	20	1533	32 0	30 0
08-03-00	22	1523	32 2	30 5
09-04-00	17	1430	32 2	37 1
08-05-00	16	1450	33 0	38 0
10-06-00	23	1570	31 7	--
08-07-00	10	1380	33 3	--
08-08-00	21	1900	28 5	38 8
09-09-00	13	1585	30 0	36 0
08-10-00	22	1390	32 9	34 6
08-11-00	16	1371	32 3	32 9
06-12-00	16	1386	31 8	39 0
09-01-01	16	1403	31 6	27 8
10-02-01	15	1377	29 7	26 5
12-03-01	18	1370	29 5	29 0
08-04-01	9	1370	31 5	33 9
12-05-01	7	1400	32 4	41 8
10-06-01	8	1362	33 2	38 0
18-08-01	--	1370	35 3	37 2
21-10-01	--	1400	30 5	32 0
24-11-01	--	1400	25 8	24 6
26-01-02	--	--	--	--
25-03-02	--	--	--	--
28-04-02	--	1034	33 0	30 8
27-05-02	--	--	--	--
24-06-02	--	1285	37 7	29 5
30-07-02	6	1286	26 5	35 5
26-08-02	7	1333	31 9	34 0
09-09-02	--	--	--	--

WADI SHAFAN BASIN

DB957411AB, FALAJ AL HIJARI AT AL HIJARI

WATER QUALITY DATA,Oct 1995 to Jun 2001

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
21-10-95	197	--	--	338	0 20	--	2 5	175
29-12-95	192	--	0 25	379	0 23	--	2 9	191
11-06-96	204	--	--	366	0 89	--	2 7	181
30-12-96	154	--	--	388	0 21	--	2 5	181
15-07-97	181	--	--	422	0 13	--	2 7	180
16-09-97	176	--	--	411	0 10	--	2 6	214
13-01-98	187	--	--	473	0 14	--	3 2	92
08-12-98	320	--	--	182	0 10	--	1 2	49
10-06-00	220	--	--	266	0 10	--	3 0	14
10-06-01	204	--	--	216	0 45	--	3 1	181
Mean	**204**	**--**	**0 25**	**344**	**0.26**	**--**	**2.6**	**146**
Min	**154**	**--**	**0.25**	**182**	**0.10**	**--**	**1.2**	**14**
Max	**320**	**--**	**0.25**	**473**	**0.89**	**--**	**3.2**	**214**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
21-10-95	45	0 06	5 1	0 7	65	0 05	191	--
29-12-95	53	0 05	5 9	0 6	78	0 05	210	--
11-06-96	58	0 05	5 8	0 8	72	0 05	214	--
30-12-96	43	0 05	6 1	1 0	74	0 05	224	--
15-07-97	62	0 05	7 0	0 5	76	-0 05	266	--
16-09-97	57	0 05	6 8	0 8	66	0 05	256	--
13-01-98	53	0 05	7 7	0 4	59	0 05	226	--
08-12-98	49	0 05	3 7	0 2	68	0 05	103	--
10-06-00	36	0 05	4 7	-0 6	49	0 05	158	--
10-06-01	38	0 05	4 9	0 7	54	0 05	170	--
Mean	**49**	**0.05**	**5.8**	**0.5**	**66**	**0 05**	**202**	**--**
Min	**36**	**0.05**	**3.7**	**-0 6**	**49**	**0.05**	**103**	**--**
Max	**62**	**0.06**	**7.7**	**1.0**	**78**	**0 05**	**266**	**--**

WADI SHAFAN BASIN

DB957411AB, FALAJ AL HIJARI AT AL HIJARI

WATER QUALITY DATA,Oct 1995 to Jun 2001

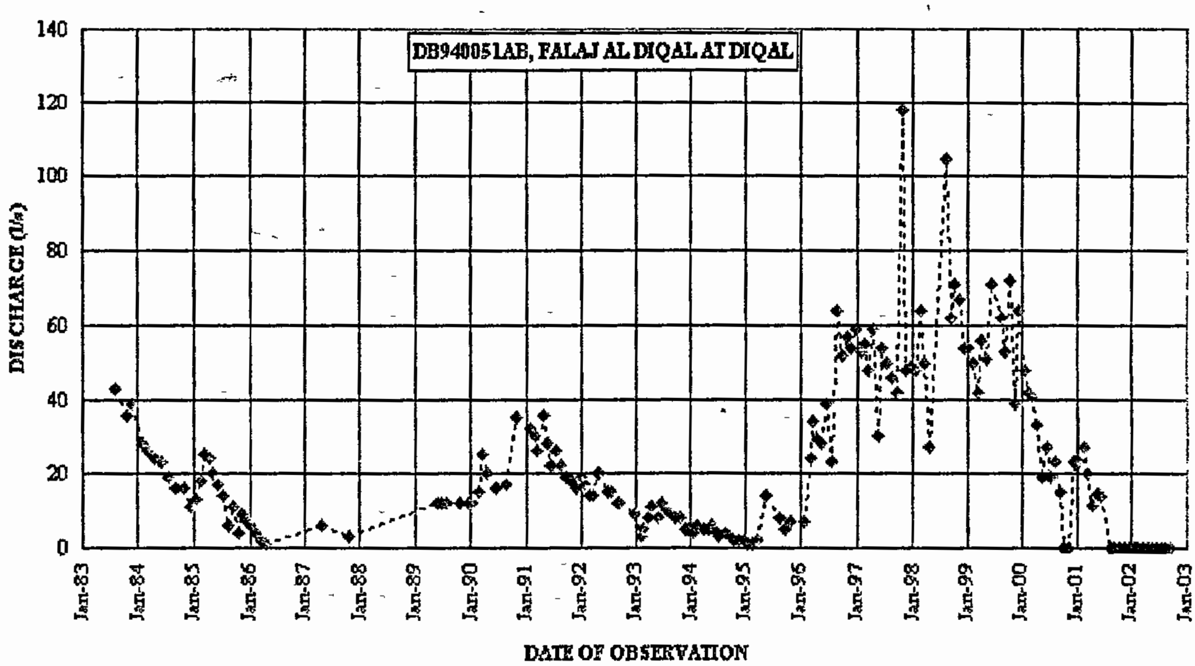
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
21-10-95	197	380	--	17	16	952	1640	8 1
29-12-95	192	452	--	19	18	1049	1830	8 0
21-04-96	203	460	--	19	19	1082	1930	8 3
11-06-96	204	442	--	18	18	1037	1860	8 1
30-12-96	194	411	--	19	18	1047	1870	8 6
15-07-97	181	469	--	19	21	1138	2070	7 9
16-09-97	176	413	--	20	20	1132	1970	8 1
13-01-98	187	379	--	19	18	1043	1800	7 8
08-12-98	320	407	--	13	13	662	1152	7 3
10-06-00	220	293	--	12	13	679	1428	6 7
10-06-01	204	319	--	14	14	806	1400	8 2

WADI AL HAWASINAH BASIN
DB940051AB, FALAJ AL DIQAL AT DIQAL

LOCATION

UTM	490594 E, 2640306 N
LATITUDE	23° 59' 27"
LONGITUDE	56° 54' 27"
FALAJ TYPE	Daudı
PERIOD OF RECORD	August 1983 to September 2002
REMARKS	175 measurements have been made at the sıte
MEASURED EXTREMES	Maxımum measured dıscharge, 118 l\s, 21 October 1997 Mınımum measured dıscharge, 1 0 l\s, 13 Apr 86 and 13 Feb 95



WADI AL HAWASINAH BASIN
DB940051AB, FALAJ AL DIQAL AT DIQAL
DISCHARGE MEASUREMENTS, Aug 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
06-08-83	43	800	33.0	--
19-10-83	36	810	35.0	--
27-11-83	39	825	32.0	--
25-01-84	28	750	30.0	--
03-03-84	26	--	--	--
14-04-84	24	--	--	--
30-05-84	23	825	34.5	--
17-07-84	19	770	33.0	--
27-08-84	16	775	33.5	--
27-10-84	16	780	29.0	--
04-12-84	11	510	29.0	--
10-01-85	13	--	--	--
12-02-85	18	--	--	--
13-03-85	25	750	30.0	--
08-04-85	24	--	--	--
05-05-85	20	780	32.0	--
12-06-85	17	790	32.0	--
13-07-85	14	--	--	--
13-08-85	6	--	--	--
14-09-85	11	780	35.0	--
19-10-85	4	--	--	--
12-11-85	9	--	--	--
10-12-85	7	750	30.0	--
11-01-86	6	700	29.0	--
11-02-86	4	750	29.0	--
10-03-86	2	700	29.0	--
13-04-86	1	810	23.0	--
23-04-87	6	700	32.0	--
17-10-87	3	950	32.0	--
27-05-89	12	800	31.0	--
14-06-89	12	830	34.0	--
22-07-89	12	--	--	--
24-10-89	12	840	35.0	--
19-12-89	12	800	28.0	--
08-01-90	12	820	32.0	--
17-02-90	15	770	32.0	--
17-03-90	25	--	--	--
16-04-90	20	--	--	--
18-06-90	16	780	37.0	--
19-08-90	17	790	32.0	--
20-10-90	35	820	--	--
21-01-91	32	--	34.0	36.0
24-02-91	30	650	35.0	--
12-03-91	26	812	33.0	--
23-04-91	36	803	33.1	--
20-05-91	28	803	32.0	--
12-06-91	22	800	33.0	--
15-07-91	26	799	33.0	41.0

WADI AL HAWASINAH BASIN
DB940051AB, FALAJ AL DIQAL AT DIQAL
DISCHARGE MEASUREMENTS, Aug 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
11-08-91	22	800	33 0	--
15-09-91	19	792	33 3	37 0
15-10-91	18	798	33 0	33 0
23-11-91	16	795	33 0	29 0
21-12-91	19	790	33 0	--
20-01-92	17	790	33 0	--
19-02-92	14	787	32 5	26 0
17-03-92	14	791	32 7	--
19-04-92	20	797	32 9	35 0
01-05-92	20	799	33 0	35 0
23-06-92	15	787	33 2	35 0
18-07-92	15	796	33 3	35 0
27-08-92	12	785	33 0	43 0
12-09-92	12	--	33 3	35 0
16-12-92	9	788	32 5	27 0
30-01-93	3	774	32 2	27 0
20-02-93	5	775	32 1	27 7
15-03-93	8	780	32 3	28 5
17-04-93	11	781	32 8	28 0
26-05-93	8	786	34 4	35 0
16-06-93	12	755	33 1	37 0
20-07-93	10	778	33 6	33 9
24-08-93	9	773	34 4	--
20-09-93	8	--	33 9	--
19-10-93	8	770	32 7	33 0
17-11-93	5	771	33 0	29 0
18-12-93	5	770	32 2	27 3
23-01-94	4	768	31 8	24 0
07-02-94	6	765	31 7	23 6
26-03-94	5	751	32 8	32 1
27-04-94	5	766	36 5	40 0
16-05-94	6	743	33 5	45 4
19-06-94	4	757	34 0	39 0
10-07-94	3	760	33 7	37 0
24-08-94	4	750	33 7	32 5
26-09-94	3	746	33 0	27 3
16-10-94	2	747	32 5	30 3
14-11-94	2	748	31 6	32 4
20-12-94	2	741	30 6	27 4
14-01-95	1	895	29 1	20 9
13-02-95	1	802	28 7	19 1
20-03-95	2	758	30 6	28 0
16-05-95	14	743	33 5	45 4
15-08-95	8	765	33 6	36 7
20-09-95	5	786	33 4	29 1
21-10-95	7	730	31.2	29 0
17-01-96	7	760	31 3	22 3
27-02-96	24	774	32 5	21 4

WADI AL HAWASINAH BASIN
DB940051AB, FALAJ AL DIQAL AT DIQAL
DISCHARGE MEASUREMENTS, Aug 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
13-03-96	34	744	32 4	24 4
21-04-96	29	--	32 8	29 6
10-05-96	28	890	33 3	--
11-06-96	39	761	33 3	30 6
15-07-96	23	802	33 6	31 5
17-08-96	64	820	34 1	38 8
16-09-96	52	826	34 5	33 1
21-10-96	57	820	--	--
13-11-96	54	805	33 9	25.1
15-12-96	59	803	33 5	26 0
25-01-97	53	816	31 3	25 1
19-02-97	55	832	31 9	29 0
10-03-97	48	--	32 3	25 9
09-04-97	59	815	32 3	27 2
13-05-97	30	835	31 5	31 0
04-06-97	54	850	32 0	33 4
15-07-97	50	560	30 5	32 8
13-08-97	46	828	33 5	34 7
16-09-97	42	870	34 3	39 6
21-10-97	118	852	34 4	37 9
17-11-97	48	843	33 1	27 6
14-12-97	49	848	30 4	27 7
13-01-98	48	--	--	--
16-02-98	64	824	27 7	30 6
17-03-98	50	842	27 8	35 2
14-04-98	27	834	29 9	42 6
08-08-98	105	816	33 4	35 0
07-09-98	62	814	34 1	33 1
07-10-98	71	818	34 2	34 4
07-11-98	67	845	34 4	35 8
08-12-98	54	830	33 7	30 3
06-01-99	54	841	33 1	29 5
07-02-99	50	853	33 1	31 2
10-03-99	42	830	32 3	25 2
06-04-99	56	500	31 8	34 2
08-05-99	51	824	31 9	38 2
09-06-99	71	823	32 4	36 6
09-08-99	62	810	33 7	38 0
08-09-99	53	830	34 0	31 2
09-10-99	72	840	34 4	33 8
08-11-99	39	750	--	--
08-12-99	64	760	34 0	26 0
15-01-00	48	840	34 0	31 0
06-02-00	42	814	33 0	30 0
08-03-00	41	823	33 2	27 4
09-04-00	33	800	33 0	30 7
08-05-00	19	822	33 0	37 0
10-06-00	27	920	31 4	--

WADI AL HAWASINAH BASIN
DB940051AB, FALAJ AL DIQAL AT DIQAL
DISCHARGE MEASUREMENTS, Aug 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
08-07-00	19	820	33 2	--
08-08-00	23	816	33 4	34 3
09-09-00	15	930	31 4	33 7
08-10-00	--	794	33 2	34 4
08-11-00	--	808	32 2	26 3
06-12-00	23	797	33 0	34 6
09-01-01	23	806	28 0	33 3
10-02-01	27	801	32 6	28 0
13-03-01	20	820	30 0	29 5
08-04-01	12	780	33 4	34 9
12-05-01	15	830	33 6	39 8
10-06-01	14	799	33 7	36 0
12-08-01	--	800	33 7	35 1
05-09-01	--	800	33 8	34 5
10-10-01	--	800	33 3	28 3
12-11-01	--	793	33 7	28 6
12-12-01	--	793	33 0	28 6
13-01-02	--	760	32 4	25 5
13-02-02	--	800	32 6	--
11-03-02	--	780	32 3	--
14-04-02	--	782	33 0	--
07-05-02	--	770	34 0	40 0
09-06-02	--	800	34 5	38 6
13-07-02	--	800	34 0	36 0
06-08-02	--	--	--	--
08-09-02	--	--	--	--

WADI AL HAWASINAH BASIN
DB940051AB, FALAJ AL DIQAL AT DIQAL
WATER QUALITY DATA,Oct 1995 to Jun 2001

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
21-10-95	230	--	--	52	0 28	--	1 9	75
29-12-95	220	--	0 12	55	0 40	--	1 7	78
16-09-96	225	--	--	68	0 21	--	1 9	91
30-12-96	233	--	--	66	0 32	--	2 0	81
15-07-97	158	--	--	93	0 10	--	2 3	94
16-09-97	192	--	--	78	0 19	--	2 2	94
13-01-98	196	--	--	85	0 25	--	2 8	87
14-04-98	201	--	--	77	0 30	--	2 4	105
08-12-98	230	--	--	74	0 10	--	3 0	93
09-06-99	218	--	--	69	0 20	--	2 9	94
10-06-00	230	--	--	65	0 10	--	3 4	89
06-12-00	221	--	--	62	0 31	--	3 7	98
10-06-01	209	--	--	60	0 46	--	3 5	95
Mean	**213**	**--**	**0 12**	**70**	**0.25**	**--**	**2.6**	**90**
Min	**158**	**--**	**0.12**	**52**	**0.10**	**--**	**1.7**	**75**
Max	**233**	**--**	**0.12**	**93**	**0.46**	**--**	**3.7**	**105**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
21-10-95	40	0 05	1 7	0 5	24	0 05	75	--
29-12-95	43	0 05	1 9	0 8	24	0 05	73	--
16-09-96	51	0 05	2 0	0 7	26	0 05	90	--
30-12-96	49	0 05	2 0	0 6	24	0 05	89	--
15-07-97	41	0 05	3 7	0 7	30	0 05	96	--
16-09-97	53	0 06	2 1	0 4	24	0 05	96	--
13-01-98	45	0 05	3 3	0 0	20	0 05	96	--
14-04-98	35	0 05	2 2	0 6	24	0 05	94	--
08-12-98	49	0 05	2 5	0 0	24	0 05	101	--
09-06-99	49	0 05	2 3	0 0	25	0 05	94	--
10-06-00	46	0 05	2 1	-0 4	22	0 05	83	--
06-12-00	53	0 05	2 5	0 2	27	0 05	88	--
10-06-01	51	0 05	2 4	0 3	27	0 05	63	--
Mean	**46**	**0.05**	**2.3**	**0.3**	**25**	**0.05**	**87**	**--**
Min	**35**	**0 05**	**1.7**	**-0.4**	**20**	**0.05**	**63**	**--**
Max	**53**	**0.06**	**3.7**	**0 8**	**30**	**0.05**	**101**	**--**

WADI AL HAWASINAH BASIN
DB940051AB, FALAJ AL DIQAL AT DIQAL
WATER QUALITY DATA,Oct 1995 to Jun 2001

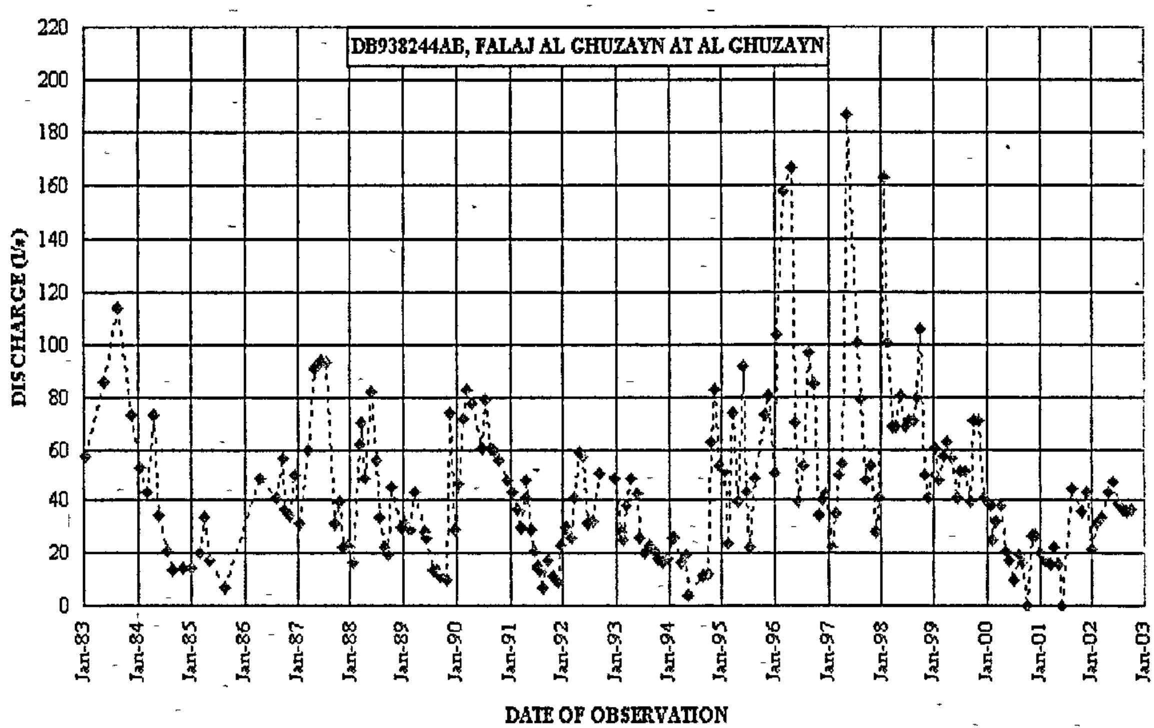
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
21-10-95	230	200	--	8	7	420	744	7 8
29-12-95	220	205	--	8	7	420	709	8 1
21-04-96	239	215	--	8	8	434	771	8 1
16-09-96	225	233	--	8	9	476	810	7 9
30-12-96	233	221	--	8	8	464	791	7 8
15-07-97	158	224	--	8	9	465	845	8 3
16-09-97	192	231	--	8	9	476	822	7 7
13-01-98	196	195	--	8	8	470	799	7 4
14-04-98	201	186	--	9	8	473	803	8 1
08-12-98	230	224	--	9	9	501	837	7 2
09-06-99	218	226	--	8	9	482	817	7 4
10-06-00	230	205	--	9	8	466	827	6 8
06-12-00	221	243	--	8	9	485	582	7 4
10-06-01	209	239	--	8	8	445	805	7 7

WADI AL HAWASINAH BASIN
DB938244AB, FALAJ AL GHUZAYN AT AL GHUZAYN

LOCATION

UTM	498368 E, 2632602 N
LATITUDE	23° 48' 17"
LONGITUDE	56° 59' 02"
FALAJ TYPE	Daudi
PERIOD OF RECORD	January 1982 to September 2002
REMARKS	205 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 187 l\s, 13 May 1997 Minimum measured discharge, 4 l\s, 16 May 1994



WADI AL HAWASINAH BASIN
DB938244AB, FALAJ AL GHUZAYN AT AL GHUZAYN
DISCHARGE MEASUREMENTS, Jan 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
12-01-83	58	1070	25 0	--
22-05-83	86	800	35 0	--
22-08-83	114	--	--	--
14-11-83	73	1000	29 0	--
21-01-84	53	1050	24 0	--
03-03-84	43	1035	26 0	--
14-04-84	73	--	--	--
21-05-84	34	1199	32 0	--
15-07-84	21	1340	35 0	--
26-08-84	13	1350	34 0	--
27-10-84	14	1550	22 0	--
01-01-85	14	1045	26 0	--
23-02-85	20	1425	29 0	--
25-03-85	33	1500	28 0	--
05-05-85	17	1550	29 0	--
13-08-85	7	--	--	--
13-04-86	49	1250	23 0	--
09-08-86	41	--	--	--
22-09-86	57	1100	31 0	--
08-10-86	36	--	--	--
12-11-86	34	--	--	--
13-12-86	50	--	--	--
17-01-87	31	1200	27 0	--
08-03-87	60	980	29 0	--
23-04-87	91	800	29 0	--
16-06-87	94	1300	34 0	--
20-07-87	93	1250	32 0	--
16-09-87	31	--	--	--
17-10-87	39	1560	31 0	--
15-11-87	22	1400	30 0	--
13-12-87	23	--	--	--
19-01-88	16	1380	32 0	--
29-02-88	62	--	--	--
14-03-88	70	1160	30 0	--
09-04-88	49	1300	35 0	--
25-05-88	82	1150	32 0	--
22-06-88	56	1200	34 0	--
18-07-88	33	1200	35 0	--
23-08-88	22	1200	34 0	--
19-09-88	19	1200	33 0	--
12-10-88	45	1150	--	--
17-12-88	30	--	--	--
11-01-89	31	1290	28 0	--
13-02-89	29	1525	25 0	--
19-03-89	43	1400	26 0	--
27-05-89	28	1330	32 0	--
14-06-89	26	1400	35 0	--
22-07-89	13	--	--	--
19-08-89	13	1300	36 0	--
13-09-89	11	--	--	--
24-10-89	10	1430	32 0	--
21-11-89	74	1180	31 0	--

WADI AL HAWASINAH BASIN
DB938244AB, FALAJ AL GHUZAYN AT AL GHUZAYN
DISCHARGE MEASUREMENTS, Jan 1982 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
19-12-89	29	970	25 0	--
08-01-90	47	1100	28 0	--
17-02-90	72	730	25 0	--
17-03-90	83	--	--	--
11-04-90	78	--	--	--
18-06-90	61	850	35 0	--
19-07-90	79	--	--	--
19-08-90	61	990	35 0	--
17-09-90	60	--	--	--
20-10-90	56	1000	--	--
09-12-90	48	--	30 0	29 0
21-01-91	43	980	34 0	28 0
24-02-91	36	900	34 0	--
12-03-91	30	1157	27 0	--
22-04-91	41	1075	29 9	--
24-04-91	48	--	29 0	29 0
20-05-91	29	1145	29 9	--
12-06-91	21	1179	32 7	--
08-07-91	14	--	37 0	48 0
10-07-91	15	--	36 0	42 0
14-07-91	15	--	35 0	39 0
15-07-91	14	--	33 0	41 0
22-07-91	13	1275	34 0	43 0
11-08-91	7	1349	32 2	--
15-09-91	17	1235	25 5	39 0
15-10-91	11	1353	30 0	29 0
27-11-91	9	1396	29 4	21 0
21-12-91	23	1274	30 0	28 0
20-01-92	30	--	--	--
19-02-92	26	--	--	--
17-03-92	41	1219	28 1	--
19-04-92	59	1059	28 3	37 0
11-05-92	58	1122	31 0	30 0
23-06-92	31	1189	31 5	35 0
18-07-92	32	1230	34 9	38 0
12-09-92	51	1139	33 5	32 0
16-12-92	49	1130	28 1	32 0
30-01-93	28	1147	27 5	26 0
20-02-93	25	1164	28 5	27 6
15-03-93	38	1113	28 6	26 5
17-04-93	49	1074	28 8	27 0
26-05-93	42	1103	33 3	36 8
16-06-93	26	1129	34 4	33 5
20-07-93	20	1160	36 7	33 5
24-08-93	23	1140	36 8	40 6
20-09-93	21	1130	33 5	31 9
19-10-93	18	986	33 1	27 7
17-11-93	16	1173	32 0	35 0
18-12-93	18	1185	28 7	23 4
23-01-94	26	1197	28 8	22 5
07-02-94	26	1217	28 6	22 6
26-03-94	16	1242	30 1	26 3

WADI AL HAWASINAH BASIN
DB938244AB, FALAJ AL GHUZAYN AT AL GHUZAYN
DISCHARGE MEASUREMENTS, Jan 1982 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
27-04-94	19	1256	35.5	44.0
16-05-94	4	1252	32.3	44.2
27-08-94	11	1247	36.8	31.9
26-09-94	12	1198	35.6	38.6
16-10-94	63	1058	32.0	30.5
14-11-94	83	1011	29.3	28.2
20-12-94	54	1092	27.9	38.2
14-01-95	52	1239	26.3	20.1
13-02-95	24	1345	26.6	24.0
20-03-95	74	1079	27.2	27.2
18-04-95	39	1172	29.0	22.5
24-05-95	92	1000	31.8	38.6
19-06-95	43	1017	34.5	39.7
17-07-95	22	1049	--	35.0
15-08-95	49	715	32.6	33.3
21-10-95	73	1010	30.2	42.9
14-11-95	81	825	27.9	26.0
29-12-95	51	729	24.0	24.8
17-01-96	104	813	22.8	19.3
27-02-96	158	801	23.5	23.3
21-04-96	167	1100	28.2	27.6
15-05-96	70	878	30.0	38.2
11-06-96	39	914	31.4	28.4
15-07-96	54	947	34.3	37.2
17-08-96	97	969	34.0	41.9
16-09-96	85	1010	31.9	34.2
21-10-96	34	1050	--	--
13-11-96	40	1060	29.7	23.3
15-12-96	42	1089	28.0	24.0
25-01-97	22	--	25.5	--
19-02-97	35	1123	26.8	23.5
10-03-97	50	900	27.1	28.5
09-04-97	55	747	28.1	27.3
13-05-97	187	767	28.0	31.0
15-07-97	101	820	36.5	47.0
13-08-97	79	967	33.9	37.0
16-09-97	48	--	34.4	40.2
21-10-97	54	1075	30.5	33.5
17-11-97	28	769	26.5	24.5
14-12-97	41	849	23.7	21.3
13-01-98	163	950	23.0	21.6
16-02-98	101	790	22.0	28.9
17-03-98	69	828	25.2	30.2
14-04-98	69	916	26.8	47.0
12-05-98	81	905	29.2	38.5
13-06-98	69	1037	27.8	40.3
06-07-98	71	1030	33.2	52.5
10-08-98	71	1082	33.9	42.4
07-09-98	80	1071	33.4	32.9

WADI AL HAWASINAH BASIN
DB938244AB, FALAJ AL GHUZAYN AT AL GHUZAYN
DISCHARGE MEASUREMENTS, Jan 1982 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
03-10-98	106	1126	32.9	33.1
07-11-98	50	1130	29.5	32.5
01-12-98	41	1172	27.1	29.1
05-01-99	61	1120	27.5	26.2
06-02-99	48	1229	26.6	24.0
07-03-99	58	729	23.8	26.7
06-04-99	63	993	38.0	28.1
03-05-99	57	635	30.0	31.6
06-06-99	41	1100	31.7	40.6
06-07-99	52	1218	33.9	35.0
03-08-99	52	1274	35.1	38.0
06-09-99	39	1352	35.0	36.0
04-10-99	71	1329	32.0	36.0
03-11-99	71	1220	31.6	29.8
07-12-99	41	1500	29.0	30.0
30-01-00	38	1603	29.0	31.0
06-02-00	25	1661	28.0	26.0
05-03-00	32	1658	28.5	30.0
03-04-00	38	1710	30.1	37.7
03-05-00	21	1920	32.0	44.0
05-06-00	17	2050	34.7	--
03-07-00	10	2050	34.4	--
06-08-00	19	1944	33.0	41.0
05-09-00	16	1970	33.0	35.2
03-10-00	--	--	--	--
05-11-00	26	1475	31.9	29.9
04-12-00	27	1680	--	--
03-01-01	20	1728	28.1	27.3
05-02-01	17	1770	27.0	28.2
12-03-01	15	1770	28.5	32.1
04-04-01	22	1772	31.5	37.0
07-05-01	15	1860	32.6	38.7
05-06-01	--	--	--	--
15-08-01	44	1310	34.4	36.0
21-10-01	36	1400	32.7	28.9
25-11-01	43	1439	30.3	27.4
26-12-01	22	1486	25.4	28.6
27-01-02	31	1608	--	--
03-03-02	33	--	--	--
25-04-02	43	1370	29.6	32.0
28-04-02	43	1254	30.8	35.3
27-05-02	47	--	--	--
30-06-02	39	1214	33.2	50.0
30-07-02	36	--	32.9	29.5
26-08-02	36	1239	33.6	36.0
26-09-02	36	--	31.1	38.0

WADI AL HAWASINAH BASIN
DB938244AB, FALAJ AL GHUZAYN AT AL GHUZAYN
WATER QUALITY DATA, Oct 1995 to Jun 2001
ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
21-10-95	147	--	--	103	0 10	--	2 3	98
29-12-95	127	--	0 08	92	0 19	--	2 4	84
16-09-96	138	--	--	138	0 12	--	1 5	114
30-12-96	141	--	--	178	0 20	--	1 0	120
15-07-97	177	--	--	95	0 17	--	2 9	102
16-09-97	91	--	--	153	0 10	--	2 2	130
13-01-98	137	--	--	129	0 14	--	2 1	120
14-04-98	125	--	--	124	0 23	--	1 4	103
10-12-98	150	--	--	236	0 10	--	0 8	125
06-06-99	129	--	--	221	0 10	--	0 5	126
06-07-99	121	--	--	248	0 17	--	1 1	125
05-06-00	160	--	--	507	0 10	--	1 0	44
04-12-00	130	--	--	388	0 16	--	1 8	146
05-06-01	115	--	--	485	0 40	--	1 2	216
Mean	**135**	**--**	**0.08**	**221**	**0.16**	**--**	**1.6**	**118**
Min	**91**	**--**	**0.08**	**92**	**0.10**	**--**	**0.5**	**44**
Max	**177**	**--**	**0 08**	**507**	**0.40**	**--**	**2.9**	**216**

WADI AL HAWASINAH BASIN
DB938244AB, FALAJ AL GHUZAYN AT AL GHUZAYN
WATER QUALITY DATA, Oct 1995 to Jun 2001

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
21-10-95	24	0 06	3 9	0 2	44	0 05	69	--
29-12-95	23	0 05	3 6	0 3	40	0 05	57	--
16-09-96	31	0 05	5 0	0 8	47	0 05	105	--
30-12-96	29	0 05	5 0	1 0	50	0 05	126	--
15-07-97	43	0 05	3 5	0 2	29	0 05	98	--
16-09-97	32	0 05	5 6	0 7	39	0 05	109	--
13-01-98	33	0 05	3 8	0 3	37	0 05	85	--
14-04-98	30	0 05	4 3	0 5	41	0 05	95	--
10-12-98	33	0 05	5 7	0 0	48	0 05	136	--
06-06-99	34	0 05	5 5	0 6	46	0 05	129	--
06-07-99	37	0 05	6 0	0 7	47	0 01	144	--
05-06-00	56	0 06	7 3	-0 3	59	0 07	224	--
04-12-00	54	0 05	6 6	0 0	64	0 05	185	--
05-06-01	54	0 05	7 7	0 5	70	0 05	238	--
Mean	**36**	**0.05**	**5.2**	**0.4**	**47**	**0.05**	**128**	**--**
Min	**23**	**0.05**	**3.5**	**-0.3**	**29**	**0 01**	**57**	**--**
Max	**56**	**0.06**	**7.7**	**1.0**	**70**	**0.07**	**238**	**--**

WADI AL HAWASINAH BASIN
DB938244AB, FALAJ AL GHUZAYN AT AL GHUZAYN
WATER QUALITY DATA, Oct 1995 to Jun 2001

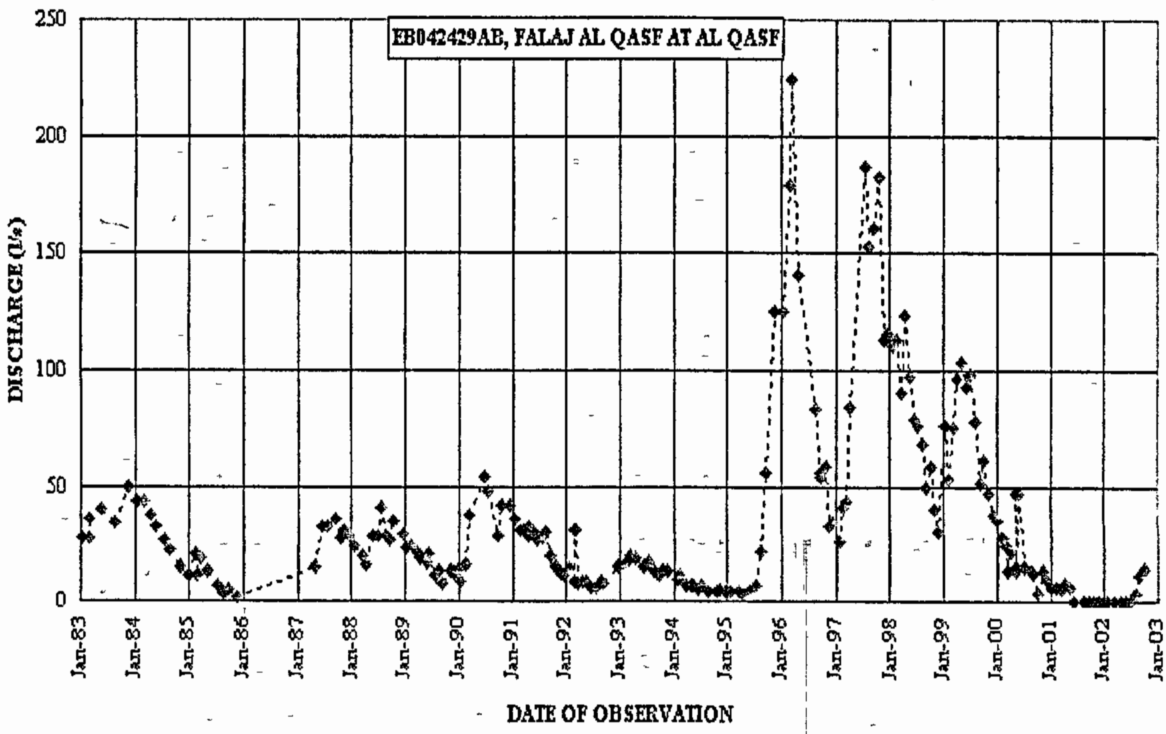
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
21-10-95	147	241	--	8	8	443	816	8 0
29-12-95	127	222	--	7	7	389	674	8 3
21-04-96	120	188	--	7	6	369	697	8 7
16-09-96	158	269	--	10	10	544	994	8 5
30-12-96	167	277	--	11	11	616	1086	8 7
15-07-97	177	226	--	9	9	493	841	7 7
16-09-97	110	239	--	9	10	546	979	8 5
13-01-98	137	235	--	9	8	503	900	8 2
14-04-98	137	243	--	8	9	488	870	8 4
10-12-98	150	280	--	12	12	682	1164	7 7
06-06-99	141	275	--	12	11	652	1123	8 4
06-07-99	142	286	--	13	12	700	1214	8 4
05-06-00	160	385	--	19	18	1004	1995	7 1
04-12-00	130	400	--	17	16	935	1247	7 7
05-06-01	115	425	--	21	19	1150	2008	8 2

WADI AL HAWASINAH BASIN
EB042429AB, FALAJ AL QASF AT AL QASF

LOCATION

UTM	501953 E, 2645039 N
LATITUDE	23° 55' 01"
LONGITUDE	57° 01' 09"
FALAJ TYPE	Daudi
PERIOD OF RECORD	January 1983 to September 2002
REMARKS	199 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 225 l\s, 13 March 1996 Minimum measured discharge, 2 l\s, 12 November 1985



WADI AL HAWASINAH BASIN
EB042429AB, FALAJ AL QASF AT AL QASF
DISCHARGE MEASUREMENTS, Jan 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
12-01-83	27	820	30 0	--
27-02-83	27	850	30 0	--
03-03-83	36	850	31 0	--
22-05-83	40	750	35 0	--
22-08-83	34	--	--	--
14-11-83	50	805	32 0	--
21-01-84	44	815	29 0	--
03-03-84	44	765	29 0	--
14-04-84	38	--	--	--
21-05-84	32	850	33 0	--
15-07-84	26	940	37 0	--
26-08-84	22	850	33 0	--
27-10-84	15	960	25 0	--
26-12-84	11	875	28 0	--
11-02-85	20	--	--	--
23-02-85	12	870	23 0	--
15-03-85	18	900	29 0	--
05-05-85	13	910	30 0	--
13-07-85	7	--	--	--
13-08-85	3	--	--	--
14-09-85	5	930	32 0	--
12-11-85	2	--	--	--
23-04-87	15	810	30 0	--
16-06-87	33	1000	35 0	--
20-07-87	32	950	30 0	--
16-09-87	36	--	--	--
17-10-87	27	1200	32 0	--
15-11-87	30	1120	31 0	--
13-12-87	28	--	--	--
19-01-88	24	950	30 0	--
14-03-88	19	950	30 0	--
09-04-88	16	900	34 0	--
25-05-88	28	900	35 0	--
22-06-88	28	900	35 0	--
18-07-88	41	910	33 0	--
23-08-88	28	900	33 0	--
19-09-88	26	900	32 0	--
12-10-88	35	940	31 0	--
17-12-88	29	--	--	--
11-01-89	23	940	29 0	--
13-02-89	24	1050	--	--
19-03-89	21	990	--	--
08-04-89	18	--	--	--
27-05-89	17	1000	31 0	--
14-06-89	20	960	35 0	--
22-07-89	11	--	--	--
19-08-89	13	1050	35 0	--
13-09-89	8	--	--	--

WADI AL HAWASINAH BASIN
EB042429AB, FALAJ AL QASF AT AL QASF
DISCHARGE MEASUREMENTS, Jan 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
02-11-89	13	1050	30 0	--
24-11-89	12	1020	30 0	--
19-12-89	13	1050	28 0	--
08-01-90	9	1000	30 0	--
17-02-90	16	1050	27 0	--
17-03-90	38	--	--	--
18-06-90	54	790	35 0	--
19-07-90	48	790	34 0	--
19-09-90	28	724	34 0	--
20-10-90	42	900	34 0	--
09-12-90	42	--	32 0	26 0
21-01-91	36	1000	32 0	26 0
24-02-91	31	740	33 0	30 0
12-03-91	31	933	31 0	30 0
22-04-91	32	935	32 0	34 0
24-04-91	28	--	33 0	29 0
20-05-91	30	959	32 0	32 0
12-06-91	26	944	32 5	32 0
22-07-91	27	952	33 0	--
11-08-91	30	959	30 0	33 2
15-09-91	19	959	32 5	37 0
15-10-91	15	977	31 0	31 0
23-11-91	12	983	30 5	32 0
21-12-91	11	982	29 0	31 0
20-01-92	14	936	28 0	26 0
19-02-92	9	990	27 0	26 0
24-02-92	31	740	33 0	33 0
12-03-92	31	933	31 0	31 0
17-03-92	8	995	29 0	29 0
19-04-92	9	1059	28 3	37 0
11-05-92	9	994	31 0	33 0
19-06-92	6	974	32 5	35 0
18-07-92	6	982	32 6	38 0
22-08-92	9	1103	33 0	40 0
12-09-92	8	972	31 6	33 0
16-12-92	15	984	29 5	27 0
30-01-93	16	984	28 7	31 0
20-02-93	17	990	28 9	26 9
15-03-93	19	996	29 5	26 3
17-04-93	18	986	30 5	29 0
16-06-93	15	990	32 6	37 8
20-07-93	17	981	33 1	35 0
24-08-93	13	954	32 4	40 4
20-09-93	11	974	31 9	35 5
19-10-93	13	974	29 7	28 8
17-11-93	13	981	33 0	30 0
23-01-94	10	990	11 6	12 1
07-02-94	11	991	31.5	28 3

WADI AL HAWASINAH BASIN
EB042429AB, FALAJ AL QASF AT AL QASF
DISCHARGE MEASUREMENTS, Jan 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
26-03-94	7	982	32 2	33 4
27-04-94	7	995	36 5	38 0
16-05-94	7	982	33 1	35 0
19-06-94	5	979	33 0	38 0
10-07-94	7	1010	34 0	39 0
24-08-94	4	998	34 1	33 6
16-10-94	4	1000	33 1	40 6
14-11-94	5	1006	32 3	26 0
20-12-94	4	997	31 1	29 2
14-01-95	4	1123	29 6	24 0
20-03-95	4	1000	30 1	29 2
18-04-95	3	1134	30 9	30 2
24-05-95	4	1000	33 0	30 6
19-06-95	5	1001	33 6	43 9
17-07-95	7	999	33 9	37 4
15-08-95	21	946	33 8	35 9
20-09-95	56	907	33 8	32 7
14-11-95	125	902	34 3	31 5
17-01-96	125	894	33 6	26 3
27-02-96	179	858	32 5	25 5
13-03-96	225	850	32 3	27 0
21-04-96	141	--	32 0	27.5
20-08-96	83	860	33 1	39 1
16-09-96	54	880	33 1	37 0
20-09-96	56	907	33 8	32 7
21-10-96	59	895	--	--
13-11-96	32	880	32 6	26 1
15-12-96	34	880	32 9	30 0
25-01-97	25	--	--	--
19-02-97	41	914	--	--
10-03-97	44	--	32 2	26 3
09-04-97	84	734	31 1	29 9
15-07-97	187	804	32 8	34 3
13-08-97	153	787	32 6	37 0
16-09-97	161	840	31 9	38 2
21-10-97	183	844	33 3	37 9
17-11-97	113	848	32 9	24 7
14-12-97	115	856	32 5	29 2
13-01-98	110	855	32 3	23 2
16-02-98	113	841	31 5	28 9
17-03-98	90	853	31 2	30 1
14-04-98	123	853	31 2	46 6
12-05-98	97	858	31 3	37 5
13-06-98	79	853	27 9	38 2
06-07-98	76	830	31 9	37 3
10-08-98	68	843	32 2	39 6
07-09-98	50	839	32 4	36 3
05-10-98	59	856	32 4	35 1

WADI AL HAWASINAH BASIN
EB042429AB, FALAJ AL QASF AT AL QASF
DISCHARGE MEASUREMENTS, Jan 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
07-11-98	40	850	34 5	32 5
01-12-98	30	871	32 3	27 6
05-01-99	76	890	26 4	25 2
06-02-99	53	883	32 2	31 0
07-03-99	75	870	32 0	28 1
06-04-99	96	890	32 6	34 5
03-05-99	103	897	32 8	46 6
06-06-99	93	901	32 4	42 5
06-07-99	98	924	32 9	35 1
03-08-99	78	936	34 5	39 1
06-09-99	52	930	32 7	30 4
04-10-99	61	957	32 0	36 0
03-11-99	47	932	32 7	35 6
07-12-99	38	900	30 0	30 0
03-01-00	35	945	32 0	23 0
06-02-00	27	950	32 0	27 0
05-03-00	24	935	31 7	27 0
10-03-00	13	620	33 8	34 0
03-04-00	21	930	32 1	36 8
03-05-00	15	980	33 0	39 0
06-05-00	47	--	33 1	--
11-05-00	13	700	32 0	30 0
05-06-00	47	1130	33 1	--
03-07-00	15	940	33 1	--
06-08-00	14	980	34 2	41 8
05-09-00	13	620	34 0	34 0
03-10-00	4	620	33.8	34 0
05-11-00	13	700	32 0	30 0
04-12-00	10	970	--	--
03-01-01	6	940	26 8	30 0
05-02-01	6	950	29 4	28 0
12-03-01	5	940	31 0	31 0
04-04-01	7	931	31 2	36 4
07-05-01	6	967	32 6	37 4
05-06-01	--	--	--	--
15-08-01	--	970	33 8	--
15-09-01	--	964	29 4	--
21-10-01	--	1000	32 0	25 7
25-11-01	--	974	30 7	26 7
26-12-01	--	982	26 7	27 9
26-01-02	--	--	--	--
03-03-02	--	--	--	--
25-04-02	--	--	--	--
28-04-02	--	1000	28 0	25 1
27-05-02	--	980	32 5	42 0
29-06-02	--	960	33 5	39 2
30-07-02	4	962	22 8	34 5
26-08-02	12	985	29 2	36 0
26-09-02	14	990	30 7	38 9

WADI AL HAWASINAH BASIN
EB042429AB, FALAJ AL QASF AT AL QASF
WATER QUALITY DATA, Oct 1995 to Jun 2001

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
21-10-95	167	--	--	118	0 16	--	2 7	89
29-12-95	154	--	--	129	0 27	--	2 6	88
30-12-96	153	--	--	122	0 16	--	2 7	89
15-07-97	136	--	--	93	0 13	--	3 3	82
16-09-97	131	--	--	99	0 14	--	3 1	93
13-01-98	147	--	--	122	0 10	--	3 0	89
14-04-98	145	--	--	106	0 16	--	2 4	119
01-12-98	160	--	--	121	0 10	--	2 4	101
06-07-99	149	--	--	134	0 13	--	2 6	111
05-06-00	169	--	--	148	0 10	--	2 5	105
04-12-00	148	--	--	139	0 10	--	2 5	123
05-06-01	160	--	--	144	0 24	--	2 3	112
Mean	**152**	**--**	**--**	**123**	**0.15**	**--**	**2.7**	**100**
Min	**131**	**--**	**--**	**93**	**0.10**	**--**	**2.3**	**82**
Max	**169**	**--**	**--**	**148**	**0.27**	**--**	**3.3**	**123**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
21-10-95	27	0 04	3 5	0 1	46	0 05	77	--
29-12-95	27	0 05	3 8	0 3	47	0 05	80	--
30-12-96	29	0 05	4 1	0 8	44	0 05	93	--
15-07-97	25	0 05	3 9	0 0	33	0 05	83	--
16-09-97	26	0 05	4 0	0 2	35	0 05	86	--
13-01-98	25	0 05	5 1	0 0	34	0 05	90	--
14-04-98	26	0 05	3 9	0 3	41	0 05	85	--
01-12-98	28	0 05	4 2	0 1	42	0 05	89	--
06-07-99	31	0 05	4 4	0 2	47	0 01	93	--
05-06-00	29	0 07	4 1	-0 9	45	0 08	88	--
04-12-00	30	0 07	4 4	0 2	49	0 05	91	--
05-06-01	30	0 05	4 3	0 7	50	0 05	93	--
Mean	**28**	**0 05**	**4.1**	**0.2**	**43**	**0.05**	**87**	**--**
Min	**25**	**0.04**	**3.5**	**-0.9**	**33**	**0 01**	**77**	**--**
Max	**31**	**0.07**	**5.1**	**0 8**	**50**	**0.08**	**93**	**--**

WADI AL HAWASINAH BASIN
EB042429AB, FALAJ AL QASF AT AL QASF
WATER QUALITY DATA, Oct 1995 to Jun 2001

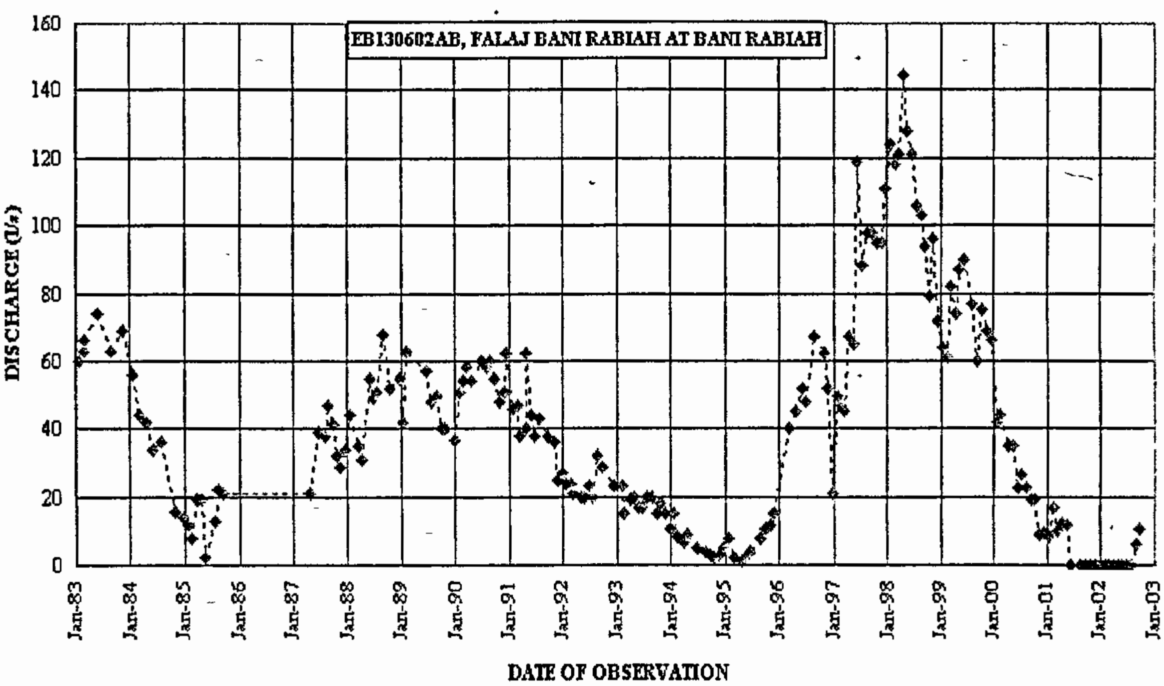
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
21-10-95	167	259	--	9	9	477	895	7 8
29-12-95	154	261	--	9	9	482	834	8 0
21-04-96	159	217	--	8	8	448	829	8 2
30-12-96	163	251	--	9	9	493	878	8 4
15-07-97	136	201	--	7	8	420	762	7 9
16-09-97	131	208	--	8	8	438	796	8 0
13-01-98	147	203	--	8	8	470	815	7 7
14-04-98	145	234	--	9	8	482	810	8 0
01-12-98	160	242	--	9	9	496	865	7 8
06-07-99	149	274	--	9	10	526	917	7 9
05-06-00	169	256	--	10	9	535	966	6 7
04-12-00	148	279	--	10	10	541	506	7 9
05-06-01	183	282	--	10	10	558	961	8 4

WADI MASHIN BASIN
EB130602AB, FALAJ BANI RABIAH AT BANI RABIAH

LOCATION

UTM	509789 E, 2636482 N
LATITUDE	23° 50' 23"
LONGITUDE	57° 05' 46"
FALAJ TYPE	Daudi
PERIOD OF RECORD	January 1983 to September 2002
REMARKS	189 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 144 l\s, 15 April 1998 Minimum measured discharge, 1.0 l\s, 24 April 1995



WADI MASHIN BASIN

EB130602AB, FALAJ BANI RABIAH AT BANI RABIAH

DISCHARGE MEASUREMENTS, Jan 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
18-01-83	60	530	--	--
27-02-83	63	475	31 0	--
03-03-83	66	550	31 0	--
22-05-83	74	515	35 0	--
22-08-83	63	--	--	--
15-11-83	69	520	32 0	--
22-01-84	56	520	30 5	--
05-03-84	44	450	28 0	--
22-04-84	42	545	34 0	--
28-05-84	34	555	26 0	--
28-07-84	36	525	34 0	--
28-10-84	16	511	24 0	--
24-12-84	14	525	29 0	--
21-01-85	12	--	--	--
19-02-85	8	525	29 0	--
22-03-85	19	575	30 0	--
20-04-85	19	520	31 0	--
20-05-85	2	560	29 0	--
22-07-85	13	550	31 0	--
18-08-85	22	--	--	--
11-09-85	21	525	30 0	--
25-04-87	21	--	31 0	--
21-06-87	39	--	--	--
29-07-87	38	--	--	--
23-08-87	47	--	--	--
23-09-87	41	575	32 0	--
21-10-87	32	--	31 0	--
17-11-87	29	--	--	--
16-12-87	34	--	--	--
20-01-88	44	550	32 0	--
12-03-88	35	500	35 0	--
10-04-88	31	500	34 0	--
29-05-88	55	600	30 0	--
26-06-88	49	--	35 0	--
18-07-88	51	550	33 0	--
30-08-88	68	500	34 0	--
17-10-88	52	500	34 0	--
19-12-88	55	500	32 0	--
14-01-89	42	490	30 0	--
02-02-89	63	510	25 0	--
18-06-89	57	560	34 0	--
24-07-89	48	540	34 0	--
20-08-89	50	565	33 0	--
23-09-89	40	540	32 0	--
22-10-89	40	670	34 0	--
30-12-89	37	560	31 0	--
29-01-90	51	520	28 0	--
21-02-90	54	530	31 0	--
18-03-90	58	520	35 0	--

WADI MASHIN BASIN
EB130602AB, FALAJ BANI RABIAH AT BANI RABIAH
DISCHARGE MEASUREMENTS, Jan 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
21-04-90	54	--	--	--
25-06-90	60	--	--	--
23-07-90	58	--	--	--
20-08-90	60	490	35 0	--
26-09-90	55	500	--	--
21-10-90	48	525	--	--
26-11-90	51	--	--	--
10-12-90	62	--	32 0	28 0
26-01-91	46	--	--	--
26-02-91	47	599	35 0	--
13-03-91	38	541	32 0	--
22-04-91	40	--	30 0	38 0
27-04-91	62	540	32 5	--
22-05-91	44	537	32 3	--
15-06-91	38	537	33 3	37 4
27-07-91	43	532	33 0	37 0
22-09-91	38	528	33 0	37 0
28-10-91	36	535	33 0	32 0
20-11-91	25	536	31 7	32 0
22-12-91	27	547	31 0	35 0
22-01-92	24	547	--	31 0
23-02-92	24	546	32 0	31 0
04-03-92	21	546	31 0	29 0
26-04-92	20	550	32 0	30 0
23-05-92	20	550	32 5	50 0
27-06-92	23	543	32 4	34 0
13-07-92	20	550	33 0	40 0
24-08-92	32	543	33 0	36 0
21-09-92	29	549	32 8	35 0
07-12-92	23	548	31 1	24 0
30-01-93	23	553	32.1	26 0
20-02-93	15	555	30 7	27 4
30-03-93	19	560	31 4	27 5
25-04-93	20	556	31 8	32 1
24-05-93	17	558	32 4	36 2
19-06-93	17	563	32 6	34 0
19-07-93	20	550	33 1	33 9
23-08-93	20	554	32 6	35 4
22-09-93	15	556	32 0	30 0
23-10-93	18	555	30 6	31 2
21-11-93	15	559	30 3	34 2
22-12-93	11	565	29 6	26 6
23-01-94	15	566	29.2	30 2
09-02-94	8	562	29 2	26 5
27-03-94	7	559	30 5	30 4
23-04-94	9	559	30 9	45 5
19-06-94	5	561	31 0	38 0
22-08-94	4	566	32 0	33 0

WADI MASHIN BASIN
EB130602AB, FALAJ BANI RABIAH AT BANI RABIAH
DISCHARGE MEASUREMENTS, Jan 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
24-09-94	3	569	29.0	31.0
18-10-94	2	574	30.0	31.5
14-11-94	3	576	28.0	29.9
21-12-94	5	570	27.0	31.0
23-01-95	8	603	25.0	--
25-02-95	2	647	25.4	25.6
24-04-95	1	628	28.5	31.6
27-05-95	3	575	30.2	28.3
24-06-95	4	575	31.3	47.4
21-08-95	8	584	32.7	42.0
25-09-95	11	594	27.4	33.0
30-10-95	12	589	31.1	24.4
25-11-95	15	588	31.2	28.9
28-02-96	40	587	31.8	25.1
22-04-96	45	540	32.6	33.7
27-05-96	52	566	33.5	30.4
29-06-96	48	558	33.5	47.7
24-08-96	67	550	34.0	33.7
21-10-96	62	535	33.0	27.8
19-11-96	52	546	32.7	28.0
21-12-96	21	540	--	--
21-01-97	50	--	--	--
18-02-97	47	554	32.3	29.0
11-03-97	45	555	32.5	28.9
12-04-97	67	560	32.9	29.1
13-05-97	65	558	31.8	27.8
09-06-97	119	568	33.9	34.1
13-07-97	88	574	33.5	31.0
16-08-97	98	556	33.4	33.0
16-09-97	98	550	--	40.0
21-10-97	95	567	33.3	26.5
19-11-97	95	574	29.5	30.6
16-12-97	111	587	33.4	25.7
13-01-98	124	596	33.4	27.1
17-02-98	118	604	33.3	29.7
16-03-98	121	619	33.5	34.0
15-04-98	144	630	33.4	29.5
13-05-98	128	595	33.6	47.0
13-06-98	121	582	33.8	42.0
14-07-98	106	586	33.5	35.0
15-08-98	103	583	33.7	34.5
09-09-98	94	583	33.5	32.0
10-10-98	79	578	33.7	43.0
09-11-98	96	580	33.3	28.1
12-12-98	72	580	32.9	26.9
10-01-99	64	580	31.1	28.2
10-02-99	61	576	33.0	28.6
09-03-99	82	598	33.0	25.6

WADI MASHIN BASIN
EB130602AB, FALAJ BANI RABIAH AT BANI RABIAH
DISCHARGE MEASUREMENTS, Jan 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
12-04-99	74	577	33 3	25 3
08-05-99	87	568	33 8	31 9
09-06-99	90	562	33 4	32 0
07-08-99	77	563	33 6	39 7
08-09-99	60	560	33 4	35 0
09-10-99	75	548	33 2	45 3
09-11-99	69	561	33 0	32 3
12-12-99	66	423	33 0	29 0
15-01-00	42	950	32 0	16 0
08-02-00	44	568	32 0	27 0
09-04-00	35	570	32 4	32 1
08-05-00	35	600	33 0	35 0
13-06-00	23	559	33 2	--
09-07-00	27	580	33 3	--
08-08-00	23	580	33 2	40 0
11-09-00	19	570	33 0	32 6
08-10-00	19	576	32 5	31 7
08-11-00	9	720	31 6	29 3
09-12-00	9	569	31 3	37 4
09-01-01	8	590	30 5	31 4
11-02-01	17	559	29 7	31 5
13-03-01	10	553	29 9	28 0
08-04-01	12	567	30 4	35 2
12-05-01	12	572	31 8	38 5
10-06-01	--	590	32 1	27 3
15-08-01	--	600	32 3	29 0
16-09-01	--	600	32 4	31 0
21-10-01	--	600	31 4	27 3
26-11-01	--	--	30 3	30 1
24-12-01	--	600	29 2	25 5
26-01-02	--	--	--	--
26-02-02	--	625	19 0	--
24-03-02	--	656	30 0	--
29-04-02	--	590	31 0	28 0
27-05-02	--	590	32 0	--
22-06-02	--	595	27 0	33 0
30-07-02	--	500	29 0	33 3
26-08-02	7	420	20 8	30 0
24-09-02	11	590	30 1	34 1

WADI MASHIN BASIN
EB130602AB, FALAJ BANI RABIAH AT BANI RABIAH
ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
20-04-85	192	0 17	--	45	0 08	0 01	1 5	35
24-06-85	192	0 17	--	47	0 09	0 01	1 2	38
25-09-95	173	--	--	54	0 11	--	1 6	44
29-06-96	168	--	--	45	0 24	--	2 1	50
22-09-96	160	--	--	44	0 22	--	2 2	48
21-12-96	160	--	--	46	0 10	--	2 2	38
13-07-97	153	--	--	47	0 10	--	2 1	40
16-09-97	146	--	--	56	0 10	--	2 0	48
16-12-97	158	--	--	53	0 10	--	2 3	46
15-04-98	154	--	--	62	0 16	--	1 9	50
12-12-98	165	--	--	59	0 10	--	1 8	59
13-06-00	159	--	--	59	0 10	--	2 2	48
09-12-00	147	--	--	54	0 10	--	2 2	58
10-06-01	155	--	--	61	0 18	--	2 3	46
Mean	**163**	**0.17**	--	**52**	**0.13**	**0.01**	**1.9**	**46**
Min	**146**	**0.17**	--	**44**	**0.08**	**0.01**	**1.2**	**35**
Max	**192**	**0.17**	--	**62**	**0.24**	**0.01**	**2.3**	**59**

WADI MASHIN BASIN
EB130602AB, FALAJ BANI RABIAH AT BANI RABIAH
WATER QUALITY DATA, Apr 1985 to Jun 2001

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
20-04-85	26	0 01	2 0	-1 5	28	0 01	41	344
24-06-85	27	0 01	2 0	-2 5	37	0 02	47	440
25-09-95	30	0 05	2 9	0 5	38	0 05	40	--
29-06-96	28	0 05	1 9	0 3	32	0 05	35	--
22-09-96	30	0 05	1 9	0 8	33	0 05	39	--
21-12-96	27	0 05	2 0	0 3	31	0 05	36	--
13-07-97	30	0 05	2 1	0 4	30	0 05	40	--
16-09-97	30	0 05	2 2	0 4	30	0 05	43	--
16-12-97	35	0 05	2 2	0 6	33	0 05	43	--
15-04-98	30	0 18	2 3	0 3	35	0 05	44	--
12-12-98	30	0 05	2 4	-0 3	34	0 05	43	--
13-06-00	27	0 06	2 3	-1 1	31	0 07	38	--
09-12-00	28	0 05	2 6	-0 1	35	0 05	40	--
10-06-01	29	0 05	2 9	0 2	37	0 05	41	--
Mean	**29**	**0.05**	**2.3**	**-0.1**	**33**	**0.05**	**41**	**392**
Min	**26**	**0 01**	**1.9**	**-2.5**	**28**	**0 01**	**35**	**344**
Max	**35**	**0.18**	**2.9**	**0.8**	**38**	**0.07**	**47**	**440**

WADI MASHIN BASIN
EB130602AB, FALAJ BANI RABIAH AT BANI RABIAH
WATER QUALITY DATA, Apr 1985 to Jun 2001

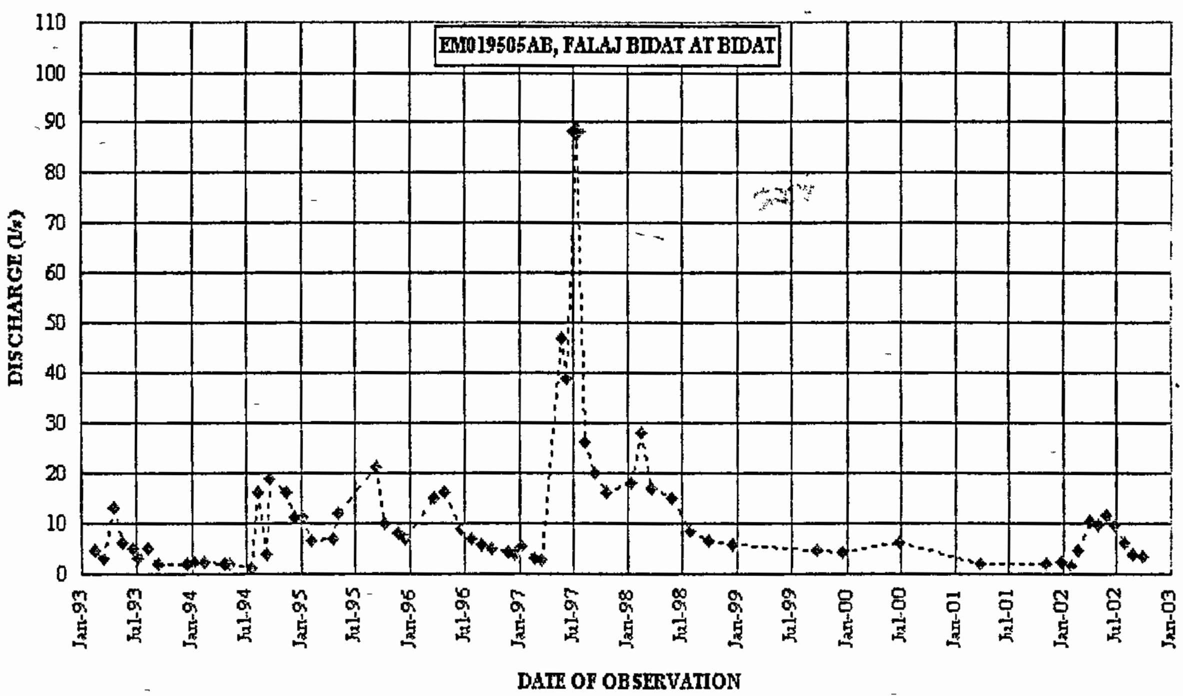
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
20-04-85	192	180	--	--	--	--	462	8 2
24-06-85	192	221	--	--	--	--	546	7 2
25-09-95	173	229	--	6	6	323	594	8 2
29-06-96	168	204	--	6	6	307	552	7 9
22-09-96	171	211	--	6	6	311	546	8 4
21-12-96	160	194	--	5	5	289	525	8 1
13-07-97	153	196	--	5	6	292	547	8 1
16-09-97	146	199	--	6	6	309	557	8 0
16-12-97	158	224	--	6	6	321	565	8 2
15-04-98	154	216	--	6	6	327	583	7 9
12-12-98	165	215	--	6	6	338	577	7 3
13-06-00	159	195	--	6	6	314	573	6 6
09-12-00	147	217	--	6	6	321	507	7 5
10-06-01	155	223	--	6	6	324	578	7 9

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EM019505AB, FALAJ BIDAT AT BIDAT

LOCATION

UTM	509000 E, 2615500 N
LATITUDE	23° 39' 01"
LONGITUDE	57° 05' 18"
FALAJ TYPE	Daudi
PERIOD OF RECORD	February 1993 to September 2002
REMARKS	68 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 88 l\s, 08 July 1997 Minimum measured discharge, 1 l\s, 18 July 1994



WADI MAYHAH-MABRAH-HAJIR SYSTEM
EM019505AB, FALAJ BIDAT AT BIDAT
DISCHARGE MEASUREMENTS, Feb 1993 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
17-02-93	4	658	28 4	24 0
16-03-93	3	659	28 5	20 0
18-04-93	13	654	28 5	33 0
18-05-93	6	665	30 8	36 0
16-06-93	5	663	31 8	35 0
06-07-93	3	656	32 3	33 0
09-08-93	5	659	31 4	34 0
12-09-93	2	655	32 5	35 0
16-12-93	2	--	20 6	--
05-01-94	2	655	28 0	27 0
09-02-94	2	654	27 5	25 0
18-04-94	2	645	31 3	--
03-05-94	2	644	32 2	40 0
18-07-94	1	653	31 9	38 0
08-08-94	16	648	33 7	39 0
07-09-94	4	658	32 4	--
16-09-94	19	604	29 8	32 0
14-11-94	16	642	29 3	27 0
07-12-94	11	658	29 9	29 0
09-01-95	11	658	29 5	25 0
06-02-95	7	656	30 0	--
19-04-95	7	670	30 2	--
07-05-95	12	647	30 4	--
13-09-95	21	590	32 3	--
08-10-95	10	615	31 9	--
23-11-95	8	619	31 9	--
17-12-95	7	626	30 5	--
18-03-96	15	509	25 3	--
23-04-96	16	558	29 7	--
16-06-96	9	556	32 3	--
20-07-96	7	594	32 8	--
26-08-96	6	596	33 0	--
25-09-96	5	596	32 8	--
24-11-96	4	611	30 5	--
17-12-96	4	617	29 5	--
08-01-97	5	620	28 9	34 0
18-02-97	3	634	28 4	--
17-03-97	3	634	28 5	20 5
21-05-97	47	436	29 6	35 5
07-06-97	39	515	31 3	40 0
08-07-97	88	507	32 1	45 4
10-08-97	26	545	32 8	37.7
10-09-97	20	571	32 7	33 0
20-10-97	16	587	30.5	38 0
12-01-98	18	497	24 0	30 0
17-02-98	28	447	22 6	27 9
23-03-98	17	481	27 3	37 0
25-05-98	15	465	28 0	35 0
28-07-98	8	545	33 2	50 9

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EM019505AB, FALAJ BIDAT AT BIDAT
DISCHARGE MEASUREMENTS, Feb 1993 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
30-09-98	7	560	33 0	32 0
15-12-98	6	573	29 4	35 1
22-09-99	4	584	33 1	37 5
18-12-99	4	--	--	--
25-06-00	6	607	23 3	40 5
23-09-00	--	602	32 0	32 5
27-03-01	2	604	32 2	--
07-11-01	2	--	--	--
24-12-01	2	--	--	--
27-01-02	2	585	28 6	31 2
20-02-02	5	600	28 0	30 0
31-03-02	10	570	31 8	31 7
29-04-02	10	607	31 9	36 0
27-05-02	12	566	36 6	45 0
23-06-02	10	590	35 9	42 0
28-07-02	6	618	33 4	40 1
26-08-02	4	583	35 0	37 0
29-09-02	4	--	--	--

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EM019505AB, FALAJ BIDAT AT BIDAT
WATER QUALITY DATA, Jan 1995 to May 1997

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
09-01-95	270	--	--	39	0 10	--	1 0	42
13-05-97	165	--	--	55	0 10	--	2 6	38
Mean	**217**	**--**	**--**	**47**	**0.10**	**--**	**1.8**	**40**
Min	**165**	**--**	**--**	**39**	**0.10**	**--**	**1.0**	**38**
Max	**270**	**--**	**--**	**55**	**0.10**	**--**	**2.6**	**42**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
09-01-95	18	0 05	2 3	1 2	81	0 05	16	--
13-05-97	17	0 05	3 8	0 3	64	0 05	25	--
Mean	**17.5**	**0 05**	**3.0**	**0.7**	**72**	**0.05**	**21**	**--**
Min	**17.0**	**0.05**	**2.3**	**0.3**	**64**	**0.05**	**16**	**--**
Max	**18.0**	**0.05**	**3.8**	**1.2**	**81**	**0 05**	**25**	**--**

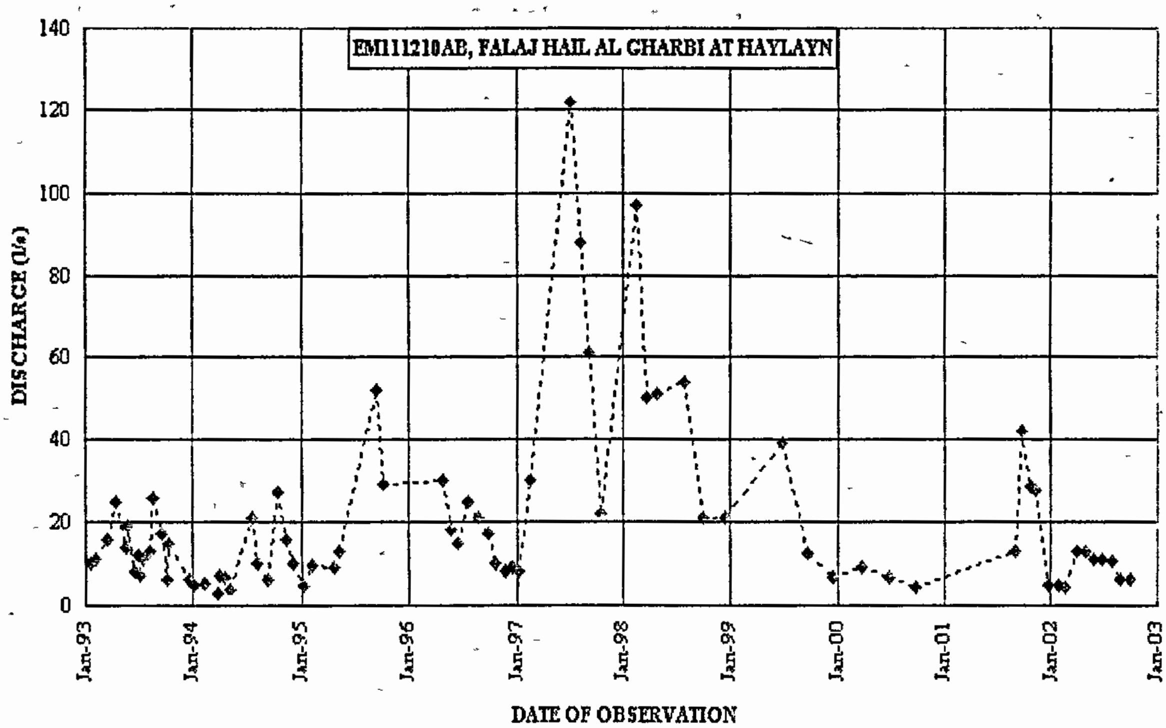
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
09-01-95	270	379	--	7	8	371	657	8 8
13-05-97	185	305	--	6	7	328	592	8 4

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EM111210AB, FALAJ HAIL AL GHARBI AT HAYLAYN

LOCATION

UTM	511100 E, 2512000 N
LATITUDE	22° 42' 55"
LONGITUDE	57° 06' 29"
FALAJ TYPE	Ghaily
PERIOD OF RECORD	January 1993 to September 2002
REMARKS	77 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 122 l\s, 08 July 1997 Minimum measured discharge, 3 0 l\s, 24 March 1994



WADI MAYHAH-MABRAH-HAJIR SYSTEM
EM111210AB, FALAJ HAIL AL GHARBI AT HAYLAYN
DISCHARGE MEASUREMENTS, Jan 1993 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
16-01-93	10	624	29 2	21 0
03-02-93	11	622	29 0	25 0
16-03-93	16	574	24 7	22 0
17-04-93	25	552	26 8	--
18-05-93	14	571	31 4	34 0
25-05-93	19	633	30 7	38 0
16-06-93	8	590	32 1	--
27-06-93	12	621	32 0	44 0
06-07-93	7	588	31 7	36 0
14-07-93	11	620	32 2	39 0
09-08-93	13	551	31 9	37 0
18-08-93	26	--	31 7	38 0
15-09-93	17	628	31 0	40 0
05-10-93	6	583	30 6	35 0
10-10-93	15	628	31 2	--
16-12-93	6	--	22 0	29 0
05-01-94	5	588	24 0	26 0
09-02-94	5	601	23 6	23 0
24-03-94	3	609	27 3	28 0
30-03-94	7	503	27 5	34 0
18-04-94	7	612	29 0	--
03-05-94	4	619	30 9	38 0
18-07-94	21	560	30 7	35 0
08-08-94	10	592	33 5	37 0
07-09-94	6	592	33 3	35 5
16-10-94	27	649	29 4	34 0
14-11-94	16	527	26 3	27 0
07-12-94	10	557	23 5	27 0
09-01-95	5	570	21 6	25 0
06-02-95	10	575	24 1	--
19-04-95	9	565	27 6	26 0
07-05-95	13	550	30 4	32 0
13-09-95	52	501	31 7	37 0
08-10-95	29	540	29 8	26 0
23-04-96	30	545	31 6	38 0
26-05-96	18	--	31 5	--
16-06-96	15	550	32 6	--
20-07-96	25	555	32 0	--
26-08-96	21	548	33 6	--
25-09-96	17	562	31 7	--
22-10-96	10	574	27 9	--
24-11-96	8	584	22 3	--
17-12-96	9	584	20 9	--
08-01-97	8	590	21 8	34 0
18-02-97	30	534	23 2	38 0
08-07-97	122	528	32 8	41 8
10-08-97	88	549	32 5	37 7
10-09-97	61	568	31 8	33 8

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EM111210AB, FALAJ HAIL AL GHARBI AT HAYLAYN
DISCHARGE MEASUREMENTS, Jan 1993 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
20-10-97	22	536	59 5	30 5
17-02-98	97	488	19 9	27 0
23-03-98	50	442	28 2	36 0
25-04-98	51	479	28 0	31 0
28-07-98	54	520	33 2	47 0
30-09-98	21	531	31.2	32 5
15-12-98	21	560	23 7	--
28-06-99	39	570	26 8	40 0
22-09-99	12	565	33 8	33 4
18-12-99	7	--	--	--
25-03-00	9	--	--	--
25-06-00	7	623	33 3	40 4
23-09-00	4	603	32 5	35 5
23-12-00	--	--	--	--
27-08-01	13	313	35 0	42 0
23-09-01	42	--	--	--
21-10-01	29	--	--	--
07-11-01	28	--	--	--
24-12-01	5	--	--	--
27-01-02	5	540	24 6	32 2
20-02-02	4	524	28 0	33 8
31-03-02	13	492	33 4	31 6
29-04-02	13	490	34 9	25 0
27-05-02	11	928	36 0	40 5
23-06-02	11	930	36 1	41 9
28-07-02	11	910	34 6	39 0
26-08-02	6	500	35 8	36 2
29-09-02	6	500	35 6	36 2

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EM111210AB, FALAJ HAIL AL GHARBI AT HAYLAYN
WATER QUALITY DATA, May 1997 to May 1997

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
12-05-97	121	--	--	51	0 10	--	2 8	44
Mean	**121**	**--**	**--**	**51**	**0.10**	**--**	**2.8**	**44**
Min	**121**	**--**	**--**	**51**	**0 10**	**--**	**2.8**	**44**
Max	**121**	**--**	**--**	**51**	**0.10**	**--**	**2.8**	**44**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
12-05-97	28	0 07	2 5	0 4	59	0 05	27	--
Mean	**28**	**0.07**	**2 5**	**0.4**	**59**	**0.05**	**27**	**--**
Min	**28**	**0.07**	**2.5**	**0.4**	**59**	**0.05**	**27**	**--**
Max	**28**	**0.07**	**2.5**	**0.4**	**59**	**0.05**	**27**	**--**

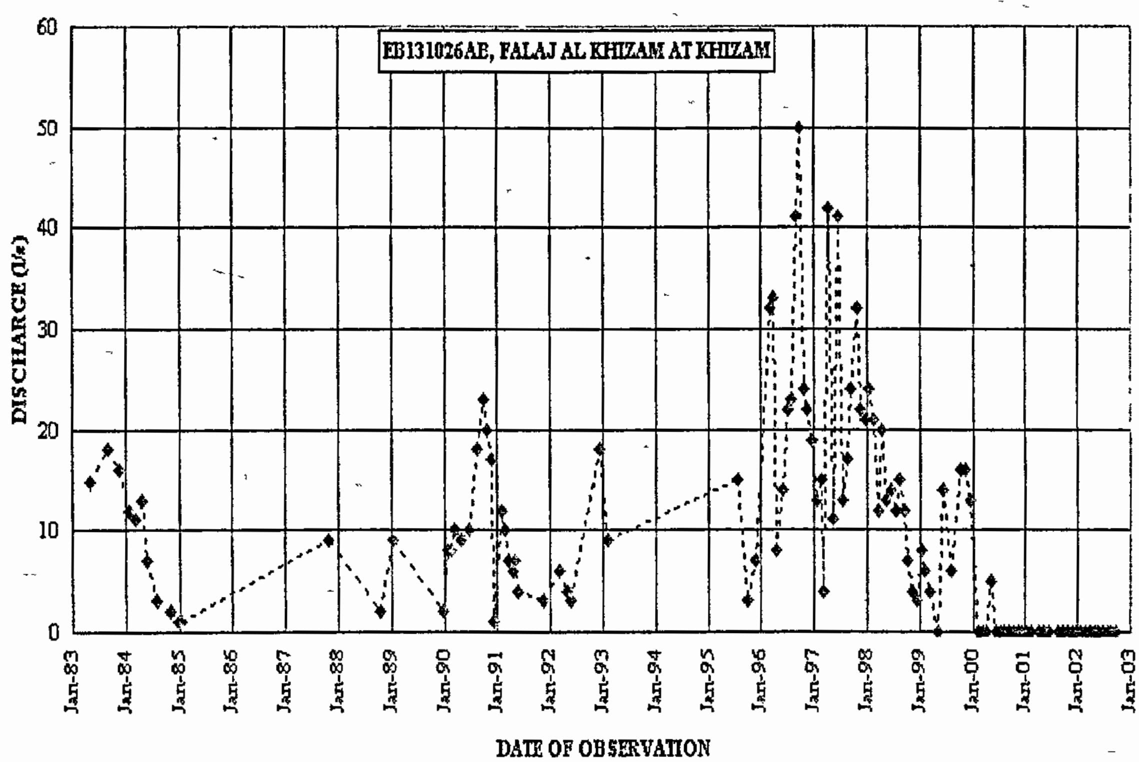
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
12-05-97	195	313	--	6	8	344	609	8 3

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB131026AB, FALAJ AL KHIZAM AT KHIZAM

LOCATION

UTM	511382 E, 2631194 N
LATITUDE	23° 47' 31"
LONGITUDE	57° 06' 42"
FALAJ TYPE	Daudı
PERIOD OF RECORD	May 1983 to September 2002
REMARKS	122 measurements have been made at the sıte
MEASURED EXTREMES	Maxımum measured dıscharge, 50 l\s, 22 September 1996 Mınımum measured dıscharge, 1 0 l\s, 21 Jan 85 and 10 Dec 90



WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB131026AB, FALAJ AL KHIZAM AT KHIZAM
DISCHARGE MEASUREMENTS, May 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
02-05-83	15	600	33 0	--
29-08-83	18	600	31 0	--
15-11-83	16	580	32 0	--
22-01-84	12	609	31 0	--
05-03-84	11	555	31 0	--
22-04-84	13	640	36 0	--
28-05-84	7	675	37 0	--
28-07-84	3	640	36 0	--
28-10-84	2	640	27 0	--
24-12-84	1	625	26 0	--
21-01-85	1	--	--	--
21-10-87	9	750	30 0	--
17-10-88	2	590	34 0	--
14-01-89	9	570	31 0	--
30-12-89	2	635	30 0	--
29-01-90	8	612	29 0	--
21-02-90	8	600	35 0	--
23-02-90	8	--	--	--
18-03-90	10	570	34 0	--
21-04-90	9	--	--	--
25-06-90	10	--	--	--
20-08-90	18	530	35 0	--
26-09-90	23	580	--	--
21-10-90	20	585	--	--
26-11-90	17	--	--	--
10-12-90	1	--	34 0	27 0
26-01-91	12	--	--	--
26-02-91	10	647	33 0	--
13-03-91	7	592	32 4	--
22-04-91	6	--	34 0	39 0
27-04-91	7	601	32 6	--
22-05-91	4	599	32 0	--
20-11-91	3	625	31 1	--
04-03-92	6	623	29 0	--
26-04-92	4	622	30 8	34 0
23-05-92	3	621	32 0	40 0
07-12-92	18	597	32 2	27 7
30-01-93	9	586	31 1	35 9
26-07-95	15	588	30 0	31 9
25-09-95	3	581	34 1	39 7
25-11-95	7	574	33 0	29 7
28-02-96	32	574	33 0	25 9
24-03-96	33	555	33 8	26 1
22-04-96	8	391	33 7	33 2
27-05-96	14	553	34 1	30 9
29-06-96	22	548	34 2	32 0
22-07-96	23	548	34 1	40 1
24-08-96	41	541	34 1	32 2
22-09-96	50	547	32 9	29 8

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB131026AB, FALAJ AL KHIZAM AT KHIZAM
DISCHARGE MEASUREMENTS, May 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
21-10-96	24	555	34 0	28 0
19-11-96	22	578	33 7	30 0
21-12-96	19	585	--	--
21-01-97	13	--	--	--
18-02-97	15	629	32 8	--
11-03-97	4	640	32 9	28 0
12-04-97	42	611	33 5	29 6
13-05-97	11	615	33 6	28 9
09-06-97	41	635	33 9	34 8
13-07-97	13	622	31 4	34 2
16-08-97	17	582	33 9	35 0
16-09-97	24	560	35 9	41 0
21-10-97	32	563	34 0	28 5
19-11-97	22	587	28 5	31 5
16-12-97	21	599	33 3	26 2
13-01-98	24	597	33 7	29 0
17-02-98	21	593	33 5	22 6
16-03-98	12	607	32 6	33 6
15-04-98	20	610	33 8	34 2
13-05-98	13	581	34 5	47.3
13-06-98	14	597	34 2	43 0
15-07-98	12	582	35 0	38 0
15-08-98	15	557	34 7	37 4
09-09-98	12	583	34 8	33 9
10-10-98	7	585	35 2	38 3
09-11-98	4	502	33 8	30 0
12-12-98	3	590	32 6	32 3
10-01-99	8	591	32 9	28 6
10-02-99	6	594	33 0	28 8
09-03-99	4	582	32 8	26 4
08-05-99	--	598	33 4	32 8
09-06-99	14	593	34 0	31 4
07-08-99	6	585	34 6	39 4
06-10-99	16	562	34 1	46 1
09-11-99	16	568	33 8	32 9
12-12-99	13	425	33 0	28 0
08-02-00	--	--	--	--
11-03-00	--	--	--	--
09-04-00	--	--	--	--
08-05-00	5	660	33 0	42 0
13-06-00	--	--	--	--
09-07-00	--	--	--	--
08-08-00	--	--	--	--
11-09-00	--	640	32 3	32 8
08-10-00	--	--	--	--
08-11-00	--	760	30 0	31 2
09-12-00	--	635	27 7	36 7
09-01-01	--	630	30 0	31 0
11-02-01	--	614	26 5	22 9
08-04-01	--	630	27 0	36 0
12-05-01	--	610	32 0	41 1

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB131026AB, FALAJ AL KHIZAM AT KHIZAM
DISCHARGE MEASUREMENTS, May 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
10-06-01	--	620	32 6	32 0
15-08-01	--	600	33 9	31 5
16-09-01	--	650	34 2	--
21-10-01	--	617	30 2	27 3
26-11-01	--	615	27 6	29 6
24-12-01	--	600	29 0	29 2
26-01-02	--	--	--	--
26-02-02	--	633	15 4	--
24-03-02	--	606	28 0	--
29-04-02	--	620	29 0	27 5
27-05-02	--	620	32 5	40 0
22-06-02	--	615	28 5	35 5
30-07-02	--	600	31 1	34 7
26-08-02	--	450	32 0	30 5
24-09-02	--	460	32 2	41 7

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB131026AB, FALAJ AL KHIZAM AT KHIZAM
WATER QUALITY DATA, Jun 1985 to Jun 2001
ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
24-06-85	205	0 23	--	79	0 06	0 05	0 9	43
25-09-95	145	--	--	65	0 10	--	1 3	41
27-12-95	145	--	--	58	0 10	--	1 5	35
29-06-96	149	--	--	61	0 89	--	1 4	39
22-09-96	156	--	--	60	0 14	--	1 3	38
21-12-96	158	--	--	66	0 10	--	1 3	32
13-07-97	153	--	--	65	0 10	--	1 2	33
16-09-97	146	--	--	65	0 10	--	1 3	36
16-12-97	152	--	--	68	0 10	--	1 8	32
13-01-98	107	--	--	51	0 10	--	1 3	28
12-12-98	170	--	--	68	0 10	--	1 5	36
09-06-99	155	--	--	73	0 10	--	1 5	38
13-06-00	180	--	--	74	0 10	--	1 6	45
09-12-00	162	--	--	80	0 10	--	1 5	58
10-06-01	137	--	--	73	0 11	--	1 5	50
Mean	**155**	**0.23**	**--**	**67**	**0.15**	**0.05**	**1.4**	**39**
Min	**107**	**0.23**	**--**	**51**	**0.06**	**0.05**	**0.9**	**28**
Max	**205**	**0 23**	**--**	**80**	**0 89**	**0.05**	**1 8**	**58**

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB131026AB, FALAJ AL KHIZAM AT KHIZAM
WATER QUALITY DATA, Jun 1985 to Jun 2001

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
24-06-85	29	0 07	4 4	-2 7	47	0 01	60	500
25-09-95	22	0 05	2 8	0 7	42	0 05	42	--
27-12-95	19	0 05	2 8	0 5	33	0 05	38	--
29-06-96	20	0 05	2 4	0 3	35	0 05	34	--
22-09-96	21	0 05	2 4	0 4	38	0 05	37	--
21-12-96	21	0 05	2 9	0 2	40	0 05	39	--
13-07-97	23	0 05	2 9	0 5	37	0 05	42	--
16-09-97	21	0 05	3 0	0 4	35	0 05	42	--
16-12-97	22	0 06	3 1	0 6	41	0 05	43	--
13-01-98	11	0 05	2 2	0 3	28	0 05	31	--
12-12-98	21	0 05	3 2	-0 3	42	0 05	43	--
09-06-99	23	0 05	3 0	-0 1	43	0 05	41	--
13-06-00	22	0 05	2 9	-1 1	40	0 05	39	--
09-12-00	24	0 05	3 4	-0 4	44	0 05	47	--
10-06-01	18	0 05	3 4	0 3	45	0 05	46	--
Mean	**21**	**0 05**	**3.0**	**0.0**	**39**	**0.05**	**42**	**500**
Min	**11**	**0.05**	**2.2**	**-2.7**	**28**	**0.01**	**31**	**500**
Max	**29**	**0.07**	**4.4**	**0.7**	**47**	**0.05**	**60**	**500**

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB131026AB, FALAJ AL KHIZAM AT KHIZAM
WATER QUALITY DATA, Mar 83 to Jun 01

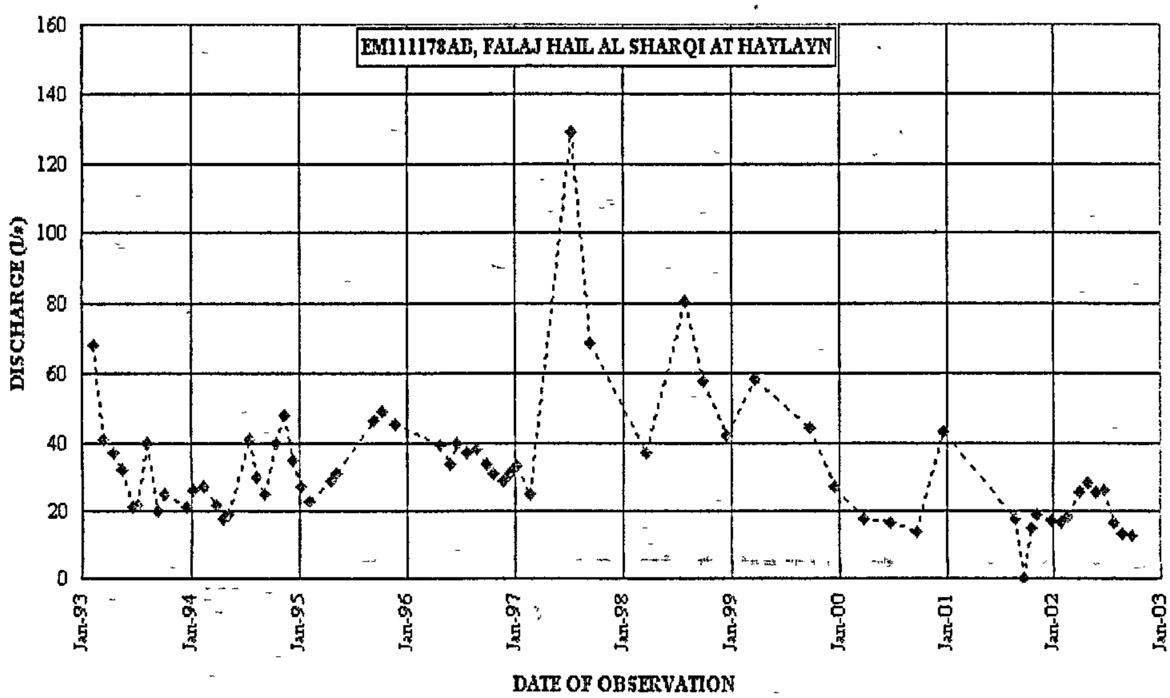
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
24-06-85	205	265	--	--	--	--	682	7 0
25-09-95	157	227	--	6	6	317	591	8 5
27-12-95	145	183	--	5	5	282	618	8 3
29-06-96	149	193	--	6	5	291	538	8 1
22-09-96	156	208	--	6	6	299	550	8 2
21-12-96	158	217	--	6	6	305	571	8 1
13-07-97	153	212	--	6	6	304	597	8 3
16-09-97	146	197	--	6	6	299	564	8 2
16-12-97	163	223	--	6	6	318	576	8 4
13-01-98	120	143	--	5	4	231	449	8 5
12-12-98	170	226	--	6	6	326	591	7.5
09-06-99	155	236	--	6	7	326	605	7 7
13-06-00	180	220	--	7	6	343	640	6 5
09-12-00	162	245	--	7	7	367	425	7 3
10-06-01	143	230	--	6	7	331	--	8 3

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EM111178AB, FALAJ HAIL AL SHARQI AT HAYLAYN

LOCATION

UTM	511761 E, 2612637 N
LATITUDE	23° 37' 27"
LONGITUDE	57° 06' 55"
FALAJ TYPE	Ghaily
PERIOD OF RECORD	March 1993 to September 2002
REMARKS	68 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 129 l\s, 08 July 1997 Minimum measured discharge, 13 l\s, 29 Sep 02 and 26 Aug 02



WADI MAYHAH-MABRAH-HAJIR SYSTEM
EM111178AB, FALAJ HAIL AL SHARQI AT HAYLAYN
DISCHARGE MEASUREMENTS, Feb 1993 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
11-02-93	68	609	21 0	23 0
16-03-93	41	574	23 2	22 0
17-04-93	37	549	25 3	--
18-05-93	32	575	27 7	34 0
16-06-93	21	593	30 1	32 0
06-07-93	22	591	31 7	36 0
09-08-93	40	557	28 9	37 0
12-09-93	20	576	21 0	33 0
05-10-93	25	586	27 9	36 0
16-12-93	21	--	21 0	29 0
05-01-94	26	592	22 9	26 0
09-02-94	27	607	21 1	23 0
24-03-94	22	616	24 7	28 0
18-04-94	18	617	26 7	--
03-05-94	19	622	28 6	38 0
18-07-94	41	566	29 1	35 0
08-08-94	30	591	31 4	37 0
07-09-94	25	594	31 1	35 5
16-10-94	40	594	27 0	33 0
12-11-94	48	542	24 8	27 0
07-12-94	35	561	21 1	27 0
09-01-95	27	573	20 1	25 0
06-02-95	23	575	23 2	25 0
19-04-95	29	564	24 9	25 0
07-05-95	31	553	27 4	30 0
13-09-95	46	502	30 4	37 0
08-10-95	49	545	27 6	25 0
23-11-95	45	547	27 8	27 0
23-04-96	39	540	31 1	38 0
26-05-96	34	541	31 1	--
16-06-96	40	545	31 2	--
20-07-96	37	552	34 2	--
26-08-96	38	544	34 6	--
25-09-96	34	551	32 2	--
22-10-96	31	578	25 8	--
24-11-96	29	582	24 2	--
17-12-96	31	577	23 2	--
08-01-97	33	594	21.1	34 0
18-02-97	25	583	24 5	37 0
08-07-97	129	527	31 6	41 8
10-09-97	68	570	30 5	33 8
23-03-98	37	503	27 8	36 4
28-07-98	80	521	31 9	42 1
30-09-98	58	537	30 7	33 0
15-12-98	42	568	20 9	30 0
23-03-99	58	550	--	--
22-09-99	44	570	30 7	35 9
18-12-99	27	--	--	--
25-03-00	18	--	--	--

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EM111178AB, FALAJ HAIL AL SHARQI AT HAYLAYN
DISCHARGE MEASUREMENTS, Feb 1993 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
25-06-00	17	620	32 2	40 4
23-09-00	14	622	30 0	35 9
23-12-00	43	--	--	--
27-08-01	18	--	33 0	39 0
23-09-01	--	--	--	--
21-10-01	15	--	--	--
07-11-01	19	--	--	--
24-12-01	17	--	--	--
27-01-02	17	522	24 2	32 2
20-02-02	19	510	26 0	34 3
31-03-02	26	473	33 4	30 4
29-04-02	28	500	30 6	35 0
27-05-02	25	485	36 0	43 0
23-06-02	26	488	37 0	42 2
28-07-02	17	495	34 3	39 6
26-08-02	13	745	35 0	35 6
29-09-02	13	745	35 6	37 2

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EM111178AB, FALAJ HAIL AL SHARQI AT HAYLAYN
WATER QUALITY DATA, May 1997 to May 1997

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
11-05-97	142	--	--	49	0 10	--	1 4	41
Mean	**142**	**--**	**--**	**49**	**0.10**	**--**	**1 4**	**41**
Min	**142**	**--**	**--**	**49**	**0.10**	**--**	**1.4**	**41**
Max	**142**	**--**	**--**	**49**	**0 10**	**--**	**1.4**	**41**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
11-05-97	18	0 05	2 0	0 6	58	0 05	27	--
Mean	**18**	**0.05**	**2.0**	**0 6**	**58**	**0 05**	**27**	**--**
Min	**18**	**0.05**	**2.0**	**0.6**	**58**	**0.05**	**27**	**--**
Max	**18**	**0.05**	**2.0**	**0 6**	**58**	**0.05**	**27**	**--**

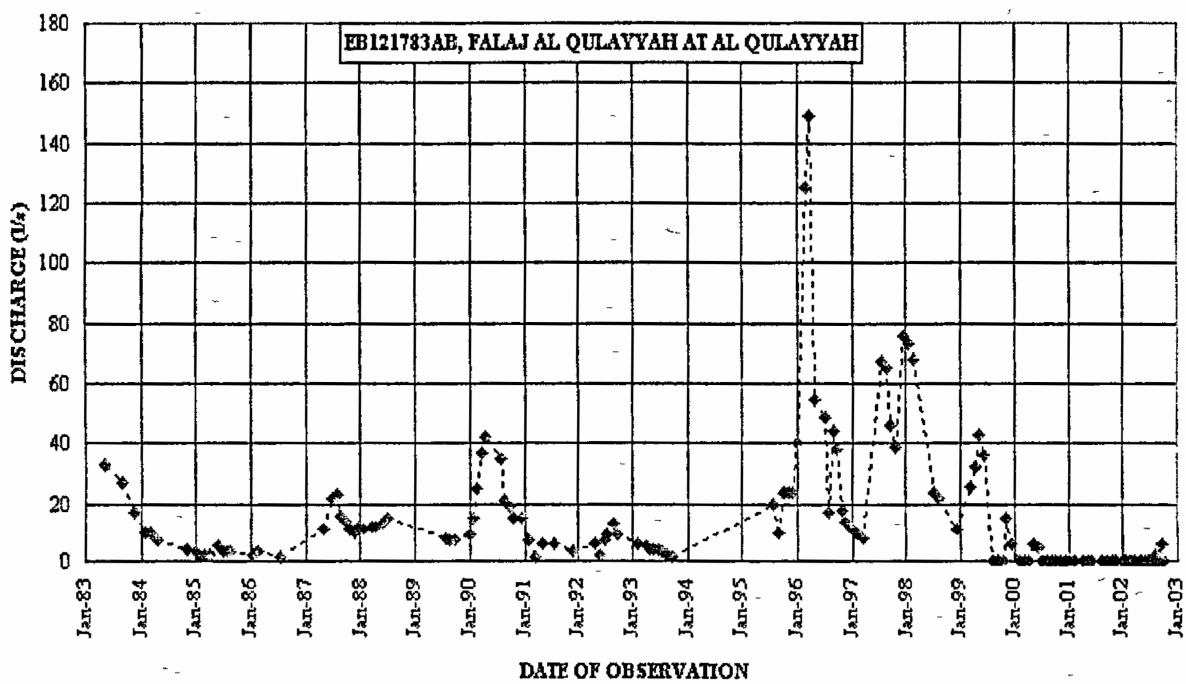
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
11-05-97	168	283	--	6	7	305	539	8 6

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB121783AB, FALAJ AL QULAYYAH AT AL QULAYYAH

LOCATION

UTM	511827 E, 2627594 N
LATITUDE	23° 45' 34"
LONGITUDE	57° 06' 58"
FALAJ TYPE	Daudi
PERIOD OF RECORD	May 1983 to September 2002
REMARKS	146 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 149 l\s, 24 March 1996 Minimum measured discharge, 1 l\s, 14 Jul 86 and 22 Sep 93



WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB121783AB, FALAJ AL QULAYYAH AT AL QULAYYAH
DISCHARGE MEASUREMENTS, May 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
02-05-83	33	650	33 0	--
29-08-83	27	650	31 0	--
15-11-83	17	620	32 0	--
22-01-84	10	600	31 5	--
05-03-84	10	575	32 0	--
22-04-84	7	640	36 0	--
28-10-84	4	560	30 0	--
24-12-84	3	550	32 0	--
21-01-85	2	--	--	--
19-02-85	2	550	31 0	--
23-03-85	2	550	30 0	--
20-05-85	5	757	31 0	--
24-06-85	3	550	34 0	--
22-07-85	3	550	31 0	--
18-08-85	3	--	--	--
07-01-86	2	500	28 0	--
10-02-86	3	520	30 0	--
14-07-86	1	--	--	--
25-04-87	11	500	31 0	--
21-06-87	22	--	--	--
29-07-87	23	525	33 0	--
23-08-87	16	640	33 0	--
20-09-87	14	830	34 0	--
21-10-87	11	850	34 0	--
17-11-87	10	--	--	--
16-12-87	12	--	--	--
20-01-88	11	640	34 0	--
12-03-88	12	650	32 0	--
10-04-88	12	650	30 0	--
29-05-88	13	650	34 0	--
26-06-88	15	--	36 0	--
24-07-89	8	600	34 0	--
20-08-89	7	600	35 0	--
23-09-89	7	600	34 0	--
30-12-89	9	670	31 0	--
29-01-90	15	650	31 0	--
21-02-90	25	900	35 0	--
18-03-90	37	610	37 0	--
21-04-90	42	--	--	--
23-07-90	35	--	--	--
20-08-90	21	600	35 0	--
26-09-90	19	620	--	--
21-10-90	15	635	--	--
11-12-90	15	--	34 0	20 0
26-01-91	7	--	--	--
13-03-91	1	606	32 7	--
27-04-91	6	593	33 0	--
24-07-91	6	560	33 4	43 0
20-11-91	3	545	32 1	--

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB121783AB, FALAJ AL QULAYYAH AT AL QULAYYAH
DISCHARGE MEASUREMENTS, May 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
26-04-92	6	631	33 0	37 0
23-05-92	2	596	30 0	40 0
27-06-92	7	602	33 0	40 0
13-07-92	9	609	33 0	35 0
24-08-92	13	610	33 0	36 0
21-09-92	9	614	33 3	34 0
30-01-93	6	591	32 1	31 5
30-03-93	5	583	32 2	28 8
25-04-93	4	571	32 5	35 8
24-05-93	4	563	32 5	30 7
19-06-93	4	563	30 0	33 5
19-07-93	3	551	33 2	35 0
23-08-93	2	542	32 0	34 0
22-09-93	1	540	--	34 0
26-07-95	20	745	33 0	31 6
21-08-95	10	612	33 4	35 0
25-09-95	24	633	33 7	36 2
30-10-95	24	651	33 5	35 6
25-11-95	24	648	33 4	25 1
27-12-95	40	704	33 8	27 2
28-02-96	125	719	32 6	28 7
24-03-96	149	663	32 8	33 1
22-04-96	55	645	33 0	41 4
30-06-96	49	637	34 7	--
23-07-96	17	635	33 1	40 2
24-08-96	44	625	32 9	33 9
22-09-96	38	636	33 3	35 0
21-10-96	18	629	33 0	27 6
19-11-96	14	648	32 9	28 0
21-12-96	12	635	--	--
21-01-97	10	--	--	--
18-02-97	9	638	32 3	27 5
11-03-97	8	636	32 9	29 0
13-07-97	67	656	33 2	30 0
16-08-97	65	533	33 2	35 0
16-09-97	46	630	34 7	41 3
21-10-97	39	650	33 0	43 0
16-12-97	76	627	32 1	22 6
13-01-98	73	630	32 2	27 0
17-02-98	68	614	31 4	28 8
14-07-98	24	589	32 7	34 0
15-08-98	22	598	32 9	41 2
12-12-98	11	620	32 4	33 5
09-03-99	26	662	32 6	26 4
12-04-99	32	624	--	32 8
08-05-99	43	619	32 9	32 3
09-06-99	36	611	32 9	33 2
07-08-99	--	609	33 2	42 2

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB121783AB, FALAJ AL QULAYYAH AT AL QULAYYAH
DISCHARGE MEASUREMENTS, May 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
08-09-99	--	--	--	--
09-10-99	--	--	--	--
09-11-99	15	611	33 0	32 6
12-12-99	6	570	32 0	27 0
08-02-00	--	--	--	--
11-03-00	--	--	--	--
04-04-00	--	--	--	--
08-05-00	6	620	33 0	42 0
13-06-00	4	582	32 7	--
09-07-00	--	--	--	--
08-08-00	--	--	--	--
11-09-00	--	--	22 7	33 6
08-10-00	--	--	--	--
08-11-00	--	860	26 8	31 2
09-12-00	--	565	30 8	36 0
09-01-01	--	560	29 9	31 1
11-02-01	--	546	22 5	26 5
08-04-01	--	553	30 1	32 0
12-05-01	--	543	31 9	41 9
10-06-01	--	620	32 6	35 0
15-08-01	--	500	32 5	31 9
11-09-01	--	--	--	--
16-09-01	--	--	--	--
20-10-01	--	--	--	--
21-10-01	--	527	31 0	26 8
11-11-01	--	--	--	--
23-12-01	--	--	--	--
26-12-01	--	--	--	--
12-01-02	--	--	--	--
23-01-02	--	--	--	--
12-02-02	--	--	--	--
26-02-02	--	--	--	--
24-03-02	--	--	--	--
24-03-02	--	--	--	--
27-04-02	--	--	--	--
29-04-02	--	523	31 0	30 0
27-05-02	--	--	--	--
22-06-02	--	514	26 7	34 5
27-06-02	--	--	--	--
27-07-02	--	--	--	--
30-07-02	2	500	30 1	31 5
26-08-02	2	--	--	--
27-08-02	--	510	31 2	41 4
27-09-02	--	--	--	--

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB121783AB, FALAJ AL QULAYYAH AT AL QULAYYAH
WATER QUALITY DATA, Jun 1985 to Jun 2001

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
24-06-85	183	0 12	--	45	0 08	0 01	1 8	41
25-09-95	181	--	--	60	0 21	--	2 0	43
27-12-95	175	--	0 09	73	0 15	--	2 8	59
30-06-96	175	--	--	53	0 10	--	2 8	57
22-09-96	183	--	--	55	0 19	--	2 6	57
21-12-96	179	--	--	57	0 10	--	2 5	51
13-07-97	153	--	--	64	0 20	--	2 9	38
16-09-97	156	--	--	59	0 10	--	2 6	54
16-12-97	166	--	--	56	0 15	--	3 1	56
15-04-98	158	--	--	52	0 20	--	2 3	68
12-12-98	180	--	--	60	0 10	--	2 5	56
09-06-99	160	--	--	55	0 10	--	2 3	58
13-06-00	151	--	--	55	0 10	--	2 6	46
09-12-00	155	--	--	49	0 10	--	2 7	80
10-06-01	176	--	--	44	0 30	--	1 2	45
Mean	**169**	**0.12**	**0.09**	**56**	**0.15**	**0 01**	**2.5**	**54**
Min	**151**	**0.12**	**0.09**	**44**	**0.08**	**0.01**	**1.2**	**38**
Max	**183**	**0.12**	**0.09**	**73**	**0.30**	**0.01**	**3.1**	**80**

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB121783AB, FALAJ AL QULAYYAH AT AL QULAYYAH
WATER QUALITY DATA, Jun 1985 to Jun 2001

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
24-06-85	36	0 01	1 7	-2 9	21	0 01	56	420
25-09-95	43	0 05	2 0	0.3	25	0 05	52	--
27-12-95	47	0 05	2 2	0 0	25	0 05	55	--
30-06-96	41	0 05	1 7	0 1	23	0 05	49	--
22-09-96	44	0 05	1 8	0 5	23	0 05	52	--
21-12-96	44	0 05	2 0	0 4	23	0 05	52	--
13-07-97	48	0 05	2 1	0 1	20	0 05	58	--
16-09-97	45	0 05	2 0	0 2	20	0 05	59	--
16-12-97	51	0 05	2 2	0 5	20	0 05	57	--
15-04-98	42	0 05	2 1	-0.1	20	0 05	55	--
12-12-98	44	0 06	2 3	0 2	22	0 06	54	--
09-06-99	45	0 05	2 1	-0 4	23	0 05	53	--
13-06-00	39	0 07	2 1	-1 0	20	0 08	46	--
09-12-00	38	0 09	2 5	-0 1	23	0 05	47	--
10-06-01	36	0 05	2 3	0 1	22	0 05	49	--
Mean	**43**	**0.05**	**2.1**	**-0.1**	**22**	**0 05**	**53**	**420**
Min	**36**	**0.01**	**1.7**	**-2.9**	**20**	**0.01**	**46**	**420**
Max	**51**	**0.09**	**2.5**	**0.5**	**25**	**0.08**	**59**	**420**

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB121783AB, FALAJ AL QULAYYAH AT AL QULAYYAH
WATER QUALITY DATA, Jun 1985 to Jun 2001

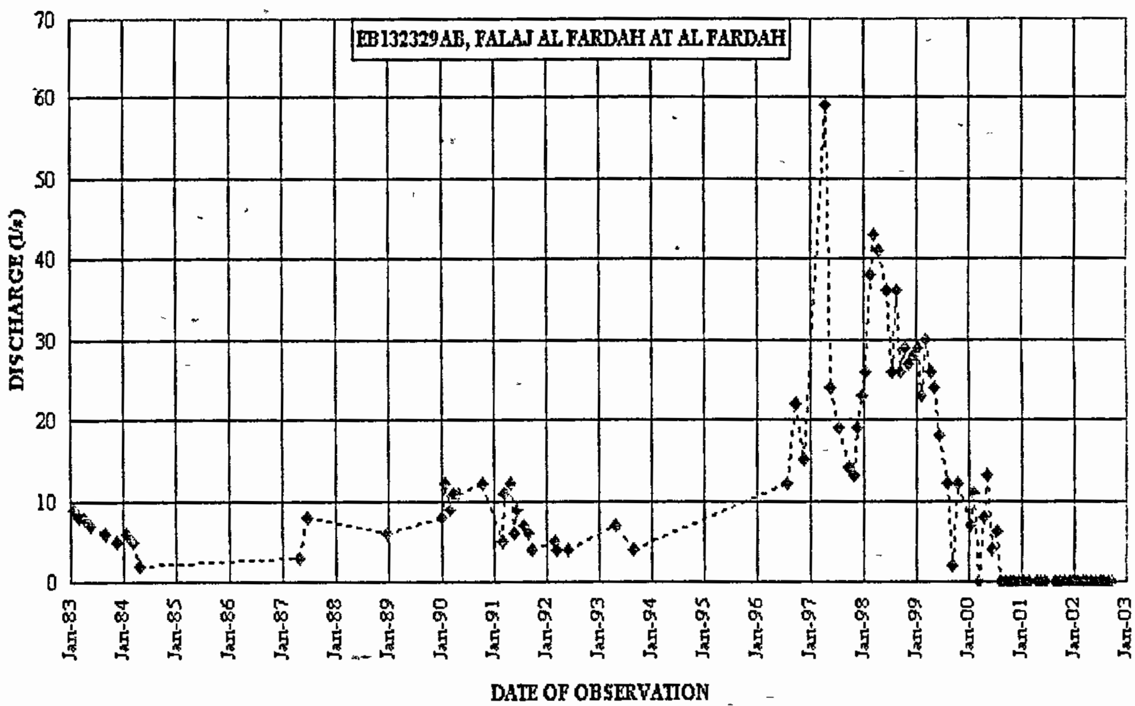
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
24-06-85	183	175	--	--	--	--	556	6 7
21-06-95	162	161	--	5	5	296	558	8 1
25-09-95	181	209	--	6	7	347	630	7 7
27-12-95	175	222	--	7	7	383	684	7 4
30-06-96	175	196	--	6	6	346	621	7 6
22-09-96	183	207	--	7	6	359	622	7 8
21-12-96	179	204	--	6	6	351	622	7 9
13-07-97	153	201	--	6	7	338	633	7 6
16-09-97	156	193	--	6	6	348	625	7 6
16-12-97	166	212	--	6	7	360	610	7 9
15-04-98	158	188	--	6	6	349	581	7 4
12-12-98	180	199	--	7	6	361	613	7 6
09-06-99	160	208	--	6	7	347	615	7 1
13-06-00	151	181	--	6	6	314	593	6 5
09-12-00	155	192	--	6	6	349	344	7 4
10-06-01	176	180	--	6	6	313	543	7 6

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB132329AB, FALAJ AL FARDAH AT AL FARDAH

LOCATION

UTM	512198 E, 2634237 N
LATITUDE	23° 49' 10"
LONGITUDE	57° 07' 11"
FALAJ TYPE	Daudi
PERIOD OF RECORD	January 1983 to September 2002
REMARKS	98 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 59 l\s, 12 April 1997 Minimum measured discharge, 2 l\s, 22 Apr 84 and 08 Sep 99



WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB132329AB, FALAJ AL FARDAH AT AL FARDAH
DISCHARGE MEASUREMENTS, Jan 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
18-01-83	9	675	--	--
27-02-83	8	680	31 0	--
03-04-83	8	750	31 0	--
22-05-83	7	660	38 0	--
29-08-83	6	670	33 0	--
15-11-83	5	655	32 0	--
22-01-84	6	650	32 0	--
05-03-84	5	550	28 0	--
22-04-84	2	680	35 5	--
25-04-87	3	600	31 0	--
21-06-87	8	--	--	--
19-12-88	6	660	34 0	--
30-12-89	8	710	32 0	--
29-01-90	12	640	30 0	--
21-02-90	9	690	--	--
18-03-90	11	650	31 0	--
21-04-90	11	--	--	--
11-10-90	12	680	--	--
26-02-91	5	690	34 0	--
13-03-91	11	648	34 2	--
27-04-91	12	646	34 0	--
22-05-91	6	642	34 0	--
15-06-91	9	644	34 0	38 0
27-07-91	7	644	34 0	41 0
31-08-91	6	643	34 5	43 0
22-09-91	4	665	33 0	32 0
23-02-92	5	663	33 0	32 0
04-03-92	4	662	33 0	--
23-05-92	4	664	34 0	48 0
25-04-93	7	669	33 8	37.9
23-08-93	4	665	34 0	35 0
22-07-96	12	664	34 1	36 0
22-09-96	22	654	33 4	28 6
19-11-96	15	669	35 0	26 7
12-04-97	59	658	34 0	29 0
13-05-97	24	654	33 8	28 7
13-07-97	19	650	34 0	32 0
16-09-97	14	620	36 7	41 2
21-10-97	13	646	34 8	29 0
19-11-97	19	661	30 2	28 6
16-12-97	23	659	34 9	25 3
13-01-98	26	657	34 6	29 0
17-02-98	38	661	34 2	26 1
16-03-98	43	685	34 0	34 2
15-04-98	41	680	33 8	32 4
13-06-98	36	670	34 5	40 0
14-07-98	26	635	34 0	38 2
15-08-98	36	630	35 6	44 2
09-09-98	26	639	34 8	36 7

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB132329AB, FALAJ AL FARDAH AT AL FARDAH
DISCHARGE MEASUREMENTS, Jan 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
10-10-98	29	636	38 9	37 0
09-11-98	27	637	34 8	32 8
12-12-98	28	650	34 6	28 1
10-01-99	29	650	34 5	27 6
10-02-99	23	638	34 1	29 8
08-09-99	0	--	--	--
09-10-99	0	--	--	--
09-11-99	15	611	33 0	32 6
12-12-99	6	570	32 0	27 0
08-02-00	--	--	--	--
11-03-00	--	--	--	--
04-04-00	--	--	--	--
08-05-00	6	620	33 0	42 0
09-03-99	30	650	33 8	23 4
12-04-99	26	932	33 6	31 4
08-05-99	24	630	33 7	35 8
09-06-99	18	620	33 8	32 8
07-08-99	12	639	34 3	39 0
08-09-99	2	645	34 4	33 0
09-10-99	12	635	34 5	41 8
15-01-00	7	680	34 0	20 0
08-02-00	11	633	34 0	27 0
10-03-00	--	--	--	--
09-04-00	8	660	33 7	32 4
08-05-00	13	700	34 0	44 0
13-06-00	4	658	33 9	--
09-07-00	6	440	31 6	--
08-08-00	--	--	--	--
11-09-00	--	--	--	--
08-10-00	--	--	--	--
08-11-00	--	875	33 8	31 8
09-12-00	--	688	32 1	36 5
09-01-01	--	680	30 0	31 0
11-02-01	--	686	28 3	30 2
08-04-01	--	698	31 0	36 0
12-05-01	--	701	33 0	41 0
10-06-01	--	717	34 0	39 0
15-08-01	--	700	33 9	31 9
16-09-01	--	919	30 7	34 0
21-10-01	--	700	31 0	26 0
26-11-01	--	732	27 2	30 6
24-12-01	--	800	27 6	26 0
26-01-02	--	--	--	--
26-02-02	--	761	16 8	--
24-03-02	--	729	25 4	--
29-04-02	--	745	29 0	27 5
27-05-02	--	740	30 0	42 0
29-06-02	--	740	27 0	38 5
30-07-02	--	800	27 4	30 3
26-08-02	--	613	34 1	34 0
24-09-02	--	736	30 0	37 2

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB132329AB, FALAJ AL FARDAH AT AL FARDAH
WATER QUALITY DATA, Jun 1995 to Jun 2001

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
21-06-95	182	--	--	80	0 10	--	1 0	37
27-12-95	172	--	0 17	82	0 10	--	1 0	46
29-06-96	178	--	--	71	0 31	--	1 4	50
22-09-96	187	--	--	69	0 10	--	1 4	47
21-12-96	182	--	--	75	0 10	--	1 5	38
13-07-97	158	--	--	69	0 10	--	1 4	38
16-09-97	159	--	--	83	0 10	--	1 5	42
16-12-97	182	--	--	72	0 10	--	1 8	40
15-04-98	160	--	--	76	0 10	--	2 1	29
12-12-98	185	--	--	75	0 10	--	1 9	40
09-06-99	174	--	--	74	0 10	--	1 7	35
13-06-00	175	--	--	82	0 10	--	1 7	41
09-12-00	173	--	--	84	0 10	--	1 8	54
10-06-01	179	--	--	89	0 20	--	1 7	56
Mean	**175**	**--**	**0.17**	**77**	**0.12**	**--**	**1.6**	**42**
Min	**158**	**--**	**0.17**	**69**	**0.10**	**--**	**1.0**	**29**
Max	**187**	**--**	**0.17**	**89**	**0.31**	**--**	**2.1**	**56**

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB132329AB, FALAJ AL FARDAH AT AL FARDAH
WATER QUALITY DATA, Jun 1995 to Jun 2001

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
21-06-95	18	0 05	5 0	0 3	38	0 05	60	--
27-12-95	19	0 05	3 0	0 4	49	0 05	49	--
29-06-96	19	0 05	2 6	0 3	42	0 05	48	--
22-09-96	22	0 05	2 9	0 5	44	0 05	53	--
21-12-96	20	0 05	3 0	0 2	43	0 05	52	--
13-07-97	20	0 05	2 9	0 3	38	0 05	55	--
16-09-97	21	0 05	2 9	0 4	38	0 05	55	--
16-12-97	20	0 05	4 0	0 6	39	0 05	55	--
15-04-98	18	0 05	2 8	0 1	40	0 05	50	--
12-12-98	20	0 05	3 3	0 3	43	0 05	53	--
09-06-99	21	0 05	2 9	0 0	45	0 05	47	--
13-06-00	20	0 07	3 1	-1 4	44	0 08	46	--
09-12-00	22	0 05	3 3	0 0	50	0 05	50	--
10-06-01	22	0 05	3 3	0 5	53	0 05	52	--
Mean	**20**	**0.05**	**3.2**	**0.2**	**43**	**0.05**	**52**	**--**
Min	**18**	**0.05**	**2.6**	**-1.4**	**38**	**0.05**	**46**	**--**
Max	**22**	**0.07**	**5.0**	**0.6**	**53**	**0.08**	**60**	**--**

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB132329AB, FALAJ AL FARDAH AT AL FARDAH
WATER QUALITY DATA, Jun 1995 to Jun 2001

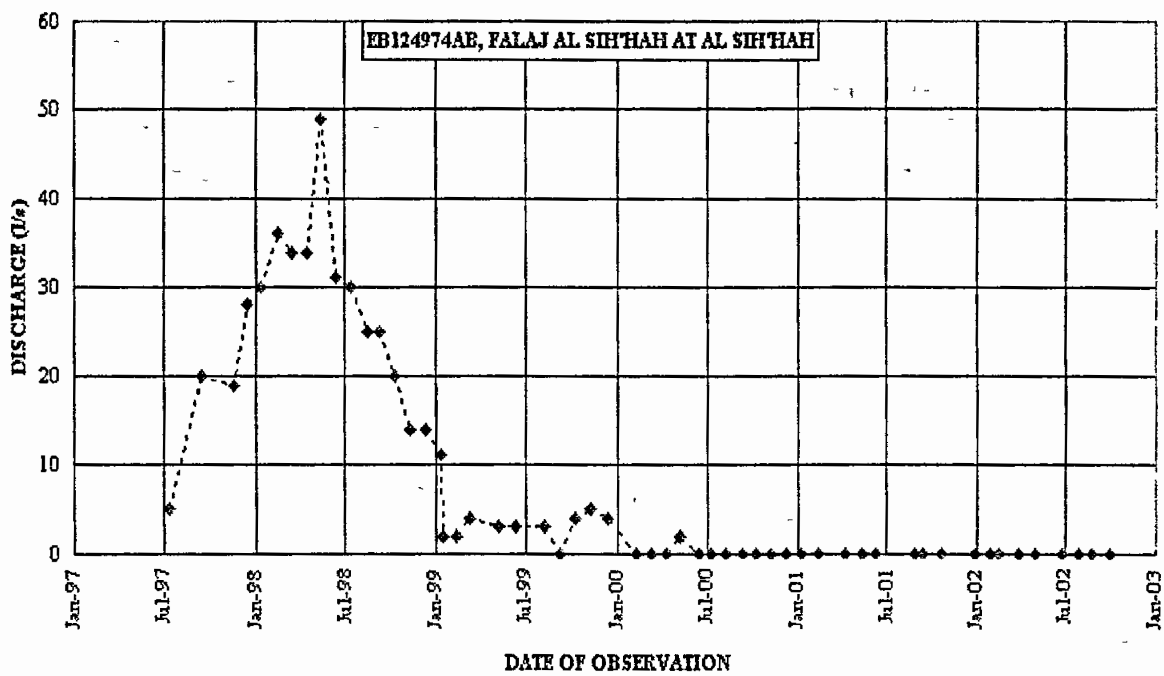
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
21-06-95	182	201	--	7	7	356	702	8.1
27-12-95	172	249	--	7	7	359	672	8.2
29-06-96	178	222	--	7	7	350	652	8.1
22-09-96	187	236	--	7	7	360	649	8.1
21-12-96	182	226	--	7	7	350	647	8.0
13-07-97	158	206	--	6	7	328	622	8.2
16-09-97	159	209	--	7	7	347	626	8.2
16-12-97	182	213	--	7	7	352	634	8.3
15-04-98	160	211	--	6	6	325	634	7.9
12-12-98	185	227	--	7	7	358	645	8.0
09-06-99	174	237	--	6	7	341	636	7.9
13-06-00	175	233	--	7	7	353	676	6.5
09-12-00	173	261	--	7	7	379	607	7.8
10-06-01	179	274	--	7	8	395	710	8.2

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB124974AB, FALAJ AL SIH'HAH AT AL SIH'HAH

LOCATION

UTM	51 010 E, 2630089 N
LATITUDE	23° 46' 55"
LONGITUDE	57° 08' 50"
FALAJ TYPE	Daudi
PERIOD OF RECORD	May 1983 to September 2002
REMARKS	63 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 49 l\s, 13 May 1998 Minimum measured discharge, 2 l\s, 15 Jan 99 and 08 May 00



WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB124974AB, FALAJ AL SIH'HAH AT AL SIH'HAH
DISCHARGE MEASUREMENTS, Jul 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
13-07-97	5	546	35 8	34 7
16-09-97	20	550	34 5	40 0
19-11-97	19	537	29 5	28 7
16-12-97	28	536	31 8	24 0
13-01-98	30	560	31.7	26 6
17-02-98	36	555	31 8	23 9
16-03-98	34	554	33 1	31 3
15-04-98	34	570	33 4	32 5
13-05-98	49	546	33 7	39 1
13-06-98	31	563	34 0	40 2
14-07-98	30	550	34 2	37 5
15-08-98	25	550	34 4	41 3
09-09-98	25	554	34 9	41 2
10-10-98	20	557	33 8	36 7
09-11-98	14	555	33 1	31 6
12-12-98	14	570	31 7	28 2
10-01-99	11	569	31 0	26 0
15-01-99	2	630	26 0	26 0
10-02-99	2	565	31 2	26 9
09-03-99	4	586	31 0	26 0
08-05-99	3	570	30 8	36 7
09-06-99	3	571	32 7	35 0
07-08-99	3	582	32 8	32 1
08-09-99	--	--	--	--
09-10-99	4	578	30 7	40 3
09-11-99	5	602	30 5	30 4
12-12-99	4	450	29 0	28 0
08-02-00	--	--	--	--
11-03-00	--	--	--	--
09-04-00	--	--	--	--
08-05-00	2	630	30 0	40 0
13-06-00	--	--	--	--
09-07-00	--	--	--	--
08-08-00	--	--	--	--
11-09-00	--	610	31 4	33 3
08-10-00	--	--	--	--
08-11-00	--	880	22 2	25 4
09-12-00	--	601	25 0	36 0
09-01-01	--	660	28 9	30 8
11-02-01	--	555	25 9	23 3
08-04-01	--	640	24 2	30 0
12-05-01	--	650	30 0	40 0
10-06-01	--	665	32 3	32 9
28-08-01	--	--	--	--
11-09-01	--	--	--	--
20-10-01	--	--	--	--
26-12-01	--	--	--	--
28-01-02	--	--	--	--

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB124974AB, FALAJ AL SIH'HAH AT AL SIH'HAH
DISCHARGE MEASUREMENTS, Jul 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
12-02-02	--	--	--	--
28-03-02	--	--	--	--
30-04-02	--	--	--	--
24-06-02	--	--	--	--
27-07-02	--	--	--	--
24-08-02	--	--	--	--
30-09-02	--	--	--	--

WADI MAYHAH-MABRAH-HAJIR SYSTEM
.EB124974AB, FALAJ AL SIH'HAH AT AL SIH'HAH
WATER QUALITY DATA, Sep 1997 to Dec 2000

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
16-09-97	121	--	--	60	0 10	--	2 3	45
16-12-97	121	--	--	58	0 10	--	1 9	44
15-04-98	129	--	--	62	0 10	--	1 9	37
12-12-98	150	--	--	64	0 10	--	2 2	52
09-06-99	126	--	--	67	0 10	--	2 3	51
09-12-00	136	--	--	80	0 10	--	2 6	88
Mean	**131**	**--**	**--**	**65**	**0.10**	**--**	**2.2**	**53**
Min	**121**	**--**	**--**	**58**	**0.10**	**--**	**1.9**	**37**
Max	**150**	**--**	**--**	**80**	**0.10**	**--**	**2.6**	**88**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
16-09-97	23	0 05	2 4	0 4	24	0 05	57	--
16-12-97	26	0 05	2 6	0 7	26	0 05	52	--
15-04-98	22	0 05	2 5	0 2	26	0 05	51	--
12-12-98	23	0 05	2 5	0 5	27	0 05	54	--
09-06-99	24	0 05	2 5	0 9	29	0 05	54	--
09-12-00	25	0 06	2 9	-0 8	34	0 05	55	--
Mean	**24**	**0.05**	**2.6**	**0.8**	**28**	**0.05**	**54**	**--**
Min	**22**	**0.05**	**2 4**	**-0 8**	**24**	**0 05**	**51**	**--**
Max	**26**	**0.06**	**2.9**	**0 9**	**34**	**0.05**	**57**	**--**

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB124974AB, FALAJ AL SIH'HAH AT AL SIH'HAH
WATER QUALITY DATA, Sep 1997 to Dec 2000

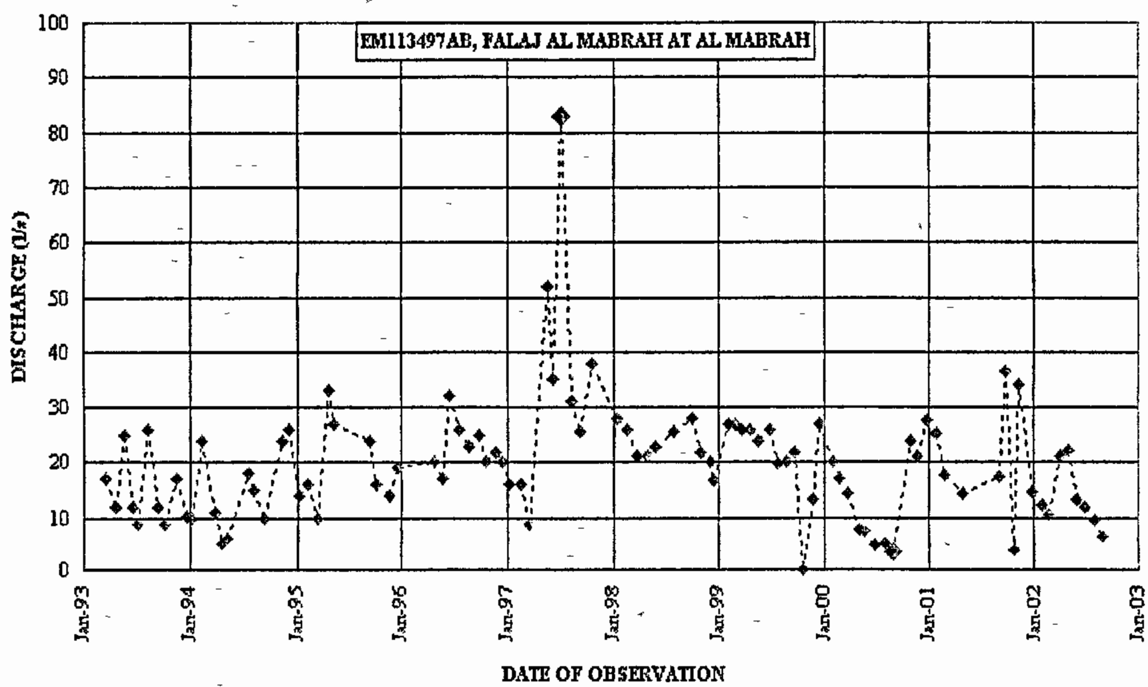
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
16-09-97	121	156	--	5	6	297	555	8 2
16-12-97	133	171	--	5	6	300	536	8 5
15-04-98	129	162	--	5	6	289	537	8 1
12-12-98	150	166	--	6	6	325	565	8 2
09-06-99	136	178	--	6	6	322	1123	8 3
09-12-00	136	201	--	7	6	381	603	7 2

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EM113497AB, FALAJ AL MABRAH AT AL MABRAH

LOCATION

UTM	515415 E, 2615871 N
LATITUDE	23° 39' 04"
LONGITUDE	57° 09' 04"
FALAJ TYPE	Ghaily
PERIOD OF RECORD	January 1993 to September 2002
REMARKS	102 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 83 l\s, 08 July 1997 Minimum measured discharge, 3 l\s, 27 August 2000



WADI MAYHAH-MABRAH-HAJIR SYSTEM
EM113497AB, FALAJ AL MABRAH AT AL MABRAH
DISCHARGE MEASUREMENTS, Mar 1993 to Aug 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
16-03-93	17	791	22.6	20.0
18-04-93	12	780	30.0	33.0
18-05-93	25	911	23.7	--
16-06-93	12	947	29.7	31.0
06-07-93	9	981	31.0	35.0
09-08-93	26	972	27.9	38.0
12-09-93	12	981	31.3	35.0
05-10-93	9	1013	26.4	33.0
14-11-93	17	1020	24.2	25.0
16-12-93	10	1073	21.0	21.0
05-01-94	10	1076	20.8	25.0
09-02-94	24	1065	19.2	19.0
24-03-94	11	1041	24.8	28.0
18-04-94	5	1085	25.1	--
03-05-94	6	1104	27.6	38.0
18-07-94	18	746	28.1	33.0
08-08-94	15	1131	31.7	37.0
07-09-94	10	1098	30.6	35.5
14-11-94	24	843	24.3	27.0
07-12-94	26	1052	20.1	26.0
09-01-95	14	1072	18.2	23.0
06-02-95	16	1074	21.4	25.0
15-03-95	10	511	18.7	22.0
19-04-95	33	999	24.8	--
07-05-95	27	914	26.7	--
13-09-95	24	677	30.1	--
08-10-95	16	812	28.7	--
23-11-95	14	814	28.8	--
17-12-95	19	853	28.0	--
23-04-96	20	749	31.5	--
25-05-96	17	841	33.3	--
16-06-96	32	889	30.3	--
20-07-96	26	675	35.1	--
26-08-96	23	762	32.0	--
25-09-96	25	861	33.7	--
22-10-96	20	928	26.3	--
24-11-96	22	971	24.2	--
17-12-96	20	987	22.4	--
08-01-97	16	1022	18.3	32.0
18-02-97	16	871	24.3	36.0
17-03-97	9	915	21.8	22.5
21-05-97	52	568	29.7	33.5
07-06-97	35	587	35.8	42.0
08-07-97	83	600	31.7	43.6
10-08-97	31	616	31.3	36.3
10-09-97	26	739	30.7	31.9
20-10-97	38	590	30.1	38.4
12-01-98	28	612	20.9	30.0
17-02-98	26	513	17.3	27.0

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EM113497AB, FALAJ AL MABRAH AT AL MABRAH
DISCHARGE MEASUREMENTS, Mar 1993 to Aug 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
23-03-98	21	545	27 6	32 0
25-04-98	21	779	28 5	33 0
24-05-98	23	709	31.2	--
28-07-98	26	665	33 1	41 2
30-09-98	28	870	30 9	34 0
26-10-98	22	864	27 2	39 6
30-11-98	20	883	20 0	30 4
15-12-98	17	919	19 1	30 0
31-01-99	27	--	--	--
28-02-99	27	--	--	--
23-03-99	26	690	--	--
19-04-99	26	--	--	--
18-05-99	24	720	--	38 0
27-06-99	26	732	28 9	--
26-07-99	20	--	--	--
23-08-99	20	878	34 0	35 9
22-09-99	22	929	32 0	33 4
20-10-99	--	--	--	--
22-11-99	13	294	26 4	29 6
18-12-99	27	--	--	--
31-01-00	20	972	20 7	--
21-02-00	17	840	21 2	--
25-03-00	14	--	--	--
30-04-00	8	--	--	--
22-05-00	7	--	--	--
25-06-00	5	1043	32 8	35 8
29-07-00	5	--	--	--
27-08-00	3	1059	32 9	--
23-09-00	--	1085	28 3	31 9
28-10-00	24	--	--	--
22-11-00	21	1104	25 3	--
23-12-00	27	--	--	--
21-01-01	25	1075	18 4	--
19-02-01	18	1034	21 8	--
25-04-01	14	--	--	--
27-08-01	17	--	33 0	39 9
23-09-01	36	--	--	--
21-10-01	4	--	--	--
07-11-01	34	--	--	--
24-12-01	15	--	--	--
27-01-02	12	918	25.2	31 1
20-02-02	10	888	27 1	30 2
31-03-02	21	965	31 0	34 0
29-04-02	22	875	33 9	35 9
27-05-02	13	727	40 0	44 5
23-06-02	12	730	41 1	43 2
28-07-02	9	812	38 6	45 1
26-08-02	7	880	34 3	36 6

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EM113497AB, FALAJ AL MABRAH AT AL MABRAH
WATER QUALITY DATA, Apr 1997 to Apr 1997

ANION

Date	Bicarbonate As HCo3 (mg/l)	Boron As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
29-04-97	73	--	--	43	0 29	--	2 0	51
Mean	**73**	**--**	**--**	**43**	**0.29**	**--**	**2.0**	**51**
Min	**73**	**--**	**--**	**43**	**0 29**	**--**	**2.0**	**51**
Max	**73**	**--**	**--**	**43**	**0 29**	**--**	**2.0**	**51**

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
29-04-97	19	0 05	1 9	0 9	48	0 05	25	--
Mean	**19**	**0.05**	**1.9**	**0.9**	**48**	**0.05**	**25**	**--**
Min	**19**	**0.05**	**1.9**	**0 9**	**48**	**0 05**	**25**	**--**
Max	**19**	**0 05**	**1.9**	**0.9**	**48**	**0 05**	**25**	**--**

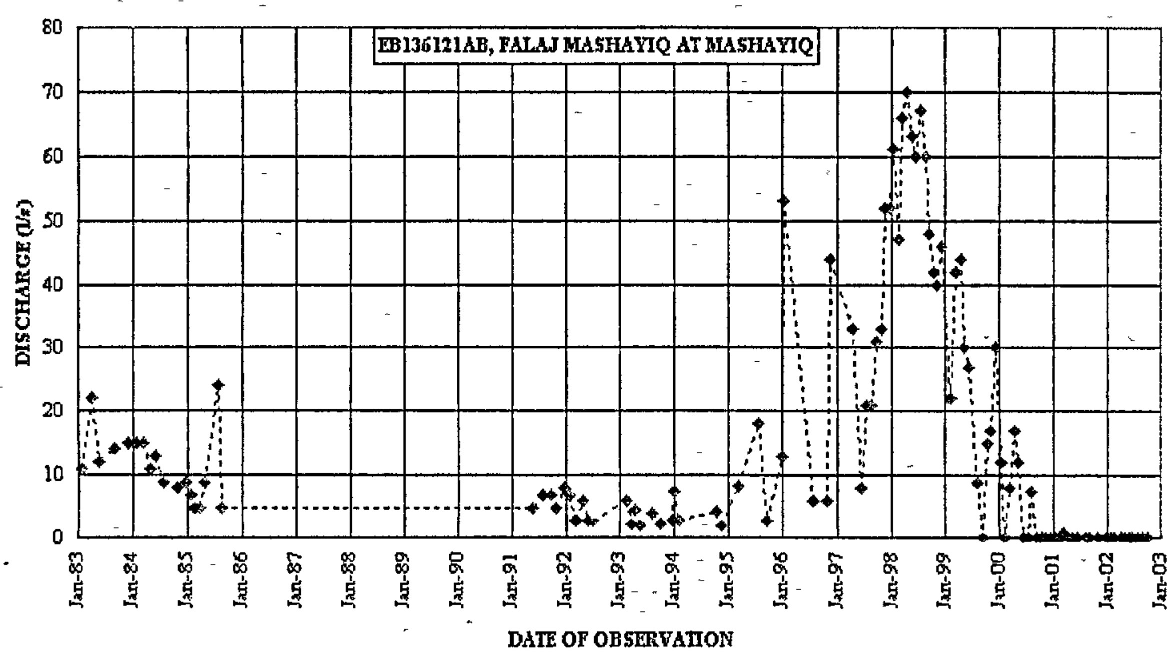
CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
29-04-97	157	243	--	6	6	292	494	9 0

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB136121AB, FALAJ MASHAYIQ AT MASHAYIQ

LOCATION

UTM	516072 E, 2631572 N
LATITUDE	23° 47' 43"
LONGITUDE	57° 09' 28"
FALAJ TYPE	Daudi
PERIOD OF RECORD	January 1983 to September 2002
REMARKS	115 measurements have been made at the site
MEASURED EXTREMES	Maximum measured discharge, 70 l\s, 15 April 1998 Minimum measured discharge, 1 l\s, 13 March 2001



WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB136121AB, FALAJ MASHAYIQ AT MASHAYIQ
DISCHARGE MEASUREMENTS, Jan 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
18-01-83	11	810	--	--
03-04-83	22	740	30 0	--
22-05-83	12	750	34 0	--
29-08-83	14	770	31 0	--
23-11-83	15	--	--	--
22-01-84	15	775	30 0	--
05-03-84	15	700	28 5	--
22-04-84	11	810	34 0	--
28-05-84	13	800	35 5	--
28-07-84	9	725	34 0	--
28-10-84	8	730	29 0	--
24-12-84	9	700	26 0	--
21-01-85	7	--	--	--
19-02-85	5	700	26 0	--
23-03-85	5	700	29 0	--
20-04-85	9	690	30 0	--
22-07-85	24	670	30 0	--
18-08-85	5	--	--	--
22-05-91	5	733	31 2	--
27-07-91	7	737	33 0	43 0
22-09-91	7	726	31 8	--
28-10-91	5	715	30 0	34 0
22-12-91	8	--	--	--
22-01-92	7	696	32 5	--
23-02-92	3	724	28 0	25 0
04-03-92	3	722	27 5	--
26-04-92	6	696	30 9	37 0
23-05-92	3	691	32 0	45 0
27-06-92	3	672	34 5	40 0
17-02-93	6	646	25 0	22 0
16-03-93	2	636	25 9	25 0
15-04-93	4	620	27 0	--
18-05-93	2	614	27 0	38 0
09-08-93	4	623	31 3	--
05-10-93	2	600	30 1	36 0
16-12-93	3	--	--	--
05-01-94	7	605	25 2	27 0
09-02-94	3	607	24 0	25 0
16-10-94	4	584	28 0	32 0
14-11-94	2	508	26 9	27 8
15-03-95	8	469	28 0	27 3
26-07-95	18	553	31 9	33 2
25-09-95	3	510	30 7	37.5
27-12-95	13	465	29 7	28 7
10-01-96	53	790	32 1	22 0
23-07-96	6	591	31 2	32 9
22-10-96	6	674	29 4	28 0
19-11-96	44	588	34 0	26 4
12-04-97	33	713	31 4	29 5

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB136121AB, FALAJ MASHAYIQ AT MASHAYIQ
DISCHARGE MEASUREMENTS, Jan 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
09-06-97	8	650	32 8	38 2
13-07-97	21	756	33 0	35 2
16-08-97	21	--	30 2	35 0
16-09-97	31	850	34 7	42 1
21-10-97	33	837	32 2	37 9
19-11-97	52	754	29 5	30 2
16-12-97	52	942	31 8	25 4
13-01-98	61	894	31 8	24 4
17-02-98	47	884	32 3	25 6
16-03-98	66	893	32.2	32 5
15-04-98	70	880	32 1	39 6
13-05-98	63	851	32 7	42 3
13-06-98	60	857	33 9	36 8
14-07-98	67	804	33 2	37 0
15-08-98	60	798	33 3	39 6
09-09-98	48	782	33 1	33 2
10-10-98	42	770	33 2	39 7
09-11-98	40	767	32 6	29 9
12-12-98	46	790	31 5	30 2
10-02-99	22	786	31 9	24 7
09-03-99	42	745	32.1	28 5
12-04-99	44	777	32 0	33 3
08-05-99	30	769	32 4	30 0
09-06-99	27	760	33 2	32 8
07-08-99	9	783	33 3	29 6
08-09-99	--	--	--	--
09-10-99	15	736	32 1	42 6
09-11-99	17	786	31 8	34 2
12-12-99	30	600	30 0	28 0
15-01-00	12	820	30 0	29 0
08-02-00	--	817	29 4	25 8
11-03-00	8	783	26 1	25 3
09-04-00	17	720	33 0	32 3
08-05-00	12	820	32 0	43 0
13-06-00	--	--	--	--
09-07-00	--	785	32 8	--
08-08-00	7	760	32 6	43 0
11-09-00	--	750	32 5	33 8
08-10-00	--	--	--	--
08-11-00	--	980	30 0	30 2
09-12-00	--	716	29 7	34 5
09-01-01	--	620	29 0	30 8
11-02-01	--	694	27 7	30 0
13-03-01	1	712	30 2	29 8
08-04-01	--	--	--	--
12-05-01	--	712	30 9	40 0
10-06-01	--	725	32 1	34 1
11-08-01	--	--	--	--
28-08-01	--	740	33 5	32 8

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB136121AB, FALAJ MASHAYIQ AT MASHAYIQ
DISCHARGE MEASUREMENTS, Jan 1983 to Sep 2002

Date	Discharge (l/s)	EC (µS/cm)	Water (°C)	Air (°C)
20-10-01	--	--	--	--
23-12-01	--	--	--	--
28-01-02	--	--	--	--
12-02-02	--	--	--	--
30-03-02	--	--	--	--
30-04-02	--	--	--	--
28-05-02	--	--	--	--
24-06-02	--	--	--	--
27-07-02	--	--	--	--
24-08-02	--	--	--	--
30-09-02	--	--	--	--

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB136121AB, FALAJ MASHAYIQ AT MASHAYIQ
WATER QUALITY DATA, Apr 1985 to Jun 2001

ANION

Date	Bicarbonate AsHCo3 (mg/l)	Boor As B (mg/l)	Bromide As Br (mg/l)	Chloride As Cl (mg/l)	Fluoride As F (mg/l)	Nitrate As N (mg/l)	Nitrate As No3 (mg/l)	Sulfate As So4 (mg/l)
20-04-85	214	0.15	--	71	0.08	0.0	1.3	44
24-06-85	222	0.21	--	71	0.07	0.0	1.0	50
21-06-95	140	--	--	46	0.10	--	1.2	28
25-09-95	150	--	--	47	0.10	--	1.5	30
27-12-95	128	--	0.07	46	0.10	--	1.4	32
29-06-96	150	--	--	54	0.31	--	1.4	43
22-09-96	178	--	--	67	0.14	--	1.2	54
21-12-96	193	--	--	75	0.10	--	1.2	53
13-07-97	180	--	--	79	0.10	--	1.3	56
16-09-97	196	--	--	108	0.10	--	1.4	83
16-12-97	217	--	--	109	0.10	--	2.0	95
15-04-98	207	--	--	90	0.16	--	1.6	69
12-12-98	210	--	--	85	0.10	--	1.7	70
09-06-99	180	--	--	87	0.10	--	1.7	73
13-06-00	210	--	--	90	0.10	--	1.8	60
09-12-00	176	--	--	96	0.10	--	1.8	87
10-06-01	175	--	--	88	0.23	--	1.9	58
Mean	**184**	**0.18**	**0.07**	**77**	**0.12**	**0.0**	**1.5**	**58**
Min	**128**	**0.15**	**0.07**	**46**	**0.07**	**0.0**	**1.0**	**28**
Max	**222**	**0.21**	**0.07**	**109**	**0.31**	**0.0**	**2.0**	**95**

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB136121AB, FALAJ MASHAYIQ AT MASHAYIQ
WATER QUALITY DATA, Apr 1985 to Jun 2001

CATION

Date	Calcium As Ca (mg/l)	Iron As Fe (mg/l)	Potassium As K (mg/l)	Lithium As Li (mg/l)	Magnesium As Mg (mg/l)	Manganese As Mn (mg/l)	Sodium As Na (mg/l)	Solids Dissolved (mg/l)
20-04-85	37	0 03	3 1	-1 8	27	0 01	69	420
24-06-85	32	0 01	2 9	-2 2	34	0 01	80	440
21-06-95	19	0 05	4 0	0 0	21	0 05	45	--
25-09-95	22	0 05	2 5	0 4	28	0 05	42	--
27-12-95	21	0 05	2 4	0 1	22	0 05	38	--
29-06-96	25	0 05	2 3	0 6	27	0 05	43	--
22-09-96	30	0 05	2 8	0 8	31	0 05	58	--
21-12-96	33	0 05	3 0	0 6	35	0 05	66	--
13-07-97	35	0 05	3 5	0 3	31	0 05	74	--
16-09-97	43	0 06	3 6	0 5	40	0 05	83	--
16-12-97	51	0 06	3 5	0 9	44	0 05	89	--
15-04-98	37	0 21	3 3	0 4	38	0 05	86	--
12-12-98	35	0 05	3 4	0 3	35	0 05	81	--
09-06-99	37	0 05	3 3	0 0	37	0 05	75	--
13-06-00	32	0 05	3 1	-0 8	33	0 07	69	--
09-12-00	30	0 05	3 2	-0 5	33	0 05	73	--
10-06-01	31	0 05	3 5	0 2	34	0 05	70	--
Mean	**32**	**0.06**	**3.1**	**0.0**	**32**	**0 05**	**67**	**430**
Min	**19**	**0.01**	**2.3**	**-2.2**	**21**	**0 01**	**38**	**420**
Max	**51**	**0.21**	**4.0**	**0.9**	**44**	**0 07**	**89**	**440**

WADI MAYHAH-MABRAH-HAJIR SYSTEM
EB136121AB, FALAJ MASHAYIQ AT MASHAYIQ
WATER QUALITY DATA, Apr 1985 to Jun 2001

CALCULATED

Date	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Ion Balance (me/l)	Total Anion (me/l)	Total Cation (me/l)	Theoretical TDS (mg/l)	Lab Conductivity (µS/cm)	Lab pH (Standard Units)
20-04-85	214	202	--	--	--	--	598	7.7
24-06-85	222	218	--	--	--	--	693	7.3
21-06-95	140	132	--	5	5	255	487	7.8
25-09-95	150	170	--	5	5	271	513	8.2
27-12-95	128	142	--	5	5	247	447	8.0
29-06-96	156	173	--	6	5	297	548	8.4
22-09-96	179	204	--	7	7	360	643	8.3
21-12-96	193	227	--	7	7	390	728	8.2
13-07-97	180	214	--	7	8	396	729	7.8
16-09-97	196	274	--	9	9	489	851	8.0
16-12-97	217	309	--	10	10	536	904	8.2
15-04-98	207	248	--	8	9	459	811	7.8
12-12-98	210	233	--	8	8	448	786	7.8
09-06-99	180	244	--	8	8	432	782	7.5
13-06-00	210	218	--	8	7	426	789	6.7
09-12-00	176	213	--	8	7	441	463	7.1
10-06-01	175	219	--	7	8	403	722	7.9

The *aflaj* irrigation system (Oman)

No 1207

1. BASIC DATA

State Party: The Sultanate of Oman

Name of property: The *aflaj* irrigation system of Oman

Location: Dakhiliya, Sharqiya and Batinah Regions

Date received by the World Heritage Centre: 29 June 2004

Included in the Tentative List: 4 July 1998

International Assistance from the World Heritage Fund for preparing the nomination: No

Category of property:

In terms of the categories of cultural property set out in Article 1 of the 1972 World Heritage Convention, this is serial nomination of five *sites*.

Brief description:

The collection systems of five *aflaj* irrigation systems represent some 3,000 still functioning systems in Oman. Water from underground water sources or springs is tapped and conducted by gravity, often over many kilometres, to support agriculture and permanent settlements in extremely arid desert lands. Ancient engineering technologies demonstrate long standing sustainable development.

The fair and effective management and sharing of water in villages and towns is still underpinned by mutual dependence and communal values and guided by astronomical observations. Numerous watchtowers built to defend the water systems reflect the former total dependence of communities on the *aflaj* system.

2. ACTIONS

Background: This is a new nomination.

Date of the Technical Evaluation Mission: 12-16 November 2005

Dates of request *for additional information and of receipt from State Party:* ICOMOS sent a request to the State Party on 29 November 2005 for them to consider the implications of extending the nomination to include more of the *aflaj* systems. On 20 February 2006, a revised nomination was submitted by the State Party which extended the nominated area of all five *aflaj* systems to include the agricultural demand area and key buildings within surrounding settlements.

Consultations: ICOMOS has consulted its International Scientific Committees on Archaeological Heritage Management and on Historic Gardens – Cultural Landscapes.

Literature: Wilkinson, J C, *Water and Tribal Settlement in South-East Arabia: A study of the Aflaj of Oman,* Oxford, 1977. Al Shaqsi, Saif bin Rashid, *Aflaj Management in the Sultanate of Oman,* PhD dissertation, University of Wales, Bangor, 1996.

Date of evaluation approval by ICOMOS: 10 April 2006

3. THE PROPERTY

Description:

The five nominated sites have been chosen to represent the sophistication and technological achievements of the total remaining working irrigation systems in Oman. Four of the sites lie around the Western Hajar mountains. The fifth site is in the southern end of the Eastern Hajar mountains.

The word *falaj* (plural *aflaj*) is used to refer to a complete irrigation system for a settlement. In classical Arabic *falaj* means to divide into shares. Applied to water, it has come to mean a physical and social structure for the sharing of water among those who have a right to it.

In physical terms, the *aflaj* system of irrigation consists of tapping substantial underground water resources, springs or surface water and conducting the water by gravity alone often over long distances, to towns and villages where it is distributed to domestic and agricultural users.

Relatively constant supplies of water are ensured by the *aflaj* system for large areas of desert throughout the year, and this in turn has led to the growth of permanent urban settlements based on an assured agricultural production and water resources for both people and livestock.

The areas nominated cover the collection and part of the distribution sections of five *aflaj* systems. This includes the underground channels which run between the mother well, spring or *wadi* (surface water) where the water is tapped, to the *shari'a* the start of the distribution network around the settlements, together with part of the above ground distribution channels around the plantations within settlements, and the associated buildings, such as mosques, watchtowers, houses, sundials, and water auction buildings.

For the underground section, the boundaries are drawn to protect the sources and channels and consist of the main channels overlaid by a strip approximately 250 metres wide.

Within the settlements and water 'demand' area, the boundaries enclose the agricultural area irrigated by the water system, and associated buildings.

Each system is further protected by a wide buffer zone, but this does not extend around the settlement and demand areas, apart from at Al-Jeela.

The areas are:

Areas in square kilometres

	Upstream	*Buffer*	*Settlement*
Falaj Al-Khatmeen	1.35028	17.564	1.004
Falaj Al-Malki	6.000	42.5571	1.572

Falaj Daris	3.89468	33.701	2.383
Falaj Al-Jeela	0.309522	38.3946	0.140
Falaj Al-Muyassar	3.00501	31.8266	1.134

The constructions in Oman are one of the largest concentrations of irrigation systems of this kind anywhere in the world: over four thousand systems have been identified in a large-scale survey completed in 2001. Around 3,000 of these systems are still functioning and these reflect a restoration programme carried out by the Ministry of Water Resources over the past 25 years. This in turn demonstrates the crucial significance of the water systems as a major national resource that still underpins agricultural systems across a large area of the country.

The precise dating of most of the underground channels is not known. The present network appears to result from several building campaigns, the earliest of which could be around 500 AD or even earlier. Recent archaeological evidence is suggesting that irrigation systems existed in the area as early as 2,500 BC, but when the first deep channels were mined and faced is not clear (see below).

In the settlements, water is still distributed through a traditional system of time-sharing, organised on a community basis.

Three types of *aflaj* are recognized in Oman:

i. *Ghaili:* This form is based on the perennial flow in a *wadi*. Water, diverted by means of a partial dam from the *wadi*, is conveyed in covered or open channels to settlements. In cases where the water flow is small or intermittent, reserves are stored in holding tanks for distribution in periods of drought. 48% of all system are *ghaili.*

ii. *Aini:* The sources of water are perennial mountain springs. They never dry up completely, but their water flow is not constant, varying according to the season and the climatic conditions in any given year. In form they are similar to *ghaili aflaj*. *Aini* account for 28% of systems.

iii. *Daoudi:* This type of *falaj* taps into underground water sources at the foot of mountains. Deep 'mother' wells are sunk to tap into the source of water and this is then conveyed to settlements on the plains through underground channels often over very long distances. 24% of systems use underground channels. The *Daoudi* is by far the most complex. Its construction relies on sophisticated engineering expertise and must also have demanded considerable labour forces and organisational capacity.

In constructing a *daoudi* system, a mother well is first dug at a point as near as possible to where the underground water system or aquifer emerges from the mountains. Finding this point demands traditional knowledge of the mountains and their geology. The mother well may need to be up to 60 m deep.

The sides of the well are lined with stone set in a mortar. This is made from cakes of clay burnt with palm tree wood, which, when needed for use, are ground to a powder and mixed with water to form the mortar. This mortar when set is water-resistant and appears to be very stable and long lasting. It is still produced by traditional methods.

From the mother well, a tunnel is constructed to the *shari'a* distribution point in the settlement. This tunnel may be many kilometres long - up to 14.8 km as at Falaj Al-Malki, and have remarkably shallow gradients as little as 1:2500.

Some tunnels have a network of side braches, like the veins of a leaf. One now dead system had 37 branches; the maximum number in a working system is 17. Where the tunnel goes thorough rock no lining is needed, but in soft rock support is provided either through stone faced walls supporting stone vaults or slabs, or through palm tree logs supporting stone slabs.

At regular points inspection shafts are constructed along the channels to allow dredging on a regular basis. In the long journey from the mother well to settlements, the water sometimes has to pass over *wadis* or other obstacles. To achieve this, the water is channelled through inverted siphons – two helical channels connected by a small aqueduct.

Shari'a and distribution channels in settlements

Such is the significance of the water distribution systems that the open channels are at the heart of the settlements.

The water emerges in the settlement at the *shari'a* which usually has a stepped access and is often next to a fort or watch-tower, a circular mud-brick structure. From there it is dispersed in a network of over ground channels to the cultivated fields which grow date palms as the main crop and also lemons, fodder grasses and a variety of seasonal food crops. The sluices are made of rock slabs, mud or rags.

Next to the *shari'a* water can be taken for drinking and cooking. The next stretch is reserved for ablutions. It then passes by the mosque and fort to places for washing clothes. Only after these uses have been satisfied, is the water diverted to palm plantations and to other crops through dividing the main channel into equal subsidiary channels which are regulated between shareholders.

Aflaj distribution system

The success of the *alfaj* systems depends on the social and economic structures which underpin it and have done for centuries. These are rooted in local communities and guarantee fair shares to stakeholders. The system is not based on any form of written or statute law, but rather on a traditional system of time-sharing that is passed from one generation to the next.

The executive authority in each system is the *falaj* agent, or *wakeel*, appointed by the local sheikh in consultation with the stakeholders and advised by a technical expert, *arreif.* The *wakeel* is responsible for the overall management of the *falaj*: his duties include responsibility for the funds, regulation of the sale and rental of individual shares, and day-to-day overseeing of the operation of the system. His subordinates, known as *areefs* (of which there may be a number, especially at the larger *aflaj*), are responsible for distributing water shares. Individual shareholders have an obligation to respect the quantity of water assigned to them and the periods when it becomes available.

The time distribution system for the water may be based on either a seven or ten day cycle. The units allocated to shareholders vary from between 12 hours down to as little as 1.25 minutes.

Such a system demands an accurate way of measuring volumes of water by flow over time. In the day time this was traditionally done by shadows from a tall stick falling on rows of small stones set into the ground. At night measurement was based on the movement of stars, a system that involved close observation of a total of 24 stars. Several settlements still preserve their sun-dials. Some also have small buildings were auctions of the water shares are held.

The nominated sites include underground channels between the mother well and the *shari'a*, and open channels within the settlements together with watch-towers, ablutions block, mosques, forts, sun-dials and the distribution system around the plantations.

Falaj Al Khatmeen

This *daoudi falaj* is fed from the Wadi Al Meaidin, which is notable for its abundant flow during periods of rain and its continuous (though not constant) flow throughout the year. The total length from mother well to *shari'a* is 2.4 km, and it irrigates a cultivated area of some 723,124 m^2. For most of its length the channel runs underground.

The open channel in the settlement passes beneath Bait Al-Redadah Fort (not included in the nomination), which was built during the Yaruba Imamates (1649–1711). At the entrance to the town, the channel is split into three equal sections, one of which irrigates the holdings of the local people and the other two the agricultural land belonging to the State Treasury (*Bait Al Mal*). The water for each of the three users is accurately controlled: if three balls of the same size and weight are thrown into the channel before it splits into three, each will run automatically into a separate branch channel.

The demand area covers abandoned traditional houses facing the water channels, two watchtowers strategically sited to over look the channels, and a mosque.

Falaj Al-Malki

This *daoudi falaj* is one of the largest *aflaj* in the Sultanate: its total length from mother well to *shari'a* (including all its 17 branches) is some 14.8 km. The demand area covers 1,572,730 m^2. The *falaj* splits into two branches, supplying the towns of Nazar and Al-Yaman.

Recent intensive building activity has reduced the flow of this system.

The demand area includes a watchtower located on a hill above the plantations and the remains of two others together with a few scattered traditional houses.

Falaj Daris

This *daoudi falaj* is thought to be the oldest in the Sultanate. The total length of its three channels is 7,990 m. Most of the water derives from the Wadi Al-Abiyadh. The cultivated area of the town of Nizwa that it supplies is 1,715,502 $m^{2.}$

The shari'a is surrounded by a small park.

The demand area includes a mosque, fort and a few old mudbrick houses.

Falaj Al-Muyassar

Another *daoudi falaj*, Falaj Al-Muyassar originates from a mother well 50 m deep. Including its branches, the *falaj* is 5.8 km in length, and it irrigates a cultivated area of 1,133,698 m^2 by means of two main branches.

Its *shari'a* is next to a watchtower and a cluster of mud brick houses now abandoned. The attractive village has many mud brick houses either side of the open water channels and a sundial and auction building.

Falaj Al-Jeela

This *aini falaj* is a located in a very small village in the remote and barren mountainous area of Wilayat Sur. The water comes from a spring of the Wadi Shab high above the settlement and is conveyed over 1.6 km by means of open channels and a small aqueduct to a collection tank in the settlement. From there the water is distributed to palm and pomegranate plantations. The total demand area is about 14,000 m^2.

Falaj Al-Jeela maintains a stable flow rate throughout the year and is barely affected by rises and falls in groundwater levels.

The demand area is tightly constrained by the surrounding mountains. It includes a small mosque, and some traditional houses.

History

The histories of the five *aflaj* in the nomination are unknown, since no written records survive. By virtue of its size and complexity, and the importance of the town of Izki that it supplies, a case could be made for Falaj Al-Malki as being one of the earliest in Oman. There are similar indications that Falaj Daris, with its links to the town of Nizwa, could be considerable antiquity. The relationship of Falaj Al-Khatmeen to the Bait Al-Redadah fort, known to have been built during the Yaruba Imamates, suggests that this *falaj* originated in the 17th century.

It would be helpful if more information could be assembled from both technical and archival sources and excavations to allow clearer indication to emerge of the chronology of *daoudi aflaj* construction.

Protection and Management

Legal provision:

The *aflaj* systems are owned by the individual shareholders, with certain shares allocated to the mosque. The legal title to shares is recorded in the form of a registration document (*sukk*); ownership of these shares is absolute, and they can be inherited. Only rarely are the entire shares owned by a single individual. Details of ownership and all transactions are recorded by the *wakeel.* Certain shares are owned communally by all the shareholders in the *falaj*, and these are available for rent through weekly auctions.

At Falaj Al Khatmeen, the demand area is owned by the Government state treasury. In the other nominated areas, the plantations, watchtowers, mosques and houses are privately owned.

There is no protection for the visual setting of the *afla*j or for the open channels and their associated structures, watch-towers, mosques and traditional houses, within settlements. Local municipalities can however restrict the removal of palm plantations in order to build houses.

The underground sections of the *aflaj* system are well protected. The key protection measure is the Water Wealth Protection Law, which was promulgated by Royal Decree No. 29/2000. This ensures that *aflaj* owners and agents need to obtain a permit from the Department of Water resources before carrying out any enlargement, repairs or maintenance on their *aflaj* from the mother well to the *shari'a*. Furthermore no work shall be undertaken which might affect the aquifers, or their water quality. Further protective measures where set in place by the Ministry after their survey (see below). Under this, no new wells shall be dug within 3.5 km of mother wells, and for any new development protection zones must be provided either side of the *falaj* route.

Management structure:

Although there are no formal management plans in force for the nominated areas as a whole, there are complex and detailed traditional management systems for the management of the water and the water channels. This system is supplemented by repairs carried out by the Ministry of Water Resources. Each *aflaj* system is managed by the *wakeel*, using the traditional form of management, in close collaboration with shareholders and the local community.

The nominated areas are said to be the best examples of co-operative water management in Oman.

Traditionally, *aflaj* have been financed entirely by their shareholders. However, the high costs of manpower and materials, as well as the deteriorating condition, made it increasingly difficult in the 1970s for shareholders to maintain their *aflaj* adequately. As a result, the Government of Oman assumed responsibility for *falaj* maintenance in the Second Five-Year Plan (1981–85) in the form of an extensive drilling and rehabilitation programme. This responsibility continues.

Justification of the Outstanding Universal Value by the State Party (summary)

- Without the existence of the *aflaj*, there would be no more than impoverished settlement in the Gulf Region (or other desert regions);
- The *aflaj* technology has been bought to a high level in Oman and has been functioning successfully for more than two millennia;
- The organisation of the water distribution systems is an outstanding example of a traditional structure at least a thousand years old which continues to play a vital role in society;
- The combined *aflaj* systems in Oman are one of the largest irrigation systems anywhere in the world.

4. EVALUATION

Conservation

Conservation history:

Since the Ministry assumed responsibility for the maintenance of the main underground *afla*j channels in 1981, many hundreds of kilometres o channels have been restored.

The Ministry of Regional Municipalities, Environment, and Water Resources created an inventory of *aflaj* between 1997 and 1998, published in 2001. The inventory includes the following data:

- Location and depth of mother wells;
- The routes of *aflaj* channels;
- Measurement of flow rates;
- Data on water quality;
- Definition and measurement of planted and demand areas;
- Data on state of conservation of channels and the nature of the flows.

Each inventoried *falaj* has been assigned a registration number and a registration plate has been placed at the *shari'a*. The project was undertaken by 134 Ministry staff members.

By contrast, the conservation of the cultural properties in the demand areas has not so far been given high priority and no grant aid has been given for these structures.

State of conservation:

Much of the restoration of the channels, particularly those underground, is carried out under the supervision of the Ministry of Regional Municipalities, Environment, and Water Resources. *Falaj* communities carry out regular monitoring of their systems and submit requests for assistance in maintenance or conservation whenever their structural or hydrological structures are affected. Upon receipt of these requests, the Ministry prepares technical specifications and drawings and supervises the maintenance work.

In some cases this has involved sinking new inspection shafts and rebuilding sections of collapsed channels. Some of this has been done using concrete. Cement has also been used for the surface of some channels where they emerge near the shari'a. For instance at *Falaj Daris* in the park near the *shahr'ia,* many of the open channels have been refinished in cement mortar. In some places this cement facing is showing sign of becoming detached from the underlying traditional mortars.

Workshops where the traditional mud mortars are made still exist and ICOMOS considers that it would be desirable if traditional materials could be used as these seen from the evidence of old channels to be exceedingly effective.

The mud forts watchtowers and traditional houses are mostly neglected and abandoned. Some are in a parlous state – but retrievable. The work however is beyond the resources of traditional owners. It is stated in the nomination that these are amongst monuments to be renovated by the Ministry of Heritage.

Protection and Management:

The water channels are very effectively managed by a combination of traditional management and support for large-scale construction projects from the Ministry of Water Resources. There is, however, no coordinated management of the surroundings or settings to the underground channels or of the demand areas. It is suggested that the *falaj* committees could form the basis for local management committees for the wider area working in collaboration with the relevant ministries and their regional offices.

Many of the traditional mud-built buildings such as watch-towers, forts, and houses which are adjacent to the water channels in the settlements are suffering from lack of maintenance and management and there is considerable re-building in some of the larger settlements.

If the integrity of the wider *aflaj* system is to be sustained in its relationship with the settlements, greater protection is needed for the surroundings of the underground water channels and for the demand areas. This should not mean turning them into museums – but managing change to respect the qualities of the places and ensuring that the key elements of the system survive.

Risk analysis:

- Development

The last few decades has seen rapid development in Oman including the smaller towns and villages. This had compromised some of the settings of the *aflaj* system, particularly when traditional mud brick buildings, including watch-towers are left to decay and palm plantations have been replaced by new houses.

Road construction has also affected the water channels and some new roads cut across the underground channels or are built next to open channels.

- Water demand

Increased development has led to increased demand for water which has resulted in the drilling of large deep wells. This in turn has affected the level of underground water supplies and made some *aflaj* that were formerly reliable throughout the year become intermittent. For instance:

Falaj Al-Malki: Recent intensive building in the area has resulted in severe pressure on the aquifer and this effect, coupled with a scarcity of rain has led to a decrease in the water flow of the *falaj*, especially in periods of drought.

Falaj Daris: The water flow has been affected as a result of development pressures and the flow rate falls during periods of drought.

- Climate change

Lack of rainfall in the Gulf Region over the past two decades has seriously lowered the water table – a process exacerbated by the drilling of new wells.

At *Falaj Al-Jeela*, the area has suffered a drought over the past 14 years and at some point this will impact on the water flow from the perennial spring. All the *daoudi aflaj* are to some extent affected.

Unexpected flash floods when rain does occur, have led to surges of water and this has also been damaging to channels. There are no disaster plans in place to deal with floods. Damage to the channels is made good through government intervention.

- Visitors

Currently it seems that very few visitors visit these sites. It is very difficult to appreciate the underground sections of the *aflaj,* and at three of the sites the overground sections are intertwined with roads and some new development. If visitors are to appreciate the scope and extent of these systems, an access strategy will need to be developed to provide information and access compatible with traditional uses.

Authenticity and Integrity

Authenticity:

The basic layout of the nominated *aflaj* is wholly authentic. There are some modern interventions such as the use of concrete for lining shafts, and cement for reinforcing the tops of the mother wells and access shafts, at some of the *shari'a*, and in the distribution channels to individual agricultural plots, and new building around the settlements.

The authenticity of the management of the *aflaj* is incontrovertible. The traditional system of ownership and management functions efficiently and is complemented by the administrative, technical and financial support from the Ministry of Water Resources.

Integrity:

Initially, only a portion of each *aflaj* system was nominated – from the mother well to the *shari'a*. Those parts of the system in the settlements, serving the needs of the community through the provision of water for cooking, washing, and agriculture, have now been added to the nomination and the nominated areas now reflect the integrity of the whole *aflaj* system.

Comparative evaluation

There is some uncertainty about where and when the *daoudi falaj* type of irrigation originated. It is known in Iran, Armenia, in large parts of Central Asia and western China, in Chile and Peru in South America, as well as in Oman and neighbouring United Arab Emirates, Egypt, Morocco, and Spain.

Also called *qanats*, the technique is known from the Iron Age in Persia, now Iran. It has been assumed that it arrived in Persia from the Caspian region at the end of the 2nd millennium BC and that the Assyrian ruler Sargon II, who reigned at the end of the 8th century BC, and his successor Sennacherib built a number of *aflaj*. Recent finds however in Oman and at El Ain, United Arab Emirates, have led to the suggestion that technology could have been transferred in the reverse direction.

Daoudi aflaj dated to the Iron Age have been excavated in El Ain and its surrounding areas of Hili, Bida Bin Saoud, Jebeeb and Al Madam, near the border with Oman. Two old *aflaj* have also been reported in Maiyser and Raki in Oman dating back to around 1,500 BC and recent excavations at Bahla Fort in Oman have reported ancient irrigations systems possibly dated to 2,500BC but confirmation of their type and precise date is still awaited.

Underground water channels began to be diffused more widely during the Achaemenid period in Persia, from the mid-6th to the mid-4th centuries BC. This was a period of Persian expansion, especially during the reign of Cyrus the Great. Much of Oman came under Achaemenid rule in the mid-6th century BC, and from AD 226 it formed part of the Sassanian Empire of Persia, until the Sassanians were finally driven out with the coming of Islam in the 7th century AD. Historical records indicate that there was a period of *falaj* construction in Oman during the Yaruba Imamates in the second half of the 17th century, when the Portuguese were finally expelled from Oman, and it became the first independent state in the Arab world.

There are close similarities between the *aflaj* in Iran and those in Oman. There are said to be 20,000 *qanats* are still in use in Iran.

In the Roman age, the first *falaj* appeared in Syria and Egypt. The technique spread along the Silk to Parthia, Bactria and Sogdia and later into Xinjiang. Underground water systems also still flourish in Chile and Peru.

Irrigation based on springs is even more widespread than the *daoudi aflaj* type. No comparative analysis is given for spring irrigation – which is found in perhaps as many as forty countries around the world. Particularly impressive examples can be found in the Himalayas for example where water is channelled for many kilometres to villages in the plains below. The one example nominated, although impressive because of its dramatic setting, cannot be said to represent this type of system.

Considering just *daoudi falaj* or *qanats,* without further research into what remains in Iran and Central Asia in particular, both in terms of construction and chronology, it is difficult to say with certainty where the structures in Oman fit into the wider picture of technology transfer for the system of tapping underground water sources for irrigation, or whether they are more technically sophisticated than other examples. It would therefore not be possible to say that the systems in Oman have high value purely on technical grounds or because they represent early uses of this technology.

However the systems in Oman are still functioning as integral and essential aspects of the production systems of villages and towns, and are still managed by long-standing traditional systems within the communities they serve. They have a value as part of a distinct and living cultural landscape and reflect particular social systems that developed in this region. Out of the 3,000 functioning systems, 627 are *daoudi aflaj*.

Outstanding Universal Value

Evaluation of criteria:

The sites are nominated on the basis of criteria ii, iv and v.

Criterion ii: This criterion is justified on the grounds that the *aflaj* system in Oman is an outstanding example of 'considerable antiquity' which survives intact and is if socio-economic benefit. More specific information is needed to demonstrate the antiquity of the parts nominated. <u>ICOMOS considers that this criterion might be justified on the basis of further detailed information.</u>

Criterion iv: This criterion is justified through suggesting irrigation underpinned settlement which in turn underpinned a successful state that influenced its region. Although this is true it is also true for many other parts of the neighbouring regions. It does not justify why the five nominated areas can reflect this larger picture. <u>ICOMOS considers that, with the available information, this criterion cannot be properly assessed at this stage.</u>

Criterion v: The nomination justifies this criterion on the grounds that the sites are threatened from the lowering of the water-table, which they are, and that the sites are an exceptionally well preserved form of land-use. <u>ICOMOS considers that the property meets this criterion.</u>

5. RECOMMENDATIONS

Recommendations

The current nomination is for part of four *daoudi aflaj* system and one *aini aflaj* system. Systems based on springs are widespread around the world and the one nominated *aini aflaj s*ite is not exceptional.

The original nomination was submitted by the Ministry of Water Resources and included those aspects of the system over which it has control. The State Party is to be congratulated on extending the nominated areas to include the wider landscape created by the *aflaj* irrigation system to include the demand areas in settlements and thus reflect social and community involvement.

The wider nomination should be considered as a collection of cultural landscapes representing distinctive, long-standing, sustainable and living ways of managing water resources.

The underground parts of the nomination and main water channels through the settlements are very effectively managed through traditional practices supported by repair work carried out by the Ministry of Water Resources. The one aspect however that could be improved is the use of materials: there is a need to re-introduce the use of traditional mortar.

The landscape within settlements has so far received less attention and is not subject to an agreed approach. There is a need to consider how the wider landscape can be managed through the development of a management process involving local communities and perhaps based, as suggested in the nomination, on an extension of the traditional *falaj* committees and supported by the Ministry of Heritage and Culture.

As many of the traditional buildings are in a state of considerable decay, there is also a need to create a short-term action plan to address how these buildings can be stabilised and where appropriate be given viable uses.

A management plan is needed to articulate these approaches and to address the need for control of new development, access for tourists and presentation of the *aflaj* systems.

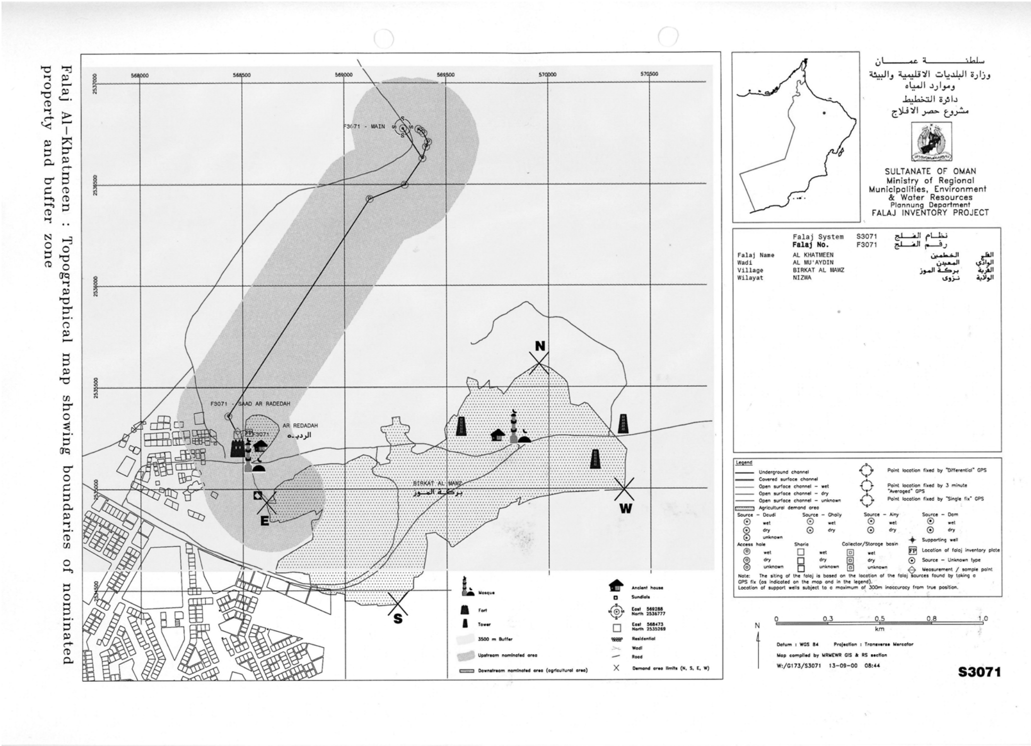
Currently the underground channels have legal protection but the nominated areas in the settlements are not protected. Consideration needs to be given as to how the settlement patterns and key structures can be protected.

Recommendation with respect to inscription

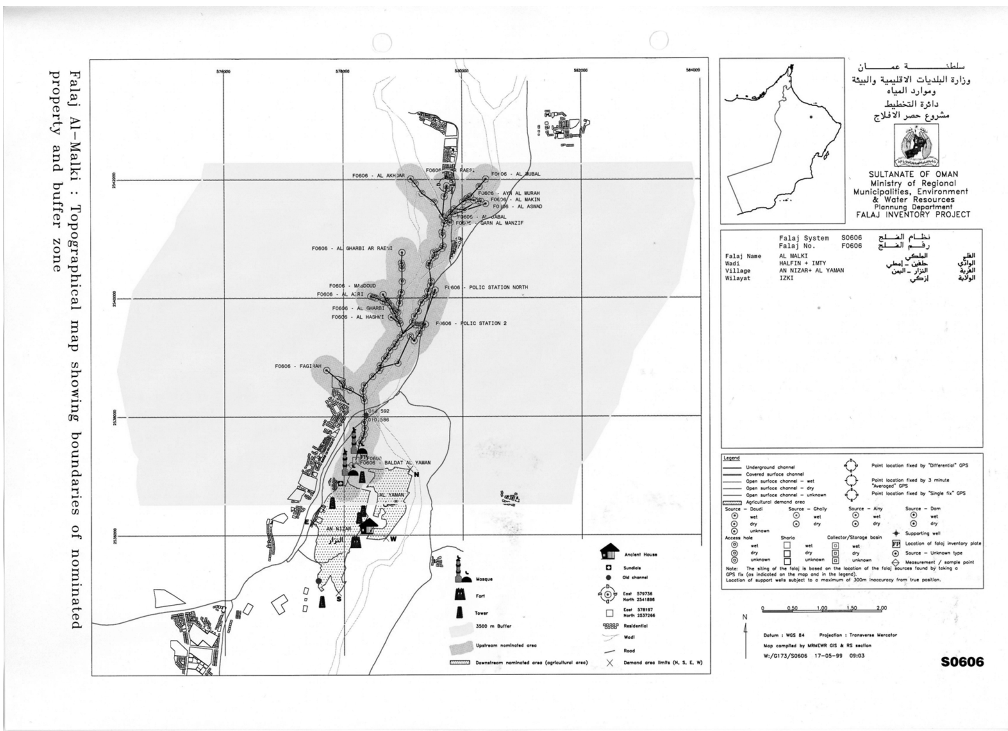
ICOMOS recommends that the *aflaj* irrigation system of Oman, be ***referred back*** to the State Party of the Sultanate of Oman to allow them to consider how:

- The enlarged areas can be given adequate protection;
- Further information can be provided in support of the proposed criteria;
- A management plan or system can be developed for the settlement areas, to complement traditional management arrangements, which addresses the restoration, and conservation of the traditional structures such as mosques, watchtowers, forts, houses, and wash places, the re-introduction of traditional mortars, the control of development, the management of visitors, and the presentation of the *aflaj*.

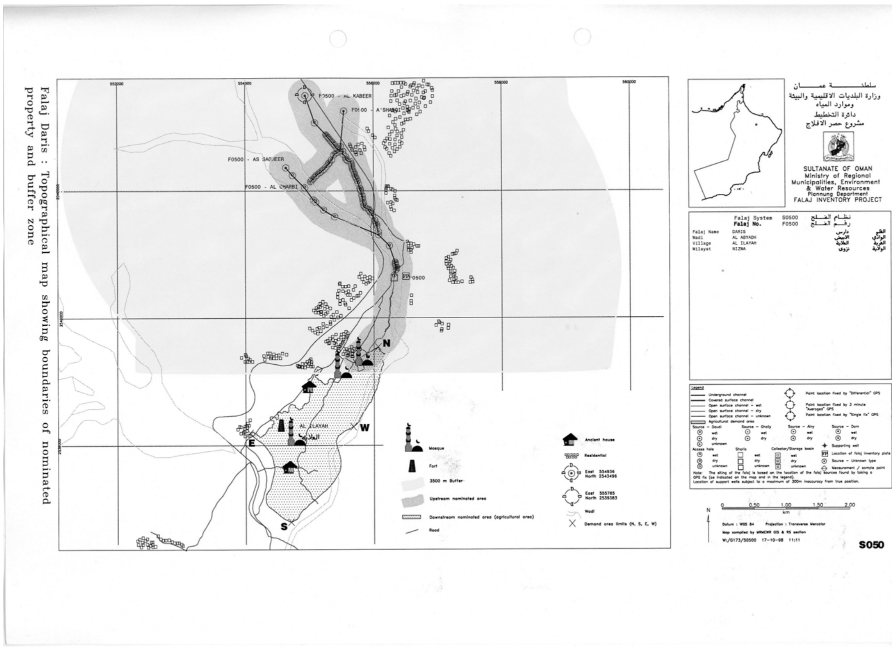
ICOMOS, April 2006



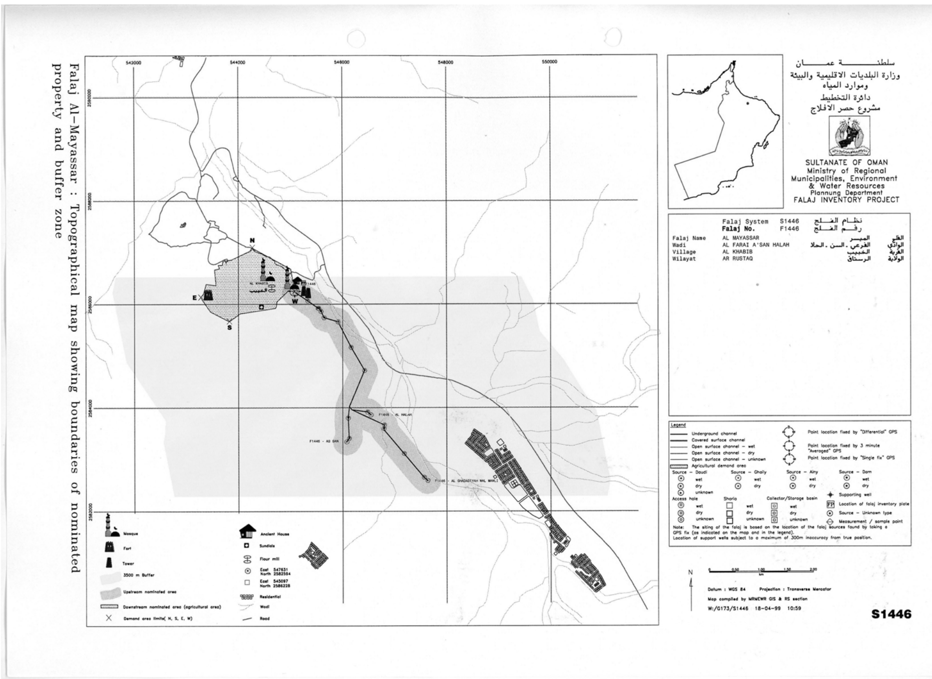
Map showing the revised boundaries of Falaj Al-Khatmeen



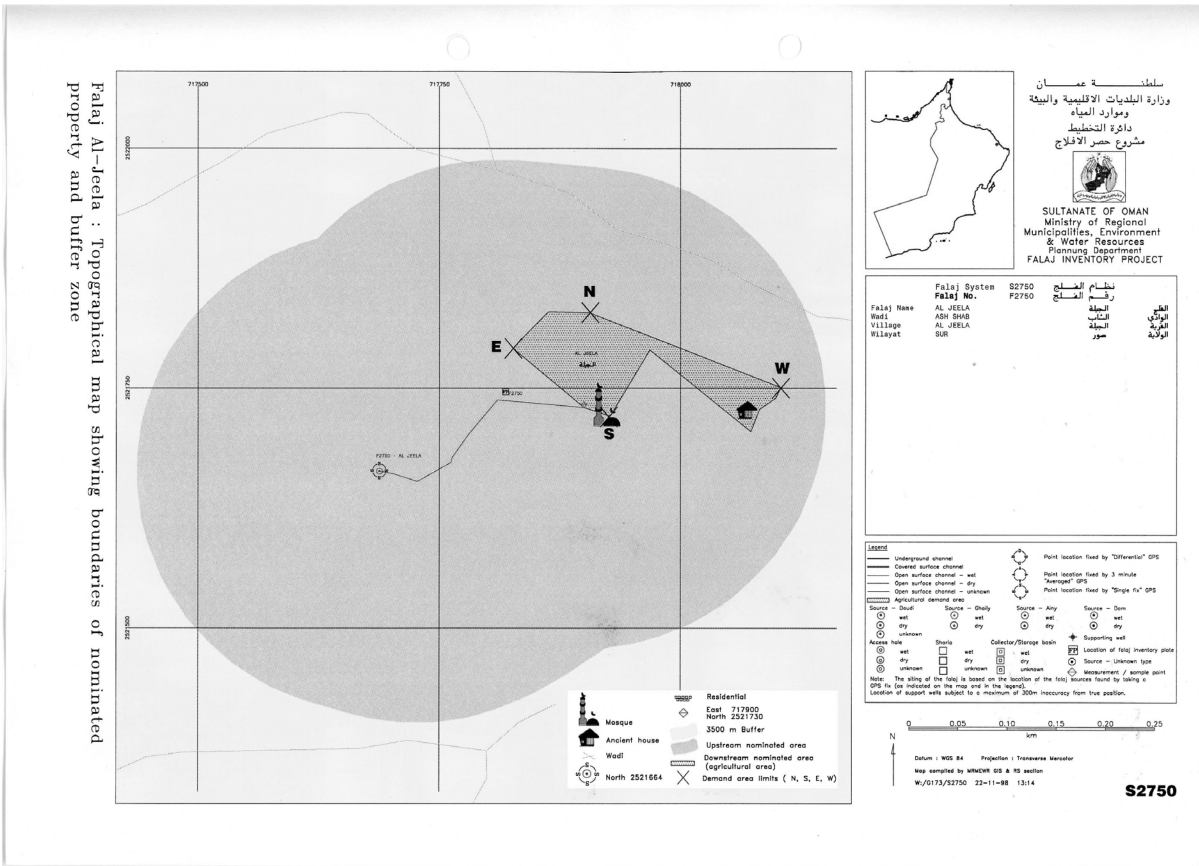
Map showing the revised boundaries of Falaj Al-Malki



Map showing the revised boundaries of Falaj Daris

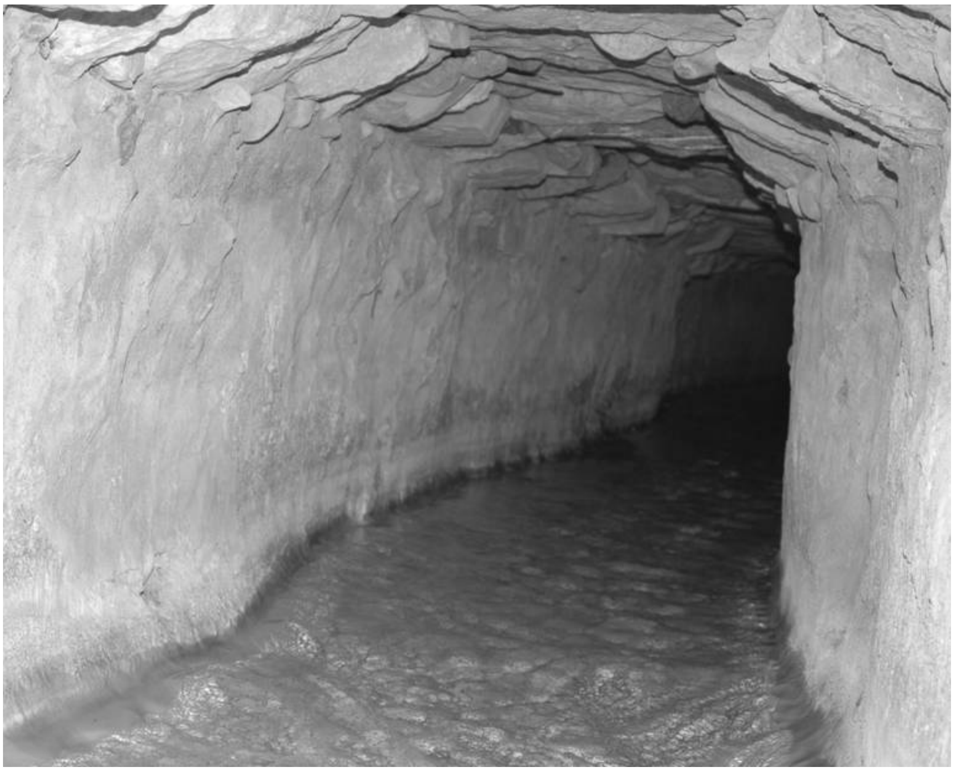


Map showing the revised boundaries of Falaj Al-Mayassar



Map showing the revised boundaries of Falaj Al-Jeela

Watch Tower



Underground channel

Shari'a

Distribution Point

Systèmes d’irrigation *aflaj* (Oman)

No 1207

1. IDENTIFICATION

État partie : Sultanat d’Oman

Bien proposé : Les systèmes d’irrigation *aflaj* d’Oman

Lieu : Régions de Dakhiliya, Sharqiya et Batinah

Date de réception par le Centre du patrimoine mondial : 29 juin 2004

Inclus dans la liste indicative : 4 juillet 1998

Assistance internationale au titre du Fonds du patrimoine mondial pour la préparation de la proposition d’inscription : Non

Catégorie de bien :

En termes de catégories de biens culturels, telles qu’elles sont définies à l’article premier de la Convention du Patrimoine mondial de 1972, il s’agit d'une proposition d’inscription en série constituée de cinq *sites*.

Brève description :

Les cinq systèmes d’irrigation *aflaj* représentent quelques 3 000 systèmes d’irrigation encore en activité en Oman. L’eau de sources d'eau souterraines est puisée et conduite par gravité, souvent sur plusieurs kilomètres, pour alimenter l'agriculture et les peuplements permanents de terres désertiques d’une extrême aridité. Ces anciennes technologies d’ingénierie sont l'incarnation d'un développement durable de longue date.

La gestion et le partage équitable et efficace de l’eau dans les villages et les villes sont toujours sous-tendus par des notions de dépendance mutuelle et de collectivité, et guidés par des observations astronomiques. La multitude de tours de guet construites pour défendre les systèmes d’adduction d’eau reflète la dépendance des communautés aux *aflaj*, dépendance jadis totale.

2. ACTIONS

Antécédents : Il s’agit d’une nouvelle proposition d’inscription.

Date de la mission d’évaluation technique : 12-16 novembre 2005

Dates de demande d’information complémentaire et d’envoi par l’État partie : Le 29 novembre 2005, l’ICOMOS a envoyé une lettre à l’État partie, en lui demandant de considérer les implications de l’extension de la proposition d’inscription à un plus grand nombre d’*aflaj*. Le 20 février 2006, une proposition d’inscription révisée a été soumise par l’État partie qui étendait la zone proposée pour inscription aux cinq systèmes *aflaj* pour inclure la zone d’approvisionnement agricole et des édifices clés des peuplements environnants.

Consultations : L’ICOMOS a consulté ses Comités scientifiques internationaux sur la gestion du patrimoine archéologique et sur les jardins historiques – paysages culturels.

Littérature : Wilkinson, J C, *Water and Tribal Settlement in South-East Arabia: A study of the Aflaj of Oman,* Oxford, 1977 ; Al Shaqsi, Saif bin Rashid, *Aflaj Management in the Sultanate of Oman,* thèse de doctorat, University of Wales, Bangor, 1996.

Date d’approbation de l’évaluation par l'ICOMOS : 10 avril 2006

3. LE BIEN

Description :

Les cinq sites proposés pour inscription ont été choisis pour illustrer la sophistication et les réussites technologiques de l’ensemble des systèmes d’irrigation encore en activité en Oman. Quatre d’entre eux se trouvent aux pieds des montagnes du Hajar occidental, le cinquième à la pointe sud du Hajar oriental.

Le mot *falaj* (*aflaj* au pluriel) fait référence à un système d'irrigation complet pour un peuplement. En arabe classique, *falaj* signifie « diviser en parts ». Par rapport à l’eau, il en est venu à désigner une structure physique et sociale de partage de l'eau entre ceux qui y ont droit.

En termes physiques, les *aflaj* sont un système qui consiste à puiser dans des ressources en eaux souterraines substantielles ou dans les eaux de surface et à les conduire par la gravité seule, souvent sur de longues distances, jusqu'aux villes et aux villages où elles sont distribuées aux utilisateurs domestiques et agricoles.

Les *aflaj* assurent à de vastes zones désertiques un approvisionnement en eau relativement constant tout au long de l’année, ce qui a favorisé l'expansion de peuplements urbains permanents, grâce à une production agricole assurée et à des ressources en eau pour les gens et pour le bétail.

Les zones proposées pour inscription comprennent les sections de collecte et une partie des sections de distribution des cinq systèmes *aflaj*. Cela comprend les canaux souterrains entre le puits mère, la source ou le wadi (point d’eau en surface) où l’eau est puisée, et la *shari’a*, le début du réseau de distribution autour des villages ainsi qu’une partie du réseau de canaux de distribution de surface autour des plantations dans les villages et les bâtiments associés, tels que les mosquées, les tours de guet, les maisons, les cadrans solaires et les maisons de vente aux enchères de l’eau.

Pour la section souterraine, les délimitations sont fixées de façon à protéger les sources et les canaux, et englobent les canaux principaux entourés d'une bande d'environ 250 mètres de large.

Dans les peuplements et les zones de distribution de l'eau, les délimitations comprennent la zone agricole irriguée par le système d'irrigation et les bâtiments associés.

Chaque système est de plus protégé par une vaste zone tampon, mais cela ne s'étend pas dans la direction des peuplements ni les zones de distribution, à l'exception de *Al-Jeela*.

Les zones sont les suivantes :

Zones km²

	Site	*Tampon*	*Peuplement*
Falaj Al-Khatmeen	1,35028	17,564	1,004
Falaj Al-Malki	6,000	42,5571	1,572
Falaj Daris	3,89468	33,701	2,383
Falaj Al-Jeela	0,309522	38,3946	0,140
Falaj Al-Muyassar	3,00501	31,8266	1,134

Les constructions d'Oman constituent l'une des plus grandes concentrations de systèmes d'irrigation de ce genre dans le monde : une étude à grande échelle terminée en 2001 en a identifié plus de quatre mille, dont 3 000 environ toujours en fonctionnement. Ces derniers ont fait l'objet d'un programme de restauration conduit par le Ministère des Ressources de l'Eau sur les 25 dernières années. Un point qui démontre bien l'importance des systèmes d'irrigation, ressource nationale majeure qui sous-tend toujours les systèmes agricoles dans une grande partie du pays.

La datation précise de la plupart des canaux souterrains est inconnue. Le réseau actuel semble résulter de plusieurs campagnes de construction, dont la plus ancienne pourrait se situer aux environs de 500 apr. J.-C., voire avant. De récentes preuves archéologiques suggèrent que les systèmes d'irrigation existaient dans la région dès 2 500 avant J.-C., mais l'époque du creusement des premiers canaux en profondeur et de leur parement est difficile à déterminer (voir ci-dessous).

Dans les peuplements, l'eau est toujours distribuée dans le cadre d'un système communautaire traditionnel de partage du temps.

On distingue trois types d'*aflaj* en Oman :

i. Ghaili : Cette forme repose sur le flux continu d'un wadi. L'eau, détournée du wadi par un barrage partiel, est transportée par des canaux couverts ou à ciel ouvert jusqu'aux peuplements. Quand le débit est faible ou intermittent, on stocke l'eau dans des réservoirs de rétention, en vue de sa distribution en période de sécheresse. 48 % des systèmes sont des *ghaili*.

ii. *Aini* : Il s'agit de sources pérennes de montagne. Elles ne se tarissent jamais totalement, mais leur débit n'est pas constant, variant en fonction des saisons et des conditions climatiques de l'année. Par leur forme, ils sont similaires aux *aflaj ghaili*, et représentent 28 % des systèmes.

iii. *Daoudi :* Ce type de *falaj* puise dans des sources d'eau au pied des montagnes. De profonds puits-mères sont creusés pour puiser dans la source ; de là, l'eau est ensuite transportée jusqu'aux peuplements des plaines par le biais des canaux souterrains, souvent sur très longues distances. 24 % des systèmes ont recours à des canaux souterrains. Le *daoudi* est de loin le plus complexe des *aflaj*. Sa construction repose sur une ingénierie complexe, et doit avoir également exigé une main d'oeuvre et des capacités d'organisation considérables.

Pour construire le *daoudi*, on creuse tout d'abord un puits-mère aussi proche que possible de l'endroit où le système d'eau souterrain, ou aquifère, émerge des montagnes. Cet endroit ne peut se trouver qu'avec des connaissances traditionnelles des montagnes et de leur géologie. Le puits-mère peut devoir descendre jusqu'à 60 mètres de profondeur.

Les flancs du puits sont revêtus de pierre et de mortier. Celui-ci est fait de galettes d'argile brûlées avec du bois de palmier, qui sont ensuite broyées au fur et à mesure des besoins. La poudre ainsi obtenue est mélangée à de l'eau pour former le mortier, qui, une fois constitué, résiste à l'eau et semble très stable et durable. On le fabrique toujours en utilisant les méthodes traditionnelles.

À partir du puits-mère, on construit un tunnel jusqu'à la *shari'a*, le point de distribution dans le peuplement. Ce tunnel peut faire plusieurs kilomètres de long - jusqu'à 14,8, comme pour le Falaj Al-Malki, avec une inclinaison remarquablement peu marquée, le gradient de pente ne dépassant pas parfois 1:2500.

Certains tunnels présentent un réseau d'embranchements secondaires, comme les nervures d'une feuille. Un système aujourd'hui désaffecté possédait 37 embranchements ; le système en activité qui en possède le plus grand nombre en compte 17. Quand le tunnel traverse de la roche, aucun parement n'est nécessaire, mais dans les roches tendres, un soutènement est assuré par des murs à parement de pierre soutenant des voûtes ou des dalles en pierre, ou par des rondins de palmiers soutenant des dalles en pierre.

Des puits d'inspection sont construits le long des tunnels pour permettre un dragage régulier. Sur le long parcours du puits-mère aux peuplements, l'eau doit parfois passer par-dessus des wadis ou d'autres obstacles. Pour ce faire, l'eau est canalisée par l'intermédiaire de siphons inversés - deux canaux hélicoïdaux reliés par un petit aqueduc.

Shari'a et canaux de distribution dans les peuplements

Les systèmes de distribution de l'eau sont d'une telle importance que les canaux de surface circulent au cœur des peuplements.

L'eau émerge dans le peuplement à la *shari'a* qui possède habituellement des escaliers d'accès et se trouve souvent à côté d'un fort ou d'une tour de guet. De là, elle est dispersée dans des canaux en surface jusqu'aux palmeraies qui constituent les principales cultures, mais aussi des citronniers, de l'herbe à fourrage et diverses cultures saisonnières. Les canaux sont faits de dalles de pierre, de boue ou de chiffons.

L'eau peut être prise à la *shari'a* pour boire et pour cuisiner. Le tronçon suivant est réservé aux ablutions. L'eau traverse ensuite les mosquées et un fort pour arriver jusqu'aux endroits où l'on lave le linge. Ce n'est qu'ensuite que l'eau est détournée vers les plantations de palmiers et les autres cultures, le canal principal se divisant en canaux secondaires de même taille.

Système de distribution des aflaj

Le succès des *aflaj* dépend des structures sociales et économiques qui le sous-tendent depuis des siècles. Celles-ci s'enracinent dans les communautés locales et garantissent une répartition égale aux parties prenantes. Le système ne repose sur aucune forme de texte écrit ou de loi statutaire, mais plutôt sur un système traditionnel de partage du temps qui se transmet d'une génération à une autre.

L'autorité exécutive de chaque système est l'agent du *falaj*, ou *wakeel*, nommé par le cheikh local en consultation avec les parties prenantes et conseillé par un expert technique, l'*arreif*. Le *wakeel* est responsable de la gestion globale du *falaj* : parmi ses devoirs, il est responsable des fonds, de la réglementation de la vente et de la location des parts individuelles et de la supervision courante du fonctionnement du système. Ses subordonnés, appelés *areefs* (qui peuvent être plusieurs, notamment dans les plus grands *aflaj*) sont responsables de la distribution des parts d'eau. Individuellement, les participants sont tenus de respecter la quantité d'eau qui leur est attribuée et les périodes de mise à disposition.

Le système de temps de distribution de l'eau est basé sur un cycle de sept ou dix jours. Les unités allouées aux participants varient de 12 heures à 1,25 minutes.

Un tel système exige une méthode précise de mesure volumétrique de l'eau sur le temps, c'est-à-dire du débit. Dans la journée, cette mesure se prenait traditionnellement au moyen des ombres d'un long bâton tombant sur des rangées de petites pierres placées dans le sol, et la nuit d'après le mouvement des étoiles, un système impliquant l'observation attentive de 24 étoiles au total. Plusieurs peuplements conservent leur cadran solaire. Certains possèdent également de petits bâtiments où se tiennent des ventes aux enchères des parts d'eau.

Les sites proposés pour inscription comprennent les canaux souterrains entre le puits-mère et la *shari'a*, et les canaux de surface avec les peuplements, les tours de guet, les zones d'ablution, les mosquées, les forts, les cadrans solaires et le système de distribution autour des plantations.

Falaj Al-Khatmeen

Ce *falaj daoudi* est alimenté par le wadi Al Meaidin, notable pour son débit abondant en période de pluie et son courant continu (quoique non constant) tout au long de l'année. Sa longueur totale du puits mère à la *shari'a* est de 2,4 km, et il irrigue une aire cultivée de 723,124 m². Sur la plupart de sa longueur, le canal est souterrain.

Le canal à ciel ouvert du peuplement passe sous le fort Bait Al-Redadah (non compris dans la proposition d'inscription), construit sous la dynastie des Yarubides (1649-1711). À l'entrée de la ville, le canal se divise en trois sections égales, dont une irrigue les possessions des habitants et les deux autres des terres agricoles appartenant au Trésor public (*Bait Al Mal*). Pour chacun des trois utilisateurs, l'eau est contrôlée avec précision : si l'on lance trois balles de même taille et de même poids dans le canal avant sa division, chacune partira automatiquement dans un embranchement séparé du canal. Ce petit nombre de canaux à ciel ouvert est compris dans la zone proposée pour inscription.

La zone de distribution comprend des maisons traditionnelles abandonnées bordant les canaux, deux tours de guet édifiées en des points stratégiques pour surveiller les canaux, ainsi qu'une mosquée.

Falaj Al-Malki

Ce *falaj daoudi* est l'un des plus grands *aflaj* du sultanat ; du puits-mère à la *shari'a* (en comptant ses 17 embranchements), il s'étend au total sur une longueur de 14,8 km, et approvisionne une zone de 1 572 730 m². Le *falaj* se divise en deux embranchements, alimentant les villes de Nazar et de Al-Yaman.

Une intense activité de construction a récemment réduit le flux du système.

La zone de distribution comprend une tour de guet édifiée sur une colline dominant les plantations et les vestiges de deux autres tours ainsi que quelques maisons traditionnelles dispersées.

Falaj Daris

On pense que ce *falaj daoudi* est le plus ancien du sultanat. La longueur de ses trois canaux s'élève au total à 7 990 m. L'eau est en majeure partie puisée dans le wadi Al-Abiyadh. La zone cultivée de la ville de Nizwa qu'il alimente couvre 1 715 50 m².

La *shari'a* est entourée d'un petit parc.

La zone de distribution comprend une mosquée, un fort et quelques vieilles maisons de briques en terre.

Falaj Al-Muyassar

Un autre *falaj daoudi*, le *falaj* Al-Muyassar, trouve son origine dans un puits-mère de 50 m de profondeur. Embranchements compris, le *falaj* mesure 5,8 km de long, et irrigue une zone cultivée de 1 133 698 m² grâce à deux embranchements principaux. Sa *shari'a* se trouve à proximité d'une tour de guet et d'un groupe de maisons en briques de terre aujourd'hui abandonnées. Le joli village possède beaucoup de maisons en briques de terre d'un côté et de l'autre des canaux à ciel ouvert, un cadran solaire et une maison de vente aux enchères. Aucun d'entre eux n'est inclus dans la proposition d'inscription.

Falaj Al-Jeela

Ce *falaj aini* se trouve dans un minuscule village, dans la région montagneuse isolée et aride de Wilayat Sur. L'eau vient d'une source du wadi Shab, loin au-dessus du peuplement ; elle est transportée sur plus de 1,6 km par des canaux à ciel ouvert et un petit aqueduc jusqu'à un réservoir de collecte. De là, l'eau est distribuée aux plantations de palmiers et de grenades. La zone de distribution totale couvre environ 14 000 m².

Le *falaj* Al-Jeela maintient un débit stable tout au long de l'année, à peine affecté par les élévations et les baisses des niveaux des eaux souterraines.

La zone de distribution est étroitement enclavée dans les montagnes environnantes. Elle comprend une petite mosquée et quelques maisons traditionnelles.

Histoire

L'histoire des cinq *aflaj* de la proposition d'inscription est inconnue, car il ne reste aucune archive écrite. De par sa taille et sa complexité, et par l'importance de Izki, la ville qu'il alimente, on pourrait juger que le *falaj* Al-Malki est l'un des plus anciens d'Oman. D'après des indications similaires, le *falaj* Daris, avec ses liens à la ville de Nizwa, pourrait être très ancien. La relation du *falaj* Al-Khatmeen au fort Bait Al-Redadah, dont on sait qu'il fut construit sous la dynastie des Yarubides, suggère que ce *falaj* date du XVIIe siècle.

Il serait utile de rassembler plus d'informations en s'appuyant sur les sources techniques, les archives et les fouilles, afin de se faire une idée plus claire de la chronologie de la construction des *aflaj daoudi*.

Protection et gestion

Dispositions légales :

Les *aflaj* appartiennent aux participants individuels du système, avec quelques parts allouées à la mosquée. Le titre de propriété des parts est consigné sous la forme d'un document d'enregistrement (*sukk*) ; la propriété des parts est absolue et elles peuvent être transmises par héritage. Il est rare que les parts appartiennent dans leur intégralité à une seule personne. Le *wakeel* se charge de consigner tous les détails concernant la propriété et les opérations. Certaines parts appartiennent collectivement à tous les participants au *falaj* ; elles sont proposées à la location lors d'enchères hebdomadaires.

Au f*alaj Al Khatmeen*, la zone de distribution est la propriété de l'État. Dans les autres zones proposées pour inscription, les plantations, tours de guet, mosquées et maisons sont des propriétés privées.

Il n'existe aucune protection couvrant le cadre visuel des *aflaj*, non plus que les canaux et leurs structures associées, tours de guet, mosquées et maisons traditionnelles au sein des peuplements. Les municipalités peuvent toutefois limiter l'arrachage des plantations de palmiers pour des constructions nouvelles.

Les sections souterraines du système *aflaj* sont bien protégées. La principale mesure de protection consiste en la Loi de protection des ressources en eau, promulguée par décret royal n° 29/2000. Elle impose aux propriétaires des *aflaj* et aux agents d'obtenir un permis du département des Ressources en eau avant de pouvoir procéder à des agrandissements, des réparations ou des travaux d'entretien sur leurs *aflaj* entre le puits-mère et la *shari'a*. En outre, les travaux susceptibles d'affecter les aquifères ou la qualité de l'eau sont interdits. Le ministère a mis en place d'autres mesures de protection après leur étude. En vertu de celles-ci, aucun nouveau puits ne peut être creusé dans un rayon de 3,5 km autour des puits-mères, et des zones de protection doivent être instaurées de chaque côté du parcours du *falaj* en cas de nouveau développement.

Structure de la gestion :

Bien qu'il n'existe aucun plan formel de gestion en vigueur pour les sections proposées pour inscription des cinq *aflaj,* des systèmes de gestion traditionnels complexes et détaillés assurent la gestion de l'eau et des canaux. Ils sont complétés par les réparations exécutées par le ministère des Ressources en eau. Chaque système est géré par son *wakeel* respectif, dans le cadre de la forme traditionnelle de gestion et en étroite collaboration avec les participants et la communauté locale.

Les zones proposées pour inscription ont la réputation d'être les meilleurs exemples de gestion coopérative de l'eau en Oman.

Traditionnellement, les *aflaj* étaient entièrement financés par les participants. Toutefois, à partir des années 1970, le coût élevé de la main d'œuvre et des matériaux, ainsi que la détérioration de leur état, ont rendu de plus en plus difficile pour les participants le maintien d'un entretien approprié de leur *aflaj*. Par conséquent, le gouvernement d'Oman a assumé la responsabilité de l'entretien des *aflaj* lors du second plan quinquennal (1981-1985), sous la forme d'un vaste programme de forage et de réhabilitation. Il en est toujours responsable.

Justification de la valeur universelle exceptionnelle émanant de l'État partie (résumé)

- Sans les *aflaj*, il n'y aurait guère plus ici que des peuplements pauvres du Golfe (ou d'autres régions désertiques) ;

- La technologie des *aflaj* a été portée à un haut niveau en Oman et fonctionne avec succès depuis plus de deux millénaires ;

- L'organisation des systèmes de distribution d'eau est un exemple exceptionnel de structure traditionnelle ancienne d'au moins un millier d'années mais qui continue à jouer un rôle vital dans la société ;

- Les *aflaj* combinés d'Oman sont l'un des plus vastes systèmes d'irrigation du monde.

4. ÉVALUATION

Conservation

Historique de la conservation :

Depuis que le ministère assume la responsabilité de l'entretien des principaux canaux souterrains des *aflaj* en 1981, plusieurs centaines de kilomètres de canaux ont été restaurés.

Le ministère des Municipalités régionales, de l'Environnement et des Ressources en eau a établi un inventaire des *aflaj* entre 1997 et 1998 et l'a publié en 2001. Cet inventaire englobe les données suivantes :

- Localisation et profondeur des puits-mères
- Parcours des canaux des *aflaj*
- Mesure des débits
- Données sur la qualité de l'eau
- Définition et mesure des zones cultivées et des zones alimentées
- Données sur l'état de conservation des canaux et la nature des débits

Chaque *falaj* inventorié s'est vu assigner un numéro d'enregistrement, et une plaque d'immatriculation a été placée au niveau de la *shari'a*. Ce projet a été entrepris par 134 employés du ministère.

En revanche, la conservation des biens culturels compris dans les zones de distribution de l'eau n'a pas bénéficié d'une haute priorité et aucune aide n'a été accordée à ces structures.

État de conservation :

Une grande partie de la restauration des canaux, en particulier les canaux souterrains, est réalisée sous la supervision du ministère des Municipalités régionales, de l'Environnement et des Ressources en eau. Les communautés des *aflaj* assurent le suivi régulier de leurs systèmes et soumettent des demandes d'assistance pour l'entretien ou la conservation lorsque les structures ou les ressources hydrologiques sont affectées. Dès réception de ces requêtes, le ministère prépare des spécifications techniques et des plans et supervise les travaux d'entretien.

Dans certains cas, cela a impliqué la construction de nouveaux puits de contrôle et la reconstruction de tronçons de canaux effondrés. Cela a parfois été fait avec du béton. Du ciment a également été utilisé pour la surface de certains canaux, là où ils émergent à proximité de la *shari'a*. Ainsi, au *falaj* Daris, dans le parc proche de la *shari'a*, une grande partie des canaux à ciel ouvert ont été rénovés à l'aide de mortier de ciment. En certains endroits, ce revêtement de ciment présente des signes de détachement des mortiers traditionnels sous-jacents.

Il existe toujours des ateliers fabriquant les mortiers traditionnels, et l'ICOMOS considère qu'il serait souhaitable d'utiliser des matériaux traditionnels, car ceux-ci semblent, au vu des anciens canaux, extrêmement efficaces.

Les tours de guet des forts construits en terre et les maisons traditionnelles sont pour la plupart négligées et abandonnées. Quelques-unes sont dans un état alarmant – mais récupérable. Les travaux sont cependant hors de portée des ressources des propriétaires traditionnels. La proposition d'inscription déclare qu'ils font partie des monuments qui doivent être rénovés par le ministère du Patrimoine.

Protection et gestion

Les canaux sont gérés de façon très efficace, dans le cadre d'une alliance entre gestion traditionnelle et soutien des projets de construction à grande échelle de la part du ministère des Ressources en eau. Il n'existe toutefois aucune gestion coordonnée des environs ou des abords des canaux souterrains ou des zones de distribution. Il est suggéré que les comités de *falaj* forment la base de comités de gestion locale pour la zone agrandie et travaille en collaboration avec les ministères concernés et leurs bureaux régionaux.

Une grande partie des édifices traditionnels en terre, tels que les tours de guet, les forts et les maisons attenantes aux canaux dans les peuplements souffrent d'un manque d'entretien et de gestion, et certains des peuplements de plus grande taille ont fait l'objet de reconstructions considérables.

Pour maintenir l'intégrité du vaste système des *aflaj* par rapport à sa relation avec les peuplements, il serait souhaitable que les abords des canaux reçoivent une protection efficace. Ce qui ne signifie pas qu'il faut les transformer en musées, mais qu'il faut gérer le changement dans le respect des caractéristiques des lieux et s'assurer que les éléments clé du système survivent.

Analyse des risques :

- Développement

Ces dernières décennies ont vu un développement rapide en Oman, y compris dans les petites villes et les villages, ce qui a compromis une partie des abords des *aflaj*, notamment quand les bâtiments traditionnels en briques de terre, dont les tours de guet, sont laissés à l'abandon, et les palmeraies ont laissé la place à de nouvelles constructions de maisons.

La construction de routes a aussi affecté les canaux et certaines nouvelles routes coupent les canaux souterrains ou sont construites à proximité de canaux à ciel ouvert.

- Demande en eau

L'accélération du développement a conduit à un accroissement de la demande en eau, entraînant le creusement de puits larges et profonds. Ces nouveaux puits ont à leur tour affecté le niveau des eaux souterraines et rendu certains *aflaj* intermittents alors qu'on pouvait auparavant compter sur eux toute l'année durant. Par exemple :

Falaj Al-Malki : Récemment, une construction intensive dans la zone a imposé une lourde pression à l'aquifère, pression qui, associée à la rareté de la pluie, a entraîné une diminution du débit de ce *falaj*, en particulier en périodes de sécheresse.

Falaj Daris : Le débit d'eau a pâti des pressions de développement, et il chute en période de sécheresse.

- Changement climatique

L'absence de pluies dans la région du Golfe ces deux dernières décennies a considérablement abaissé le niveau de la nappe phréatique, processus encore accentué par le forage de nouveaux puits.

Au *falaj* Al-Jeela, la zone a durement souffert de la sécheresse ces 14 dernières années, et viendra un moment où cela affectera le flux d'eau de la source pérenne. Tous les *aflaj daoudi* sont affectés dans une mesure ou une autre.

La pluie, quand elle finit par tomber, s'accompagne d'inondations brutales et imprévisibles ; ces brusques augmentations du niveau des eaux endommagent également les canaux. Aucun plan d'urgence n'a été mis en place pour parer aux inondations. Les dégâts faits aux canaux sont réparés par des interventions de l'État.

- Visiteurs

Il semble qu'actuellement les visiteurs de ces sites soient extrêmement rares. Il est en effet très difficile d'apprécier les sections souterraines des *aflaj*, et sur trois des sites les sections de surface s'imbriquent dans des routes et de nouveaux développements. Pour que les visiteurs puissent apprécier l'importance et l'étendue de ces systèmes, il faudrait développer une stratégie afin de fournir des informations et mettre en place un accès compatible avec les usages traditionnels.

Authenticité et intégrité

Authenticité :

La conception de base des *aflaj* proposés pour inscription est parfaitement authentique. On recense quelques interventions modernes comme l'utilisation du béton pour le revêtement des puits, et du ciment pour le haut des puits-mères et des puits de contrôle, pour certaines des *shari'a* et dans les canaux de distribution des parcelles agricoles individuelles, et des nouvelles constructions autour des peuplements.

L'authenticité de la gestion des *aflaj* est incontestable. Le système traditionnel de propriété et de gestion, d'une grande efficacité, est complété par le soutien administratif, technique et financier du ministère des Ressources en eau.

Intégrité :

Initialement, seule une partie des *aflaj* a été proposée pour inscription, à savoir la portion entre le puits-mère et la *shari'a*. Les parties du système dans les peuplements, desservant la communauté en l'approvisionnant en eau pour cuisiner, laver et irriguer ses cultures sont désormais comprises dans la proposition d'inscription. Les zones proposées pour inscription reflètent maintenant l'intégrité de l'ensemble du système *aflaj*.

Évaluation comparative

La provenance et l'époque de l'irrigation au moyen du *falaj daoudi* sont incertaines. Ce système est connu en Iran, en Arménie et dans de vastes régions d'Asie centrale et de Chine occidentale, au Chili et au Pérou en Amérique du Sud, ainsi qu'en Oman, dans les Émirats Arabes Unis voisins, en Égypte, au Maroc et en Espagne.

Également connue sous le nom de *qanat*, cette technique était connue dès l'âge du fer en Perse, l'actuel Iran. On suppose qu'elle est arrivée en Perse depuis la région de la mer Caspienne, à la fin du IIe millénaire av. J.-C. et que le souverain assyrien Sargon II, qui régna à la fin du VIIIe siècle av. J.-C. et son successeur Sennacherib construisirent plusieurs *aflaj*. Toutefois, de récentes découvertes en Oman et à Al-Ayn suggèrent que le transfert de technologie aurait en fait pu se faire dans l'autre sens.

Des *aflaj daoudi* datés de l'âge du fer ont été mis au jour à Al-Ayn et dans les zones environnantes de Hili, Bida Bin Saoud, Jebeeb et Al-Madam, aux Émirats Arabes Unis, de l'autre côté de la frontière avec l'Oman. On a signalé deux anciens *aflaj* à Maiyser et à Raki, en Oman, datant d'environ 1 500 av. J.-C., et de récentes fouilles au fort de Bahla en Oman ont révélé d'anciens systèmes d'irrigation qui pourraient dater de 2 500 av. J.-C., mais on attend toujours la confirmation de leur type et de leur datation précise.

La technique des canaux souterrains se diffusa plus largement à la période achéménide en Perse, du milieu du VIe siècle au milieu du IVe siècle av. J.-C. Ce fut l'époque de l'expansion perse, particulièrement sous le règne de Cyrus le Grand. Une grande partie de l'Oman tomba aux mains des Achéménides au milieu du VIe siècle av. J.C., et à partir de l'an 226 apr. J.-C. il fit partie de l'empire sassanide de Perse, jusqu'à ce que les Sassanides soient finalement évincés avec l'avènement de l'Islam au VIIe siècle apr. J.-C. D'après les archives historiques, l'Oman connut une période de construction de *falaj* à l'époque des Yarubides, dans la deuxième moitié du XVIIe siècle, lorsque les Portugais furent finalement expulsés d'Oman, et devint le premier État indépendant du monde arabe.

Les *aflaj* d'Iran et ceux d'Oman présentent d'étroites similitudes. On estime à 20 000, le nombre de *qanats* toujours en usage en Iran.

À l'époque romaine, le premier *falaj* fit son apparition en Syrie et en Égypte. La technique se répandit tout le long de la route de la Soie jusqu'à Parthe, la Bactrie, la Sogdie et plus tard Xinjiang. Les systèmes souterrains d'alimentation en eau sont encore très utilisés au Chili et au Pérou.

L'irrigation à partir de sources est encore plus répandue que le type d'*aflaj daoudi*. Aucune analyse comparative n'est présentée pour l'irrigation depuis les sources, alors que ce système se retrouve dans une quarantaine de pays dans le monde. On en trouve des exemples particulièrement impressionnants dans l'Himalaya, où l'eau est canalisée sur de longues distances jusqu'aux villages dans les plaines en deçà. Le seul exemple proposé pour inscription, quoique impressionnant en raison de son cadre spectaculaire, ne peut être jugé représentatif de ce type de système.

Si l'on considère exclusivement le *falaj daoudi* ou les *qanats*, sans autres recherches sur ce qui reste en Iran et en Asie centrale en particulier, que ce soit en termes de construction ou de chronologie, il est difficile de dire avec une quelconque certitude où les structures d'Oman s'inscrivent dans le contexte du transfert technologique d'utilisation des sources d'eau souterraines pour l'irrigation, ou si elles sont plus élaborées, techniquement parlant, que les autres exemples. Il serait donc impossible de dire si les systèmes d'Oman présentent une valeur exceptionnelle pour des motifs purement techniques, ou parce qu'ils représentent les premières utilisations de cette technologie.

Toutefois, les systèmes d'Oman continuent de fonctionner comme des unités intégrales et essentielles des systèmes de production des villages et des villes, et demeurent gérés par des autorités traditionnelles de longue date au sein des communautés qu'ils desservent. Leur valeur réside dans leur appartenance à un paysage culturel distinct et vivant, et dans le reflet des systèmes sociaux particuliers qui se sont développés dans cette région. Sur les 3 000 systèmes en activité, 627 sont des *aflaj daoudi*.

La proposition d'inscription actuelle ne couvre qu'une partie des quatre *aflaj daoudi* : les canaux souterrains entre le puits-mère et la *shari'a*. Sont exclues les parties du système qui approvisionnent en eau les gens et les plantations, les bâtiments associés comme les mosquées, les forts, les tours de guet et les lavoirs, et la relation entre le système d'irrigation et les peuplements - habituellement situés en hauteur et descendant vers le centre. Les zones proposées pour inscription ne reflètent donc pas la pérennité de la gestion traditionnelle sociale et technique de ces systèmes.

Des systèmes d'adduction d'eau souterrains sont toujours prospères dans d'autres régions, comme l'Afrique du Nord, l'Iran, l'Asie centrale, le Chili et le Pérou, en particulier. Il serait utile d'identifier le caractère distinctif propre au système social d'Oman et les différences qu'il présente par rapport à ces autres contrées.

Valeur universelle exceptionnelle

Déclaration générale :

Les sites sont proposés pour inscription sur la base des critères ii, iv et v :

Critère ii : Ce critère est justifié sur la base du fait que le système des aflaj d'Oman est un exemple exceptionnel, « d'une ancienneté considérable », qui a survécu intact et qui apporte des bénéfices socio-économiques. Des informations plus précises sont nécessaires pour démontrer l'ancienneté des parties proposées pour inscription, et de plus vastes zones seraient nécessaires pour démontrer les avantages socio-économiques. <u>L'ICOMOS considère que ce critère pourrait être justifié sur la base d'informations supplémentaires détaillées.</u>

Critère iv : Ce critère est justifié en suggérant que l'irrigation a sous-tendu le peuplement, qui a son tour a sous-tendu un État prospère et d'influence dans la région. C'est vrai, mais c'est aussi valable pour beaucoup d'autres parties des régions voisines, et rien ne vient expliquer en quoi les cinq zones proposées pour inscription peuvent illustrer un contexte plus vaste. <u>L'ICOMOS considère que compte tenu l'information disponible, ce critère ne peut pas être évalué correctement à ce stade.</u>

Critère v : La proposition d'inscription justifie ce critère sur la base du fait que les sites sont menacés par l'abaissement de la nappe phréatique, ce qui est le cas, et qu'ils constituent une forme d'occupation des sols exceptionnellement bien préservée. <u>L'ICOMOS considère que le bien répond à ce critère.</u>

5. RECOMMANDATIONS

Recommandations

La proposition d'inscription actuelle porte sur une partie de quatre *aflaj daoudi* et d'un *falaj aini*. Les systèmes d'irrigation fondés sur des sources sont largement répandus dans le monde, et le site proposé pour inscription ici d'un *falaj aini* n'a rien d'exceptionnel.

La proposition d'inscription initialement proposée par le ministère des Ressources en eau incluait les aspects du système sur lequel il avait le contrôle. L'État partie doit être félicité pour avoir étendu les zones proposées pour inscription au paysage plus vaste créé par le système d'irrigation *aflaj* pour inclure les zones de distribution dans les peuplements de manière à respecter l'implication sociale et communautaire.

La proposition d'inscription élargie doit être considérée comme un ensemble de paysages culturels représentatifs de modes de gestion particuliers, durables, viables et vivants des ressources d'eau.

Les sections souterraines de la proposition d'inscription et les canaux principaux sont gérés très efficacement selon les pratiques traditionnelles soutenues par des travaux de réparation effectués par le ministère des Ressources en eau. Un aspect cependant pourrait être amélioré : il s'agit de l'utilisation des matériaux. Il est nécessaire en effet de réintroduire l'utilisation du mortier traditionnel.

Le paysage au sein des peuplements a reçu beaucoup moins d'attention et n'est pas soumis à une approche convenue. Il est nécessaire d'envisager la manière de gérer l'ensemble du paysage grâce au développement d'un processus de gestion impliquant les communautés locales, éventuellement basé, comme le suggère la proposition d'inscription, sur une extension des comités traditionnels de *falaj* avec le soutien du ministère du Patrimoine et de la Culture.

Comme beaucoup de bâtiments traditionnels sont dans un état de grand délabrement, il est également nécessaire de créer un plan d'action à court terme pour traiter la stabilisation de ces bâtiments et, le cas échéant, leur donner des fonctions viables.

Un plan de gestion est nécessaire qui organiserait ces approches et traiterait le contrôle des nouveaux développements, l'accès des touristes et la présentation des *aflaj*.

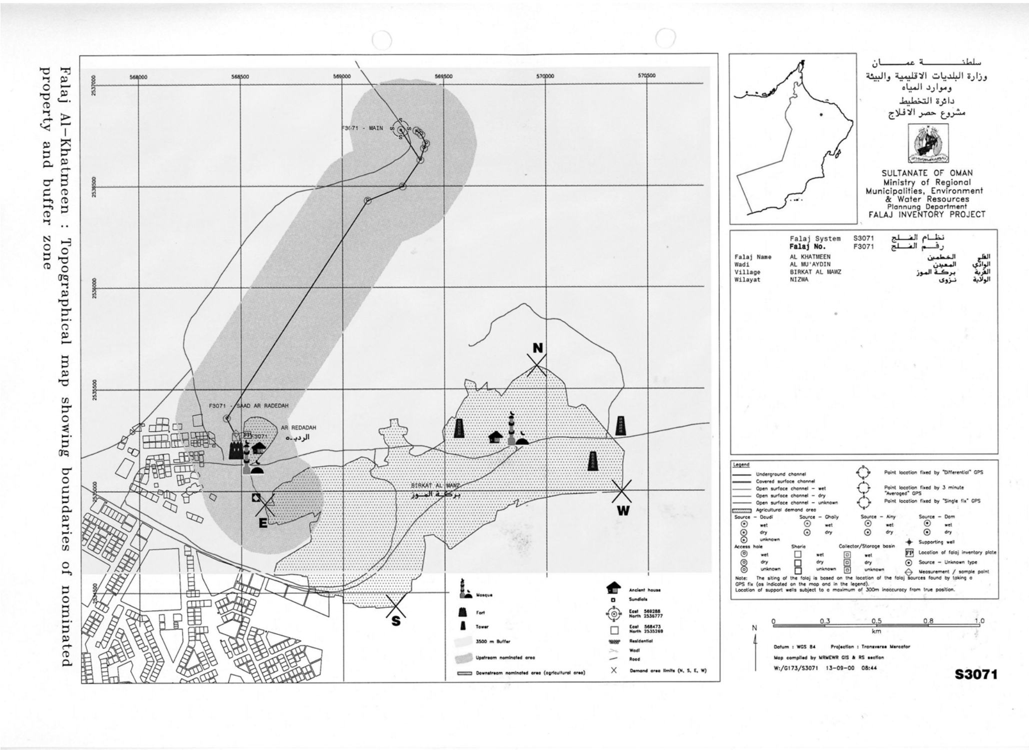
Actuellement, les canaux souterrains bénéficient d'une protection légale mais les zones proposées pour inscription dans les peuplements ne sont pas protégées. Il est nécessaire d'envisager la protection des structures clés et des schémas de peuplements.

Recommandation concernant l'inscription

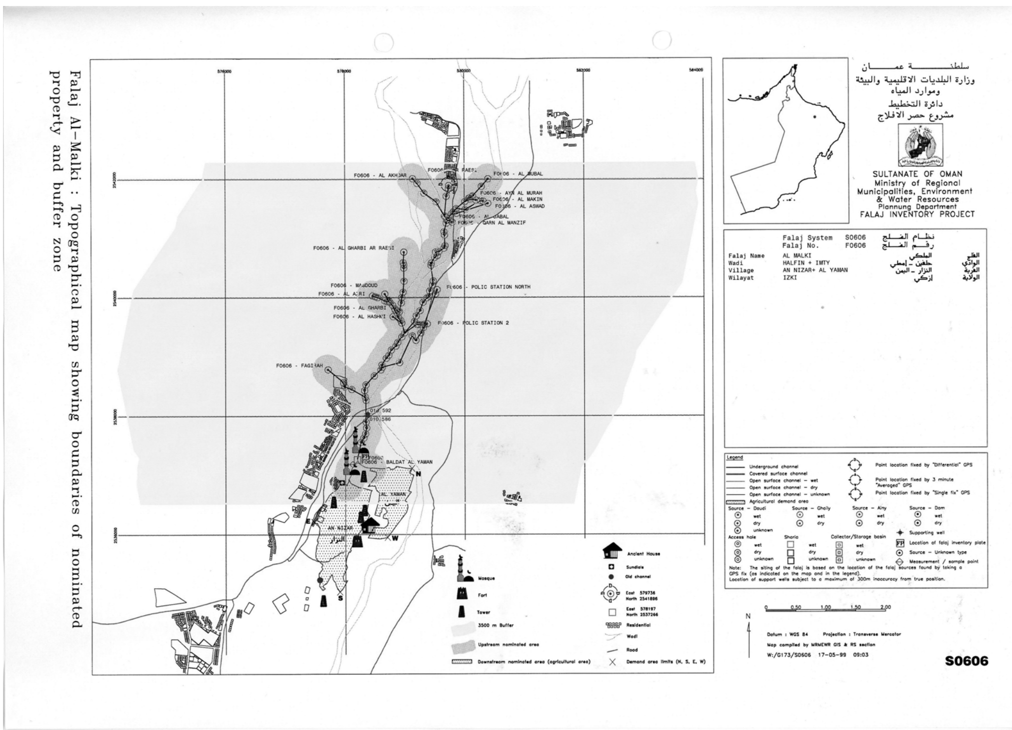
L'ICOMOS recommande que la proposition d'inscription des systèmes d'irrigation *aflaj* d'Oman soit ***renvoyée*** à l'État partie du Sultanat d'Oman, afin d'envisager comment :

- protéger de façon appropriée les zones élargies ;
- fournir de plus amples informations afin de justifier les critères proposés ;
- un plan ou un système de gestion peut être développer pour les zones de peuplement, en complément des mesures traditionnelles de gestion qui traite de la restauration et de la conservation des structures traditionnelles associées telles que les tours de guet, les forts, les maisons, les lavoirs, les mosquées, de la réintroduction des mortiers traditionnels, du contrôle du développement, de la gestion des visiteurs et de la présentation des *aflaj*.

ICOMOS, avril 2006



Plan indiquant les délimitations révisées du Falaj Al-Khatmeen



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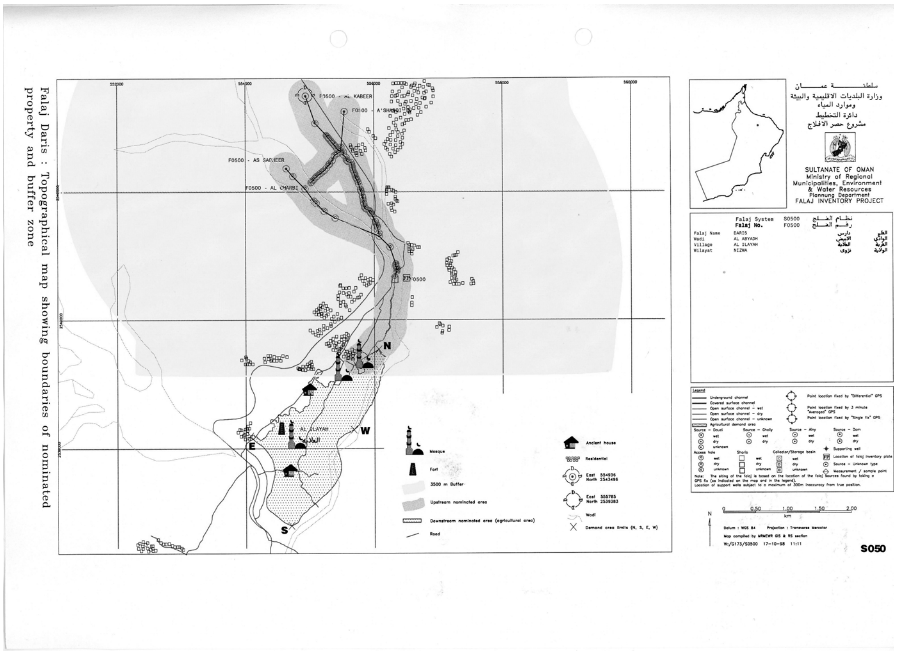
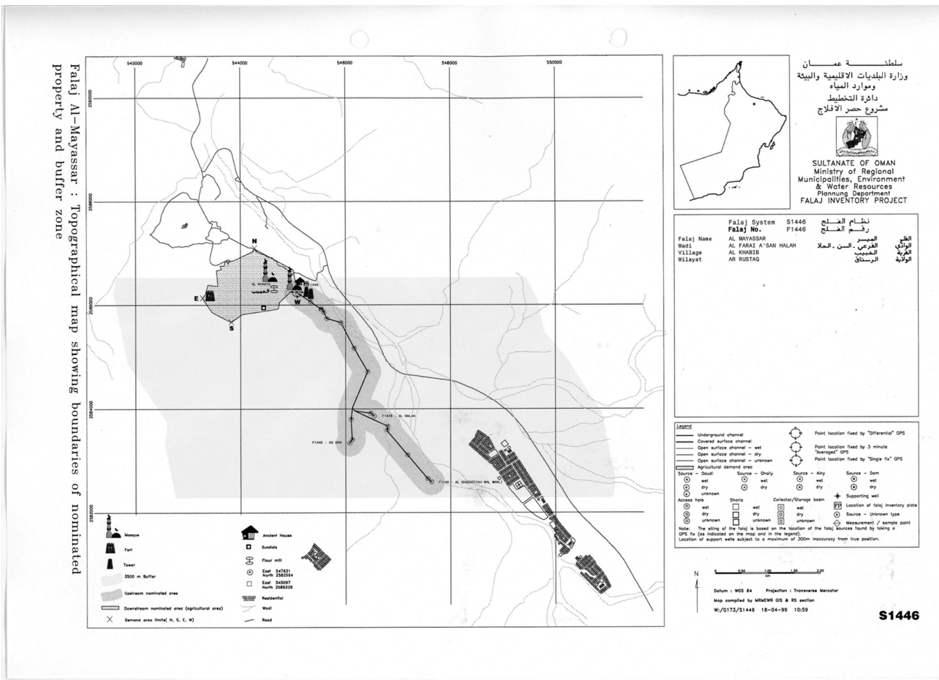
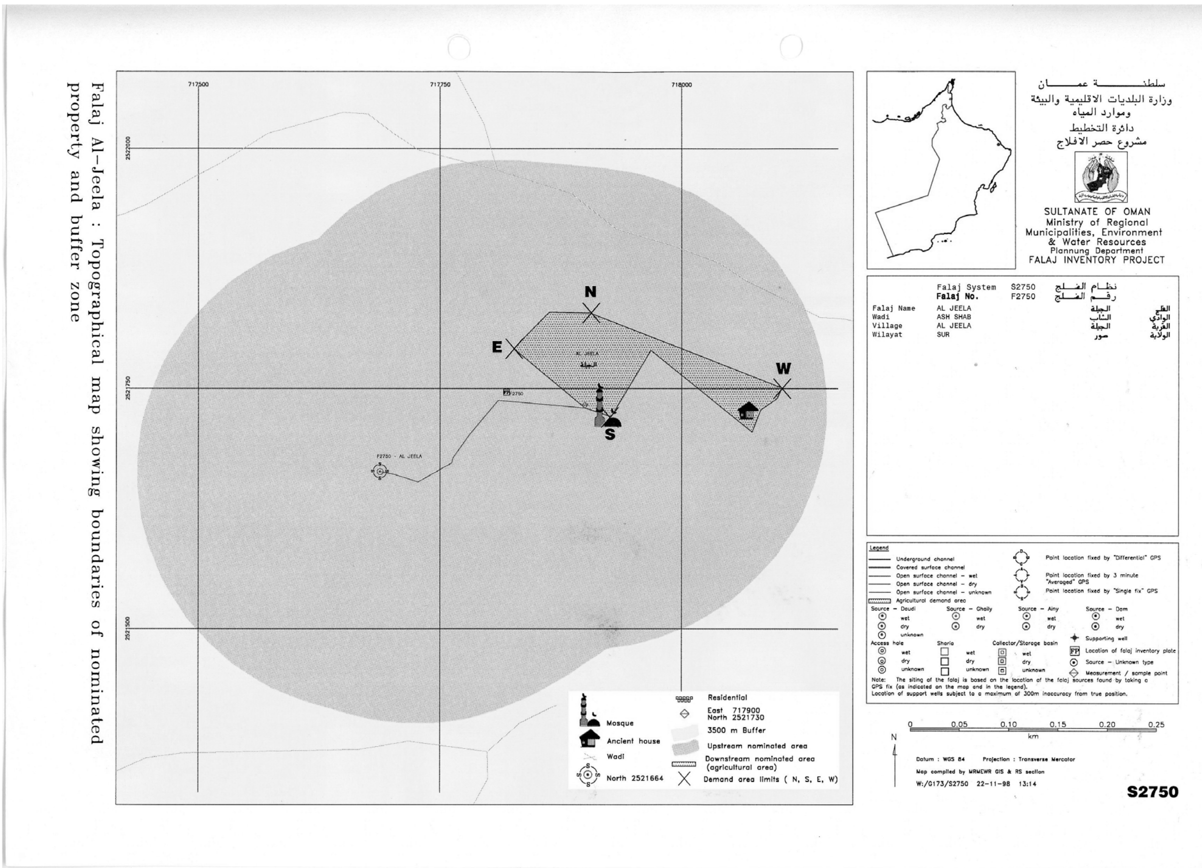


Plan indiquant les délimitations révisées du Falaj Daris

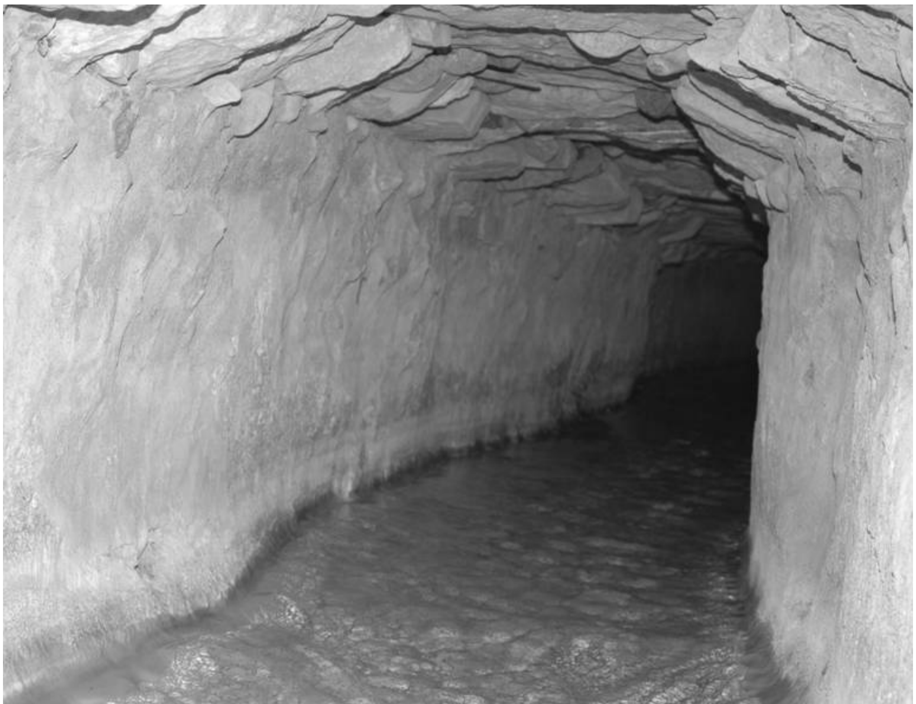


Plan indiquant les délimitations révisées du Falaj Al-Mayassar



Plan indiquant les délimitations révisées du Falaj Al-Jeela

Tour de guet



Canal souterrain

Shari'a

Point de distribution

Délégation Permanente
du Sultanat d'Oman
auprès de l'UNESCO

وفد عمان الدائم
لدى اليونسكو
باريس

Paris, 31st October 2006

Dir WHC
rec d 03. 11/06 VD

Ref : WHC/HA-1

Dear Mr Francesco Bandarin,

Subject : Nomination of properties for inscription on the World Heritage List
Aflaj Irrigation Systems of Oman
During the 30th Session of the World Heritage Committee

Please refer to your letter No WHC/74/318.1/06/147 dated 13 September 2006, the Omani National Commission for Education, Culture and Science has advised us that the Ministry of Regional Municipalities, Environment and Water Resources has confirmed the exactitude of the referred maps.

Please accept, dear Mr Francesco Bandarin, the assurances of my highest consideration.

Dr. Musa Bin Jaafar Bin Hassan
Ambassador
Permanent Delegate of the Sultanate of Oman to UNESCO

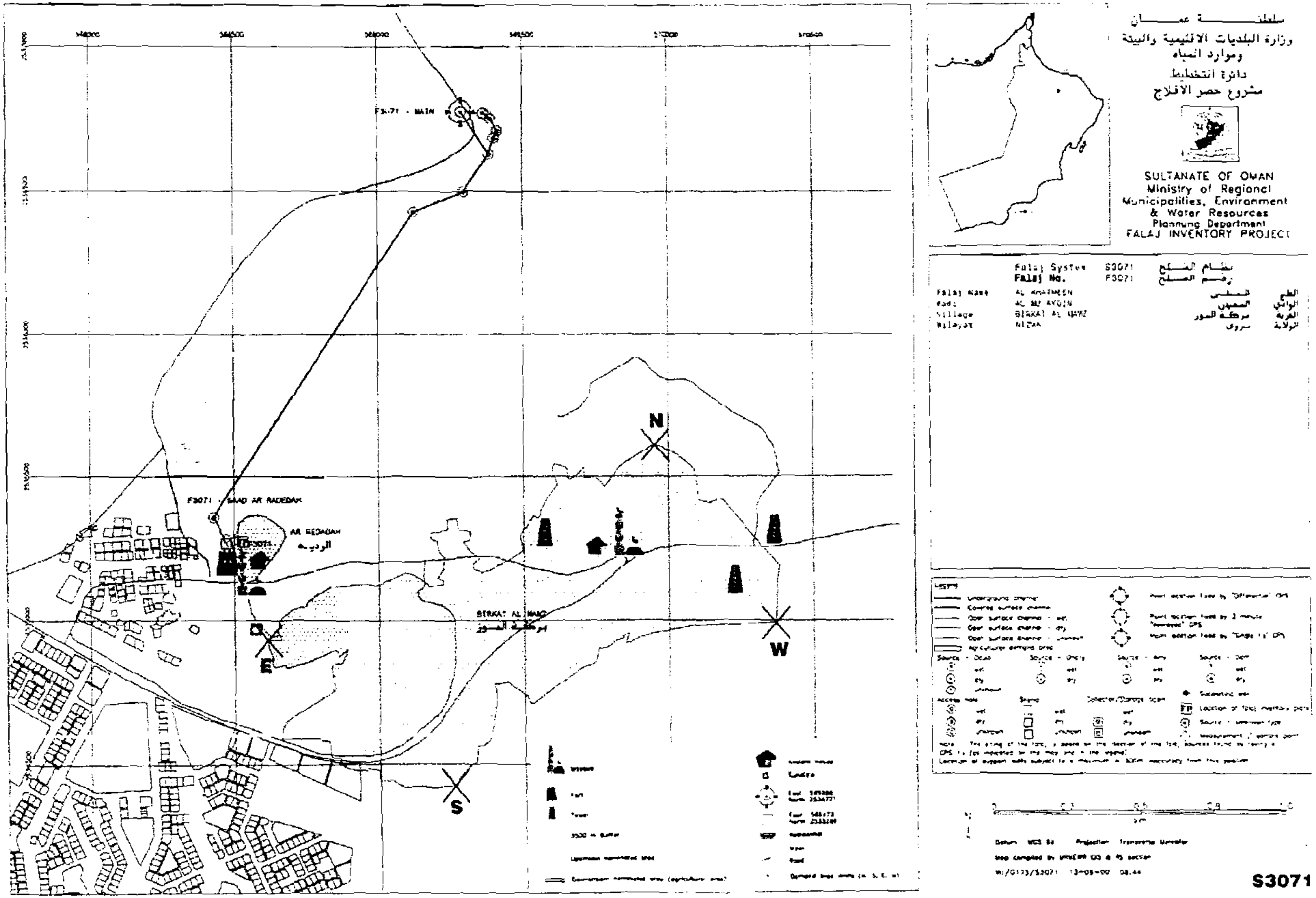
Mr Francesco Bandarin
Director
World Heritage Centre

Surface and coordinates of the property inscribed on the World Heritage List by the 30th session of the World Heritage Committee (Vilnius, Lithuania, 2006) in accordance with the *Operational Guidelines*.[1]

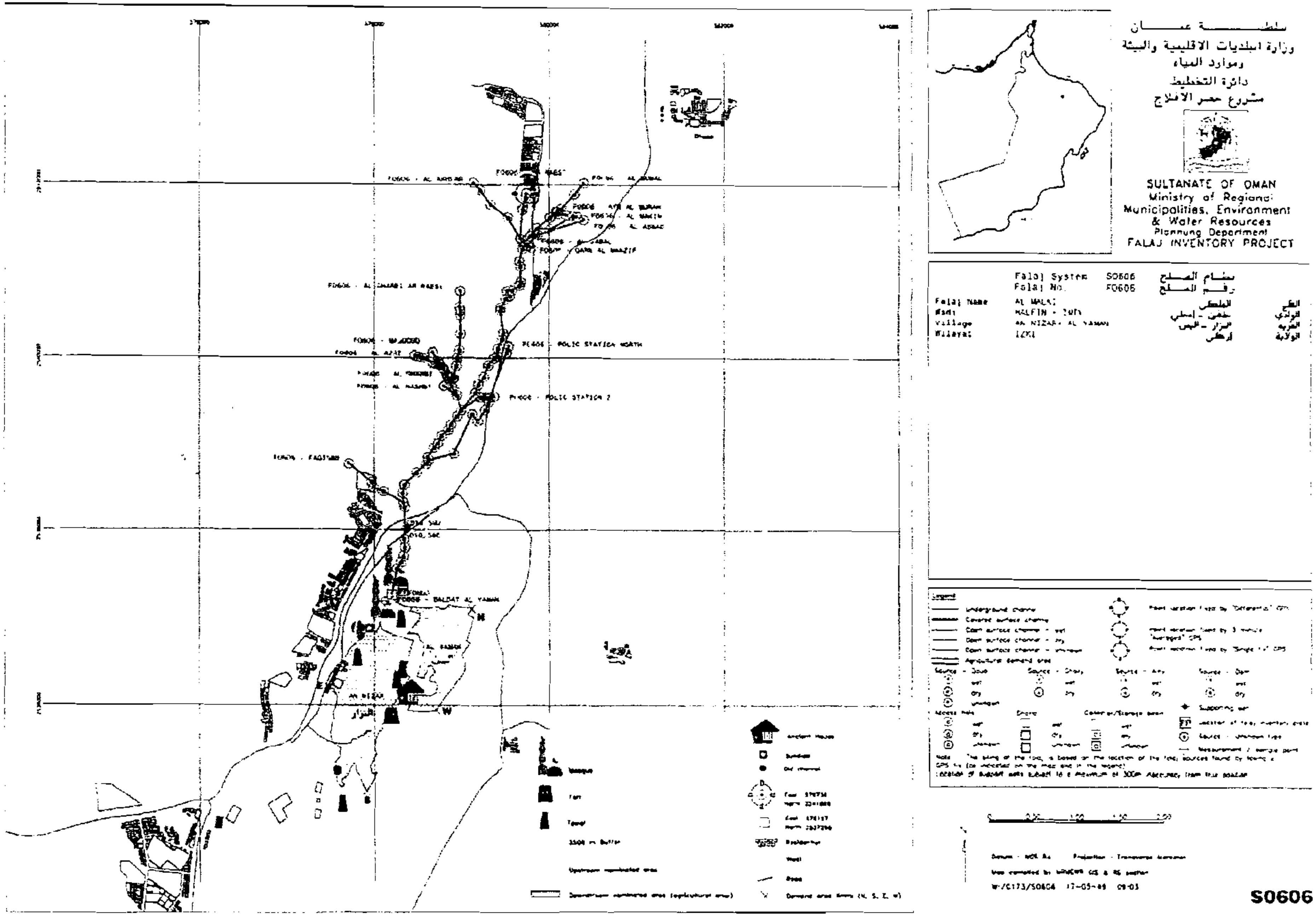
	Oman			
C 1207	*Aflaj* Irrigation Systems of Oman			
Serial ID No.	**Name**	**Area**	**Buffer zone**	**Centre point coordinates**
1207-001	Falaj Al-Katmeen	135.028 ha	1 756.4 ha	N22 56 15.5 E57 40 32.8
1207-002	Falaj Al-Malki	600 ha	4 255.71 ha	N22 44 22.3 E57 46 35.6
1207-003	Falaj Daris	389.468 ha	3 370.1 ha	N22 59 56.0 E57 32 09.8
1207-004	Falaj Al-Jeela	30.952 ha	3 839.46 ha	N22 47 15.9 E59 10 26.1
1207-005	Falaj Al-Muyasser	300.501 ha	3 182.66 ha	N23 21 08.2 E57 27 57.6
	TOTAL	**1 455.949 ha**	**16 404.33 ha**	

The following map (see next page) submitted by the authorities represents the site as inscribed by the 30th session of the World Heritage Committee.

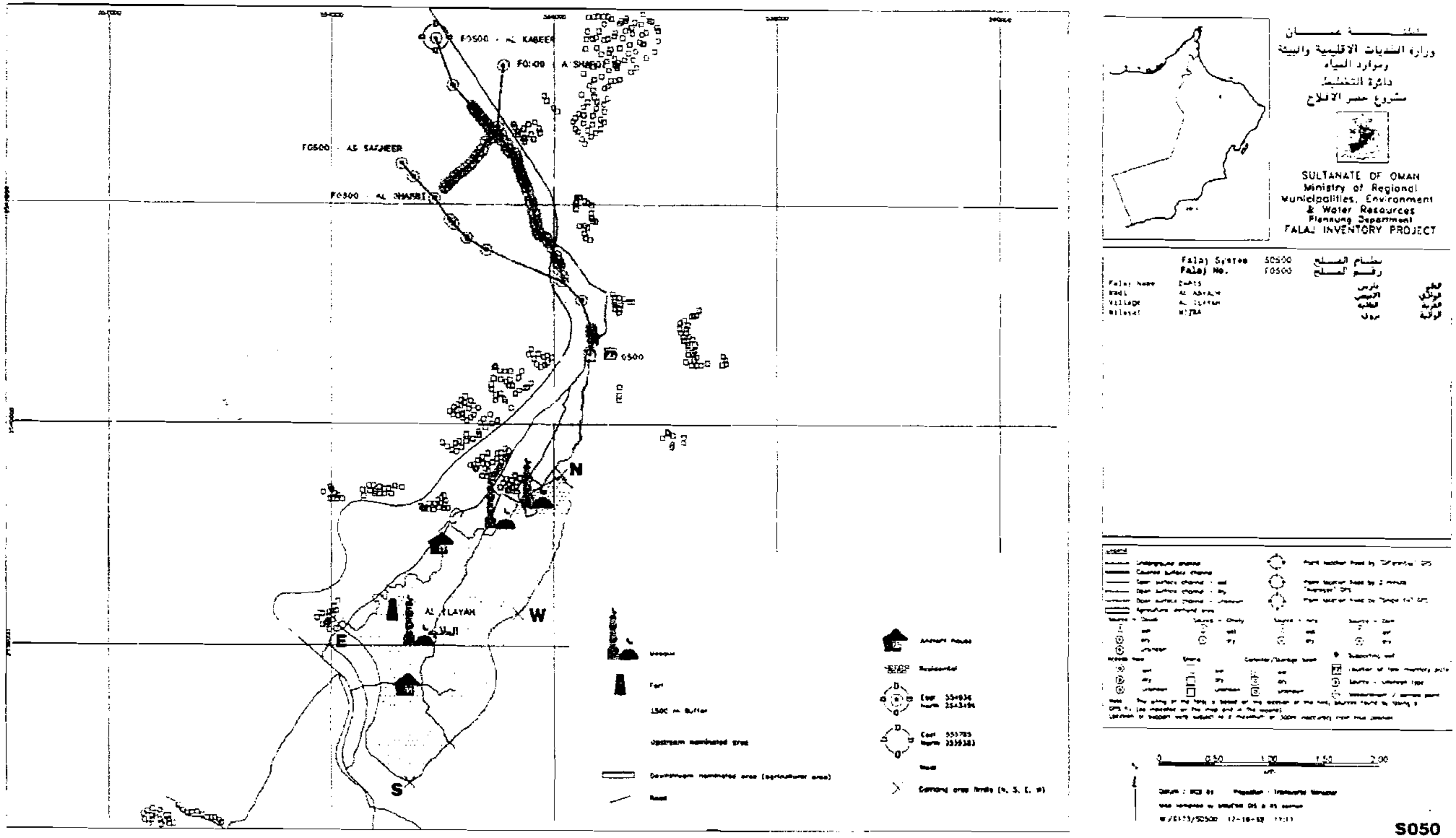
[1] Information abstracted from document WHC-06/30.COM/8B presented to the 30th session of the World Heritage Committee (Vilnius, Lithuania, 2006).



Falaj Al-Khatmeen : Topographical map showing boundaries of nominated property and buffer zone

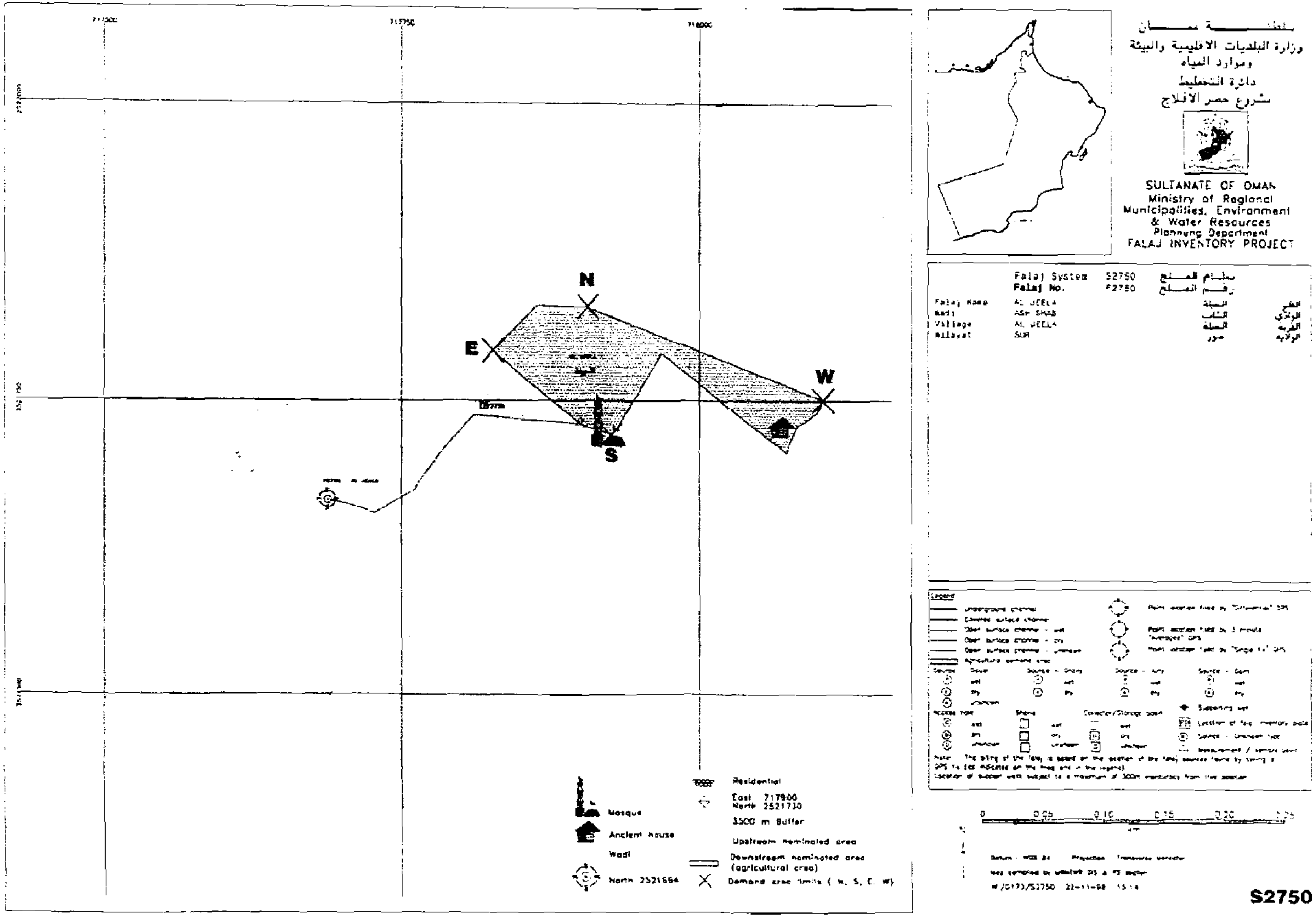


Falaj Al-Malki : Topographical map showing boundaries of nominated property and buffer zone



Falaj Daris : Topographical map showing boundaries of nominated property and buffer zone

Falaj Al-Jeela : Topographical map showing boundaries of nominated property and buffer zone



Falaj Al-Muyassar : Topographical map showing boundaries of nominated property and buffer zone