3. Water Resources Inventory

3.1. Water Resources and Well Inventory

3.1.1. General

Water resources of all oases involved into the Project, and of several other oases important for the study, were directly checked by the Hydrogeologist of the Study Team cooperating with the hydrogeologists and/or engineers of each CRDA. Water resource(s) for each oasis, most of them are deep tube wells though, were checked their current situation such as a kind of resources, an application, an extraction method when it was a tube well, etc.; surveyed the location by GPS; and measured its water quality (E.C and temperature) when it is available. In the case of tube well, further detail information such as the well depth, constructed year, aquifer type, yield (unit and yearly total), results of chemical analysis, and so forth were collected later.

Based on the field check and data collected, the "Inventory of Oasis Water Resources" and "Well Inventory" for each Province were prepared separately. The location of water sources, measured by the Team, are plotted in the topo-sheet of 1:100,000.- scale and attached in this report as an annex.

3.1.2. Water Resources Inventory

In the inventory, water resources of each oasis were simply classified into D.T.W (Deep Tube Well), Dug-well, Natural Spring, River, and Pipe Line Supply from the other site(s). For every cases, an application system, an average information and index for tube well when the source was well, and water quality are listed.

The application system is categorized into four systems; a "reservoir" which means a reservoir tank system collecting and mixing water from plural wells, a "well" or "wells" which mean individual well system, a "dam" means small scale surface reservoir dam, and a "gravity" means water use in gravity as literally. Well index shows the number of well utilized, name of aquifer, averaged depth, extraction method such as electric motor pump or diesel, were simply noted. In the column, the code name of all wells utilizing in the oasis, to check the "Well Inventory" for further detail information, is also marked. In the column of water quality, E.C and temperature data were values measured by the Study Team, and the salinity data were come from each CRDA.

Besides the water resources data, the inventory has information on hydrogeological classification of oasis and gypsum soil. Hydrogeological classification of oasis (type of oasis) is just according to the explanation described in the previous section of 2.3. Oasis Hydrogeology. The information on gypsum are two; a distribution of gypsum soil based on the information obtained from Soil Department of each CRDA, and an oasis at where the gypsum survey was conducted by the Team.

3.1.3. Well Inventory

Groundwater supplied through a deep tube well is the major water resource for most of the oases, because there is no other reliable water source in the Southern Tunisia. Thus, there are numerous tube wells in the South, mostly drilled legally but considerable numbers of illicitly.

During the field survey periods, in both Phase 1 and 2 stages, more than 400 of tube wells and some other water sources were checked and further information on them were also collected by the Team. These information were summarized as "Well Inventory" individually but in closed relation in between/from the "Water Resources Inventory" explained above, because the well information were too much in many aspects to be described in the one sheet together with the latter.

The inventory has main five information of a location, a topo-sheet, a well drilling, a delivery and a water quality, besides the name and code numbers (well code by the Team and IRH of DGRE).

The column of location has two systems; one is an international coordination system of longitude and latitude which is measured by GPS, and another is French Grade system converted from the coordination by the Team. The converting formula, which is modified by the Team through try and error method to fix the several reference positions, are as follows:

- Latitude (N) $X^{Grad} = 1.1112 \cdot x^{\circ} - 0.0018$
- Longitude (E) $Y^{Grad} = 1.1111 \cdot y^{\circ} - 2.5935$

Column of topo-sheet has also two data on the sheet number of 1:100,000.- scale topo-map, and elevation of well point read from the said topo-sheet. The elevation listed here is, therefore, very rough because the elevation contour line in the sheet is 20 m interval.

Data group of "Well Drilling" is consisted of five data; a depth, an aquifer type, a static water level (S.W.L), an yield, and a year of drilled. Aquifer type in this column is followed to the systematic aquifer classification code by DGRE, as explained in the section 2.2. Hydro-geology and Aquifers in Target Provinces. Major codes are shown below;

Gafsa Province
- 71521: Gafsa North
- 73111: El Guettar
- 73221: Gafsa South
- 74314: Chott El Gharsa North

Tozeur Province
- 73314: Tamerza
- 74311: C.T.
- 74312: C.I.

Kebili Province
- 91311: C.I. (Basin South)
- 91211～93331: C.T.
- 94111: C.I. (Garaat Bou Flidja)

Gabes
- 81111～81141: Gabes North
- 81221～81241: Gabes South
- 91111: C.I.
- 91231～91241: Chenchou

Data on "Delivery" includes a type of extraction, a delivery system, and a production volume (m^3/year). For an extraction type, EMP means electric motor pump, DEP is diesel engine pump. Column of delivery system has six categories of E.T. (individual elevated tank system), Res. (Reservoir tank system), C.T. (cooling tower system), Direct. (direct supply from well to hydrant), Dir.(A.C.) (direct supply through air chamber), and others. Production volume has come from the yearly book of "annuaire de l'exploitation des nappes profondes" (DGRE, 1994).

Finally, the data group of "Water Quality" includes two kinds, five items of data. One kind is water qualities such as E.C, salinity, and temperature measured by the Team. Another is salinity value measured by CRDA and an index for existence of further detail chemical analysis data by CRDA. The detail chemical analysis data are attached in the appendix.

3.2. Water Resources Inventory

The following pages are "Water Resources Inventory" for all four Provinces, in the order of Gafsa, Tozeur, Kebili, and Gabes.

INVENTORY OF OASIS WATER RESOURCES - 1
GAFSA GOUVERNORAT

Code Num.	Oasis		Region	Area (ha)	Water Resource	Applica-tion	Wells				Water Quality*1			Gypsum Soil		Note
	Name	Type					Nos.	Aquifer	Av.depth (m)	Extract	E.C (m S/m)	Temp. (°C)	Salinity (g/l)	dist. *2	Survey	
GF-1	Kasba	c	Gafsa Sud	698	D.T.W	reservoir+wells	(12)+4	Gafsa N & S	(253)+139	EMP	216.0	30.5	1.99	+		reserv. cosits of 12
							Code: GFW-1,2,3,4,5,6,7,8,9,10,11,12, and GFW-13,14,15,16									Pilot area
GF-2	Sud Ouest	c	Gafsa Sud	703	D.T.W	reservoir+wells	(12)+3	Gafsa N & S	(253)+168	EMP	216.0	30.5	1.99	++	o	well's water
							Code: GFW-1,2,3,4,5,6,7,8,9,10,11,12, and GFW-17,18,19									
GF-3	El Guettar	b3	Guettar	450	D.T.W	2 reservoirs	4	El Guettar	89.7	EMP	332.0	25.0	2.20			
							Code: GFW-27,28,29,30									
GF-4	Lalla	c	Ksar	700	D.T.W	reservoir+dam	7	Gafsa N	606.7	EMP	285.0	32.7	2.82			reserv. cons. 7 wells
							Code: GFW-24,25,26 (and other 4 wells)									
GF-5	El Ksar	c	Ksar	578	D.T.W	reservoir+wells	(12)+3	Gafsa N & S	(253)+243	EMP	216.0	30.5	1.99			same with Kasba
							Code: GFW-1,2,3,4,5,6,7,8,9,10,11,12, and GFW-20,21,22,23									
GF-6	Oued Shilli	c	Metalaoui	56	D.T.W	well	1	C.T.	858.0	EMP	610.0	34.8	3.85	+++	o	
							Code: GFW-31									Pilot area
GF-7	Thelja	c	Metalaoui	65	D.T.W	wells	2	C.T.	300.0	EMP	434.0	22.2	2.20			
							Code: GFW-36,37									
GF-8	Segdoud	e	Redeyef	217	D.T.W	reservoir	4	Chott E. G. N	1425.0	EMP	609.0	38.9	4.24			reserv. cons. 3 wells
							Code: GFW-32,33,34,35									
	Total			3,467			40									

D.T.W. : Deep Tube Well C.T. : Complex Terminal EMP:Electric Motor Pump

*1: EC & Temp. are measured by the Team.

*2: +;slightly, ++;commonly, +++;heavily

INVENTORY OF OASIS WATER RESOURCES - 2
TOZEUR GOUVERNORAT

Code Num.	Oasis		Region	Area (ha)	Water Resource	Applica-tion	Wells				Water Quality*1			Gypsum Soil		Note
	Name	Type					Nos.	Aquifer	Av.depth (m)	Extract	E.C (m S/m)	Temp. (°C)	Salinity (g/l)	dist. *2	Survey	
TZ-1	Tozeur	b1	Tozeur	929	D.T.W	wells	12	C.T.	429.5	EMP	280.0	26.6	2.23	++	o	Pilot area
							Code: TZW-1,2,3,4,5,6,7,8,9,10,11,12									
TZ-2	Kastilia	b1	Tozeur	50	D.T.W	wells	3	C.T.	357.3	EMP			1.98			
							Code: TZW-64,65,66									
TZ-3	O. El Koucha	b1	Tozeur	62	D.T.W	well	1	C.T.	219.0	EMP	321.0	33.2	1.90			
							Code: TZW-67									
TZ-4	Neflayette	b1	Tozeur	72	D.T.W	wells	2	C.T.	378.0	EMP			2.30			
							Code: TZW-58,59									
TZ-5	Chemsa	b3	Tozeur	90	D.T.W	wells	2	C.T.	608.0	EMP	403.0	29.3	2.30	+		
							Code: TZW-56,57									
TZ-6	Helba Est	b3	Tozeur	75	D.T.W	wells	2	C.T.	378.5	EMP			1.92			
							Code: TZW-62,63									
TZ-7	Helba Ouest	b3	Tozeur	50	D.T.W	wells	2	C.T.	378.0	EMP			1.94			
							Code: TZW-60,61									
TZ-8	Jhim 1	e	Tozeur	40	D.T.W	well	1	C.T.	633.0	EMP			2.00	+		
							Code: TZW-38									
TZ-9	Jhim 2	b1	Tozeur	167	D.T.W	well	1	C.T.	671.0	EMP			2.20	+		
							Code: TZW-39									
TZ-10	Ibn Chabbat 3	e	Tozeur	325	D.T.W	reservoir	5	C.T.	682.0	EMP			3.00	+		
							Code: TZW-13,14,15,16,17									
TZ-11	Nefta	b1	Nefta	852	D.T.W	wells	14	C.I.+C.T.	652.3	EMP	355.0	29.9	2.94	+		
							Code: TZW-103,104,105,106,107,108, 109,110,111,112,113,114,115,116									
TZ-12	Ghardgaya	b3	Nefta	40	D.T.W	well	1	C.T.	440.0	EMP			2.30			
							Code: TZW-92									
TZ-13	Ibn Chabbat 1	e	Nefta	240	D.T.W	reservoir	5	C.T.	630.0	EMP			3.21			
							Code: TZW-24,25,26,27,28									

Code Num.	Oasis Name	Oasis Type	Region	Area (ha)	Water Resource	Applica-tion	Wells Nos.	Wells Aquifer	Wells Av.depth (m)	Wells Extract	Water Quality*1 E.C (m S/m)	Water Quality*1 Temp. (°C)	Water Quality*1 Salinity (g/l)	Gypsum Soil dist. *2	Gypsum Soil Survey	Note
TZ-14	Ibn Chabbat 2	c	Nefta	272	D.T.W	reservoir	6	C.T.	700.0	EMP			3.08			
							Code: TZW-18,19,20,21,22,23									
TZ-15	Draa Sud	c	Nefta	198	D.T.W	reservoir	3	C.T.	656.7	EMP	409.0	31.9	2.40	++	o	Pilot area
							Code: TZW-29,30,31									
TZ-16	Hazoua 1	c	Hazoua	72	D.T.W	wells	2	C.T.	566.5	EMP	364.0	31.0	2.76	++		
							Code: TZW-93,94									
TZ-17	Hazpua 2	c	Hazoua	48	D.T.W	well	1	C.T.	589.0	EMP			2.66	++		
							Code: TZW-95									
TZ-18	Hazoua 3	c	Hazoua	238	D.T.W	wells	6	C.T.	581.7	EMP	343.0	31.3	2.93	++		
							Code: TZW-96,97,98,99,100,101									
TZ-19	Oued Loghgrissi	c	Hazoua	78	D.T.W	well	1	C.T.	555.0	EMP			2.69	++		
							Code: TZW-102									
TZ-20	Tazrarit	c	Degache	48	D.T.W	reservoir	3	C.I.+C.T.	815.0	EMP			5.88			salinity sample is one
							Code: TZW-86,87,88									
TZ-21	Cedada	c	Degache	55	D.T.W	wells	2	C.I.+C.T.	?	EMP			1.94			
							Code: TZW-84,85									
TZ-22	Dghoumes	c	Degache	104	D.T.W	wells	3	C.T.	641.0	EMP			2.60			
							Code: TZW-89,90,91									
TZ-23	Degache	b1	Degache	822	D.T.W	wells	9	C.T.	214.7	EMP			1.65	+		
							Code: TZW-68,70,71,72,73,74,75,76,78									
TZ-24	Chakmou	b3	Degache	90	D.T.W	wells	2	C.T.	588.0	EMP			6.20	+		salinity sample is one
							Code: TZW-40,41									
TZ-25	El Hamma	b3	Degache	400	D.T.W	wells	5	C.T.	162.6	EMP			2.07	+		
							Code: TZW-42,43,44,45,46									
TZ-26	Tamerza	a	Tamerza	80	N. Spring	gravity	0	Tamerza	0.0	-	205.0	26.9	2.40			
							Code: TZW-121									

Code Num.	Oasis		Region	Area (ha)	Water Resource	Applica-tion	Wells				Water Quality*1			Gypsum Soil		Note
	Name	Type					Nos.	Aquifer	Av.depth (m)	Extract	E.C (m S/m)	Temp. (°C)	Salinity (g/l)	dist. *2	Survey	
TZ-27	Chebika	b3	Tamerza	23	N. Spring	gravity	0	Tamerza	0.0	-	358.0	27.8	2.50			
							Code: TZW-122									
TZ-28	Foum El Khanga	b3	Tamerza	48	River	gravity	0	Tamerza	0.0	-	283.0	23.4	2.20			
							Code: TZW-120									
TZ-29	Mides	a	Tamerza	29	Dug-well	Dug-wells	many	Tamerza	20.0	DEP	252.0	22.3	2.00			Shallow well + DEP
							Code: TZW-117									
TZ-30	Ain El Karma	a	Tamerza	25	Dug-well	Dug-wells	many	Tamerza	20.0	DEP	219.0	20.0	1.20			includes springs
							Code: TZW-118									
	Total			5,622			94									

EMP:Electric Motor Pump
DEP:Diesel Engine Pump

*1: EC & Temp. are measured by the Team.
*2: +;slightly, ++;commonly, +++;heavily

INVENTORY OF OASIS WATER RESOURCES - 3
KEBILI GOUVERNORAT

Code Num.	Oasis		Region	Area	Water Resource	Applica-tion	Wells				Water Quality*1			Gypsum Soil		Note
	Name	Type		(ha)			Nos.	Aquifer	Av.depth (m)	Extract	E.C (m S/m)	Temp. (°C)	Salinity (g/l)	dist. *2	Survey	
KB-1	Bechri	d	Souk Lahad	162	Pipe line supply		(3)	C.I.+C.T.	(1321.0)	EMP+art	485.0	66.0*	(2.81)	++		mixed hot/cold water other site
							Code: (KBW-121,122,123)									
KB-2	Bouabdallah	b1	Souk Lahad	270	D.T.W	reservoir	3	C.I.+C.T.	793.3	EMP+art	605.0	68.9*	3.12	++		mixed hot/cold water
							Code: KBW-125,126,127									
KB-3	Fatnassa	b1	Souk Lahad	205	D.T.W	well	(3)+1	C.I.+C.T.	(1321)+185	EMP+art			(2.81)	++		
							Code: KBW-120 + (121,122,123)									
KB-4	El Gliaa	b1	Souk Lahad	94	D.T.W	wells	2	C.T.	106.5	EMP+art	473.0	26.0	2.35	+++		
							Code: KBW-117,118									
KB-5	Menchia	b3	Souk Lahad	140	D.T.W	wells	2	C.I.	2405.0	art.	662.0	68.4	2.40	+++		cooling towers
							Code: KBW-169,170									
KB-6	Nagga	d	Souk Lahad	181	D.T.W	wells	7	C.T.	156.5	EMP+art	287.0	27.8	2.10	++		
							Code: KBW-103,104,105,106,107,108,10									
KB-7	Oum Somaa	d	Souk Lahad	162	D.T.W	reservoir	4	C.I.+C.T.	372.0	EMP+art			3.33	+++		mixed hot/cold water
							Code: KBW-112,113,115,116									
KB-8	Oued Zira	b1	Souk Lahad	176	D.T.W	wells	2	C.T.	136.0	EMP+art	436.0	26.1	3.05	+++		
							Code: KBW-110,111									
KB-9	Ouled Touati	b1	Souk Lahad	62	D.T.W	well	1	C.T.	86.0	EMP	442.0	25.9	2.90	++		
							Code: KBW-129									
KB-10	Tenchig	d	Souk Lahad	54	Pipe line supply		(6)	C.I.	(160.0)	art.			(1.93)	+		
							Code: (KBW-67,68,69,70,71,72)									from PIK
KB-11	Zaouiet El Anes	d	Souk Lahad	125	(D.T.W)	coop. well	(1)	C.I.	(2229)	art.	635.0	68.7	(2.30)	++		
							Code: (KBW-168)									
KB-12	Zaouiet El Harth	d	Souk Lahad	81	(D.T.W)	coop. well	(1)	C.I.	(2229)	art.	635.0	68.7	(2.30)	++		
							Code: (KBW-168)									
KB-13	Ziret Louhichi	d	Souk Lahad	86	D.T.W	well	1	C.T.	75.0	EMP	424.0	25.9	2.80	++		
							Code: KBW-128									

Code Num.	Oasis		Region	Area (ha)	Water Resource	Applica-tion	Wells				Water Quality*1			Gypsum Soil		Note
	Name	Type					Nos.	Aquifer	Av.depth (m)	Extract	E.C (m S/m)	Temp. (°C)	Salinity (g/l)	dist. *2	Survey	
KB-14	Chouchet Nagga	e	Souk Lahad	26	D.T.W	well	1	C.T.	99.0	EMP+art	287.0	27.5	2.20	+++		
							Code: KBW-119									
KB-15	Guataya	d	Kebili Nord	150	D.T.W	wells	4	C.T.	151.3	EMP+art	267.0	26.5	2.01	+++	o	
							Code: KBW-55,56,57,58									
KB-16	Jedida	b1	Kebili Nord	133	D.T.W	reservoir	(3)	C.I.+C.T.	(1659)	EMP+art			(2.77)	+		same to Mansoura
							Code: (KBW-74,75,76)									
KB-17	Mansoura	b1	Kebili Nord	86	D.T.W	reservoir	(3)	C.I.+C.T.	(1659)	EMP+art			(2.77)	+		same to Jedida
							Code: (KBW-74,75,76)									
KB-18	Rabta	b1	Kebili Nord	162	D.T.W	wells	2	C.T.	92.0	EMP+art	357.0	27.0	2.08	+		
							Code: KBW-65,66									
KB-19	Telmine	b1	Kebili Nord	240	D.T.W	wells	4	C.T.	127.5	EMP+art	352.0	24.8	1.93	+		
							Code: KBW-59,60,61,62									
KB-20	Tembib	b1	Kebili Nord	118	D.T.W	well	1	C.T.	84.0	art	289.0	28.7	2.10	+		
							Code: KBW-73									
KB-21	Tombar	b1	Kebili Nord	127	D.T.W	wells	2	C.T.	93.0	EMP	290.0	26.9	2.53	+		
							Code: KBW-63,64									
KB-22	Limaguess	e	Kebili Nord	57	D.T.W	well	1	C.I.	1752.0	art	641.0	66.3	2.32	+		
							Code: KBW-174									
KB-23	Mazraa Neji	e	Kebili Nord	66	D.T.W	well	1	C.T.	652.0	EMP				+	o	
							Code: KBW-179									
KB-24	Oum El Farth	e	Kebili Nord	55	D.T.W	wells	3	C.I.+C.T.	1009.2	EMP+art	662.0	64.5*	2.66	+		
							Code: KBW-175,176,177									
KB-25	Stiftimi	e	Kebili Nord	82	D.T.W	wells	3	C.I.+C.T.	1014.7	art	595.0	44.7	3.15	+		
							Code: KBW-171,172,173									
KB-26	Saidane	e	Kebili Nord	30	D.T.W	well	1	C.I.	800.0	art	622.0	54.2	2.94	+++		
							Code: KBW-178									
KB-27	Barghouthia	d	Kebili Sud	52	D.T.W	wells	2	C.T.	231.0	EMP+art	247.0	24.4	1.95	+		
							Code: KBW-1,2									

Code Num.	Oasis		Region	Area (ha)	Water Resource	Applica-tion	Wells				Water Quality*1			Gypsum Soil		Note
	Name	Type					Nos.	Aquifer	Av.depth (m)	Extract	E.C (m S/m)	Temp. (℃)	Salinity (g/l)	dist. *2	Survey	
KB-28	Bazma	d	Kebili Sud	146	D.T.W.	wells	2	C.T.	209.5	EMP+art			2.50	+		
							Code: KBW-19,20									
KB-29	B'chelli	d	Kebili Sud	135	D.T.W.	well	1	C.T.	143.0	EMP+art	223.0	23.6	1.80	+		
							Code: KBW-50									
KB-30	Blidette	d	Kebili Sud	75	D.T.W.	wells	2	C.T.	198.0	EMP+art	268.0	25.5	2.22	+		
							Code: KBW-33,34									
KB-31	Zarcine	d	Kebili Sud	70	D.T.W.	wells	3	C.T.	196.3	EMP+art	260.0	24.7	1.72	+		
							Code: KBW-35,36,37									
KB-32	Jemna	d	Kebili Sud	112	D.T.W.	reservoir	(2)+2	C.I.+C.T.	(2481)+134	EMP+art	586.0	(43.8)*1	(2.69)	+		same to Mtouria
							Code: KBW-3,4 + (5,6)									
KB-33	Mtouria	d	Kebili Sud	81	D.T.W.	reservoir	(2)	C.I.	(2418)	art	586.0	(43.8)*1	(2.69)	+		same to Jemna
							Code: (KBW-5,6)									
KB-34	Msaid	d	Kebili Sud	95	D.T.W.	well	1	C.T.	171.0	EMP+art			1.58	+		
							Code: KBW-45									
KB-35	Rahmat	d	Kebili Sud	85	D.T.W.	wells	3	C.T.	191.3	EMP+art	230	24.2	1.82	+++		
							Code: KBW-42,43,44									
KB-36	Ras El Ain	d	Kebili Sud	268	D.T.W.	wells	(1)+6	C.T.	(2580)+158.7	EMP+art	293	25.0	2.36	++	o	
							Code: KBW-21,22,23,24,25,26 + (27)									
KB-37	Souk El Baiez	d	Kebili Sud	65	D.T.W.	wells	2	C.T.	83.0	EMP+art	553	22.9	3.25	+		
							Code: 53,54									
KB-38	Ben Zitoun 1 et 2	e	Kebili Sud	147	D.T.W.	wells	(1)+4	C.T.	(2580)+199.5	EMP+art	255	25.0	1.75	+		
							Code: KBW-28,29,30,31 + (27)									
KB-39	Bourzine	e	Kebili Sud	94	D.T.W.	well	1	C.T.	102.0	EMP	197	23.7	1.50	+		
							Code: KBW-41									
KB-40	Gueliada	e	Kebili Sud	103	D.T.W.	well	1	C.T.	147.0	EMP+art	254	24.8	1.84	+		
							Code: KBW-32									
KB-41	Kelwamen	e	Kebili Sud	47	D.T.W.	well	1	C.T.	205.0	EMP+art			1.78	+		
							Code: KBW-40									

Code Num.	Oasis		Region	Area (ha)	Water Resource	Applica-tion	Wells				Water Quality*1			Gypsum Soil		Note
	Name	Type					Nos.	Aquifer	Av.depth (m)	Extract	E.C (m S/m)	Temp. (°C)	Salinity (g/l)	dist. *2	Survey	
KB-42	Klibia	e	Kebili Sud	92	D.T.W.	wells	2	C.T.	168.0	EMP+art	250	24.8	1.66	+		
							Code: 38,39									
KB-43	Sidi Hamed	e	Kebili Sud	100	D.T.W.	well	1	C.T.	87.0	EMP+art			1.60	+		
							Code: KBW-51									
KB-44	Atilet	e	Kebili Sud	220	D.T.W.	reservoir	3	C.T.	100.3	EMP	395	22.7	1.47	+		
							Code: KBW-46,47,49									
KB-45	Douz	d	Douz	280	D.T.W.	reservoir	6	C.I.+C.T.	776.7	EMP+art	418	22.0	2.67	+++		mixed hot/cold water
							Code: KBW-93,94,95,96,97,98									
KB-46	El Ghoula	d	Douz	75	D.T.W.	well	1	C.T.	150.0	EMP+art			1.10	+		
							Code: KBW-102									
KB-47	El Golaa	d	Douz	65	D.T.W.	well	1	C.T.	150.0	EMP+art	284	22.7	1.46	+		
							Code: KBW-83									
KB-48	Grad	d	Douz	111	D.T.W.	wells	1	C.T.	140.0	EMP+art			1.60	+		
							Code: KBW-79									
KB-49	El H'say	d	Douz	90	D.T.W.	wells	2	C.T.	180.0	EMP	701	22.6	3.00	+++		
							Code: KBW-84,85									
KB-50	Nouiel	d	Douz	97	D.T.W.	wells	2	C.T.	165.0	EMP+art	248	25.3	1.71	+		
							Code: KBW-77,78									
KB-51	Zaafrane	d	Douz	101	D.T.W.	wells	4	C.T.	118.0	art	156	23.2	1.54	+		
							Code: KBW-86,87,88,89									
KB-52	Bouhamza	e	Douz	80	D.T.W.	well	1	C.T.	60.0	EMP+art	412	22.9	2.30	+		
							Code: KBW-99									
KB-53	Ksar Ghilane	e	Douz	100	D.T.W.	wells	2	C.I.	680.0	art	625	34.4	4.46	+		
							Code: KBW-181,182									
KB-54	Sakkouma	e	Douz	80	D.T.W.	well	1	C.T.	156.0	EMP+art	210	23.0	1.10	+		
							Code: KBW-92									
KB-55	Tarfaya	e	Douz	77	D.T.W.	wells	2	C.T.	129.5	EMP+art	316	22.8	1.55	+		
							Code: KBW-100,101									

Code Num.	Oasis		Region	Area	Water Resource	Applica-tion	Wells				Water Quality*1			Gypsum Soil		Note
	Name	Type		(ha)			Nos.	Aquifer	Av.depth (m)	Extract	E.C (m S/m)	Temp. (℃)	Salinity (g/l)	dist. *2	Survey	
KB-56	Dhomrana	e	Douz	45	D.T.W.	well	1	C.T.	200.0	EMP			1.70	+++		
							Code: KBW-90									
KB-57	Smida	e	Douz	64	D.T.W.	well	1	C.T.	100.0	EMP+art	174	22.8	1.20	+++		
							Code: KBW-91									
KB-58	Ghidma	d	Faouar	80	D.T.W.	wells	3	C.T.	153.0	EMP+art			1.77	+		
							Code: KBW-138,139,140									
KB-59	Sabria	d	Faouar	60	D.T.W.	wells	2	C.T.	174.5	EMP+art	200	24.6	1.50	+		
							Code: KBW-141,142									
KB-60	El Faouar 1	e	Faouar	87	D.T.W.	reservoir	(1)+3	C.T.+C.T.	(1894)+177	EMP+art	211	26.0	1.73	+		mix with hot water
							Code: KBW-143,144,145 + (147)									
KB-61	El Faouar 2	e	Faouar	80	D.T.W.	reservoir	(1)+1	C.T.+C.T.	(1894)+172	EMP+art			1.90	+		mix with hot water
							Code: KBW-146 + (147)									
KB-62	Bechni	e	Faouar	100	D.T.W.	well	1	C.T.	199.0	EMP+art	264	25.0	1.98	+		
							Code: KBW-136									
KB-63	Dargine	e	Faouar	72	D.T.W.	well	1	C.T.	200.0	EMP+art	225	22.7	1.70	+		
							Code: KBW-137									
KB-64	Matrouha	e	Faouar	100	D.T.W.	wells	2	Miocene	288.0	art	391	26.7	3.30	+		
							Code: KBW-131,132									
KB-65	Regim Maatoug 1	e	Faouar	104	D.T.W.	wells	(1)+1	Miocene	(230)+225	EMP+art			2.00	+++		
							Code: KBW-134 + (135)									
KB-66	Regim Maatoug 2	e	Faouar	96	D.T.W.	wells	(1)+1	Miocene	(230)+236	art			2.20	+++	o	
							Code: KBW-133 + (135)									
KB-67	Tarfayet Elma	e	Faouar	52	D.T.W.	well	1	C.T.	250.0	EMP+art	215	25.1	1.38	+		
							Code: KBW-130									
	Total			7,213			142									

EMP:Electric Motor Pump
DEP:Diesel Engine Pump

*1: EC &.Temp. are measured by the Team.
*2: +;slightly, ++;commonly, +++;heavily

INVENTORY OF OASIS WATER RESOURCES - 4
GABES GOUVERNORAT

Code Num.	Oasis		Region	Area (ha)	Water Resource	Applica-tion	Wells				Water Quality*1			Gypsum Soil		Note
	Name	Type					Nos.	Aquifer	Av.depth (m)	Extract	E.C (m S/m)	Temp. (°C)	Salinity (g/l)	dist. *2	Survey	
GB-1	Ain Zrig	b2	Gabes est	140	D.T.W	wells	2	Djeffara	309.0	art.			2.96			
							Code: GBW-1,2									
GB-2	Temoula 1	e	Gabes est	40	D.T.W	well	1	Djeffara	238.0	EMP+art			2.72			
							Code: GBW-3									
GB-3	Temoula 2	e	Gabes est	20	D.T.W	well	1	Djeffara	240.0	EMP+art			2.64			
							Code: GBW-4									
GB-4	Zrig Dakhlania	b3	Gabes est	30	D.T.W	well	1	Djeffara	324.0	EMP+art			3.20			
							Code: GBW-5									
GB-5	Teboulbou	b2	Gabes est	520	D.T.W	wells	6	Djeffara	163.5	EMP+art			2.71	+		
							Code: GBW-6,7,8,9,10,11									
GB-6	Oasis de Gabes	b2	Gabes ouest	734	D.T.W	wells	7	Djeffara	169.9	EMP+art	409	29.3	2.96	+	o	
							Code: GBW-12,13,14,15,16,17,18									
GB-7	Limaoua 1 et 2	b3	Gabes ouest	148	D.T.W	wells	2	Djeffara	140.0	EMP			2.64			each 1 well
							Code: GBW-19,20									
GB-8	M'dou	b2	Gabes ouest	40	D.T.W	well	1	Djeffara	300.0	EMP	343	23.9	2.44			
							Code: GBW-21									
GB-9	Chott El Ferik	b2	Gabes ouest	31	D.T.W	well	1	Djeffara	150.0	EMP+art			2.72			
							Code: GBW-22									
GB-10	Bouchamma	b2	Gabes ouest	143	D.T.W	wells	2	Djeffara	185.5	EMP	430	29.3	3.59			
							Code: GBW-24,25									
GB-11	Mahjoub	b2	Ghannouch	374	D.T.W	wells	3	Djeffara	121.7	EMP+art	437	28.1	3.25			
							Code: GBW-26,27,28									
GB-12	Salem	b2	Ghannouch	99	D.T.W	well	1	Djeffara	130.0	EMP	432	28.3	3.12			
							Code: GBW-29									
GB-13	Sboui	b2	Ghannouch	72	D.T.W	well	1	Djeffara	105.0	EMP+art			3.08			
							Code: GBW-30									

Code Num.	Oasis		Region	Area (ha)	Water Resource	Applica-tion	Wells				Water Quality *1			Gypsum Soil		Note
	Name	Type					Nos.	Aquifer	Av.depth (m)	Extract	E.C (m S/m)	Temp. (°C)	Salinity (g/l)	dist. *2	Survey	
GB-14	Faycal	b2	Ghannouch	260	D.T.W	wells	3	Djeffara	135.7	EMP+art	426	28.2	3.08			
							Code: GBW-31,32,33									
GB-15	M'ziraa Ghannouch	e	Ghannouch	280	D.T.W	wells	2	Djeffara		EMP+art			3.66			
							Code: GBW-34,35									
GB-16	Metouia	b2	Metouia	268	D.T.W	wells	4	Djeffara	93.5	EMP	438	24.0	3.51	++	o	
							Code: GBW-36,37,38,39									
GB-17	Ouedhref	b2	Metouia	263	D.T.W	wells	3	Djeffara	81.7	EMP	408	22.6	3.27	++		
							Code: 40,41,42									
GB-18	Aouinette	e	Metouia	232	D.T.W	wells	2	Djeffara	106.5	EMP+art	542	24.2	3.35	+++	o	
							Code: GBW-43,44									
GB-19	Chenchou 1	b1	El Hamma	57	D.T.W	well	1	C.T.	53.0	EMP	604	(41.6)	3.08			Temp. is not exact.
							Code: GBW-46									
GB-20	Chenchou 2	e	El Hamma	40	D.T.W	well	1	C.T.	90.0	EMP			4.46			
							Code: GBW-47									
GB-21	Tekouri	b1	El Hamma	32	D.T.W	well	1	C.T.	45.0	EMP	624	38.6	3.66			
							Code: GBW-48									
GB-22	Hamma Oasis	b1	El Hamma	400	D.T.W	wells	3	C.T.	118.3	EMP	685	38.6	3.67	+		
							Code: GBW-49,50,51									
GB-23	Mziraa Hamma	b1	El Hamma	80	D.T.W	well	1	C.T.		EMP	468	29.6	3.28			
							Code: GBW-52									
GB-24	Bechima 1	b1	El Hamma	280	D.T.W	wells	3	C.T.	500.0	EMP+DEP	681	65.7	3.33			
							Code: GBW-53,54,55									
GB-25	Bechima 2	b1	El Hamma	290	D.T.W	well	1	C.I.	860.0	art.	484	(63.8)	3.03			Temp. is not exact.
							Code: GBW-56									
GB-26	Khebayet	b1	El Hamma	96	D.T.W	well	1	C.I.	866.0	art.	633	(63.5)	2.72			Temp. is not exact.
							Code: GBW-57									
GB-27	Ben Ghilouf	b3	El Hamma	180	D.T.W	well	1	C.I.	1,100	art.	517	68.2	2.72			
							Code: GBW-58									

Code Num.	Oasis		Region	Area (ha)	Water Resource	Applica-tion	Wells				Water Quality*1			Gypsum Soil		Note
	Name	Type					Nos.	Aquifer	Av.depth (m)	Extract	E.C (m S/m)	Temp. (°C)	Salinity (g/l)	dist. *2	Survey	
GB-28	Glib Doukhane	b1	El Hamma	70	D.T.W	well	1	C.I.	1,324	art.	245	66.1	2.80			
							Code: GBW-59									
GB-29	Oued Nakhla	b3	El Hamma	30	D.T.W	well	1	C.I.	450.0	EMP+art	541	33.5	4.52			
							Code: GBW-60									
GB-30	Arram	b2	Mareth	163	D.T.W	wells	2	C.T.	614.0	EMP+art	350	27.2	2.53			
							Code: GBW-70,71									
GB-31	Mareth 1	b2	Mareth	100	D.T.W	well	1	C.T.	250.0	EMP			2.54			
							Code: GBW-72									
GB-32	Mareth 2	b2	Mareth	180	D.T.W	wells	2	C.T.	354.5	EMP+art	360	31.7	2.55			
							Code: GBW-73,74									
GB-33	Mareth 3	b2	Mareth	30	D.T.W	well	1	C.T.	268.0	EMP	278	23.1	2.56			
							Code: GBW-75									
GB-34	Mareth 5	b2	Mareth	115	D.T.W	well	1	C.T.	278.0	EMP+art			2.58			
							Code: GBW-76									
GB-35	Mareth 6	b2	Mareth	88	D.T.W	well	1	C.T.	611.0	EMP			2.68			
							Code: GBW-77									
GB-36	Zarat 2	b2	Mareth	174	D.T.W	wells	2	C.T.	429.5	art.			2.58			
							Code: GBW-78,79									
GB-37	Zerkine1 et 3	b2	Mareth	116	D.T.W	well	1	C.T.	231.0	EMP+art			2.72			
							Code: GBW-80									
GB-38	Zerkine 2	b2	Mareth	156	D.T.W	wells	2	C.T.	262.0	EMP+art	323	24.5	2.50			
							Code: GBW-81,82									
GB-39	Ayoun Zerkine	b2	Mareth	30	D.T.W	well	1	C.T.	154.0	EMP			2.64			
							Code: GBW-83									
GB-40	Madssia	b2	Mareth	58	D.T.W	well	1	C.T.	188.0	EMP+art	238	26.7	2.50			
							Code: GBW-84									
GB-41	Kettana 1	b2	Mareth	98	D.T.W	well	1	C.T.	262.0	EMP+art			2.60			
							Code: GBW-86									

Code Num.	Oasis		Region	Area (ha)	Water Resource	Applica-tion	Wells				Water Quality*1			Gypsum Soil		Note
	Name	Type					Nos.	Aquifer	Av.depth (m)	Extract	E.C (m S/m)	Temp. (°C)	Salinity (g/l)	dist. *2	Survey	
GB-42	Kettana 3	b2	Mareth	140	D.T.W	wells	2	C.T.	220.5	art.	333	25.3	2.66			
							Code: GBW-87,88									
GB-43	Kettana 4	b2	Mareth	125	D.T.W	wells	2	C.T.	271.5	EMP+art	340	25.2	2.64			
							Code: GBW-89,90									
GB-44	Sidi Sellam	e	Mareth	120	D.T.W	well	1	C.T.	271.0	DEP+art	335	25.5	2.54			
							Code: GBW-91									
GB-45	Zrig Barrania	b2	Mareth	71	D.T.W	well	1	C.T.	257.0	EMP+art			2.66			
							Code: GBW-92									
GB-46	Ghandri	e	Mareth	30	D.T.W	well	1	C.T.	187.0	DEP			2.90			
							Code: GBW-93									
GB-47	Laaradh 1	e	Matmata	35	D.T.W	well	1	C.T.	228.0	EMP	268	18.8	3.18			
							Code: GBW-94									
GB-48	Laaradh 3	e	Matmata	55	D.T.W	well	1	C.T.	169.0	EMP	408	26.3	3.18			
							Code: GBW-95									
	Total			7,133			83									

Djeffara:Shallow C.T., but sourced by C.I.

EMP:Electric Motor Pump

DEP:Diesel Engine Pump

*1: EC & Temp. are measured by the Team.

*2: +;slightly, ++;commonly, +++;heavily

3.3. Well Inventory

The following pages are "Well Inventory" for all four Provinces, in the order of Gafsa, Tozeur, Kebili, and Gabes.

WELL INVENTORY - 1 (GAFSA)

Well Code	Name of Well	Num. IRH	No.	Name of Oasis	LOCATION: Latitude (N) deg	min	sec	Longitude (E) deg	min.	sec.	French System (G) (N)	(E)	TOPO-SHEET: Sheet Num	Elevation (m)	WELL DRILLING: Depth (m)	Aquifer Type	S.W.L (m)	Yield (l/s)	Drilled (year)	DELIVERY: Type of extract	Delivery System	Volume (m3/year)	Water Quality - Measured by Team - E.C (mS/m)	Salinity (%)	Temp. (°C)	Salinity (g/l)	Others (y/n)	Note
GFW- 1	Regouba P-K	-1957015	0	(Gafsa)	34	26	07.1	8	49	15.7	38.26271	7.20754	66	325	470	71521	23.7	30	1987	EMP	Res.	-	(mS/m)	(%)	(°C)	2.50	n	Piezometric Well
GFW- 2	Regouba P-6	206610143		Kasba	34	26	08.9	8	49	00.7	38.26265	7.20291	66	325	480	71521	20.9	15	1987	EMP	Res.	125,403				2.62	n	Mixed with all wells
GFW- 3	Regouba P-7	206610144		Sud Ouest	34	25	50.7	8	49	52.8	38.25765	7.21899	66	322	625	71521	20.7	70	1987	EMP	Res.	1,338,372				2.68	n	excepting P-6
GFW- 4	Regouba P-5	206610132		El Ksar	34	25	40.2	8	49	28.1	38.25441	7.21137	66	320	487	71521	18.3	70	1987	EMP	Res.	663,912				2.04	n	
GFW- 5	Regouba P-4	206610131			34	25	43.2	8	49	01.5	38.25533	7.20316	66	320	461	71521	18.1	70	1987	EMP	Res.	1,113,336	216	0.10	30.5	1.98	n	mixed water
GFW- 6	Regouba P-3	206610129			34	25	27.1	8	48	52.5	38.25036	7.20038	66	318	358	71521	14.0	70	1987	EMP	Res.	1,322,244				1.92	n	
GFW- 7	Regouba P-9	206610141			34	25	44.8	8	48	27.8	38.25593	7.19276	66	318	230	71521	18.4	70	1987	EMP	Res.	1,241,100				1.84	n	
GFW- 8	Regouba P-2	206610126			34	25	03.8	8	48	35.9	38.24317	7.19526	66	310	232	71521	11.6	70	1987	EMP	Res.	1,416,744				1.84	n	
GFW- 9	Regouba P-1	206610125			34	24	50.5	8	48	24.2	38.23907	7.19165	66	306	338	71521	12.0	70	1986	EMP	Res.	1,043,532				1.70	n	
GFW- 10	Regouba P-11	206610152			34	24	44.8	8	48	04.8	38.23731	7.18566	66	303	212	71521	11.7	70	1993	EMP	Res.	381,780				1.10	n	
GFW- 11	Regouba 2 bis	206610022			34	24	34.2	8	48	13.1	38.23404	7.18822	66	303	287	71521	14.0	80	1980	EMP	Res.	1,393,560				1.80	n	
GFW- 12	Regouba P-10	206610150			34	24	37.3	8	48	06.4	38.23499	7.18616	66	302	282	71521	15.2	70	1992	EMP	Res.	1,181,124				1.85	n	
GFW- 13	G.S.R. 3	206610120	GF-1	Kasba	34	24	33.9	8	45	53.6	38.22094	7.14517	66	265	170	73221	28.3	30	1987	EMP	E.T.	377,676	284	0.14	24.8	2.44	n	
GFW- 14	G.S.R. 6	206610134			34	24	21.3	8	46	03.2	38.23005	7.14813	66	268	152	73221	30.0	57	1987	EMP	E.T.	374,544				3.22	n	
GFW- 15	G.R.N. 1	206610130			34	25	41.9	8	48	04.2	38.25493	7.18548	66	313	59	71521	4.0	70	1987	EMP	E.T.	1,428,036				1.42	n	
GFW- 16	Deouly 2	206610149			34	25	20.4	8	48	05.1	38.24830	7.18575	66	310	174	71521	6.1	40	1992	EMP	E.T.	572,400				1.50	n	
GFW- 17	G.S.R. 5	206610127	GF-2	Sud Ouest	34	23	42.9	8	45	24.3	38.21820	7.13612	66	255	151	73221	19.8	70	1987	EMP	E.T.	771,984				2.72	n	
GFW- 18	G.S.R. 2	206610060			34	24	05.0	8	45	13.0	38.22502	7.13264	66	256	177	73221	25.0	40	1986	EMP	E.T.	617,904				2.66	n	
GFW- 19	G.S.R. 1	206610059			34	24	39.8	8	44	41.8	38.23576	7.12301	66	252	176	73221	24.8	40	1986	EMP	E.T.	182,326				3.00	n	
GFW- 20	G.S.R. 4	206610128	GF-5	El Ksar	34	24	10.7	8	47	02.9	38.22678	7.16636	66	280	187	73221	36.9	30	1987	EMP	E.T.	468,396	241	0.12	24.1	2.08	n	
GFW- 21	Bouhabib (SE 367)	206610012			34	23	50.8	8	46	17.5	38.22064	7.15254	66	270	251	73221	22.7	50	1972	EMP	E.T.	611,712	244	0.13	22.9	2.16	n	non list
GFW- 22	Mnagaa	206610018			34	25	05.0	8	47	18.4	38.24354	7.17134	66	300	319	71521	1.6	70	1964	EMP	E.T.	806,544	160	0.08	26.4	1.16	n	
GFW- 23	G.N.R. 2	-		-	34	24	40.1	8	47	35.4	38.23586	7.17659	66	293	214	-	30.0	70	1987	-	-	-	-	-	-	2.50	n	abandoned
GFW- 24	Lalla P-3	206610122	GF-4	Lalla	34	24	02.1	8	49	56.4	38.22413	7.22011	66	300	599	71521	13.0	60	1987	EMP	Res.	831,600				1.86	n	
GFW- 25	Lalla P-4	206610146			34	24	27.2	8	50	06.9	38.23188	7.22335	66	300	700	71521	0.7	40	1987	EMP	Res.	284,544	285	0.12	32.7	3.60	n	mixed water
GFW- 26	Lalla P-2 bis	206610137			34	23	55.1	8	49	53.3	38.22197	7.21915	66	300	521	71521	2.7	70	1987	EMP	Res.	1,437,408				3.00	n	(4 other wells exist)
GFW- 27	El Gallaa 2	206710027	GF-3	El Guettar	34	19	58.2	8	58	01.5	38.14884	7.36983	67	250		73111				EMP	Res.	1,202,040	330	0.16	25.6	3.40	n	mixed water
GFW- 28	El Galaa 1	206710002			34	19	59.5	8	57	58.1	38.14925	7.36878	67	252	126	73111	39.6	60	1987	EMP	Res.	711,216				2.96	n	
GFW- 29	Lortess AIC	206610005			34	20	51.1	8	54	25.2	38.16517	7.30307	66	250	65	73111	33.0	60	1982	EMP	Res.	1,137,456				1.60	n	
GFW- 30	Lortess 6	206610023			34	20	48.2	8	54	16.8	38.16428	7.30048	66	255	78	73111	38.2	70	1987	EMP	Res.	806,148	333	0.17	24.7	2.05	n	mixed water
GFW- 31	O. Shilli	207110148	GF-7	Oued Shilli	34	11	35.6	8	12	19.6	37.993711	6.52357	71	36	858	74314	2.0	50	1989	EMP	Direct	927,720	610	0.27	34.8	3.85	y	
GFW- 32	Segdoud CT 3	206510041	GF-8	Segdoud	34	16	08.4	8	05	27.0	38.07791	6.39622	65	36	984	74314	8.0	40	1993	EMP	Res.	772,200	609	0.27	38.9	4.01	n	mixed water
GFW- 33	Segdoud CT 4	-			34	15	55.5	8	05	30.6	38.07393	6.39734	65	35		74314	-	-	-	-	-	-				3.50	n	not yet used
GFW- 34	Segdoud CT 2	206510031			34	16	16.4	8	04	52.3	38.08038	6.38552	65	33	1,305	74314	20.0	60	1986	EMP	Res.	692,280				4.62	n	
GFW- 35	Segdoud CT 1	206510030			34	16	20.1	8	05	53.7	38.08152	6.40447	65	42	1,986	74314	3.1	50	1986	EMP	Res.	701,280	597	0.29	28.8	4.60	n	
GFW- 36	Krichet Nsan3	1928015	GF-7	Thelja	34	19	19.5	8	18	57.7	38.13690	6.64644	65	180	300	74314	121.0	11	1985	EMP	E.T.		434	0.24	22.2	1.40	n	
GFW- 37	Krichet Nsan 4	1991315			34	19	15.9	8	18	42.8	38.13579	6.64215	65	175	300	74314	117.0	14	1993	EMP	E.T.	44,361				3.00	n	

WELL INVENTORY - 2 (TOZEUR)

Well Code	Name of Well	Num. IRH	No	Name of Oasis	LOCATION: Latitude (N) deg	mn	sec	Longitude (E) deg	mn	sec	French System (G) (N)	(E)	TOPO-SHEET: Sheet Num	Elevation (m)	WELL DRILLING: Depth (m)	Aquifer Type	S.W.L (m)	Yield (l/s)	Drilled (year)	DELIVERY: Type of extract	Delivery System	Volume (m3/year)	Water Quality - Measured by Team - E.C. (mS/m)	Salinity (%)	Temp. (°C)	Salinity (g/l)	Others (V/n)	Note
TZW- 1	Tozeur 5	207910038	TZ-1	Tozeur	33	54	43.0	8	07	25.4	37.68115	6.43277	79	55	202	74311	11.0	84	79	EMP	E.T.	2,032,430				2.02	n	
TZW- 2	Tozeur 6	207910039			33	54	42.8	8	07	42.8	37.68109	6.43814	79	50	330	74311	10.0	83	74	EMP	E.T.	501,088				1.86	n	
TZW- 3	Tozeur 7 bis	207910042			33	54	54.5	8	07	53.9	37.68470	6.44156	79	52	397	74311	11.9	10	79	EMP	E.T.	1,296				1.94	n	
TZW- 4	Tozeur 7 ter	207910117			33	54	54.5	8	07	53.9	37.68470	6.44156	79	52		74311	5.8	67	92	EMP	E.T.	1,432,969				2.00	n	
TZW- 5	Tozeur 4 bis	207910101			33	54	22.0	8	07	41.5	37.67467	6.43774	79	50	585	74311	4.0	58	88	EMP	E.T.	1,238,393				2.20	n	
TZW- 6	Brulifa	207910034			33	53	48.4	8	08	02.8	37.66430	6.44431	79	35	652	74311	9.0	58	85	EMP	E.T.	1,401,466				2.32	n	
TZW- 7	Touareg	207910097			33	54	23.7	8	08	47.9	37.67520	6.45823	79	35	653	74311	-3.0	46	87	EMP	E.T.	1,163,174	261	0.13	22.9	2.10	y	Pilot area
TZW- 8	Tozeur 8	207910043			33	54	44.5	8	08	12.6	37.68162	6.44734	79	45	415	74311	-8.0	63	76	EMP	E.T.	1,678,547	300	0.15	30.4	2.10	n	
TZW- 9	El Berka	207910098			33	55	10.1	8	08	57.2	37.68952	6.46110	79	38	636	74311	13.0	61	88	EMP	E.T.	1,319,576				2.40	n	
TZW- 10	Tozeur 12	207810111			33	55	35.1	8	09	11.4	37.69723	6.46548	79	40			3.0	26	92	EMP	E.T.					2.60	n	
TZW- 11	Tozeur 2	207910035			33	54	24.7	8	06	48.1	37.67550	6.42126	79	70	178	74311	13.0	66	81	EMP	E.T.	1,853,280				2.62	n	
TZW- 12	Tozeur 3	207910037			33	54	28.1	8	07	03.9	37.67655	6.42613	79	65	247	74311	15.0	69	81	EMP	E.T.	1,777,550				2.78	n	
TZW- 13	Ibn Chabbat 15	207910073	TZ-10	Ibn Chabbat 3	33	56	45.6	8	00	54.4	37.71900	6.31209	79	46	707	74311	-12.0	46	84	EMP	Res.	841,248				2.96	n	
TZW- 14	Ibn Chabbat 14	207910103			33	56	23.0	8	01	43.1	37.71202	6.32712	79	58		74311	-25.0	46	84	EMP	Res.	1,069,610				2.80	n	
TZW- 15	Ibn Chabbat 13	207910074			33	56	21.2	8	01	24.1	37.71146	6.32126	79	60	624	74311	-28.0	54	83	EMP	Res.	1,269,432				3.04	n	
TZW- 16	Ibn Chabbat 12	207910102			33	56	14.0	8	01	01.4	37.70924	6.31425	79	68	700	74311	-28.0	50	80	EMP	Res.	1,185,480				3.02	n	
TZW- 17	Ibn Chabbat 11 b	207910091			33	56	09.4	8	00	31.1	37.70782	6.30490	79	70	700	74311	-36.0	48	86	EMP	Res.	1,080,000				3.00	n	
TZW- 18	Ibn Chabbat 10 b		TZ-14	Ibn Chabbat 2	33	56	03.1	8	00	05.6	37.70588	6.29703	79	70	700	74311	-25.0	53	81	EMP	Res.					3.08	n	
TZW- 19	Ibn Chabbat 9	207910030			33	55	58.2	7	59	34.7	37.70436	6.28749	79	72	700	74311	-39.5	42	82	EMP	Res.	930,938				3.12	n	
TZW- 20	Ibn Chabbat 8	207910029			33	55	54.2	7	59	05.1	37.70313	6.27836	79	72	700	74311	41.0	55	81	EMP	Res.	1,169,982				3.10	n	
TZW- 21	Ibn Chabbat 7	207910091			33	55	47.7	7	58	40.4	37.70112	6.27073	79	74	700	74311	29.0	34	82	EMP	Res.	1,422,346				3.06	n	
TZW- 22	Ibn Chabbat 6 b	207910028			33	55	42.5	7	58	19.7	37.69952	6.26434	79	75	708	74311	-29.0	56	82	EMP	Res.	1,274,515				3.06	n	
TZW- 23	Ibn Chabbat 5 b	207910104			33	55	44.9	7	57	51.6	37.70026	6.25567	79	68	700	74311	29.0	47	89	EMP	Res.	1,137,701				3.00	n	
TZW- 24	Ibn Chabbat 4	207910026	TZ-13	Ibn Chabbat 1	33	55	42.6	7	57	33.9	37.69955	6.25021	79	70	633	74311	25.0	20	80	EMP	Res.	477,216				3.08	n	
TZW- 25	Ibn Chabbat 3 b	207910023			33	55	38.4	7	56	48.6	37.69764	6.23623	79	67	610	74311			79	EMP	Res.					3.14	n	
TZW- 26	Ibn Chabbat 2	207910024			33	55	38.1	7	56	14.8	37.69754	6.22579	79	65	641	74311	-25.0	38	81	EMP	Res.	882,497				3.30	n	
TZW- 27	Ibn Chabbat 1	207910022			33	55	29.7	7	55	23.9	37.69557	6.21008	79	60	640	74311	-12.0	44	78	EMP	Res.	1,019,621				3.30	n	
TZW- 28	Ibn Chabbat 1 b	207910092			33	55	24.2	7	57	05.7	37.69387	6.24150	79	80	625	74311	39.0	47	87	EMP	Res.	970,700				3.20	n	
TZW- 29	Mrau Lahouar 5	207910077	TZ-15	Draa Sud	33	52	14.8	7	59	43.6	37.63541	6.29024	79	65	650	74311	-9.0	55	85	EMP	Res.	1,205,622				2.40	n	Pilot area
TZW- 30	Mrau Lahouar 3	207910075			33	51	51.6	7	59	53.7	37.62825	6.29336	79	43	670	74311	8.0	41	85	EMP	Res.	872,759	409	0.18	31.9	2.40	n	(mixed these 3)
TZW- 31	Mrau Lahouar 4	207916076			33	51	50.0	7	59	26.3	37.62775	6.28690	79	46	650	74311	11.0	45	85	EMP	Res.	967,626				2.20	n	
TZW- 32	Mrau Lahouar 2 b	207910089		(Mrau Lahouar)	33	51	55.0	8	00	30.4	37.62930	6.30468	79	42		74311	-6.0	61	92	EMP	E.T.	1,289,491				2.40	n	
TZW- 33	Mrau Lahouar 1 b	207910090			33	52	10.9	8	01	00.9	37.63420	6.31410	79	50	645	74311	3.0	70	87	EMP	E.T.	1,317,708	411	0.18	32.5	2.40	n	
TZW- 34	PK 13 bis	207910087			33	52	17.8	8	01	52.2	37.63633	6.32993	79	50		74311	3.0	60	87	EMP	E.T.	1,348,056				2.20	n	
TZW- 35	PK 14 bis	207910088			33	52	18.5	8	02	34.7	37.63655	6.34305	79	48		74311	3.2	68	87	EMP	E.T.	1,271,491	340	0.15	31.0	2.26	n	
TZW- 36	Menzel 4 bis				33	52	20.5	8	03	02.9	37.63717	6.35175	79	45		74311	2.0	50	94	EMP	E.T.		233	0.10	31.4	2.30	n	
TZW- 37	Menzel 3	207910020			33	52	31.8	8	04	00.5	37.64066	6.36953	79	43		74311	2.0	70	72	EMP	E.T.	2,213,568				2.26	n	
TZW- 38	Jhum 1	207910080	TZ-8	Jhum 1	33	54	03.8	8	07	26.3	37.66905	6.40305	79	47	633	74311			37	EMP	E.T.	784,282				2.00	n	
TZW- 39	Jhum 2 bis	207910094	TZ-9	Jhum 2	33	53	23.7	8	07	00.1	37.65668	6.42496	79	40	671	74311	6.0	66	94	EMP	E.T.	2,022,451				2.20	n	
TZW- 40	Chakmou 3 bis	207110130	TZ-24	Chakmou	33	05	41.0	8	12	43.2	36.77306	6.53085	71	125	588	74311	10.0	25	85	EMP	E.T.	631,800				5.60	n	
TZW- 41	Chakmou 4	207110123			33	05	45.9	8	12	46.7	36.77457	6.53193	71	125		74311	12.7	25	83	EMP	E.T.	630,000				6.20	n	
TZW- 42	El Hamma 14 bis	207110085	TZ-25	El Hamma	33	59	40.5	8	09	42.4	37.77298	6.47505	71	77	105	74311	-12.3	50	90	EMP	E.T.	1,428,300				2.40	n	
TZW- 43	El Hamma 15	207110030			33	59	31.7	8	09	29.6	37.77026	6.47110	71	72	111	74311	-13.1	48	78	EMP	E.T.	1,239,322				2.14	n	
TZW- 44	El Hamma 13 bis	207110031			33	59	19.5	8	09	35.4	37.76650	6.47289	71	75	103	74311	-35.0	25	89	EMP	E.T.					2.00	n	
TZW- 45	El Hamma 16	207110125			33	59	31.4	8	09	03.2	37.77017	6.46295	71	60	226	74311	18.0	55	92	EMP	E.T.	1,182,258				2.00	n	
TZW- 46	El Hamma 11 bis	207110124			34	00	04.6	8	09	42.7	37.78042	6.47514	71	70	268	74311	3.7	50	78	EMP	E.T.	1,099,800				2.50	n	
TZW- 47	El Hamma 9 bis	207110074		(Sodad)	34	02	22.7	8	13	02.6	37.82305	6.53684	71	45		74311	-7.0	68	85	EMP	E.T.	967,450				3.00	n	
TZW- 48	El Hamma 7 bis	207110064			34	02	24.2	8	12	20.3	37.82351	6.52379	71	40		74311	-8.0	70	84	EMP	E.T.	1,189,440				3.00	n	
TZW- 49	El Hamma 6 bis	207110082			34	02	24.2	8	12	20.3	37.82351	6.52379	71	40		74311	-	-	77	-	-	-				2.90	n	abandoned
TZW- 50	El Hamma 4 bis	207110083			34	01	16.1	8	11	24.8	37.80249	6.50666	71	50		74311	1.8	60	87	EMP	E.T.	1,175,688				3.60	n	
TZW- 51	El Hamma 5 bis	207110078			34	00	56.7	8	11	00.0	37.79650	6.49960	71	50		74311	-41.0	71	86	EMP	E.T.	1,298,448				3.60	n	

TZW- 52	El Hamma 8 bis	207110077			34	00	41.6	8	10	43.0	37.79184	6.49375	71	53		74311	-3.6	61	86	EMP	E.T.	1,137,528				3.70	n	
TZW- 53	El Hamma Cl 3	207110081		(Geothermal)	33	58	39.5	8	09	31.2	37.75415	6.47159	71	75		74312	60.0	35	86			1,103,760				2.70	n	
TZW- 54	El Hamma Cl 2	207110075			33	58	33.8	8	10	00.4	37.75239	6.48061	71	82		74312		28	86			883,008				2.69	n	
TZW- 55	El Hamma Cl 1 bis	207110062			33	58	54.7	8	10	06.8	37.75884	6.48258	71	85		74312	72.0	35.5	85			1,119,528				2.69	n	
TZW- 56	Chemsa 1 bis	207910094	TZ-5	Chemsa	33	56	38.2	8	02	29.4	37.71671	6.34141	79	53	602	74311	-6.0	20	87	EMP	E.T.	174,240	403	0.19	29.3	2.90	n	
TZW- 57	Chemsa 2 bis	207910082			33	56	37.9	8	03	12.9	37.71662	6.35484	79	58	614	74311	-12.8	55	87	EMP	E.T.	1,358,280				2.80	n	
TZW- 58	Neflayette 2 bis	207910093	TZ-4	Neflayette	33	57	55.7	8	06	50.2	37.74063	6.42376	79	48	372	74311	1.4	20	77	EMP	E.T.	352,800				2.30	n	
TZW- 59	Neflayette 3 bis	207110065			33	58	02.1	8	07	09.6	37.74261	6.42789	79	52	384	74311	-4.1	52	84	EMP	E.T.	1,337,864				2.30	n	
TZW- 60	Helba 1 bis	207910110	TZ-7	Helba Ouest	33	55	45.4	8	07	46.3	37.70041	6.43922	79	60	491	74311		60	86	EMP	E.T.	1,563,840				1.90	n	
TZW- 61	Tozeur Gare 2 bis	207910108			33	55	41.6	8	07	47.8	37.69924	6.43968	79	50	265	74311		43	80	EMP	E.T.	803,412				1.94	n	
TZW- 62	Helba 3 bis	207910096	TZ-6	Helba Est	33	55	59.5	8	08	51.1	37.70477	6.45922	79	60	300	74311	+5.0	50	85	EMP	E.T.	577,620				2.00	n	
TZW- 63	Helba 4 bis	207910092			33	56	07.6	8	09	05.1	37.70727	6.46354	79	53	457	74311	-18.0	25	86	EMP	E.T.	273,600				1.92	n	
TZW- 64	Kastilia 2 bis	207910081	TZ-2	Kastilia	33	56	40.9	8	10	15.2	37.71754	6.48517	79	40	466	74311	-3.0	54	84	EMP	E.T.	1,389,960				1.94	n	
TZW- 65	Kastilia 4	207910051			33	56	55.8	8	09	58.6	37.72214	6.47943	79	70	216	74311	-10.0	36	73	EMP	E.T.	883,742				2.02	n	
TZW- 66	Kastilia 1 bis	207910093			33	56	55.5	8	10	37.0	37.72205	6.49190	79	50	390	74311	+9.5	50	86	EMP	E.T.	1,310,400				1.90	n	
TZW- 67	O. El Kouclia 2 b	207910055	TZ-3	Oued El Kouclia	33	57	30.2	8	11	28.1	37.73276	6.50706	79	55	219	74311		40	85	EMP	E.T.	812,736	321	0.14	33.2		n	
TZW- 68	Oued El Kebir	207110005	TZ-23	Degache	33	57	43.2	8	11	35.0	37.73677	6.50980	79	60	203	74311	+1.4	48	79	EMP	E.T.	1,151,021				1.58	n	
TZW- 69	Oued Koucha 1				33	57	54.7	8	11	45.1	37.74032	6.51292	71	65														n	not yet used
TZW- 70	Oued Koucha 1 b	207910069			33	57	54.7	8	11	45.1	37.74032	6.51292	71	65	219	74311	10.0	40	86	EMP	E.T.	646,272					n	
TZW- 71	Oued El Kebir 3	207110004			33	58	02.1	8	11	58.9	37.74261	6.51718	71	60	192	74311	15.0	50	85	EMP	E.T.	1,291,860					n	
TZW- 72	Ain Jedida 1 bis	207110007			33	58	10.3	8	12	13.6	37.74514	6.52172	71	58	233	74311	-40.0	42	85	EMP	E.T.	948,175				1.84	n	
TZW- 73	El Manachi 4 bis	207110003			33	58	12.7	8	12	29.2	37.74588	6.52653	71	50	221		8.5	48	83	EMP	E.T.					1.80	n	
TZW- 74	El Manachi 2 bis	207110070			33	58	31.3	8	12	44.4	37.75162	6.53122	71	53	242	74311	-13.0	55	85	EMP	E.T.	1,518,264				1.90	n	
TZW- 75	El Manachi 2	207110084			33	58	31.3	8	12	44.4	37.75162	6.53122	71	53	221	74311	-4.2	55	85	EMP	E.T.	1,227,996				1.90	n	
TZW- 76	Ain Torba 3 ter	207110122			33	58	56.0	8	13	12.2	37.75925	6.53980	71	60	183	74311	-10.0	52	89	EMP	E.T.	503,755				1.54	n	
TZW- 77	Degacha nord 1	-	-	-	33	59	04.2	8	13	45.0	37.76178	6.54993	71	47	342	-	-	-	69	-	-	-						n	abandoned.
TZW- 78	Degacha nord 2	207110010			33	59	04.2	8	13	45.0	37.76178	6.54993	71	47	218	74311	+2.1	35	70	EMP	E.T.	679,266				1.60	n	
TZW- 79	Zaoual El Arab 1 t	207110126		(Zaoual El Arab)	33	59	23.7	8	14	02.1	37.76780	6.55520	71	50		74311	-6.6	42	94	EMP	E.T.	1,033,754				1.70	n	
TZW- 80	Zaoual El Arab 2				33	59	26.8	8	14	01.6	37.76875	6.55505	71	50			-1.8			EMP	E.T.						n	
TZW- 81	Degacha Cl 1	207110076		(El Mahassen)	34	01	04.3	8	14	40.2	37.79885	6.56696	71	97		74312	38.0	32	80			1,009,152				2.60	n	
TZW- 82	Degacha Cl 3	207110055			34	00	45.6	8	14	24.9	37.79308	6.56224	71	120		74312		28	85			885,427				1.80	n	
TZW- 83	Kriz 3 ter	207110127			34	00	26.4	8	15	16.6	37.78715	6.57820	71	63		74311	-100.0	31	85	EMP	E.T.	804,524				2.32	n	
TZW- 84	Cedada 3	207110131	TZ-21	Cedada	34	00	40.9	8	15	49.7	37.79162	6.58841	71	55	502	74311	-3.5	20	69	EMP	E.T.	439,344				1.94	n	
TZW- 85	Cedada Cl				34	00	50.1	8	15	39.5	37.79446	6.58527	71	75			63.0	40	92							2.20	y	
TZW- 86	Tozrant2	207110056	TZ-20	Tozrant	34	01	38.1	8	17	06.8	37.80928	6.61221	71	70	108	74311	-11.0	30	77	EMP	Res.	71,820				5.88	n	
TZW- 87	Tozrant 1 bis	207110066			34	00	59.0	8	18	05.4	37.79721	6.63030	71	32	639	74311	-8.0	31	85	EMP	Res.	601,895					n	
TZW- 88	Tozrant Cl				34	01	46.9	8	16	55.0	37.81200	6.60857	71	80			53.0	2.5	92									n	
TZW- 89	Dghoumes 2	207110029	TZ-22	Dghoumes	34	02	32.6	8	20	02.5	37.82610	6.66644	71	75	650	74311	-0.2	20	72	EMP	E.T.	131,616				3.70	n	
TZW- 90	Dghoumes 1 bis	207110080			34	01	27.8	8	19	27.1	37.80610	6.65551	71	40		74311	0.0	27	85	EMP	E.T.	535,961				2.40	n	
TZW- 91	Dghoumes 3 bis	207110120			34	01	19.6	8	19	59.9	37.80357	6.66564	71	35	632	74311	-40.8	45	91	EMP	E.T.	846,612				2.00	n	
TZW- 92	Gardgaya 4 bis	207910089	TZ-12	Ghardgaya	33	52	05.7	7	57	40.3	37.63260	6.25218	79	65	440	74311	-18.0	50	88	EMP	E.T.	1,177,200				2.30	n	
TZW- 93	Hazoua 2 bis	207810024	TZ-16	Hazoua 1	33	43	55.0	7	35	24.7	37.48114	5.83997	78	48	567	74311	-4.0	55	87	EMP	E.T.	1,459,458	364	0.18	31.0	2.77	n	
TZW- 94	Hazoua 1 bis	207810002			33	44	03.3	7	35	15.6	37.48370	5.83716	78	49	546	74311	12.5	35	76	EMP	E.T.	409,248				2.74	n	
TZW- 95	Hazoua 4	207810016	TZ-17	Hazoua 2	33	44	14.7	7	36	13.3	37.48722	5.85496	78	48	589	74311		35	84	EMP	E.T.	560,070				2.66	n	
TZW- 96	Hazoua F-1		TZ-18	Hazoua 3 & 4	33	44	40.0	7	37	16.2	37.49503	5.87438	78	48	554				84	EMP	E.T.					3.08	n	
TZW- 97	Hazoua F-2	2078100151			33	44	50.3	7	37	36.3	37.49821	5.88058	78	48	580	74311	12.0	50	83	EMP	E.T.	854,820				2.83	n	
TZW- 98	Hazoua F-3	19197151			33	44	53.9	7	37	58.9	37.49932	5.88756	78	48	580		13.0		84	EMP	E.T.					2.89	n	
TZW- 99	Hazoua F-5	2078100191			33	43	58.1	7	39	32.0	37.48209	5.91629	78	39	612	74311	17.5	50	85	EMP	E.T.	1,089,720				2.80	n	
TZW- 100	Hazoua F-4	2078100181			33	43	37.8	7	38	39.6	37.47583	5.90012	78	39	584	74311	18.0	45	84	EMP	E.T.	968,112	343	0.18	31.3	2.80	n	
TZW- 101	Hazoua F-6	2078100201			33	42	55.0	7	39	27.0	37.46262	5.91475	78	36	580	74311	9.0	45	85	EMP	E.T.	960,660				2.70	n	
TZW- 102	Oued Ghrissi	207810013	TZ-19	Oued Leghrissi	33	43	27.7	7	39	07.6	37.47271	5.90876	78	38	555	74311		60	82	EMP	E.T.	1,027,944				2.69	n	
TZW- 103	Nefta 4	207810026	TZ-11	Nefta	33	52	00.0	7	50	45.8	37.63084	6.12425	78	32	497	74311		60	70	EMP	E.T.	1,897,344				3.24	n	
TZW- 104	Nefta 4 bis	207810022			33	51	55.8	7	50	54.4	37.62954	6.12691	78	26	662	74311	18.0	52	86	EMP	E.T.	1,115,712					n	
TZW- 105	Nefta 6 bis	207810021			33	51	58.8	7	51	28.1	37.63047	6.13069	78	33	512	74311	15.0	66	85	EMP	E.T.	1,440,806					n	
TZW- 106	Nefta 7	207910001			33	52	00.3	7	51	49.3	37.63093	6.14385	78	30	460	74311	-20.0	30	77	EMP	E.T.	691,308				3.06	n	
TZW- 107	Nefta 3 bis	207910007			33	52	04.3	7	52	48.6	37.63217	6.16154	78	33	414	74311	15.0	40	80	EMP	E.T.	818,928				2.66	n	
TZW- 108	Nefta 11	207910112			33	51	57.8	7	53	03.4	37.63016	6.16672	78	26	623	74311	-1.0	55	91	EMP	E.T.	1,260,270				2.20	n	

TZW- 109	Nefta 1 bis	207910003			33	52	21.8	7	52	51.5	37.63757	6.16305	78	35	200	74311	-13.0	66	77	EMP	E.T.	1,287,554				2.76	n	
TZW- 110	Nefta 2 bis	207910084			33	52	15.7	7	52	51.0	37.63569	6.16289	78	30	250	74311	-3.0	50	81	EMP	E.T.	1,161,720					n	
TZW- 111	Nefta SONED	207910002			33	52	33.7	7	52	57.5	37.64124	6.16490	78	80	700	74311		48	76	EMP	E.T.	1,382,400	355	0.19	29.9	3.52	y	(Layoun)
TZW- 112	Nefta CI 1	207910071			33	52	55.1	7	52	52.8	37.64785	6.16345	78	95	2150	74312		9	83			283,824				3.14	n	
TZW- 113	Nefta CI 2	207910070			33	53	05.1	7	52	30.4	37.65093	6.15654	78	95	2645	74312		12	86			378,432	507	0.17	(69.4)		n	temp is low
TZW- 114	Nefta Ras El Ain	207910009			33	52	29.1	7	52	27.9	37.62982	6.15576	78	75		74311	-28.0	30	95	-	-	-					n	not yet used
TZW- 115	Nefta 9	207910086			33	52	01.0	7	53	49.3	37.63115	6.18089	79	40		74311	-3.0	37	87	EMP	E.T.	816,649				2.30	n	
TZW- 116	Nefta 10	207910105			33	52	00.9	7	54	05.0	37.63112	6.18573	79	45		74311	-2.0	50	90	EMP	E.T.	1,143,000				2.40	n	
TZW- 117	Midès 2	206510001	TZ-29	Midès	34	24	50.9	7	55	01.3	38.23919	6.20311	65	380	20	73314		16	85	DEP	Direct	301,248	252	0.13	22.3		n	shallow well
TZW- 118	a dug-well	-	TZ-30	Ain El Karma	34	24	13.5	7	59	00.9	38.22765	6.27706	65	375	20	73314				DEP	Direct		219	0.11	20.0		n	one of many wells
TZW- 119	a spring	-			34	24	13.5	7	59	00.9	38.22765	6.27706	65	375	-	73314				-	Grv		173	0.09	19.2		n	one of springs
TZW- 120	surface flow	-	TZ-28	Foum El Khanga							-	-	65	320	-	-				-	Grv		283	0.15	23.4		n	water source
TZW- 121	spring	-	TZ-26	Tamerza	34	23	08.7	7	5	46.7	38.20765	5.29171	65	420	-	73314	-	70		-	Grv		205	0.10	26.9		y	mixed spring water
TZW- 122	a spring	-	TZ-27	Chebika	34	19	16.1	7	58	22.9	38.13585	6.22829	65	125	-	73314		10		-	Grv		358	0.17	27.8		n	

WELL INVENTORY - 3 (KEBILI)

Well Code	Name of Well	Num. IRH	No.	Name of Oasis	LOCATION							TOPO-SHEET		WELL DRILLING					DELIVERY			Water Quality					Note
					Latitude (N)			Longitude (E)			French System (G)			Depth	Aquifer	S.W.L.	Yield	Drilled	Type of extract	Delivery System	Volume	- Measured by Team -			Salinity	Others	
					deg.	mn.	sec.	deg.	mn.	sec.	(N)	(E)	Num.	(m)	(m)	Type	(m)	(l/s)	(year)			(m3/year)	E.C	Salinity	Temp.	(g/l)	(y/n)	
KBW- 1	Barghouthia 2	208910012	KB-27	Barghouthia	33	36	03. 8	8	54	43. 7	37.33569	7.30878	89	22	255	93221	1.2	4.0	1990	EMP	E.T.	106,000	(mS/m)	(%)	(°C)	1.90	y	
KBW- 2	Barghouthia	208910076			33	35	56. 2	8	54	48. 7	37.33335	7.31032	89	22	207	93221	28.5	4.0	1972	Art.+EMP	E.T.	45,738	247	0.13	24.4	2.00	n	
KBW- 3	Jemna 1 bis	208910075	KB-32	Jemna	33	34	06. 3	9	00	48. 4	37.29942	7.42134	89	40	150	93221	0.0	60.0	1993	EMP	Res.	1,099,224				1.50	y	
KBW- 4	Jemna 2	208910021			33	34	21. 9	9	00	43. 2	37.30424	7.41973	89	40	118	93221	22.6	8.4	1973	Art.+EMP	Res.	218,333				1.30	y	
KBW- 5	Jemna Cf 11	208910066		Jemna+Mu.	33	33	11. 3	9	00	46. 7	37.28245	7.42081	89	45	2,162	93211	217.2	126.4	1986	Art.	C.T.	3,708,720	586	0.22	(43.8)	2.88	y	
KBW- 6	Kebili Cf 16	208110055		(KB-32,33)	33	40	56. 0	9	00	30. 2	37.42527	7.41572	81	50	2,800	93211	139.3	110.0	1994	Art.	C.T.	166,320				2.50	y	
KBW- 7	Soast 7	208910070		(Sodad)	33	36	15. 2	9	01	16. 4	37.33921	7.42998	89	45	150	93221	2.1	22.0	1988	EMP	E.T.	264,449				2.60	n	
KBW- 8	Soast 5 bis	208910062			33	36	08. 9	9	02	09. 4	37.33727	7.44634	89	55	130	93221		47.8	1985	Art.+EMP	E.T.	622,858	385	0.21	23.1	2.00	n	
KBW- 9	Soast 6	208910037			33	36	15. 8	9	01	53. 8	37.33940	7.44152	89	48	102		13.0	35.0	1972	Art.+EMP	E.T.					1.54	n	
KBW- 10	Chott salhia 2	208910019			33	35	36. 4	8	59	45. 2	37.32724	7.40183	89	40	150	93221	25.9	29.3	1972	Art.+EMP	E.T.	483,660	202	0.11	23.4	1.40	n	
KBW- 11	Soast 5	208910062			33	35	59. 9	9	02	14. 0	37.33449	7.44776	89	55	150	93221		47.8	1972	EMP	E.T.	622,858				1.50	n	
KBW- 12	Soast 4	208910015			33	36	16. 5	9	00	43. 8	37.33961	7.41986	89	42	103	93221		21.6	1948	EMP	E.T.	496,742				1.70	n	
KBW- 13	Chott salhia 1	208910018			33	35	50. 8	9	00	14. 2	37.33168	7.41078	89	42	139	93221		2.0	1969	Art.+EMP	E.T.	49,169				2.00	n	
KBW- 14	Messaad Still 2	208910063			33	36	38. 5	8	57	00. 2	37.34640	7.35091	89	26	206	93221	5.9	25.0	1985	EMP	E.T.	366,847	225	0.11	24.0	1.56	n	
KBW- 15	Soast 3	208910014			33	36	03. 6	9	01	24. 8	37.33563	7.42257	89	48	80	93221		22.2		EMP	E.T.	261,792	284	0.15	23.2	1.50	n	
KBW- 16	T. STIL	208910044			33	27	36. 4	8	56	57. 6	37.17908	7.35010	89	45	74	93221	21.6	72.9	1971	Art.+EMP	E.T.	2,214,864	216	0.11	22.8	1.45	n	
KBW- 17	El Hasy STIL 2	208910071			33	23	53. 4	8	59	21. 2	37.11024	7.39442	89	52	203	93221	6.3	20.0	1988	EMP	E.T.	632,448				1.90	n	
KBW- 18	El Hasy Stil 1	208910042			33	23	53. 4	8	59	21. 2	37.11024	7.39442	89	52		93221		31.7		EMP	E.T.	353,610					n	
KBW- 19	Bazma 6	208110045	KB-28	Bazma	33	39	24. 6	9	00	48. 9	37.39767	7.42149	81	48	153	93221	-12.1	32.6	1990	EMP	E.T.	707,832				2.50	y	
KBW- 20	Bazma 5	208110026			33	39	54. 9	9	00	29. 1	37.40703	7.41538	81	45	266	93221	4.0	77.7	1975	Art.+EMP	E.T.	1,666,656				2.50	n	
KBW- 21	Dar El Gaid 1 bis	208110060	KB-36	Ras El Ain	33	41	24. 8	8	58	32. 5	37.43477	7.37939	81	35	250	93221	-8.5	72.8	1993	EMP	E.T.	1,437,206	350	0.18	25.5	2.10	y	
KBW- 22	Kebili Village	208110040			33	41	03. 2	8	58	02. 7	37.42811	7.37020	81	30	160	93221	6.2	55.0	1985	Art.+EMP	E.T.	1,104,840	235	0.12	24.5	1.80	y	
KBW- 23	Ras El Ain 1	208110014			33	41	54. 7	8	58	43. 5	37.44400	7.38279	81	52	97	93221	30.6	106.2	1959	Art.+EMP	E.T.	2,343,240				3.10	y	
KBW- 24	Ras El Ain 3	208110021			33	41	38. 4	8	59	04. 0	37.43897	7.38912	81	40	130	93221	-1.1	10.0	1980	EMP	E.T.	45,612				2.50	y	
KBW- 25	Ras El Ain 4	208110022			33	41	54. 7	8	58	43. 5	37.44400	7.38279	81	52	115	93221	-1.3	25.6	1980	EMP	E.T.	494,424				2.60	n	
KBW- 26	Kebili west	208110018			33	41	22. 6	8	57	44. 1	37.43410	7.36466	81	30	200	93221	13.9	31.7	1976	Art.+EMP	E.T.	487,584				1.80	y	
KBW- 27	Kebili Cf 10	208110041		Ras Ain + B.Z.	33	41	56. 5	8	59	05. 3	37.44456	7.38952	81	50	2,580	91311	176.0	76.8	1986	Art.	C.T.	2,289,168	495	0.17	(56.5)	2.40	y	
KBW- 28	Ben Zitoun 1	208810001	KB-38	Ben Zitoun 1et 2	33	34	20. 3	8	52	37. 7	37.30375	7.26989	88	26	170	93221	38.6	50.0	1951	Art.+EMP	E.T.	1,581,120				1.68	y	
KBW- 29	Ben Zitoun 2	208810002			33	34	46. 2	8	52	05. 3	37.31174	7.25989	88	27	257	93221	26.3	1.7	1977	Art.+EMP	E.T.	34,223	255	0.13	25.0	1.86	y	
KBW- 30	Ben Zitoun 1 bis	208810003			33	34	20. 3	8	52	37. 7	37.30375	7.26989	88	26	170	93221	28.0	8.4	1981	Art.+EMP	E.T.	231,552				1.76	n	
KBW- 31	Ben Zitoun 3	208810024			33	34	37. 8	8	52	15. 3	37.30015	7.26298	88	25	201	93221	24.5	42.0	1985	Art.+EMP	E.T.	837,439				1.70	n	
KBW- 32	Gueheda 2	208810005	KB-40	Gueheda	33	33	52. 7	8	53	31. 2	37.29523	7.28640	89	28	147	93221	36.4	50.0	1971	Art.+EMP	E.T.	1,551,744	254	0.13	24.8	1.84	y	
KBW- 33	Bludette 3	208810008	KB-30	Bludette	33	34	26. 5	8	50	48. 4	37.30566	7.23554	88	30	214	93221	32.3	22.0	1977	Art.+EMP	E.T.	566,438				2.04	n	
KBW- 34	Bludette 5	208810030			33	34	26. 5	8	50	48. 4	37.30566	7.23554	88	30	182		20.9	19.0	1980	Art.+EMP	E.T.		268	0.13	25.5	2.40	y	leaking water
KBW- 35	Zarcune 2	208810010	KB-31	Zarcune	33	32	15. 2	8	49	24. 8	37.26513	7.21035	88	25	149	93221	42.4	10.9	1960	Art.+EMP	E.T.	305,856				1.80	n	
KBW- 36	Zarcune 3	208810011			33	32	08. 6	8	49	19. 6	37.26309	7.20875	88	23	240	93221	42.5	11.2	1973	Art.+EMP	E.T.	297,475	245	0.13	23.3	1.66	n	Zarcune 1
KBW- 37	Zarcune 4	208810025			33	32	03. 4	8	49	50. 3	37.26149	7.21822	88	22	200	93221	34.7	26.2	1985	Art.+EMP	E.T.	757,037	275	0.14	26.1	1.70	y	
KBW- 38	Klebia 1	208810012	KB-42	Klebia	33	31	17. 0	8	50	22. 9	37.24717	7.22828	88	30	170	93221		37.2	1952	Art.+EMP	E.T.	1,077,062	250	0.13	24.8	1.52	y	
KBW- 39	Klebia 2	208810023			33	31	13. 7	8	49	56. 5	37.24615	7.22014	88	28	166	93221	33.0	53.7	1983	Art.+EMP	E.T.	1,587,082				1.80	n	
KBW- 40	Kelwamen	208910055	KB-41	Kelwamen	33	35	16. 5	8	54	33. 7	37.32109	7.30569	89	27	205	93221	17.5	91.8	1985	Art.+EMP	E.T.	1,331,084				1.78	n	
KBW- 41	Bourzane 2	208910061	KB-39	Bourzane	33	34	29. 5	8	59	14. 1	37.30839	7.39223	89	45	102	93221	10.5	80.2	1985	EMP	E.T.	1,673,870	197	0.10	23.7	1.50	y	
KBW- 42	Rahmet 5	208910005	KB-35	Kahmat	33	38	13. 8	8	59	45. 1	37.37582	7.40180	89	40	293	93221	5.6	57.1	1985	EMP	E.T.	816,322	230	0.12	24.2	2.17	y	
KBW- 43	Rahmet 4	208910008			33	38	48. 3	8	59	26. 5	37.38647	7.39606	89	30	153	93221	16.9	40.0	1975	Art.+EMP	E.T.					2.00	n	
KBW- 44	Rahmet 3	208910057			33	38	32. 2	8	59	31. 5	37.38150	7.39760	89	35	128	93221	11.5	34.9	1969	Art.+EMP	E.T.	649,584				1.30	n	
KBW- 45	Messaad 5	208910056	KB-34	Msaid	33	37	08. 4	8	57	51. 2	37.35563	7.36665	89	45	171	93221	12.6	78.8	1985	Art.+EMP	E.T.	1,555,502				1.58	y	
KBW- 46	Ain Salah 2	208910058	KB-44	Atilet	33	34	50. 0	9	03	54. 2	37.31291	7.47868	89	65	102	93221	-7.6	9.8	1985	EMP	Res.	175,266	412	0.22	22.6	2.08	y	
KBW- 47	Ain Salah 1	208910049			33	34	32. 9	9	03	04. 3	37.30764	7.46328	89	60	105	93221	-2.6	71.1	1982	EMP	Res.	1,083,456	354	0.19	22.9	1.40	n	
KBW- 48	Chottyane	208910056			33	33	31. 9	9	03	01. 7	37.28881	7.46248	89	60	102	93221	2.9	50.0	1982	-	-	-				1.30	n	not function
KBW- 49	Brka	208910050			33	33	53. 1	9	04	03. 9	37.29535	7.48168	89	45	92	93221	-4.0	63.8	1983	EMP	Res.	1,247,976	420	0.23	22.6	1.10	n	
KBW- 50	Bchelli 3	208910011	KB-29	Bchelli	33	36	39. 1	8	54	58. 5	37.34659	7.31273	89	25	148	93221	28.6	96.5	1973	Art.+EMP	E.T.	1,506,211	223	0.12	23.6	1.80	y	
KBW- 51	Sidi Hamed	208910023	KB-43	Sidi Hamed	33	34	17. 1	8	58	13. 4	37.30276	7.37350	89	45	87	93221	22.1	54.0	1977	Art.+EMP	E.T.	1,007,309				1.60	y	
KBW- 52	Metouna 2	208910025	KB-33	Mtouna	33	32	44. 2	9	00	26. 9	37.27408	7.41470	89	45	150	93221	16.0	60.0	1976	-	-	-	-	-	-	1.30	n	abandoned
KBW- 53	Ksar Tabeul	208110013	KB-37	Souk El Baez	33	41	59. 0	8	58	30. 0	37.44533	7.37862	81	50	82			25.0	1946	Art.+EMP	E.T.					3.30	y	

KBW- 54	Dar Keskes 1 bis	20K110051			33	42	16.1	8	58	38.4	37.45061	7.38122	81	50	84	93221	-25.0	40.0	1993	EMP	E.T.	857,664	553	0.30	22.9	3.20	y	
KBW- 55	Guettaya 9	20K010056	KB-15	Guataya	33	39	55.8	8	52	33.5	37.40730	7.26859	80	20	170	93221	21.5	60.8	1991	Art.	Direct.	1,741,824				2.14	n	
KBW- 56	Guettaya 1	20K010023			33	40	37.2	8	52	34.9	37.42008	7.26902	80	23	125	93221		5.6	1933	Art.	Direct.	158,371				2.00	n	
KBW- 57	Guettaya 2	20K010024			33	40	37.2	8	52	34.9	37.42008	7.26902	80	23	150	93221	33.3	9.0	1951	Art.	Direct.	243,043	267	0.13	26.5	1.80	n	
KBW- 58	Guettaya 3	20K010025			33	40	34.4	8	52	33.5	37.41922	7.26859	80	22	160	93221	39.0	38.4	1972	Art.+EMP	E.T.	1,180,224				2.10	n	
KBW- 59	Telmine 3 bis	20K110055	KB-19	Telmine	33	42	57.3	8	54	54.1	37.46333	7.31199	81	24	201	93221	2.3	70.0	1994	EMP	E.T.	1,723,680				2.20	n	
KBW- 60	Guettaya 7 bis	20K110047			33	42	21.0	8	54	23.8	37.45212	7.30264	81	23	152	93221	30.6	82.0	1978	Art.+EMP	E.T.	2,569,536				1.70	n	
KBW- 61	Telmine 2	20K110008			33	42	46.5	8	55	06.9	37.45999	7.31594	81	26	70	93221	16.9	40.0	1947	Art.+EMP	E.T.	847,440	352	0.18	24.8	2.00	n	
KBW- 62	Telmine 3	20K110009			33	42	47.0	8	55	20.7	37.46015	7.32020	81	27	87	93221	23.0	13.0	1973	Art.	E.T.	368,496				1.80	n	
KBW- 63	Tombar 5	20K010040	KB-21	Tombar	33	43	53.7	8	53	34.6	37.48074	7.29745	80	22	100	93221	4.4	73.7	1985	EMP	E.T.	1,590,048				2.06	y	
KBW- 64	Tombar 3	20K010031			33	43	56.6	8	53	42.4	37.48163	7.29886	80	23	86	93221		32.0	1965	EMP	E.T.	668,160	290	0.14	26.9	3.00	n	
KBW- 65	Rabta 2 bis	20K110054	KB-18	Rabta	33	43	38.5	8	55	05.7	37.47343	7.31557	81	25	106	93221	7.2	69.1	1982	EMP	E.T.	1,602,648	357	0.18	27.0	2.25	y	
KBW- 66	Rabta 3	20K110003			33	43	21.3	8	55	00.2	37.47073	7.31387	81	22	76	93221	15.8	32.0	1972	Art.+EMP	E.T.	597,888				1.90	n	
KBW- 67	Guettaya 4	20K010026		(PIK)	33	40	48.4	8	53	13.8	37.42354	7.28103	80	23	154	93221	42.1	27.0	1973	Art.	Res.	853,905				2.00	n	
KBW- 68	Guettaya 4 bis	20K010027			33	40	48.4	8	53	13.8	37.42354	7.28103	80	23	203	93221	36.4	14.2	1975	Art.	Res.	432,000	281	0.14	27.1	2.10	n	
KBW- 69	Guettaya 5	20K010028			33	42	18.9	8	53	46.2	37.45147	7.29103	80	23	196	93221	26.7	80.0	1975	Art.+EMP	Res.	2,044,800	285	0.14	27.8	1.90	n	mixed water
KBW- 70	Guettaya 6	20K010029			33	40	15.6	8	52	50.4	37.41342	7.27381	80	24	150	93221	37.3	154.1	1977	Art.	Res.	4,578,941	268	0.13	25.4	1.90	n	
KBW- 71	Guettaya 8	20K010030			33	39	57.4	8	53	06.9	37.40780	7.27890	80	23	178	93221	37.6	86.0	1977	Art.	Res.	2,614,507				1.80	n	
KBW- 72	Tombar 4	20K010032			33	43	51.4	8	53	21.8	37.48003	7.28350	80	22	70	93221	16.0	2.0	1972	Art.	Res.	36,896				1.90	n	
KBW- 73	Tembib 4	20K110007	KB-20	Tembib	33	42	57.8	8	54	33.9	37.46348	7.30575	81	24	84	93221	23.1	85.5	1973	Art.	Direct.	1,567,440	289	0.14	28.7	2.10	y	
KBW- 74	Djedida	20K110010		Jedida + Man.	33	43	09.9	8	56	02.0	37.46722	7.33294	81	25	95	93221	10.6	34.7	1969	EMP	Res.	651,254				2.90	n	
KBW- 75	Manscura Cl 3	20K110038		(KB-16,17)	33	43	25.4	8	56	47.4	37.47200	7.34696	81	28	2,200	91311	56.5	13.6	1985	Art.	C.T.	352,512				3.02	y	
KBW- 76	Manscura Cl 13	20K110046			33	43	06.8	8	56	38.7	37.46626	7.34365	81	23	2,682	93211	197.3	30.0	1992	Art.	C.T.	948,672				2.40	y	
KBW- 77	Nouvel 2	20K810021	KB-50	Nouvel	33	29	42.7	8	51	32.2	37.21806	7.24967	88	28	169	93221	26.6	92.0	1986	Art.+EMP	E.T.	790,070				1.70	y	
KBW- 78	Nouvel 1	20K810013			33	29	34.6	8	51	55.1	37.21562	7.25674	88	30	161	93221	28.8	31.2	1957	Art.+EMP	E.T.	640,570	248	0.12	25.3	1.72	n	
KBW- 79	Grad 2	20K910074	KB-48	Grad	33	30	43.7	8	59	36.7	37.23689	7.39921	89	50	150	93221	4.1	82.3	1989	EMP	E.T.	1,815,959				1.70	y	
KBW- 80	Grad	20K910028			33	30	36.4	8	59	33.2	37.23464	7.39813	89	48	130	93221	20.7	-	1951	-	(E.T.)	-				1.50	n	not yet used
KBW- 81	Dbaa SDZ 9	20K610019		(Serres)	33	18	38.0	8	38	57.6	37.01289	7.01677	96	40	288	93221	36.61	6.9	1984	Art.	Direct.	190,123	234	0.12	24.1	1.60	y	
KBW- 82	Aiguan 2	-			33	17	07.9	8	45	18.6	36.98508	7.13375	96	58			7.7	20.0	1991	-	-	-	86	0.04	21.9	1.70	n	Geological servey
KBW- 83	El Golea 2	20K910060	KB-47	El Golea	33	28	46.1	9	00	28.0	37.20059	7.41504	89	55	150	93221	6.8	80.0	1986	Art.+EMP	E.T.	1,217,088	284	0.15	22.7	1.46	y	
KBW- 84	El Hsay 6	20K910059	KB-49	El Hsay	33	24	14.0	9	00	19.6	37.11660	7.41245	89	55	210	93221	2.3	70.0	1985	EMP	E.T.	1,354,968	701	0.38	22.6	3.00	y	
KBW- 85	Hsay 5 bis	20K910053			33	23	53.9	9	00	13.9	37.11040	7.41069	89	55	150	93221	5.9	36.2	1985	EMP	E.T.	715,370				4.88	n	
KBW- 86	Zaafrane 3 bis	20K910052	KB-51	Zaafrane	33	26	34.1	8	54	20.6	37.15985	7.30165	89	40	122	93221	24.7	38.8	1982	Art.	E.T.	1,031,011				1.62	y	
KBW- 87	Zaafrane 2	20K910046			33	26	30.6	8	54	59.1	37.15877	7.31353	89	45	110	93221	24.5	4.0	1969	Art.	E.T.	126,490	160	0.08	23.4	1.00	n	
KBW- 88	Zaafrane 1	20K910045			33	26	40.0	8	55	21.9	37.16167	7.32057	89	45		93221		20.0		Art.	E.T.	632,448	151	0.08	23.0	1.28	n	
KBW- 89	Zaafrane 3 ter	20K910081			33	26	34.1	8	54	20.6	37.15985	7.30165	89	40	122	93221	10.0	20.2	1994	Art.	E.T.	478,210				2.00	n	
KBW- 90	Douz Nord 1	20K910065	KB-56	Dhemmne	33	28	22.5	9	02	54.3	37.19331	7.46020	89	65	200	93221	-2.5	31.4	1986	EMP	E.T.	561,269				1.70	y	
KBW- 91	Smida	20K910051	KB-57	Smida	33	28	27.7	8	56	29.2	37.19491	7.34134	89	40	100	93221	26.6	54.3	1982	Art.+EMP	E.T.	1,451,174	174	0.09	22.8	1.20	y	
KBW- 92	Draa Sakoumra	20K910029	KB-54	Sakkoumra	33	29	31.9	8	58	56.4	37.21473	7.38739	89	48	156	93221	24.5	91.0	1975	Art.+EMP	E.T.	1,741,522	210	0.11	23.0	1.10	y	
KBW- 93	Douz Sud 4	20K910033	KB-45	Douz	33	26	24.2	9	01	44.7	37.15679	7.43871	89	60	182	93221	3.7	31.8	1972	EMP	Res.	578,534	418	0.23	22.0	3.00	y	
KBW- 94	Douz Ouest	20K910034			33	26	43.7	9	00	48.2	37.16281	7.42128	89	48	150	93221	14.9	40.6	1975	Art.+EMP	Res.	723,463				1.50	y	
KBW- 95	Douz 6	20K910035			33	26	35.7	9	01	37.7	37.16034	7.43655	89	60	153	93221	1.1	83.5	1978	EMP	Res.	1,708,066				2.46	y	
KBW- 96	Douz 2 bis	20K910030			33	27	03.2	9	01	19.7	37.16883	7.43100	89	58	75	93221		65.7	1915	EMP	Res.	1,118,110				0.80	y	
KBW- 97	Douz Cl 12	20K910067			33	26	09.7	9	01	58.8	37.15231	7.44307	89	65	2,080	93211	198.2	35.7	1986	Art.	C.T.	1,088,035				4.28	y	
KBW- 98	Douz Cl 18	20K910081			33	24	27.6	9	00	52.1	37.12080	7.42248	89	60	2,020	93211	186.0	114.0	1994	Art.	(C.T.)	172,368				4.00	y	
KBW- 99	Bouhamza	20K910036	KB-52	Bouhamza	33	26	09.6	9	00	06.3	37.15228	7.40834	89	67	60	93221	17.6	82.0	1973	Art.+EMP	E.T.	1,430,136	412	0.22	22.9	2.30	y	
KBW- 100	Tarfaya El Kroub	20K910043	KB-55	Tarfaya	33	27	34.4	8	58	30.4	37.17846	7.37875	89	47	99	93221	21.6	79.4	1956	Art.+EMP	E.T.	1,458,331	316	0.17	22.8	1.60	y	
KBW- 101	Zaafrane 3	20K910047			33	26	34.1	8	54	20.6	37.15985	7.30165	89	40	160	93221	10.2	5.0	1972	Art.	Direct	158,112				1.50	n	
KBW- 102	El Ghoula	20K910027	KB-46	El Ghoula	33	30	47.6	8	58	24.9	37.23809	7.37705	89	40	150	93221	27.5	73.0	1976	Art.+EMP	E.T.	1,430,215				1.10	y	
KBW- 103	Negga 7	20K010059	KB-6	Negga	33	44	03.4	8	50	11.8	37.48373	7.22486	80	20	136	93221	16.5	23.2	1991	Art.	Direct.	672,538				2.40	y	
KBW- 104	Negga 4 bis	20K010070			33	44	13.7	8	49	34.0	37.48691	7.21519	80	20	160	93221	6.0	25.0	1993	Art.	Direct.	520,830				2.50	n	
KBW- 105	Negga 2	20K010011			33	44	13.2	8	49	30.3	37.48675	7.21205	80	20	87	93221		3.8	1933	Art.	Direct.	110,765	285	0.14	27.5	2.00	n	
KBW- 106	Negga 3	20K010012			33	44	16.4	8	49	37.1	37.48774	7.21415	80	22	163	93221		7.2	1950	Art.	Direct.	226,800	284	0.14	27.7	2.00	n	
KBW- 107	Negga 4	20K010013			33	44	16.4	8	49	37.1	37.48774	7.21415	80	22	129	93221		11.4	1968	Art.	Direct.	337,651				2.00	n	
KBW- 108	Negga 5	20K010014			33	44	09.3	8	50	13.8	37.48555	7.22548	80	22	150	93221		13.6	1976	Art.	Direct.	411,264	292	0.14	28.2	1.90	n	
KBW- 109	Negga 6	20K010016			33	44	27.0	8	49	44.2	37.49101	7.21634	80	22	251	93221	1.0	38.5	1977	Art.+EMP	E.T.	487,087				1.90	n	
KBW- 110	Oued Zira 3	20K010060	KB-8	Oued Zira	33	45	49.0	8	53	21.5	37.51632	7.28341	80	38	143	93221	-1.1	36.8	1991	EMP	E.T.	705,060				3.30	n	
KBW- 111	Oued Zira 7	20K010022			33	45	35.2	8	53	37.3	37.51207	7.28928	80	32	129	93221	3.4	75.7	1974	Art.+EMP	E.T.	1,408,133	436	0.22	26.1	2.80	n	

KBW- 112	Om Somaa 4	208010063	KB-7	Oum Somaa	33	47	04. 7	8	48	16. 3	37.53969	7.18921	80	26	117	93221	-11.9	61.0	1991	Art.+EMP	Res.	1,153,357				3.00	n	
KBW- 113	Om Somaa 1 bis	208010069			33	47	00. 6	8	48	31. 0	37.53843	7.19375	80	25	50	93221	+14.4	43.0	1993	Art.+EMP	Res.	929,614				3.90	n	
KBW- 114	Om Somaa 1	208010006			33	47	00. 6	8	48	31. 0	37.53843	7.19375	80	25	131	93221	-0.3	25.0	1968	-	-	-				3.60	n	abandoned
KBW- 115	Bou abd. Cl 1	208010034			33	46	39. 6	8	50	06. 6	37.53194	7.22325	80	27	1,420	93211	20.9	18.9	1983	Art.	C.T.	555,206				2.80	y	
KBW- 116	Bou abd. 1 bis	208010065			33	46	41. 8	8	49	59. 2	37.53256	7.22097	80	25	142		-16.0	44.0	1993	EMP	Res.					3.00	y	
KBW- 117	El Glea 2	208010061	KB-4	El Ghaa	33	46	14. 8	8	51	25. 0	37.52429	7.24745	80	23	140	93221	15.0	25.4	1991	Art.+EMP	E.T.	524,682				2.50	y	
KBW- 118	El Glea	208010017			33	46	22. 8	8	50	56. 3	37.52676	7.23859	80	27	73	93221	-1.3	40.0	1971	EMP	E.T.	831,600	473	0.24	26.0	2.20	n	
KBW- 119	Chott Negga 2	208010036	KB-14	Choucher Negga	33	44	12. 0	8	52	31. 1	37.48638	7.26785	80	22	99	93221	10.0	30.0	1983	Art.+EMP	E.T.	465,984	287	0.14	27.5	2.20	y	
KBW- 120	Fatnassa 2	208010001	KB-3	Fatnassa	33	47	37. 1	8	44	29. 2	37.54969	7.11912	80	22	185	93221	10.9	26.3	1973	EMP	Res.	526,176				3.60	n	
KBW- 121	Taourgha	208010003		Fat. + Bechn	33	47	47. 7	8	45	44. 2	37.55296	7.14227	80	24	78	93221		83.9	1956	EMP	Res.	1,869,192	463	0.23	26.5	3.90	y	
KBW- 122	Taourgha Cl 2	208010037		(KB-1,3)	33	47	28. 8	8	46	04. 6	37.54713	7.14856	80	24	1,405	93211	38.6	28.0	1984	Art.	Res.	885,427	459	0.16	46.4	2.32	y	
KBW- 123	Debabcha Cl 14	208010064			33	47	50. 8	8	44	33. 2	37.55392	7.12035	80	24	2,480	93211	217.5	32.0	1992	Art.	Res.	1,011,917	511	0.19	(44.7)	2.20	y	
KBW- 124	Fatnassa 1	208010007		(Debabcha)	33	47	59. 0	8	44	01. 0	37.55645	7.11042	80	23	188	93221	7.9	8.0	1973	EMP	E.T.	29,491				3.80	n	
KBW- 125	Bou Abd. 2	208010008	KB-2	Bouabdallah	33	46	36. 3	8	50	38. 5	37.53092	7.23310	80	33	128	93221	-8.2	37.6	1971	EMP	Res.	439,682				3.50	y	
KBW- 126	Bou Abd. 3	208010009			33	46	39. 0	8	50	16. 6	37.53176	7.22634	80	27	52	93221	-9.0	46.4	1973	EMP	Res.	867,874	485	0.25	25.6	3.50	n	
KBW- 127	Zt. Chorfa Cl 4	208010038			33	47	09. 1	8	49	49. 9	37.54105	7.21810	80	55	2,200	93211	205.9	79.2	1985	Art.	C.T.	2,051,222	605	0.16	68.9	2.36	n	
KBW- 128	Ziret Louhichi	208010018	KB-13	Ziret Louhichi	33	46	11. 8	8	51	49. 8	37.52336	7.25511	80	23	75	93221	-1.6	75.2	1971	EMP	E.T.	1,778,832	424	0.21	25.9	2.80	y	
KBW- 129	Zt. Oul. Tounsy	208010021	KB-9	Ouled Tounsi	33	45	57. 4	8	52	37. 5	37.51892	7.26963	80	30	86	93221	0.0	89.1	1973	EMP	E.T.	1,774,541	442	0.22	25.9	2.90	y	
KBW- 130	Tarfaya El Ma	209610010	KB-67	Tarfaya Elma	33	22	39. 0	8	44	04. 8	37.08728	7.11159	96	48	250	93321	17.8	41.0	1986	Art.+EMP	E.T.	802,742	215	0.10	25.1	1.38	y	
KBW- 131	Matrouha	209410001	KB-64	Matrouha	33	20	52. 4	7	46	35. 3	37.05437	6.04694	94	40	274	93331		25.8	1985	Art.	Direct.	718,157	391	0.19	26.7	3.20	y	
KBW- 132	Matrouha 2	209410003			33	20	55. 3	7	46	39. 9	37.05527	6.04836	94	40	302	93331	23.9	46.8	1990	Art.	Direct.	1,156,205				3.40	n	
KBW- 133	R. Mastoung 7	209510012	KB-66	R. Mastoug 2	33	19	52. 4	8	01	47. 2	37.03585	6.32859	95	28	236	93331	32.1	75.8	1990	Art.+EMP	E.T.	2,216,160	309	0.15	26.3	2.20	y	
KBW- 134	R. Mastoung 2	209510002	KB-65	R. Mastoug 1	33	19	02. 7	8	01	33. 6	37.02051	6.32419	95	40	225	93331		38.9	1977	Art.	E.T.	892,512				2.00	n	
KBW- 135	R. Mastoung 3	209510003		R.M. 1 + R.M. 2	33	19	47. 4	8	01	32. 0	37.03431	6.32369	95	38	230	93331	36.1	37.1	1983	Art.	E.T.	930,398				2.30	n	
KBW- 136	Bechro	208810014	KB-62	Bechro	33	29	01. 4	8	47	21. 4	37.20531	7.17227	88	42	199	93221	31.4	75.6	1978	Art.+EMP	E.T.	2,075,587	264	0.13	25.0	1.98	y	
KBW- 137	Derg. El Anseur	208810015	KB-63	Dargine	33	27	48. 9	8	42	19. 1	37.18293	7.09748	88	24	200	93221	39.7	52.2	1980	Art.+EMP	E.T.	1,384,992	225	0.12	22.7	1.70	y	
KBW- 138	Guidma	208810020	KB-58	Ghidme	33	25	59. 2	8	49	10. 6	37.14907	7.20597	88	45	98	93221		24.8	1957	Art.+EMP	E.T.	779,976				1.60	y	
KBW- 139	Guidma 2	208810031			33	25	49. 5	8	49	01. 8	37.14608	7.20319	88	40	211	93221		26.0	1991	Art.	Direct.	829,526				1.70	n	
KBW- 140	Guidma 1 bis	208810032			33	25	55. 7	8	49	16. 9	37.14799	7.20791	88	45	150	93221	8.0	10.2	1994	Art.	Direct.	34,969				2.00	n	
KBW- 141	Sabna 3	209610008	KB-59	Sabna	33	20	44. 8	8	44	51. 2	37.05203	7.12591	96	24	159	93321	14.6	50.0	1985	Art.+EMP	E.T.	1,581,120	180	0.08	24.5	1.40	y	
KBW- 142	Sabna 2	209610001			33	20	59. 7	8	44	41. 6	37.05663	7.12795	96	24	190	93321	19.5	6.0	1976	Art.	Direct.	189,734	220	0.11	24.7	1.60	n	
KBW- 143	El Facuar 4	209610009	KB-60	El Facuar 1	33	21	31. 3	8	40	08. 7	37.06638	7.03872	96	40	195	93321	21.2	50.2	1985	Art.+EMP	Res.	1,488,888				1.70	y	
KBW- 144	El Facuar 1	209610002			33	21	37. 7	8	40	55. 0	37.06836	7.05301	96	45	176	93321	17.2	9.8	1949	Art.	Res.	279,202				1.70	n	
KBW- 145	El Facuar 2	209610003			33	21	37. 7	8	40	55. 0	37.06836	7.05301	96	45	160	93321		8.0	1949	Art.	Res.	252,979	211	0.09	26.0	1.80	y	
KBW- 146	El Facuar West	209610005	KB-61	El Facuar 2	33	20	59. 2	8	40	00. 3	37.05647	7.03613	96	45	172	93321	24.8	47.5	1977	Art.+EMP	E.T.	1,379,419				1.90	y	
KBW- 147	El Facuar Cl 19	209610026		El Facuar 1 + 2	33	20	14. 5	8	40	01. 8	37.04268	7.03659	96	50	1,894	93211	211.7	30.0	1993	Art.	Res.	948,672				2.00	y	
KBW- 148	Essalem 1	209410002		(O.D.R.M.)	33	20	36. 0	7	48	17. 4	37.04931	6.07845	94	40	355	93331	28.8	16.8	1986	Art.	Direct.	505,699	386	0.19	27.4	2.40	n	
KBW- 149	R. Mastoung 4	209510004			33	19	38. 9	7	56	28. 6	37.03169	6.23005	95	45	400	93331	33.2	39.3	1985	Art.	E.T.	1,212,624				2.00	n	
KBW- 150	R. Mastoung 5	209510005			33	19	49. 4	7	53	02. 8	37.03493	6.16654	95	45	368	93331	32.5	6.0	1985	Art.	Direct.	147,139	371	0.19	26.2	2.00	n	
KBW- 151	Mouaha Ellafaa	209510007			33	19	31. 0	7	53	51. 3	37.02925	6.18150	95	45	350	93331	32.1	26.2	1986	Art.	E.T.	749,520	360	0.18	26.7	1.90	n	
KBW- 152	Guettare 1	209510008			33	20	12. 1	7	50	28. 5	37.04193	6.11891	94	45	352	93331	30.0	12.2	1986	Art.	E.T.	326,160				1.90	n	
KBW- 153	Ferdaous 1	209510009			33	19	01. 1	7	59	35. 1	37.02002	6.28761	94	41	320	93331	33.1	37.8	1986	Art.	E.T.	1,102,853				2.70	n	
KBW- 154	R. Mastoung 6	209510012			33	20	19. 4	7	49	32. 0	37.04419	6.10147	94	45	601	93331	34.8	75.8	1986	Art.	Direct.	2,216,160	610	0.21	32.5	5.06	n	
KBW- 155	C2F1	209510017			33	18	37. 5	8	00	25. 8	37.01274	6.30326	95	42	343	93331	27.7	34.3	1993	Art.	E.T.	1,067,040	281	0.14	25.0	1.75	n	
KBW- 156	C3F1	209510016			33	18	23. 4	7	59	30. 3	37.00838	6.28613	95	42	300	93331	29.2	46.6	1993	Art.	E.T.	1,229,126	353	0.18	25.4	1.80	n	
KBW- 157	C5F1	209510015			33	17	38. 7	7	58	57. 2	36.99459	6.27592	95	45	300	93331	28.0	31.0	1993	Art.	E.T.	938,736				2.50	n	
KBW- 158	C2N1	209510014			33	19	00. 8	7	55	51. 2	37.01993	6.21851	95	45	301	93331	26.5	53.2	1992	Art.	E.T.	1,561,766	360	0.18	27.3	1.90	n	
KBW- 159	C4F1	209510018			33	17	47. 7	8	00	23. 9	36.99736	6.30268	95	42	300	93331	28.9	44.4	1993	Art.	E.T.	1,223,510				2.00	n	
KBW- 160	C4N1	209310020			33	17	57. 9	7	58	52. 2	37.00051	6.23734	95	45	300	93331	26.2	37.4	1992	Art.	E.T.	1,101,773				1.80	n	
KBW- 161	C3N1	209510019			33	18	40. 1	7	58	42. 5	37.01354	6.23434	95	45	301	93331	27.0	47.1	1992	Art.	E.T.	1,561,578	339	0.16	27.1	1.90	n	
KBW- 162	C1F2	209510025			33	19	08. 2	7	57	27. 9	37.02221	6.24836	95	45	300	93331	25.7	30.0	1993	Art.	E.T.	948,672				1.90	n	
KBW- 163	C3F2	209510027			33	18	26. 5	7	57	35. 7	37.00934	6.25076	95	45	300	93331	20.6	37.1	1993	Art.	E.T.	1,105,920				1.90	n	
KBW- 164	C2F2	209610024			33	19	15. 1	7	58	22. 5	37.02434	6.26521	95	43	300	93331	26.6	40.0	1993	Art.	E.T.	1,107,648	294	0.14	26.4	2.00	n	
KBW- 165	C5F2	209510028			33	17	36. 4	7	57	51. 8	36.99388	6.25573	95	45	300	93331	21.7	17.0	1994	Art.	E.T.	116,100	320	0.16	27.0	1.80	n	
KBW- 166	C4F2	209510032			33	18	26. 9	7	58	31. 4	37.00946	6.26795	95	45	310	93331	20.9	30.3	1994	Art.	E.T.	544,385				2.00	n	
KBW- 167	C2N2	209510033			33	19	23. 7	7	54	48. 8	37.02700	6.19956	95	43	300	93331	20.0	28.2	1994	Art.	E.T.	135,072				2.00	y	
KBW- 168	Zt. Anes Cl 5	208010042	11-12	Zt. Anes-Harth	33	47	19. 4	8	47	49. 6	37.54423	7.18097	80	35	2,229	93211	212.2	83.6	1985	Art.	C.T.	2,442,960	635	0.17	68.7	2.30	y	
KBW- 169	Menchia Cl 6	208010057	KB-5	Menchia	33	48	53. 9	8	51	35. 8	37.53636	7.25078	80	50	2,310	93211	202.3	86.4	1986	Art.	Res.	2,622,240	662	0.18	68.4	2.50	y	

KBW- 170	S. Jahad Cl 17	208010065			33	48	41.1	9	43	21.8	37.56945	7.09832	80	23	2,500	93211	205.0	107.5	1994	Art.	Res.	325,080				2.30	y	
KBW- 171	Steftimi Cl 7	208110042	KB-25	Suftimi	33	47	51.1	9	00	51.8	37.55401	7.42239	81	53	1,987	91311	178.5	50.0	1986	Art.	C.T.	1,581,120				2.70	y	
KBW- 172	Steftimi 2	208110028			33	48	00.7	9	00	43.2	37.55698	7.41973	81	52	52	91311		6.7	1961	Art.	Res.	166,406				3.60	y	
KBW- 173	Steftimi 3	208110029			33	48	00.7	9	00	43.2	37.55698	7.41973	81	52	1,005	91311	56.6	13.0	1961	Art.	Res.	411,091	595	0.18	44.7	3.42	y	
KBW- 174	Lunagues Cl 8	208110043	KB-22	Lunagues	33	46	06.4	9	04	46.3	37.52170	7.69476	81	80	1,752	91311	152.9	46.4	1985	Art.	C.T.	1,280,016	641	0.18	66.3	2.32	y	
KBW- 175	Behaer Cl 9	208110044	KB-24	Oum El Farth	33	47	12.4	9	15	23.6	37.54207	7.69146	81	48	1,621	91311	137.3	57.9	1986	Art.	C.T.	1,717,632	662	0.19	64.5	2.66	y	
KBW- 176	Om El Ferth 2	208110031			33	47	56.4	9	13	17.9	37.55565	7.65239	81	50	904	91311		35.9	1952	Art.+EMP	E.T.	488,232	534	0.24	33.7	3.38	y	
KBW- 177	Om El Ferth 3	208110032			33	47	03.5	9	14	04.8	37.53932	7.66714	81	48	503	91311	31.4	14.1	1955	Art.+EMP	E.T.	259,704	705	0.39	39.6	4.62	n	
KBW- 178	Saidane	208110039	KB-26	Saidane	33	45	09.7	9	17	41.9	37.50419	7.72414	81	80	800	91311	73.6	28.0	1985	Art.	Direct.	885,427	622	0.20	54.2	2.94	y	
KBW- 179	Mazraa Nejs 3 ter	208110033	KB-23	Mazraa Nejs	33	47	25.5	9	18	09.4	37.54611	7.74263	81	45	652	91311	8.8	44.1	1958	EMP	E.T.	666,972				4.50	y	
KBW- 180	Kadhouan	208110048		(Kadouan)	33	43	45.0	9	14	15.8	37.47805	7.67053	81	125	200	91311	-20.7	14.6	1991	EMP	E.T.	166,698	733	0.40	23.5	4.90	y	
KBW- 181	Ksar Ghalane 2	201061002	KB-53	Ksar Ghalane	32	59	13.0	9	38	21.1	36.65329	8.11661	106	198	676	94111		57.2	1963	Art.	E.T.	1,706,573	625	0.33	34.4	4.40	y	
KBW- 182	Ksar Ghalane 3/b	201061003			32	59	12.5	9	38	21.2	36.65314	8.11664	106	198	680	94111	69.4	68.6	1980	Art.	E.T.	2,109,024				4.46	n	

WELL INVENTORY - 4 (GABES)

Well Code	Name of Well	Num. IRH	No	Name of Oasis	LOCATION Latitude (N) deg	min	sec	Longitude (E) deg	min	sec	French System (G) (N)	(E)	TOPO-SHEET Sheet Num	Elevation (m)	WELL DRILLING Depth (m)	Aquifer Type	S.W.L (m)	Yield (l/s)	Drilled (year)	DELIVERY Type of extract	Delivery System	Volume (m3/year)	Water Quality - Measured by Team - E.C	Salinity (‰)	Temp (°C)	Salinity (g/l)	Others (y/n)	Note
GBW- 1	Ain zeng 3	207510007	GB=1	Ain zng	33	51	50.8	10	06	16.9	37.62800	8.63383	75	22	344	81111	20.2	120.0	1973	Art.	E.T.	1,052,784	(mS/m)	(‰)	(°C)	3.18	n	
GBW- 2	Chentech	207510013			33	51	42.1	10	06	54.5	37.62531	8.62691	75	25	274	81111	24.3	11.0	1944	Art.	(E.T)	499,133				2.96	y	
GBW- 3	Ain Temoula 1	208310026	GB=2	Temoula 1	33	47	24.1	10	08	24.6	37.54568	8.67324	83	30	238	81241	23.8	20.0	1971	Art.+EMP	E.T.	133,866				2.72	y	
GBW- 4	Ain Temoula 2	208310028	GB=3	Temoula 2	33	48	18.7	10	08	00.7	37.56191	8.66586	83	26	240	81241	29.2	13.0	1971	Art.+EMP	E.T.	107,010				2.64	y	
GBW- 5	Ain Zeng	207510003	GB=4	Zeng Dakhlania	33	51	18.2	10	06	11.4	37.617941	8.63213	83	30	324	81111	11.0	75.0	1973	Art.+EMP	E.T.	260,064				3.20	y	
GBW- 6	Teboulbou 1	208310005	GB=5	Teboulbou	33	50	14.1	10	06	43.8	37.59815	8.64213	83	27	200	81241	25.5	14.0	1933	Art.+EMP	E.T.	354,499				2.30	n	
GBW- 7	Teboulbou 4	208310021			33	50	20.5	10	06	39.5	37.60013	8.64080	83	30	126	81241	15.3	22.0	1966	Art.	E.T.	703,555				2.80	y	
GBW- 8	Teboulbou 2	208310019			33	50	03.3	10	06	53.3	37.59482	8.64506	83	26	194	81241	10.5	85.0	1964	Art.+EMP	E.T.	612,814				2.80	y	
GBW- 9	Teboulbou 8	208310039			33	50	20.5	10	06	39.5	37.60013	8.64080	83	30	175	81241	12.7	70.0	1978	Art.+EMP	E.T.	1,605,856				2.80	y	
GBW- 10	Teboulbou 1 b	208310064			33	50	13.6	10	06	59.9	37.59800	8.64710	83	27	153	81241	12.0	49.0	1985	Art.	E.T.	1,208,182				2.76	n	
GBW- 11	Teboulbou 4 b	208310119			33	50	04.9	10	06	47.4	37.59531	8.64324	83	27	133	81241	11.2	26.0	1988	Art.	E.T.	862,358				2.80	y	
GBW- 12	Chenini Nord	207510091	GB=6	Oasis de Gabes	33	52	33.5	10	03	08.5	37.64118	8.57506	75	50	97	81121	12.4	71.0	1983	Art.+EMP	E.T.	1,061,572	402	0.19	29.2	3.02	y	Pilot Area 1
GBW- 13	Oued Lousaf	207510183			33	52	58.7	10	03	28.4	37.64854	8.58182	75	40	122	81121	3.0	89.0	1985	EMP	E.T.	1,245,917	404	0.19	28.6	2.86	y	
GBW- 14	Sed Rehs	207510054			33	51	45.3	10	03	35.7	37.62630	8.58407	75	25	296	81111	7.8	24.5	1980	Art.+EMP	E.T.	135,393				2.98	n	
GBW- 15	Sidi Bou Abdellah	207510056			33	53	05.8	10	04	41.8	37.65115	8.60447	75	20	184	81111	13.4	80.0	1981	Art.+EMP	E.T.	1,434,499				2.96	y	
GBW- 16	Ras Layoun	207510055			33	51	55.8	10	02	27.6	37.62954	8.56306	75	45	154	81121	0.1	90.0	1981	EMP	E.T.	1,331,035				2.96	y	
GBW- 17	Sidi Abdedhaher	207510048			33	52	36.8	10	03	52.5	37.64220	8.58926	75	30	137	81111	10.0	80.0	1976	Art.+EMP	E.T.	1,171,883	421	0.19	30.2	3.02	y	
GBW- 18	Sidi Daoued	207510049			33	53	43.1	10	05	03.6	37.66266	8.61120	75	20	199	81111	22.6	61.0	1976	Art.	E.T.	2,054,160				2.90	y	
GBW- 19	Limaoua 1	208310032	GB=7	Limaoua 1 et 2	33	45	16.3	10	05	17.5	37.50623	8.61549	83	70	118	81241	12.0	44.0	1973	EMP	Dir.(AC)	687,485				2.60	y	Pilot Area 2
GBW- 20	Limaoua 2	208310114			33	44	06.6	10	04	49.9	37.48472	8.60697	83	80	162	81241	-25.9	40.0	1987	EMP	E.T.	637,961				2.68	y	
GBW- 21	M'dou 2	208310023	GB-8	M'dou	33	48	06.9	10	04	33.5	37.55889	8.60191	83	45	300	81231	0.4	24.0	1966	EMP	E.T.	467,078	343	0.18	23.9	2.44	y	
GBW- 22	Chett El Fferq 1 bis	207510191	GB-9	Chett El Ferik	33	52	59.6	10	03	46.3	37.64924	8.58734	75	30	150	81131	11.5	18.0	1990	Art.+EMP	E.T.	153,000				2.72	y	
GBW- 23	Jebel Dissa	207510019		(Dissa)	33	53	24.1	9	58	58.5	37.65680	8.49852	75	70	50	81131	-28.0	10.0	1958	DEP	E.T.	81,562	462	0.25	22.6	2.88	y	
GBW- 24	Boucherrma 2	207510007	GB-10	Boucherrma	33	53	49.0	10	03	27.8	37.66448	8.58164	75	40	170	81131	0.4	40.0	1958	EMP	E.T.	812,448	430	0.20	29.3	3.00	y	
GBW- 25	Boucherrma 3 bis	207510025			33	54	08.0	10	03	46.7	37.67035	8.58747	75	35	201	81121	15.0	40.0	1963	EMP	E.T.	575,316				4.18	y	
GBW- 26	Mahjoub 2	207510046	GB-11	Mahjoub	33	55	55.4	10	02	35.3	37.70350	8.56543	75	40	94	81131	0.9	85.0	1975	EMP	Dir.(AC)	991,274	437	0.21	28.1	3.38	y	
GBW- 27	Mahjoub 3	207510051			33	55	42.4	10	03	08.0	37.69949	8.57552	75	35	169	81131	3.0	85.0	1977	EMP	Dir.(AC)	1,058,832				3.20	y	
GBW- 28	Dhahra 1 bis	207510086			33	56	21.5	10	02	52.2	37.71156	8.57065	75	30	111	81121	7.7	87.0	1981	Art.+EMP	E.T.	1,280,779				3.16	y	
GBW- 29	Riguet Hamma	207510087	GB-12	Salem	33	55	10.0	10	03	32.6	37.68949	8.58312	75	30	130	81121	1.4	70.0	1982	EMP	Dir.(AC)	924,930	432	0.21	28.3	3.12	n	
GBW- 30	Sbeau 2	207510052	GB-13	Sbeau	33	56	00.6	10	03	56.8	37.70511	8.59059	75	20	195	81141	11.0	60.0	1979	Art.+EMP	Dir.(AC)	878,821				3.08	y	
GBW- 31	Bir Hassen 1 bis	207510085	GB-14	Faycal	33	56	52.1	10	02	30.0	37.72100	8.56380	75	22	115	81131	8.3	60.0	1982	Art.+EMP	Dir.(AC)	735,228	410	0.20	27.6	3.66	y	
GBW- 32	Faycal 2	207510044			33	56	25.4	10	03	45.0	37.71276	8.58694	75	20	103	81142	16.9	15.0	1974	Art.	E.T.	473,040	443	0.21	28.8	3.36	n	
GBW- 33	Faycal 4	207510092			33	56	50.6	10	03	34.6	37.72054	8.58373	75	15	189	81141	18.2	39.0	1984	Art.	E.T.	1,299,456				2.21	n	
GBW- 34	Mziraa Ghan. 1	207510187	GB-15	M'zirao	33	57	42.9	10	03	10.5	37.73668	8.57630	75	15		81141	10.1	14.0	1988	Art.+EMP	E.T.	1,597,622				3.66	y	
GBW- 35	Mzirao Ghan. 2	207510195		Chennouch	33	57	44.1	10	02	14.9	37.73705	8.55916	75	20		81141	10.7	75.0	1992	EMP	E.T.	264,600				3.10	n	
GBW- 36	Methoura 1 bis	207510194	GB-16	Methoura	33	57	41.8	9	59	26.5	37.73634	8.50716	75	30	100	81141	2.0	20.0	1987	EMP	Dir.(AC)	195,494				2.94	y	
GBW- 37	Methoura 4 ter	207510186			33	58	19.3	10	00	10.7	37.74792	8.52080	75	20	100	81141	1.9	40.0	1987	EMP	Dir.(AC)	660,528				3.88	y	
GBW- 38	Methoura 5 ter	207510193			33	57	31.3	10	01	10.1	37.73310	8.53914	75	28	79	81141	0.3	40.0	1975	EMP	Dir.(AC)	415,739	438	0.17	24.0	3.44	y	
GBW- 39	Methoura 8 ter	207510192			33	57	59.8	9	59	55.2	37.74190	8.51602	75	25	95	81141	1.9	20.0	1992	EMP	Dir.(AC)	397,678				3.76	y	
GBW- 40	Goutfa 2 bis	207510184	GB-17	Ouedhref	33	59	52.8	9	58	33.3	37.77678	8.49074	75	28	90	81141	1.0	45.0	1987	EMP	E.T.	806,861	408	0.22	22.6	3.38	y	
GBW- 41	Goutfa 3 bis	207510088			34	00	08.5	9	59	10.4	37.78162	8.50219	75	23	90	81141	1.0	70.0	1982	EMP	E.T.	489,431				3.26	y	
GBW- 42	Ouedhref 19 bis	207510089			33	59	17.0	9	57	52.2	37.76573	8.47806	75	30	65	81141	1.7	40.0	1982	EMP	E.T.	757,915				3.18	y	
GBW- 43	Aouanette 1 ter	19585	GB-18	Aouanette	34	01	18.9	10	00	45.4	37.80335	8.53151	75	22	70	81141	0.0	35.0	1987	EMP	E.T.	50,400	542	0.29	24.2	3.80	n	
GBW- 44	Oued El Malah 4	207510022			34	00	10.6	9	59	56.6	37.78227	8.51645	75	20	143	81141	1.4	26.0	1983	Art.	E.T.	801,446				3.35	y	
GBW- 45	El Hicha	18767		(Hicha)?	34	09	49.8	9	59	24.9	37.94253	8.50667	69	18	200		5.2		1978		E.T.		741	0.39	24.9	5.82	n	
GBW- 46	Chenchou 1	207410006	GB-19	Chenchou 1	33	53	52.1	9	52	24.5	37.66544	8.37691	74	75	531	91231	-20.5	32.0	1959	EMP	C.F.	801,731	604	0.22	(48.7)	3.08	y	temp is not sure
GBW- 47	Chenchou 2 bis	207410073	GB-20	Chenchou 2	33	53	37.6	9	53	52.6	37.66097	8.40411	74	65	90	91231	-25.1	22.0	1990	EMP	Dir.(AC)	410,904				4.46	y	
GBW- 48	Tekoun 2	207410064	GB-21	Tekoun	33	53	38.6	9	48	38.0	37.66127	8.30639	74	75	45	91241	-12.9	20.0	1988	EMP	E.T.	313,993	624	0.26	38.6	3.66	y	
GBW- 49	Hamma 2 bis	207410059	GB-22	Hamma Oasis	33	53	56.3	9	47	43.7	37.66674	8.29025	74	70	50	91231	-1.8	85.0	1982	EMP	E.T.	337,561	676	0.29	35.5	3.54	y	
GBW- 50	Ain bory 1 bis	207410060			33	53	01.7	9	47	41.1	37.64988	8.28945	74	70	152	91231	-4.9	24.0	1986	EMP	E.T.	517,104				3.80	y	
GBW- 51	Source Abdelkade	207410017			33	53	00.2	9	47	35.0	37.64942	8.28756	74	70	153	91231		42.0	1971	EMP	(Bath)	179,820	695	0.27	(41.6)	3.80	n	temp is not sure
GBW- 52	Sombat 2	208210011	GB-23	Mzirao Hamma	33	52	17.7	9	45	39.9	37.63650	8.25206	82	56	267	91221	-4.2	30.0	1973	EMP	E.T.	727,531	468	0.22	29.6	3.28	y	

GBW- 53	Oued Hamma		GB-24	Bechuma 1	33	52	51.2	9	45	47.7	37.64664	8.25445	74	53		91221		60.0		EMP	E.T.	76,118				4.06	n	
GBW- 54	Mzaraa 1 bis	208210014			33	52	00.6	9	45	27.5	37.63103	8.24821	82	58	600	91231	-12.0	38.0	1980	EMP	E.T.	615,053				3.66	y	
GBW- 55	Mzaraa 3 bis	207410075			33	51	19.4	9	46	45.2	37.61831	8.27219	82	66	400	91231	-5.1	40.0	1993	DEP	C.T.	250,646	681	0.19	65.7	3.00	n	
GBW- 56	Chott Fejaj 3 bis	207410022	GB-25	Bechuma 2	33	54	52.2	9	41	06.1	37.68399	8.16753	74	48	860	91111	93.1	92.0	1983	Art.	C.T.	2,901,312	484	0.10	63.8	3.93	y	
GBW- 57	Chott Fejaj 1 bis	207410025	GB-26	Khebayet	33	54	33.2	9	39	41.7	37.67813	8.14149	74	45	866	91111	73.0	82.5	1984	Art.	C.T.	2,466,374	633	0.17	63.5	2.72	n	
GBW- 58	Chott Fejaj 2 bis	207410062	GB-27	Ben Ghuleuf	33	53	26.2	9	36	00.8	37.65745	8.07331	74	48	1100	91111	87.3	71.0	1987	Art.	C.T.	2,832,797	517	0.15	68.2	2.72	y	
GBW- 59	Chott Fejaj 2	207410005	GB-28	Club Dokhane	33	53	59.3	9	34	20.0	37.66766	8.04220	74	45	1324	91111	140.0	58.0	1951	Art.	C.T.	1,789,949	265	-	66.1	2.80	y	
GBW- 60	Oued Nakhla	208210043	GB-29	Oued Nakhla	33	51	28.7	9	28	43.0	37.62118	7.93818	82	45	450	91111	11.1	35.0	1987	Art.+EMP	E.T.	275,746	541	0.24	33.5	4.52	n	
GBW- 61	Chenchou 9	207410012		(OEP)	33	52	39.3	9	53	09.6	37.66149	8.39083	74	70	47	91231	-18.9	100.0	1974	EMP	E.T.	283,622				3.30	y	
GBW- 62	Chenchou 10	16699			33	55	29.8	9	53	48.9	37.69560	8.40296	74	60	135	91231	-14.0	34.0	1974	EMP	E.T.					3.45	n	
GBW- 63	Chenchou 8	208210034			33	52	03.2	9	52	50.7	37.63183	8.38500	82	80	100	91231	-31.5	99.5	1970	EMP	E.T.	1,051,949				3.30	y	
GBW- 64	Chenchou 4 bis	207410065			33	53	31.8	9	52	19.4	37.65911	8.37534	74	80	100	91231	-30.5	90.0	1986	EMP	E.T.	1,314,432				3.15	y	
GBW- 65	Beni Aissa Sud	208210023		(Beni Aissa)	-	-	-	-	-	-	-	-	-	-	123	91231	-59.4	8.0	1976	DEP	E.T.	64,080				3.26	y	could not visit
GBW- 66	Oued Gona	208210039		(Gona)	-	-	-	-	-	-	-	-	-	-	180	91231	-43.7	7.0	1976	DEP	E.T.	28,436				2.86	n	could not visit
GBW- 67	Chenchou 5 bis	207410067		(IRA)	33	52	52.4	9	53	24.6	37.64701	8.39546	74	77	90	91231	-31.8	20.0	1974	EMP	E.T.	245,887	574	0.25	34.6	3.80	y	
GBW- 68	Chenchou 16	208210030		(Geprim-Sanitec)	33	52	52.8	9	52	20.4	37.64708	8.37565	64	80	100	91231	-34.0	40.0	1983	EMP	E.T.	643,378	427	0.11	54.0	3.75	y	
GBW- 69	El Hamma Sud	207410074		(Oued Ennour)	33	51	57.4	9	47	42.1	37.63004	8.28976	82	68	179	91231	-4.7	53.0	1988	EMP	E.T.	809,689				5.36	y	
GBW- 70	Arram 1	208310013	GB-30	Arram	33	35	40.4	10	19	25.3	37.32847	8.87716	83	51	614	81231	10.6	52.0	1987	Art.+EMP	E.T.	817,488				2.42	y	
GBW- 71	Arram 2 bis	208310011			33	35	13.4	10	19	50.7	37.32014	8.88500	83	55	614	81231	3.9	36.0	1987	EMP	E.T.	521,892	350	0.17	27.2	2.64	y	
GBW- 72	Mareth 1 ter	208310113	GB-31	Mareth 1	33	37	30.4	10	17	01.0	37.36242	8.83262	83	55	250	81241	0.3	60.0	1986	EMP	E.T.	903,694				2.54	y	
GBW- 73	Mareth 8 bis	208310121	GB-32	Mareth 2	33	38	37.7	10	18	42.9	37.38320	8.86407	83	42	228	81231	6.0	50.0	1989	Art.+EMP	Dir.(AC)	1,204,787	360	0.16	31.7	2.50	y	
GBW- 74	Mareth 2 bis	208310104			33	38	13.9	10	18	33.6	37.37585	8.86120	83	43	481	81231	7.6	47.0	1986	Art.+EMP	Dir.(AC)	892,228				2.60	y	
GBW- 75	Mareth 3 bis	208310105	GB-33	Mareth 3	33	37	01.4	10	17	59.2	37.35347	8.84873	83	52	268	81241	2.4	20.0	1986	EMP	E.T.	122,198	278	0.13	23.1	2.56	y	
GBW- 76	Mareth 5 ter	208310109	GB-34	Mareth 5	33	38	06.3	10	17	55.2	37.37350	8.84935	83	48	278	81241	6.6	69.0	1987	Art.+EMP	E.T.	1,143,659				2.58	y	
GBW- 77	Mareth 6 bis	208310027	GB-35	Mareth 6	33	37	19.5	10	18	40.7	37.37906	8.86339	83	45	611	81231	9.0	50.0	1992	EMP	E.T.	491,717				2.68	y	
GBW- 78	Zarat 1	208310014	GB-36	Zarat 2	33	38	24.2	10	19	46.6	37.37903	8.88373	83	33	505	81231	22.3	35.0	1949	Art.	Direct.	1,153,786				2.43	n	
GBW- 79	Zarat 2 bis	208310115			33	38	11.5	10	19	22.1	37.37511	8.87617	83	38	354	81231	10.4	43.0	1987	Art.	Direct	1,217,894				2.72	n	
GBW- 80	Zerkane 4	208310030	GB-37	Zerkane 1 et 3	33	42	04.4	10	15	55.6	37.44700	8.81244	83	52	231	81241	24.2	66.0	1971	Art.+EMP	Dir.(AC)	1,376,944				2.72	y	
GBW- 81	Zerkane 2	208310012	GB-38	Zerkane 2	33	41	11.6	10	13	35.4	37.43070	8.76916	83	47	254	81241	18.1	75.0	1948	Art.+EMP	E.T.	744,898	323	0.15	-	2.44	y	
GBW- 82	Zerkane 2 bis	208310110			33	41	11.6	10	13	35.4	37.43070	8.76916	83	47	270	81241	7.3	75.0	1987	Art.+EMP	E.T.	980,794				2.56	y	
GBW- 83	Ayoun Zerkane	208310106	GB-39	Ayoun Zerkane	33	39	12.7	10	13	36.8	37.39400	8.76960	83	50	154	81241	-1.6	20.0	1986	EMP	Dir.(AC)	296,888				2.64	y	
GBW- 84	Z. Tnolet	208310010	GB-40	Madissa	33	41	15.1	10	09	09.4	37.43178	8.68707	83	78	188	81241	20.6	15.0	1938	Art.+EMP	Direct.	250,776	238	0.17	26.7	2.50	y	
GBW- 85	Zerkane CEPA	208310059		(CEPA)	33	40	41.8	10	15	38.3	37.42150	8.80710	83	40	250	81241	17.9	50.0	1984	Art.	Direct	1,751,846	349	0.17	26.5	2.60	y	
GBW- 86	Kettana 1 bis	208310029	GB-41	Kettana 1	33	45	25.6	10	12	21.2	37.50910	8.74626	83	28	262	81241	19.0	50.0	1971	Art.+EMP	E.T.	962,266				2.60	y	
GBW- 87	Kettana 3	208310006	GB-42	Kettana 3	33	45	02.6	10	11	25.1	37.50200	8.72895	83	35	216	81241	27.8	30.0	1934	Art.	E.T.	806,890	333	0.17	25.3	2.60	y	
GBW- 88	Kettana 3 bis	208310117			33	45	02.6	10	11	25.1	37.50200	8.72895	83	35	225	81241	14.6	28.0	1988	Art.	E.T.	809,050				2.72	y	
GBW- 89	Kettana 4	208310015	GB-43	Kettana 4	33	44	54.4	10	10	58.5	37.49947	8.72074	83	40	303	81241	19.5	19.0	1950	Art.	E.T.	549,158	340	0.17	25.2	2.60	y	
GBW- 90	Kettana 4 bis	208310108			33	44	54.4	10	10	58.5	37.49947	8.72074	83	40	240	81241	10.1	21.0	1987	Art.+EMP	E.T.	630,720				2.68	n	
GBW- 91	Sidi Sellam	208310038	GB-44	Sidi sellam	33	43	27.2	10	11	46.6	37.47256	8.73620	83	47	271	81241	12.0	60.0	1977	Art.+DEP	E.T.	1,019,959	335	0.17	25.5	2.54	y	
GBW- 92	Zeng Remrem 1 b	208310123	GB-45	Zeng Remrem	33	43	58.2	10	09	20.0	37.48212	8.69034	83	50	257	81241	18.0	40.0	1988	Art.+EMP	Dir.(AC)	811,017				2.66	y	
GBW- 93	El Ghandri	208310124	GB-46	Ghandri	33	42	52.5	10	08	08.3	37.46185	8.66821	83	70	187	81241	-11.7	25.0	1990	DEP	E.T.	172,080				2.90	n	
GBW- 94	Matmata 1	208310025	GB-47	Lasradh 1	33	40	44.1	10	00	00.2	37.47221	8.51756	83	140	228	81221	71.7	22.0	1968	EMP	E.T.	154,278	368	0.22	18.8	3.18	y	
GBW- 95	Matmata 4	208310056	GB-48	Lasradh 3	33	40	05.1	10	00	35.4	37.41017	8.52843	83	140	169	81221	77.0	36.0	1981	EMP	E.T.	236,155	408	0.21	26.3	3.18	n	

3.4. Summary and Conclusion

3.4.1. Summary

Water resources of all target oases and of several other oases important for the study, were directly checked by the Hydrogeologist of the Study Team cooperating with the hydrogeologists and/or engineers of each CRDA. Water resource(s) for each oasis, most of them are deep tube wells though, were checked their current situation, surveyed their location by GPS, and measured their water quality when it is available. In the case of tube well, further detail information such as the well depth, constructed year, aquifer type, yield, results of chemical analysis, and so forth were collected later.

Based on the field check and data collected, the "Inventory of Oasis Water Resources" and "Well Inventory" for each Province were prepared separately.

In the former, water resources of each oasis were simply classified into D.T.W (Deep Tube Well), Dug-well, Natural Spring, River, and Pipe Line Supply from the other site(s). For every cases, an application system, an average information and index for tube well when the source was well, and water quality are listed.

During the total field survey periods, more than 400 of tube wells and some other water sources were checked and further information on them were also collected by the Team. These information were summarized as "Well Inventory" individually but in closed relation in between/from the "Water Resources Inventory" explained above, because the well information were too much in many aspects to be described in the one sheet together with the latter. The inventory has main five information of a location, a topo-sheet, a well drilling, a delivery and a water quality, besides the name and code numbers (well code by the Team and IRH of DGRE).

These inventories are shown in the previous pages, and the further detail chemical analysis data and location map of wells are attached in the annex.

3.4.2. Conclusion

Based on the field survey and data collection, two kinds of inventories, "Water Resources Inventory" and "Well Inventory" were prepared by the Team. These are, however, having closed relation but not yet systematically related. To shift them into so called relational data base is recommendable.

B4. Field Hydrogeological Survey

B4.1. Background

At the most of Oases included in the Project, the water resources for irrigation are mainly groundwater, and the groundwater in these areas are usually brackish much or less. Especially at the region where they utilize the deepest aquifer represented by C.I., the irrigation water is considerably brackish. Mostly in these areas, a salinity contents of soil is also high, and a trend of over-irrigation to leach out the salinity is observed, of course depending upon the grade of salinity contents and the groundwater availability as well.

While in the Southern Tunisia, it is reported that gypsum or other evaporites are widely distributed at shallow depth, ranging from 1.0 to 1.5m below the ground surface. As a general speaking, the gypsum layer or the other evaporites are hardly permeable (aquiclude). When the area underlain those evaporites is over-irrigated, the water cannot permeate across the layer and stagnate above such aquicludes. And when the supply of irrigation water is interrupted, the stagnant water shall move upward by a capillary phenomenon and evaporate out, leaving the dissolved chlorides in the ground. If the irrigation water itself were originally saline, the salinization of the ground through this mechanism is highly emphasized.

Through the First Field Survey, gypsum layers were found out in some oases under the Project. Thus, the Tunisian counterpart, and the Study Team, worried about the further salinization of the oasis through the irrigation, and the requirement to know the situations of gypsum layer distribution and the permeability of the ground was arose. Although the surveys on gypsum layer and permeability were not included in the original TOR, the Supervising Committee on the Project and JICA accepted the proposal of the Consultants on this matter and the survey was carried out in the Second Field Survey term.

The hydrogeological survey includes two purposes as shown below;

- to know the situation of gypsum layer distribution,
- to grasp the condition of permeability of the ground.

The outline of the survey on each purpose and the results on them shall be explained and/or discussed in the following sections one by one.

B4.2. Gypsum Survey

4.2.1. Gypsum soil

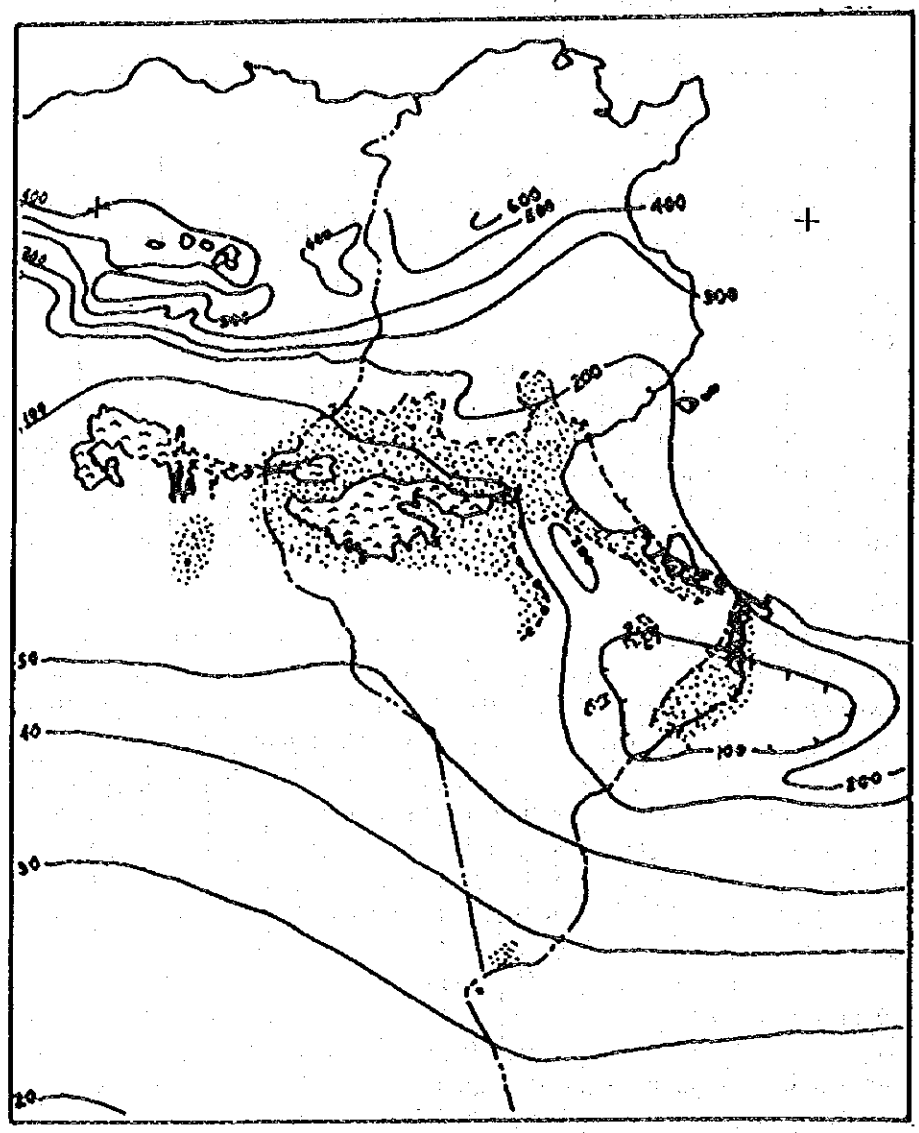
Gypsum soils do occur in several desert regions of the world, and Tunisia is well known as one of the countries extensively covered by them. Chemically, gypsum is calcium sulfate with two water molecules attached ($CaSO_4 \cdot 2H_2O$), and two other kinds of calcium sulfates exist naturally: anhydrite ($CaSO_4$) and hemihydrite ($CaSO_4 \cdot 1/2H_2O$). The most common natural occurrences of calcium sulfate are as a gypsum precipitation from evaporation of modern saline lake and as layers of anhydrite or gypsum in bedrock (Delano, 1983). The latter beds are commonly seen in the mountain ranges surrounding Chotts. And the former is just remarkably observed in the Chotts such as El Jerid, Gharsa or Fejej.

In general, a "gypsum soil" means a soil or soil layer which contains much gypsum component, or consisted of only gypsum grains. It appears as sand with some characteristic colors (creamy yellow brown to milky white), and is consolidated as hard crust sometimes but only when it is dry. There are two ways to cause gypsum soil; one is of course a simple fluvial deposition from gypsum-rich parent materials such as rock gypsum, and another is secondary accumulation in soil from water saturated by calcium sulfate. On the latter phenomena, there

are also two hypotheses; one is that water rich in calcium sulfate percolates downward and deposits it at a shallow depth, and one is that groundwater rich in calcium sulfate rise by capillarity through the soil and evaporate. Both phenomena should be happening in parallel but the former should be the major mechanism to cause gypsum soil in this area (W. Delano Page, 1983).

The sulfate is very soluble in water, therefore, any kinds of sulfates have been leached out by rain even though there were much gypsum-rich parent materials. It is believed that the gypsum must be leached out by rain if the annual rain-fall is more than approximately 175 mm. On the contrary, water can not erode the gypsum-rich material, nor concentrate sulfate in it, when annual rain-fall is too less (approximately less than 50 mm). Further, the solubility of gypsum in H_2O is high in the temperature range from 16 to 40℃, and the highest at 20℃. While, mean annual temperatures of target four provinces are from 18.8 to 21.5℃. Those are the reasons why gypsum soil is commonly observed in this area. Figure 4.2.1. indicates the relationship of mean annual precipitation (in mm) and distribution of gypsum soil.

Figure 4.2.1. Distribution of gypsum soil



Relationship of mean annual precipitation (in mm.) to gypsum encroûtement (stippled) in southern Tunisia. (Rainfall data from Dubief, 1963).

4.2.2. Field Survey on Gypsum Soil

a) General

In the South and a part of the Central Tunisia, especially in the low-lying zone from Chott El Djerid to Gulf of Gabes, the gypsum soil is rather commonly observed, as mentioned in the previous section. They said, it harms normal growing of plants sometimes and is one of the obstacles to develop new oases. Among the 153 of target oases for the Study, around 90 oases are underlain or covered by gypsum soil, seriously or slightly. Thus, a gypsum survey using Hand Auger was planned and conducted at 11 oases in the four provinces.

The total numbers and the linear length of the hand auger boring conducted in this period are shown in the Table 4.2.1.

Table 4.2.1. Work Volume of Hand Auger Boring

Province	Oasis Name	Number of Boring	Linear Length (m)
Gafsa	Sud Ouest	6	10.8
	Oued Shili	6	16.5
Tozeur	Tozeur	10	40.1
	Draa Sud	7	20.8
Kebili	Ras El Ain	8	39.3
	Guetaya	7	29.6
	Mazraa Neji	7	26.8
	Regim Maatoug 2	6	14.5
Gabes	Oasis de Gabes	7	29.1
	Methouia	7	30.7
	Aouinette	7	15.8
Total	11 Oases	78	274.0

b) Methodology

The survey on gypsum layer was conducted by the means of a "Hand-Auger Boring". The hand-auger is the simplest boring device driven by man power, and it can drill through the ground around 5 meters in normal soil condition. In the case encountered to the semi-consolidated layer such as gypsum or evaporites, a screw type bit should be applied instead of a normal post-hole type bit.

At each boring point, a soil-log was taken through hand-auger boring up to the depth about 5 meters. Of course it could not drill through rocks, or hardly consolidated layer, so the boring should be stopped at the depth where it encountered with such hard layers, even though it was within 5 meters in linear length. Soil samples at each one meter interval were taken from the boring, and some 40 typical samples were sent to the Central Reserch of MOA for laboratory soil classification test. The soil characteristic logs taken thus were attached at the end of this section, and the report from the Central Reserch is attached in Appendix.

c) Target oasis and the points for the survey

Prior to the actual field survey in each Province, the target oases to be surveyed were determined through a discussion with the engineers or pedologists of CRDA. As a rule, the target oases were selected as the heaviest, moderate, and slightly underlain by gypsum soil among the oases involved in the Project.

At the oasis determined to be surveyed, the boring points were allocated by the Hydrogeologist through the reading of oasis planning map of 1:2,000. scale (or topo-map when it s not available) and by the actual reconnaissance of the oasis. The number of

boring were at least 6 points to cover the whole area when it was small, or at the most important area of the oasis when it was a large oasis, and to be able to grasp the gypsum layer distribution in three dimensionally.

The each boring points were, after completion of boring, measured their exact positions by GPS and converted to the French Grad system later to make up the location map .

4.2.3. Results of the Survey –Gafsa Province–

a) General situation

As a general speaking, Gafsa province is located in comparatively high land, and most of the target oases situate on huge fan deposit, so that they have almost no severe problem on drainage. By the situation, the province was not included in the targets on gypsum survey at first. Later on but rather early stage, the province was added into the target on survey based on the further exact information.

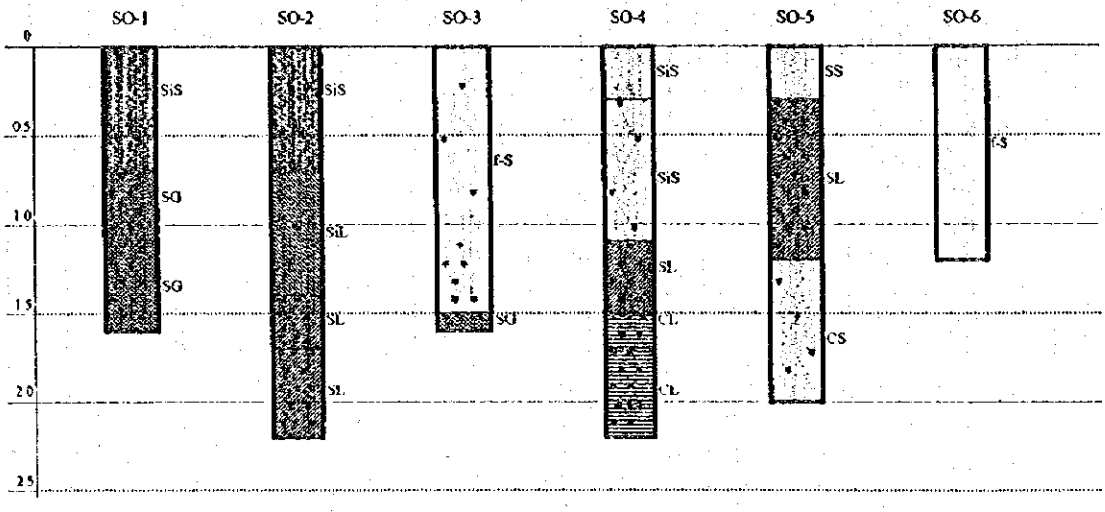
Among eight (8) of oases involved in the Study, the two oases of Sud Ouest and Oued Shili were underlain by gypsum soil, and then, these two oases were surveyed in this period. Besides them, Kasba and El Ksar oases were said to have some gypsum soil but very slightly as negligible. Rather severe problem related to gypsum has occurred in a certain newly developed oasis but it is not included in this Study (i.e. Neguez).

The location of these oases is shown in Figure 4.2.13. (a) and (b) because they are far apart each other. Positions of auger–borings are shown in Figure 4.2.14. and Figure 4.2.15. for Sud Ouest and Oued Shili respectively. In the both figures, (a) is the location map with contour lines and (b) is so–called bird–eye s figure of the area.

b) Sud Ouest Oasis

Sud Ouest is one of the three oases consisting Gafsa Oasis. As shown in Figure 4.2.14., total six (6) borings were drilled here. The area covered by the boring is almost half of the total area, at the central portion of oasis. Results of hand–auger borings are shown as Soil Logs at the appendix and summarized as Figure 4.2.2.

Figure 4.2.2. Results of hand–auger borings (Sud Ouest)



As shown in the above figure, there is no boring which could reach to 5 m in depth. Most of them were stopped to drill at the range between 1.6 and 2.2 m, and the

shortest one is only 1.2 m in depth, mainly because of the hardness of the ground consisted of sand-gravel. No groundwater table was detected in these depths.

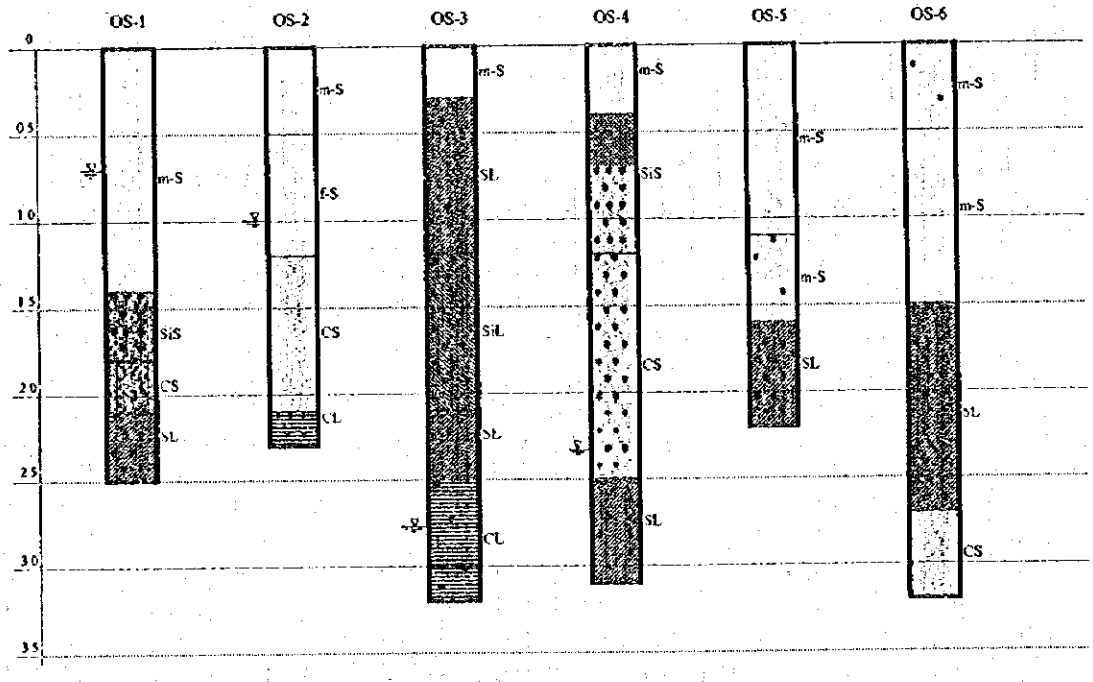
The oasis was developed on an alluvial fan deposits, nevertheless, some loamy layers such as Sandy Loam or Clayey Loam were encountered in 2, 3 holes. These are, however, seemed to be discontinued because groundwater table is not shallow, lower than 2.2 m from the ground surface at least.

Occurrences of gypsum in this oasis are classified into two styles, one is gypsum sand fill in sandgravel layers, and another is gypsum sand patch in loamy layers. The source of them, in both cases, shall be a hard gypsum block once precipitated and exposed on the ground. Gypsum blocks were eroded again and included as gravel in sandgravel layers sometime, or buried in loamy layers sometimes. And in both cases, they were easily weathered into sand, gluing the surrounding gravel in the case included in sandgravel or forming white gypsum patch in the case buried in loamy layers. In any rate, they are still sand as a soil texture (sometimes it became very fine though), and shall cause no trouble on the drainage condition of the ground.

c) Oued Shili Oasis

Oued Shili Oasis locates far apart from Gafsa city, near to the border with Tozeur Province. The area is very flat alluvial plain, opened toward Chott El Gharsa. At the oasis, total six (6) hand-auger borings were curried out. Location of boring and the bird-eye s figure are shown in Figure 4.2.15. (a) and (b). results of borings are summarized as Figure 4.2.3., shown below.

Figure 4.2.3. Results of hand-auger borings (Oued Shili)



In this oasis also, all borings had been stopped to drill at less than 3.5 m in depth, mainly because of hardness and/or stickiness of loamy layers. The oasis situate on an alluvial plain, nevertheless all of the borings encountered with no sandgravel layer, considerable amount of fine grain layers such as silty loam or clayey loam for instead. Groundwater table was detected in the borings of OS-1 to OS-4 but OS-5 and OS-6. The

groundwater table is very shallow at OS-1 and OS-2, and deeper than 2.3 m at the other boring sites. However, the level must be tentative, because the zone near OS-1 was just irrigated.

The oasis area had ever been covered by hard gypsum crust of 20 to 30 cm of thickness, and they were excavated off when the oasis was constructed. Such situation can be observed at near around OS-4 site still now.

Gypsum in this area is distributing as gypsum sand layers (or gypsum rich sand as more exact saying) with a characteristic color of creamy yellow brown, although it shifts to loamy layer as a soil texture sometimes. The occurrence of them shall be a simple alluvial sand deposition, and the source was almost pure rock gypsum contained in the mountain ranges near around Gafsa city. Semi-consolidated secondary gypsum crusts are observed at upper part of OS-4. The main body of gypsum sand distributes throughout the oasis at the depth from 1.3 to 2.5 m, excepting OS-4.

Originally, most of the layers underlying near around the area should be gypsumferous, however, the gypsum contained in the upper part of the ground, at the major part of oasis, has already been leached by irrigation water because a gypsum is easily leached away by water. The area near OS-4 is just outer hedge and not yet enough irrigated to leach away gypsum, so that the site has still thick gypsum sand layer. The gypsum included in a sandy soil is easily leached out but the one contained in loamy layer is rather hardly leached out because of the difference of permeability of the layer. It is one of the reason that most of loamy layers in this oasis have gypsum. However, such situation that the gypsum sand mainly distributes around the depth of 1.5 m, regardless it s sand or loam, means the drainage level is also nearly that depth. And the reason why the drainage water level is such high is a distribution of silty or clayey loam of semi-pervious to impervious, underlying at 2.0 to 2.5 m of depth.

4.2.4. Results of the Survey -Tozeur Province-

a) General situation

Most of the area of Tozeur Province is occupied by salty lakes of Chott El Gharsa and El Jerid, otherwise by sand dunes. Only the area of human activities, and the distribution of oases also, is limited at along the very narrow zone so called Tozeur corridor which separates two huge salt lakes above mentioned.

In the province there are 30 oases involved into the Project, and among them 14 oases are said to be underlain by gypsum soil, severely or slightly (refer to the Water Resources Inventory). And two of actual gypsum survey targets: Tozeur and Draa Sud Oases, were selected out through the discussion between the Study Team and engineers of CRDA Tozeur. The guide map on these oases is attached as Figure 4.2.16. The location of borings, as well as bird-eye s figures, are shown as Figure 4.2.17. and 4.2.18., (a) and (b), respectively.

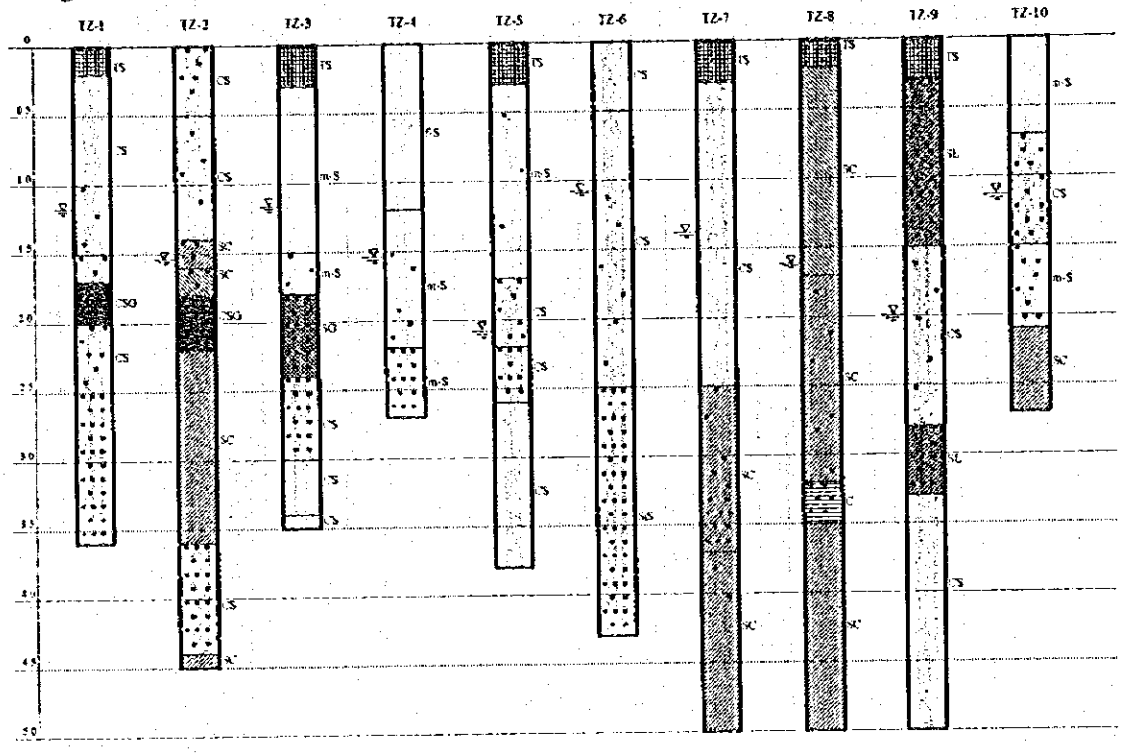
b) Tozeur Oasis

As shown in such figures mentioned above, total 10 hand-auger borings were drilled in this oasis. The number of 10 borings is the largest among all oases surveyed but the survey density is rather pale because the area is very wide.

Results of borings are summarized as Figure 4.2.4. at next page, and the soil characteristic logs are attached in Appendix.

Three borings out of 10 (TZ-7 to 9) were drilled to the depth of 5 m and the shortest borings were 2.7 m (TZ-4 and 10). The average depth of the borings was 4.0 m, and the major reason to stop drilling was too hard to drill by man-power. The depth of

Figure 4.2.4. Results of hand-auger borings (Tozeur Oasis)



groundwater table detected through hand-auger varies from 1.10 m (TZ-6) to 2.10 m (TX-5), around 1.48 m in an average.

As clearly shown in Figure 4.2.17. (b), the oasis was developed on the lake side terrace opened to Chott El Jerid, and therefore, the ground surface is very flat and gently
inclined towards south-east. Terrace deposits at this oasis are mainly sand but including considerable amount of clayey layers. At the north-western hedge, a small sandgravel layer distributes locally. The borings of TZ-1, 2, 5, 6, and 10 encountered with a weathered rock zone at their bottom, and it means the surface configuration of bed rock is not simple but rather complicated. An underground ridge of bed rock seems to be extended from TZ-6 site to TZ-1 site through TZ-5 site, and it may have some relation with thick clay layers at TZ-7 and TZ-8.

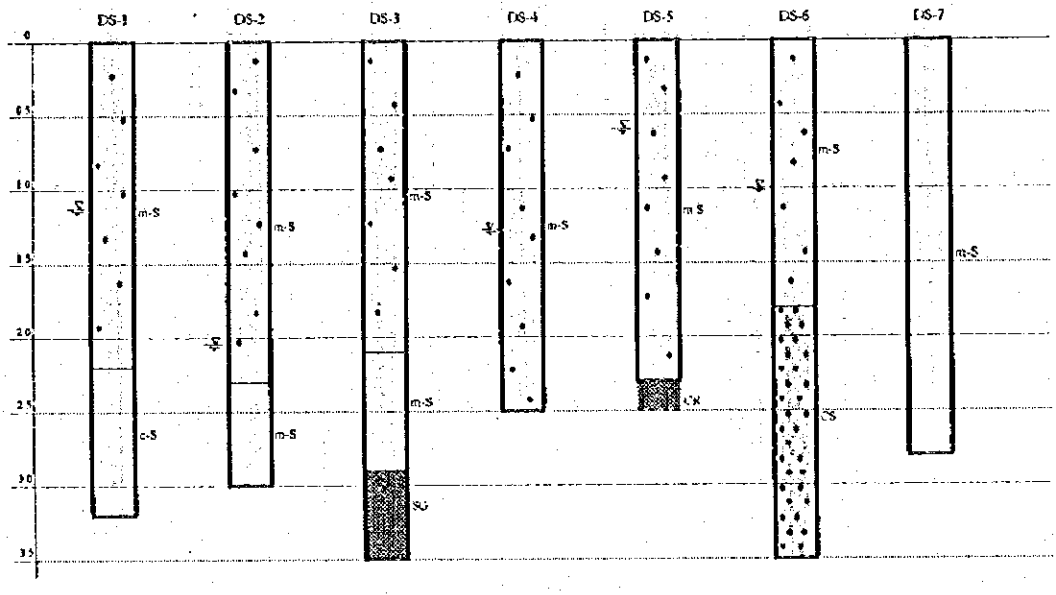
Gypsum in the area is also existing as gypsum sand layers with characteristic creamy yellow brown color, in 1.0 to 1.5 m of thickness. However, the gypsum in clayey layer of TZ-9 may be a secondary gypsum precipitated. The averaged depth of groundwater table, around 1.5 m, should be an averaged drainage level and few gypsum can be observed above the level excepting TZ-9. Irregular shaped bad-rock surface and some clayey layers distributing 2.1 to 2.5 m in depth are keeping the groundwater level in this level, nevertheless most of the layers are sandy.

c) Draa Sud Oasis

In this oasis, total seven (7) auger borings have been drilled at around the western half of the area. the results of borings are shown in Figure 4.2.6. As shown in the figure, most of the borings have been stopped to drill at shallow depth, from 2.3 to 3.5 m. The reasons to stop drilling were hole collapsing by sand layer (DS-1,2), toughness of the soil (DS-3,4,6,7), and by hard gypsum crust (DS-5). Although most of the soil layers

underlying the area are sand, medium to coarse commonly, auger holes allocated at lower zone have water table in them. This situation suggests the impervious lake deposits underlies at rather shallow depth along the southern hedge of the oasis.

Figure 4.2.5. Results of hand-auger borings (Draa Sud Oasis)



Hard gypsum crust was detected at DS-5 site, and gypsum sand with characteristic creamy color is found at DS-6 site closed to the DS-5. In the other holes, sand layers include only some gypsum component. The situation means that the distribution of gypsum soil is quite local and limited at western corner of the oasis.

4.2.4. Results of the Survey -Kebili Province-

a) General situation

Kebili Province is one of the largest provinces in Tunisia, however, the area of human activities is limited at along the eastern bank of Chott El Jerid. The other part of the province is occupied by the Chott and sand dunes. As a physiographic characteristics, many small isolated island-like hills, mainly covered by oasis plants, are observed every where.

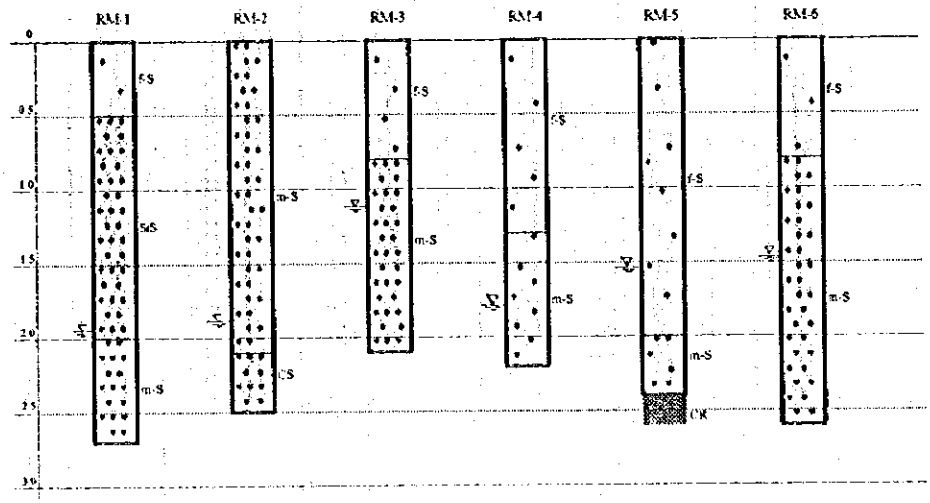
There are 67 target oases of the Project in the province, which is the largest number among the four provinces involved. And almost all of the oases are said to be underlain, or covered sometimes, by gypsum soil. Through discussions with pedologists of CRDA Kebili, four oases of Regim Matoug 2, Guetaya, Ras El Ain, and Mazraa Neji were selected as the target oases of actual survey, as representatives of the heaviest, heavy, middle, and slightly affected by gypsum soil. Location of these oases is shown in Figures of 4.2.19. (a), (b), and (c), and location maps of hand-auger boring are given as Figure 4.2.20 to 4.2.23.

b) Regim Matoug 2 Oasis

Six (6) auger borings were drilled here but all of them were stopped to drill at the depth around 2.5 m. Half of them (RM-1, 4, and 6) could not drill any more than the depth because of hole collapsing (sand under groundwater level), and another half touched

to the hard gypsum crust. Groundwater table was detected in the all holes at the depth from 1.2 to nearly 2.0 m. Results of boring are summarized as Figure 4.2.6., below.

Figure 4.2.6. Results of hand-auger borings (Regim Matoug 2 Oasis)



The oasis is just newly developed, and some construction works are still on going. The current ground surface is not the original but slightly lower than the original, because the ground surface was covered by hard gypsum crust with around 30 cm thickness. The blocks of gypsum crust excavated off are found every where inside the oasis still now. Besides the gypsum crust covered the ground surface, another hard gypsum crust was detected at the depth around 2.5 m. Thickness of it was not checked directly but it can be supposed as around 30 to 50 cm on the analogy of other sites. The crust is still hard and enough thick to take a role of impervious bed in this area, so that the groundwater table is very shallow.

c) Guetaya Oasis

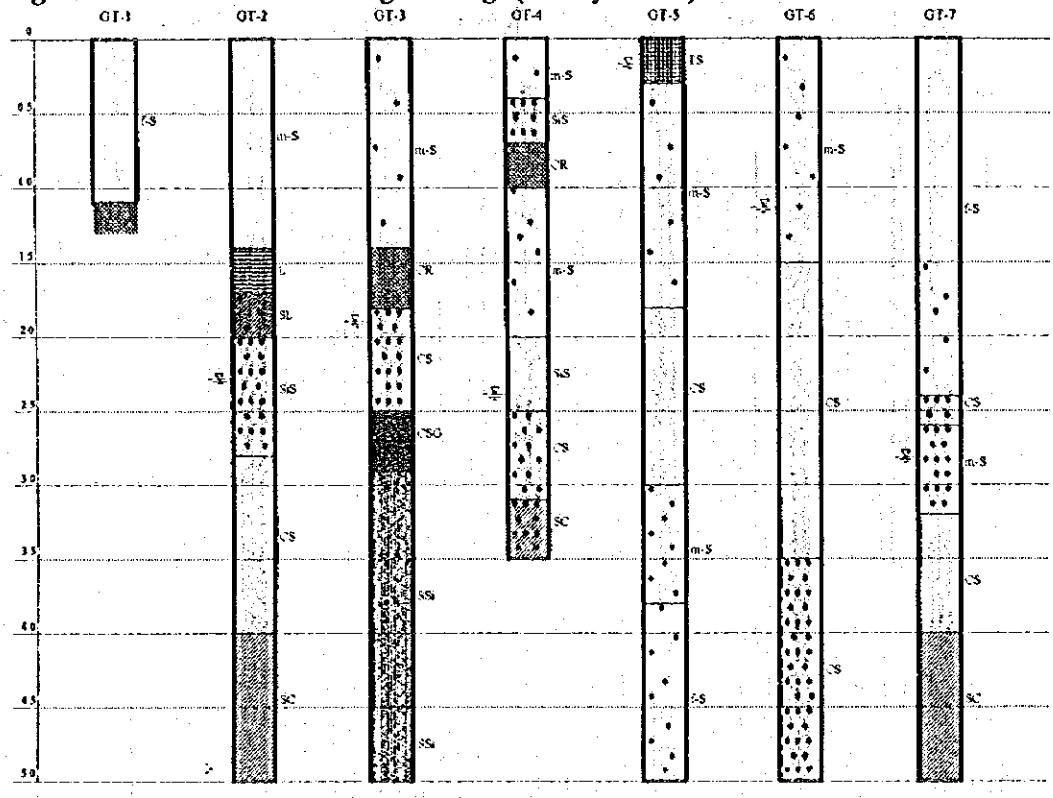
Total seven (7) hand-auger holes were drilled in this oasis. The oasis is one of typical island-like hill oases but having two peaks, and auger holes were drilled at north and south slopes of hill axis and at the saddle between the two peaks. Five augers out of seven could reach to 5 m depth, and the remains were 3.5 and 1.1 m in depth. Groundwater was detected in the most of hole, excepting GT-1 which is only 1.1 m in linear length, and the depth to groundwater table varies from 1.2 to 2.8 m.

Figure 4.2.7. shows the summarized results of boring. As shown in the figure, some holes indicate the existence of hard crust (e.g. GT-3, 4), however, the crust in this oasis is mainly hard calcareous crust (so-called calcareous caliche) associated with gypsum sand. Further, the layers upper and lower than the caliche also include calcareous blocks or gravel much or less, and it suggests the layers penetrated by augers are weathered residual soils and ever exposed in a considerably humid circumstances enough to precipitate carbonates.

Gypsum soils found in the lower part, such as the ones seen in GT-4 or GT-6, are seems to be a secondary gypsum because they include crystalline gypsum which are now on the way to grow up.

The lowest level of groundwater table found in the auger holes is

Figure 4.2.7. Results of hand-auger borings (Guetaya Oasis)



approximately 14 m in elevation and it is almost same with average ground level surrounding the hills. Then the groundwater table comes up high and high towards the center of hill. The situation is quite normal but it suggests, in the same time, the difficulty to make lower the groundwater table at along the outer margin of the oasis.

d) Ras El Ain Oasis

The oasis extends at the south of Kebili city. Total eight (8) hand-auger holes were drilled here but they could cover only southern half (the lower half) of the oasis area. In
all of the holes, groundwater table was detected at rather shallow depth. Results of the borings are summarized as Figure 4.2.8. at next page.

Rather thick gypsum sand layers at from 2.0 to 4.0 m in depth, seen at REA-1, 2, 5, 6, and 8, are supposed to be direct alluvial gypsum deposits from pure rock gypsum because they are well sorted sand and have characteristics creamy yellow brown color. At the base of those gypsum sands, sometimes intercalating one thin alluvium, there is a thick clayey layer with grayish color, and the layer is supposed to be diluvial deposits or to be called as old lake deposits. In this base layer, crystalline gypsum are now growing up at some zones such as REA-3 or REA-4 sites.

e) Mazraa Neji Oasis

Seven (7) hand-augers were drilled here. They could penetrate into the ground to the depth more than 3.0 m but not reached to 5.0 m in depth. Groundwater table was detected in the all holes at the depths from 1.14 m (MN-1) to 2.82 m (MN-4). Soil logs of then are simply summarized as Figure 4.2.9.

Figure 4.2.8. Results of hand-auger borings (Ras El Ain Oasis)

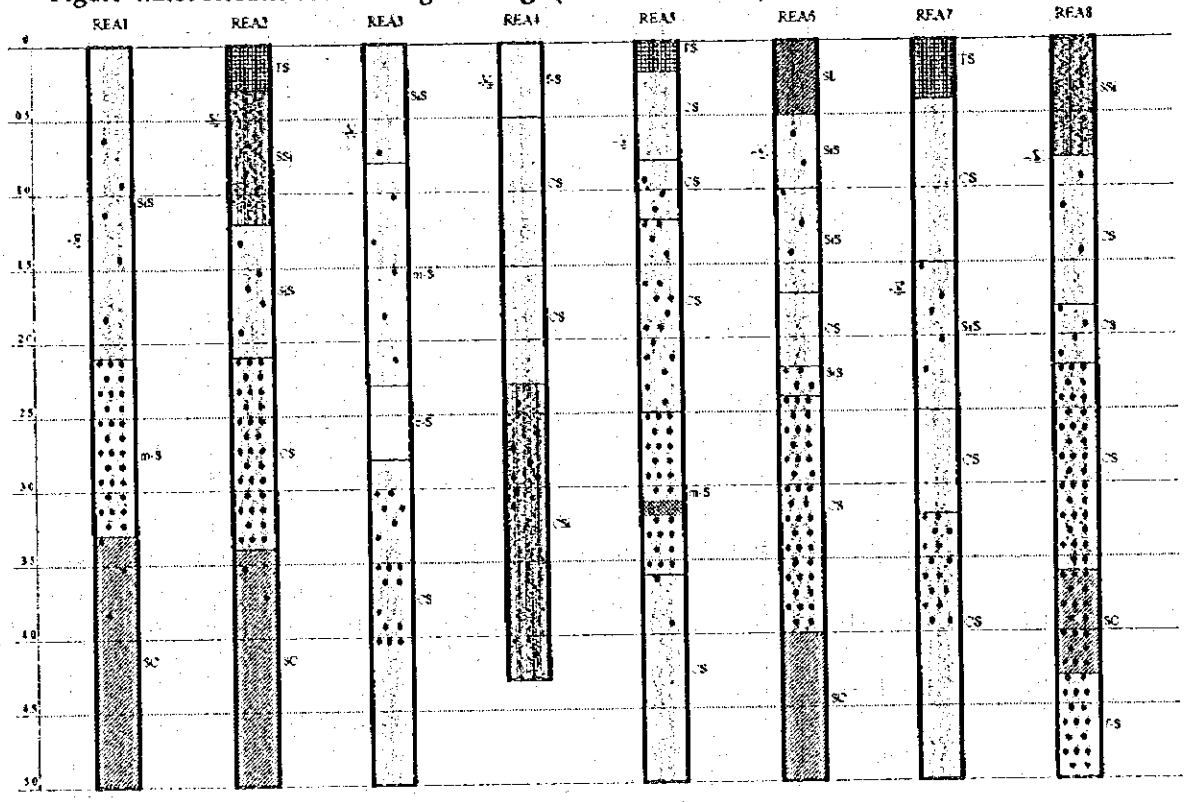
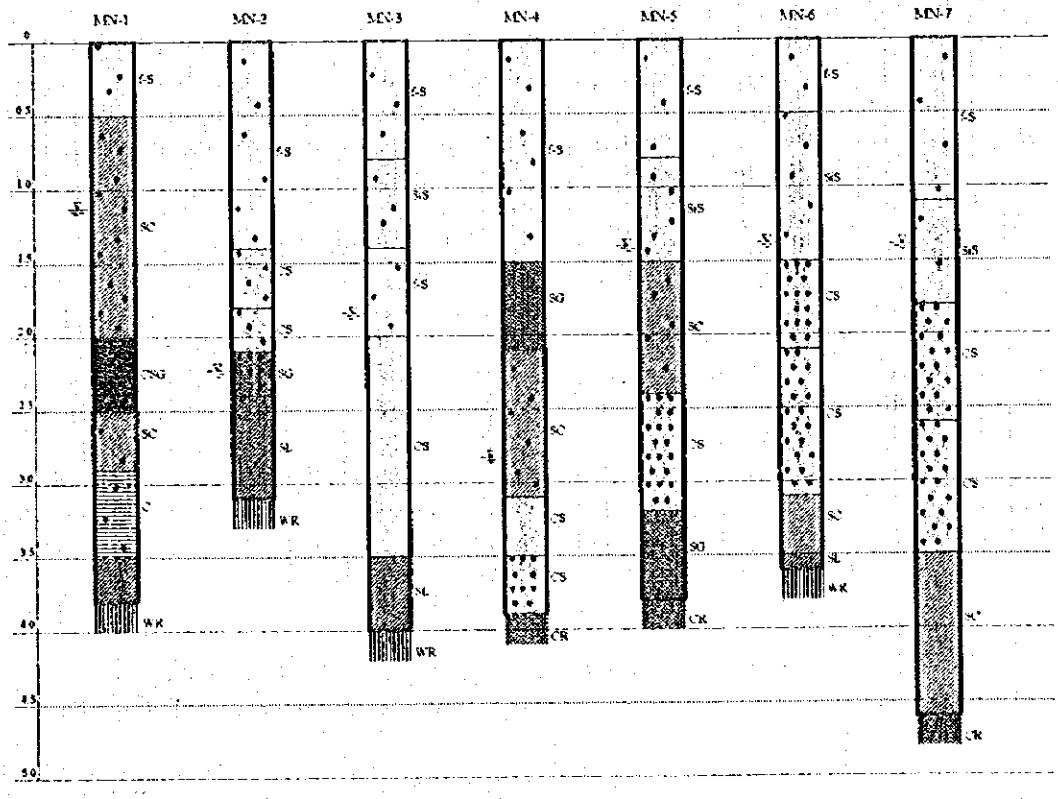


Figure 4.2.9. Results of hand-auger borings (Mazraa Neji Oasis)



The outer shape of oasis is quite narrow and long rectangular, and mono-clinic from southeast to northwest (from MN-4 towards MN-1). All of the holes were stopped to drill because of too hard layer to drill by man-power, ant they were mostly weathered rock zone of green sandstone, excepting MN-4, 5, and 7 sites at where a hard calcareous caliche was underlying. Not so much thick though, a diluvial deposits including calcareous caliche overlies the bed rock, they are, clayey layers from 2.5 m depth at MN-1, clayey sand from 2.0 m depth at MN-3, and sandy clay from 3.5 m depth at MN-7 sites. Overlying those, some alluvial deposits including gypsum sand accumulated in 2, 3 m of thickness. Thus, the most of gypsum soil in this oasis should be a simple alluvial deposition from gypsum-rich parent materials.

Groundwater table in the area is almost parallel with the ground surface excepting the lowest zone where the depth of groundwater table becomes relatively shallow than the upper zone. The diluvium is hardly pervious and the weathered rock zone in this oasis is also impervious, that is to say, drainage condition of the oasis is rather severe.

4.2.5. Results of the Survey -Gabes Province-

a) General situation

Only Gabes Province, among four of the target oases, opens towards the sea directly, and then, most of oases were developed on sea shore terraces. In this province, total 48 oases are involved in the Project, and among them five (5) oases are said underlain by gypsum soil. They are Oasis de Gages, Teboulbou, Methouia, Ouedhref, and Aouinette. And through the discussion with engineers of CRDA, Aouinette, Methouia, and Oasis de Gabes were selected out as actual survey oases, represented of severely, moderately and slightly affected by gypsum respectively.

The location of oases surveyed is shown in Figure 4.2.24., and the location of hand-auger borings at each oasis is shown in Figure 4.2.25 to 27.

b) Aouinette Oasis

Seven (7) auger holes were drilled here but non of then reached to 5 m in depth. Around half of them were stopped to drill by hard gypsum crust, some were because of stickiness (AO-3 and 7), and one hole was by hole collapsing (AO-6). In only three holes, groundwater table was found out at the depth from 1.4 to 2.2 m. Summarized soil logs of them are shown in Figure 4.2.10.

The oasis is newly developed, and the construction work is not yet completed. The ground surface had ever been covered by hard gypsum crust but excavated out already. The thickness of the crust can be supposed as around 30 cm from the gypsum blocks kept out besides the road still now. Another gypsum crust underlies at rather shallow depth, but it disappears at the center of oasis. Instead of hard crust, thick gypsum sand layers are observed at the center. Remarkably at AO-3, a loamy gypsum soil continues from the ground surface still now.

Groundwater table was detected only at three holes, rather deep ones of AO-3, 6, and 7. From a total view, the depth of groundwater table shall be around 1.5 to 2.5 m, almost in parallel with the inclination of ground surface excepting the highest part (AO-1 site). Groundwater is supposed to be suspended by gypsum crust at most of the area.

c) Methouia Oasis

In the oasis also, seven (7) hand-auger were drilled. Among them, four (4) holes reached to the depth of 5.0 m, and the other holes were stopped to drill at the depth

4.2.10. Results of hand-auger borings (Aouinette Oasis)

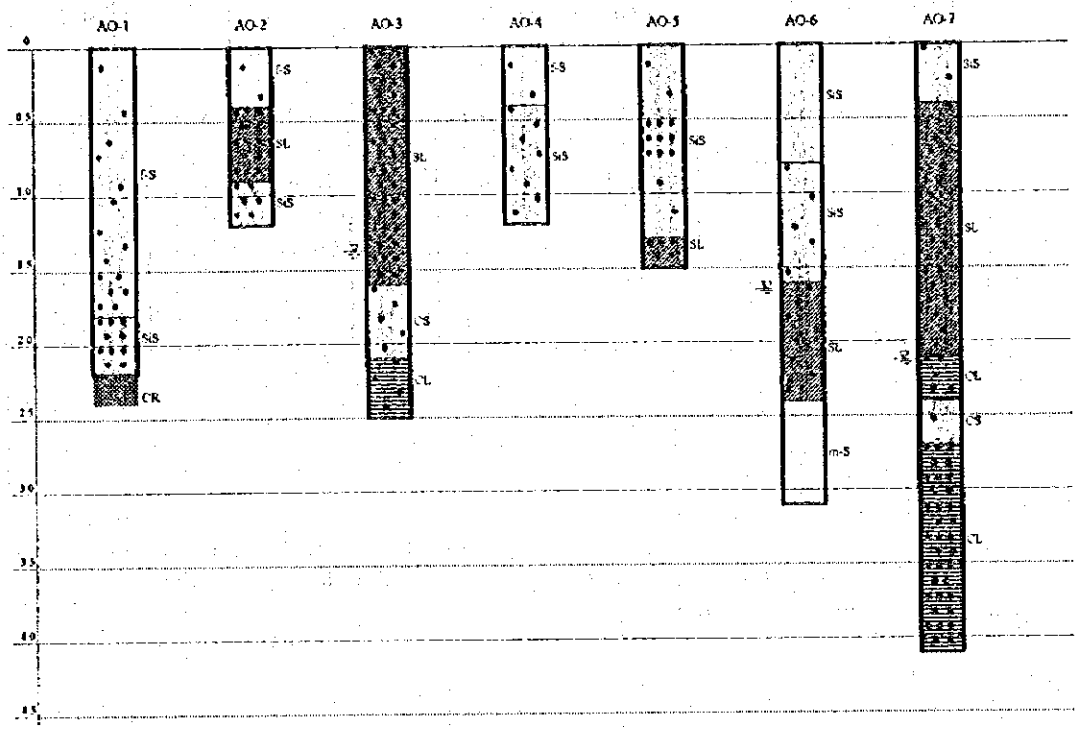
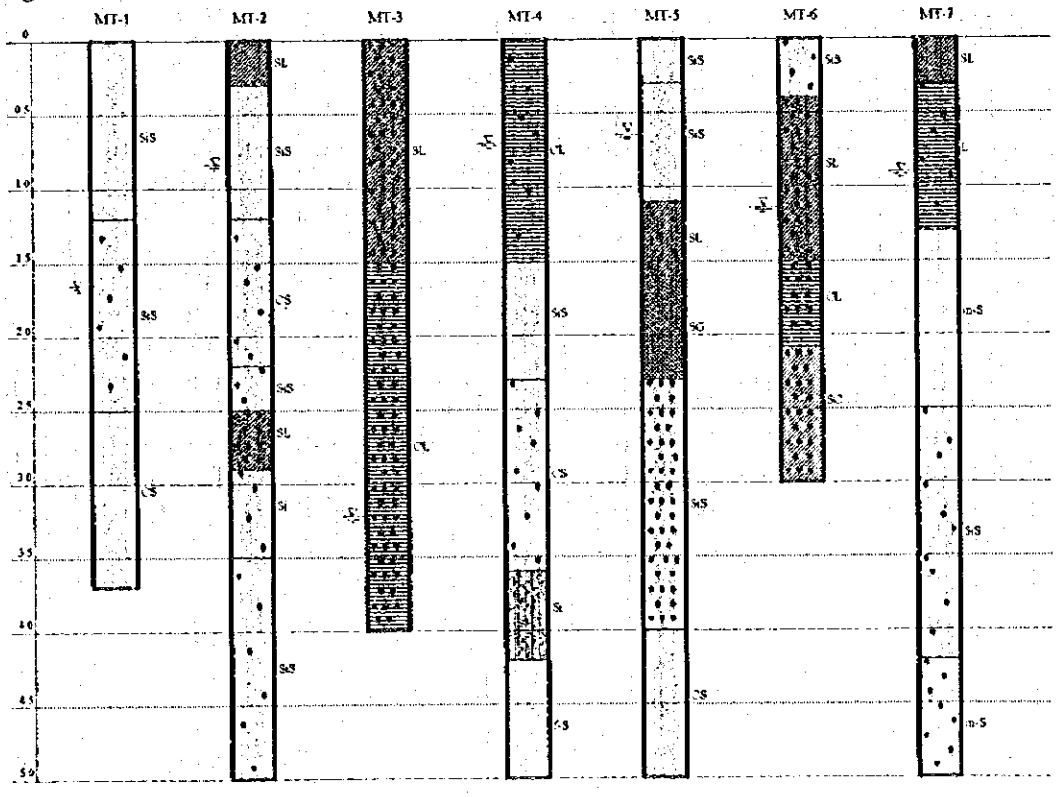


Figure 4.2.11. Results of hand-auger borings (Methouia Oasis)



around 3.0 to 4.0 m, mainly because of hardness and/or stickiness of clayey layers. Figure Groundwater table was detected at shallow depth, mostly less than 1.0 m. Results of boring are summarized as shown as Figure 4.2.11.

Northwestern zone of the oasis, near around MT-3 hole, is still covered by hard gypsum crust locally and the current cultivating level (the surface of farm land) is lower than the bottom of the crust. Remarkably in this hole, loamy layers containing many crystalline gypsum distribute from the beneath of surface gypsum crust to the depth more than 4.0 m. The similar situation is seen in the hole MT-6 of which the depth is shorter than the former though. Most of the layers of other holes are sandy soils with a few gypsum patches. The situation suggests that those are the layers deposited older than the other hole s one. In other words, there are two terraces here, old one and slightly younger one. The layers of old terrace was mainly clayey or loamy, and crystalline gypsum were growing up till very recent (but not now because of the drawdown of groundwater level near around here). In the young terrace a gypsum soil exists as a thick but local gypsum sand layer as centering with MT-5 site.

Groundwater table lies at shallow depth as less than 1.0 m from the ground surface in the central to the southeastern side but at deep as more than 3.0 m in the western side of the area. The shallow groundwater table is retained by loamy layers, which are distributing at middle depth and not continuous.

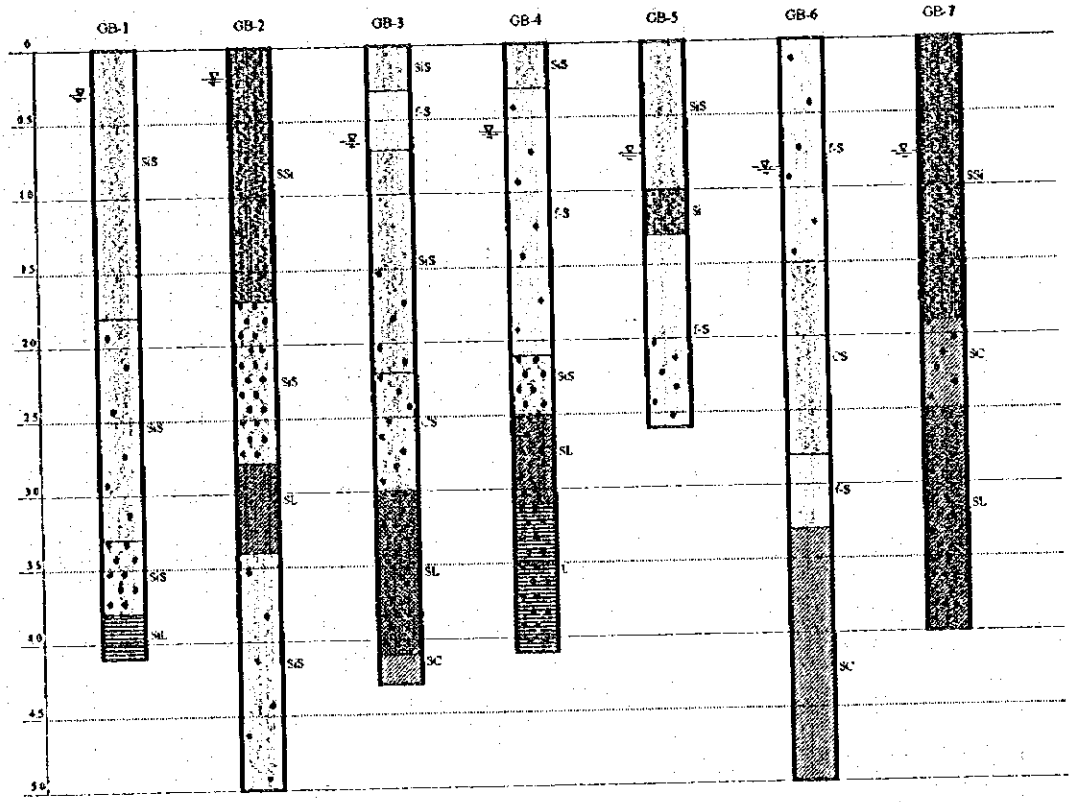
d) Oasis de Gabes

In this oasis, total seven (7) hand-auger were drilled covering the almost eastern half of the area. Two holes out of seven were drilled to 5.0 m in depth but the others were varying from 2.6 to 4.3 m in depth. Such short holes were stopped to drill because of hardness and/or stickiness of the soil, excepting GB-4 and 5 which could not drill through more because of hole collapsing. Groundwater table was found at shallow depth, less than 1.0 m from the ground surface. Results of boring are shown as Figure 4.2.12., next page.

The oasis extends on the one of lower terrace opening toward the sea. Terrace deposits here are mainly sandy soil associated with some silty and loamy soils. Clayey soil was encountered in only GB-6 at deep portion. Gypsum soil was detected at GB-1; at deep portion and as thin as 0.5 m, GB-2; at the middle range from 1.7 to 2.8 m with more than 1.0 m of thickness, GB-3; at rather deep portion of 3.0 m in depth and 1.1 m of thickness, GB-4; at middle to deep portion but thick as more than 2.0 m, and GB-7; at also middle to deep depth and thick as more than 2.1 m. The gypsum soil found out in these hole shall be one gypsum sand, however, it is not continuous layer but intercalated lenticularly. The gypsum sand is supposed to be deposited simply but now secondary crystalline gypsum are on growing up locally at almost central zone of the lenticular where is not sandy but loamy circumstances.

Groundwater table lies at considerably shallow depth. One of the reason is of course the ground elevation itself is very low, and another reason shall be that some thick semi-pervious layers such as silt or sandy loam work as impervious layer totally to keep water level high.

Figure 4.2.12. Results of hand-auger borings (Oasis de Gabes)



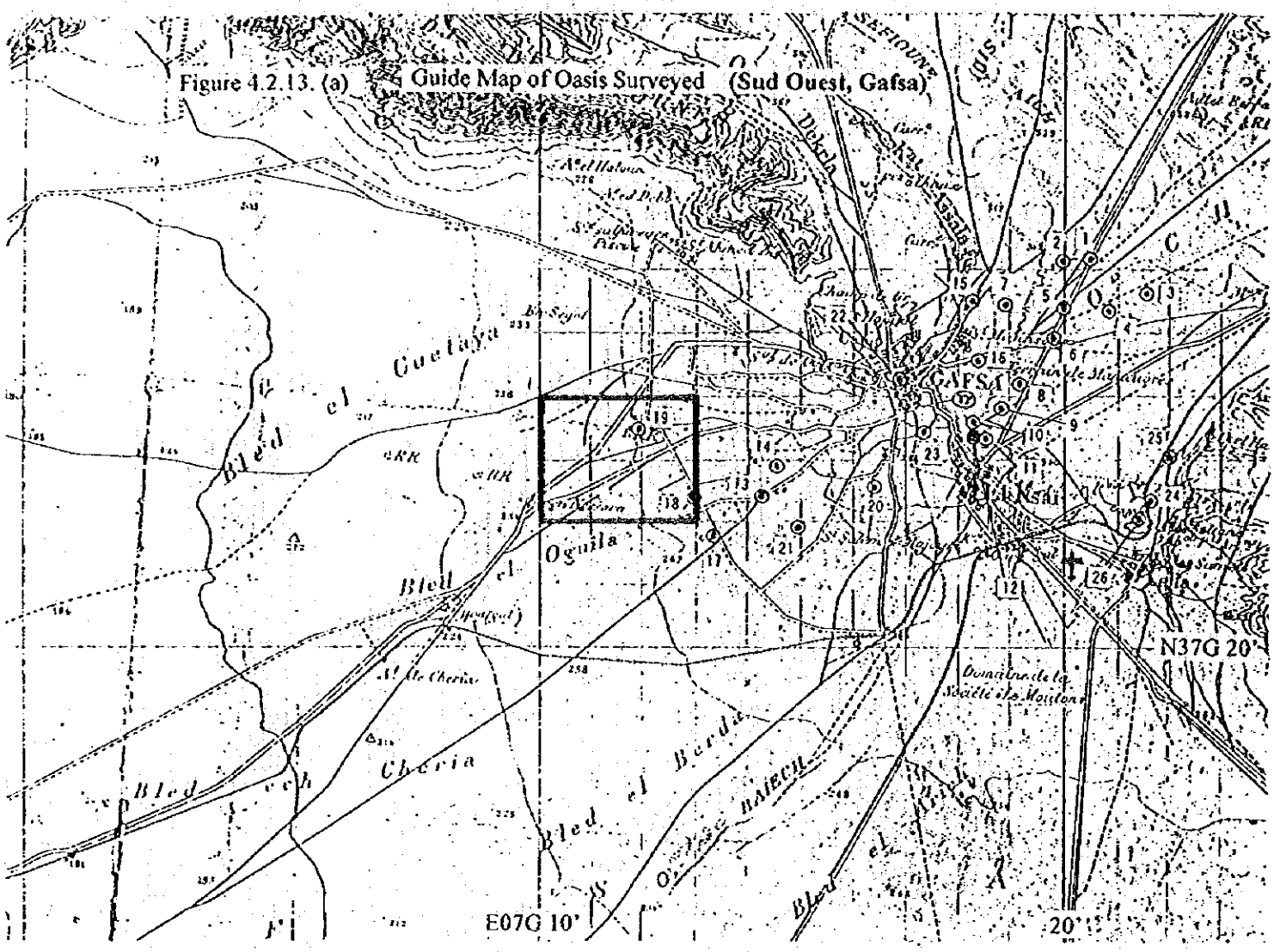


Figure 4.2.13. (a) Guide Map of Oasis Surveyed (Sud Ouest, Gafsa)

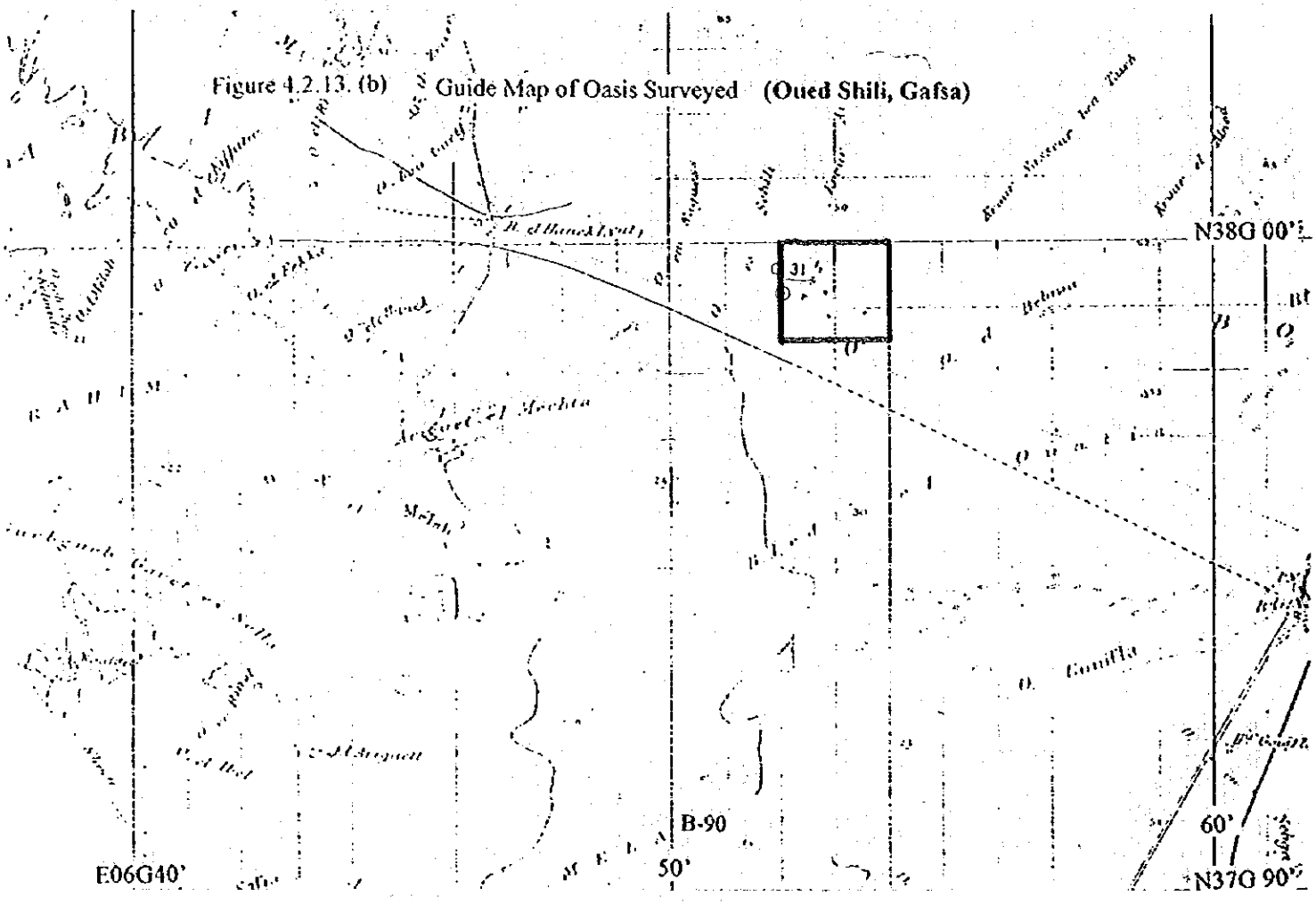


Figure 4.2.13. (b) Guide Map of Oasis Surveyed (Oued Shili, Gafsa)

Figure 4.2.14. (a) Location Map of Hand-Auger

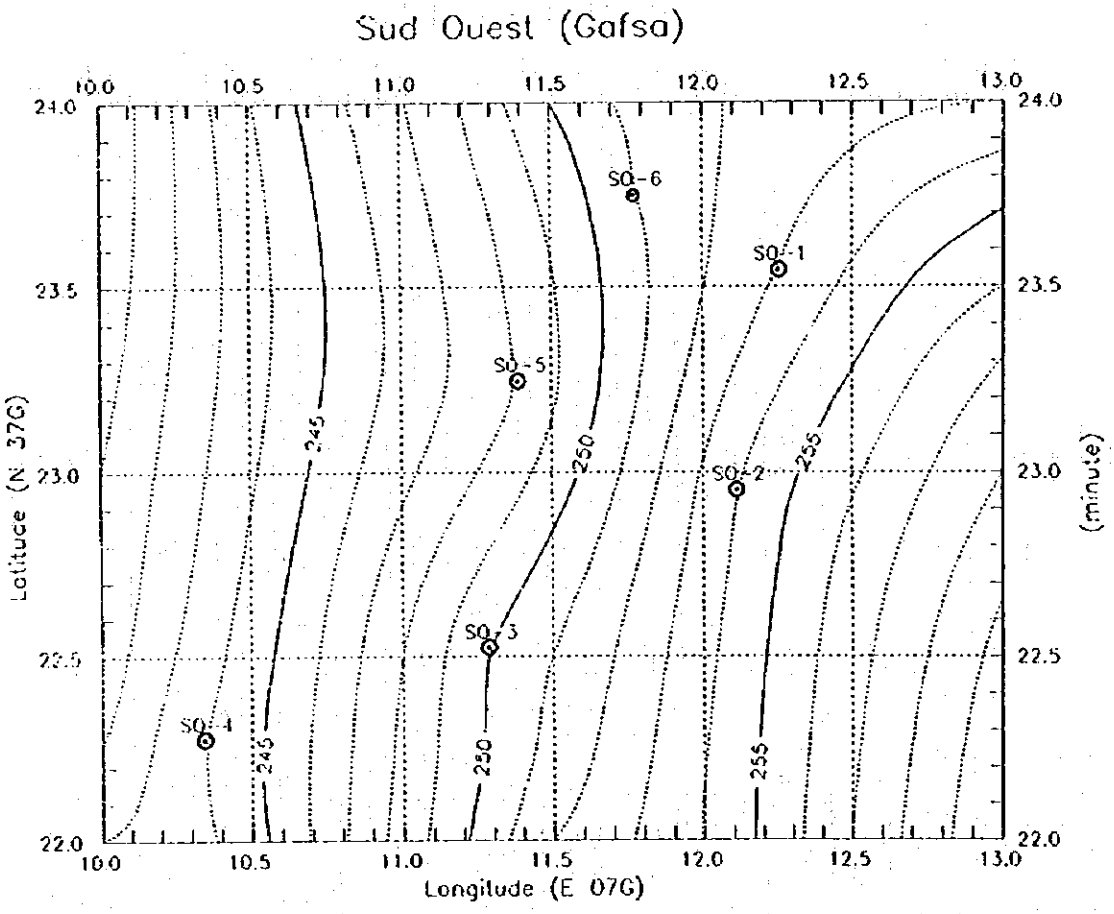


Figure 4.2.14. (b) Bird Eye's Figure

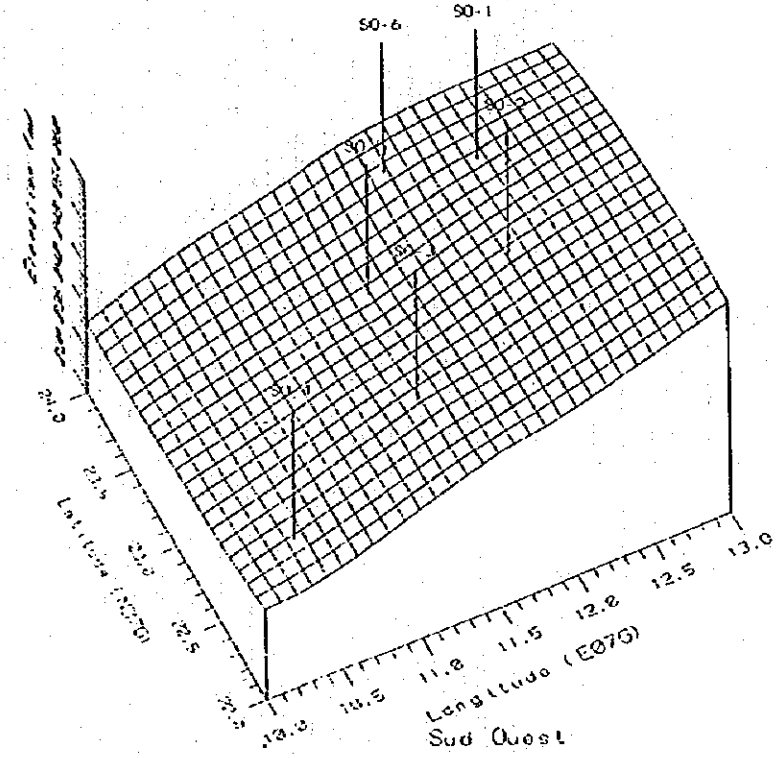


Figure 4.2.15. (a) Location Map of Hand-Auger

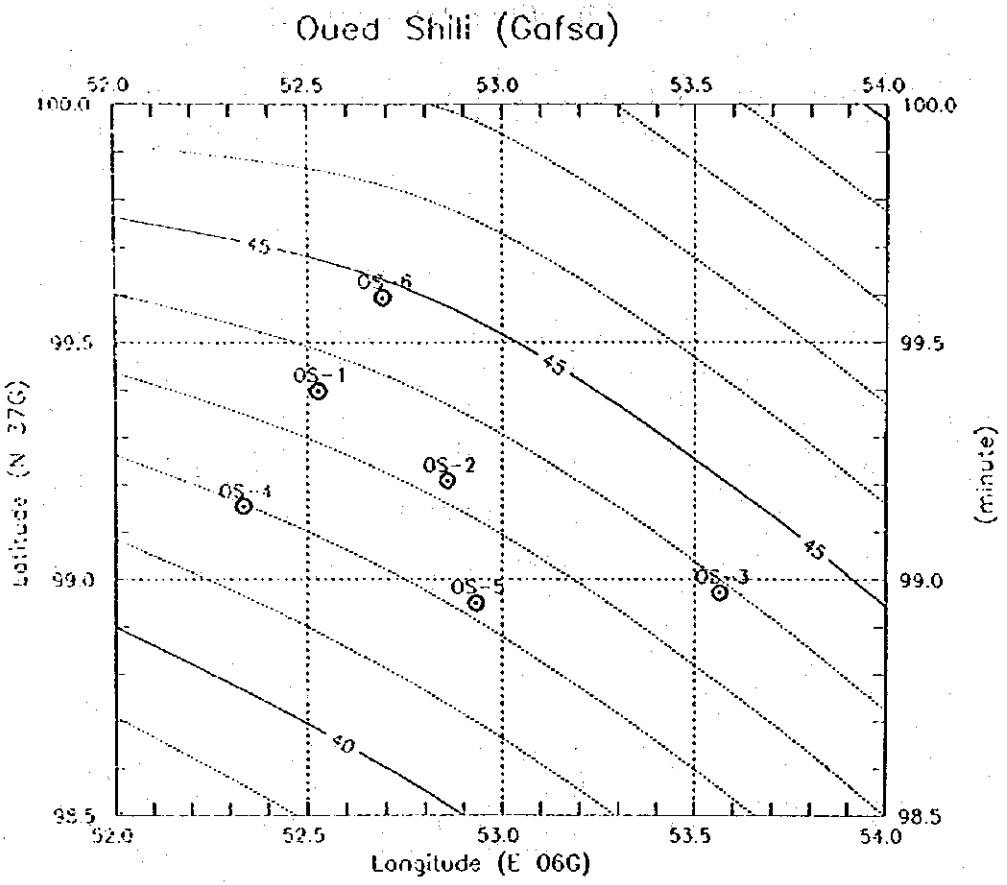


Figure 4.2.15. (b) Bird Eye's Figure

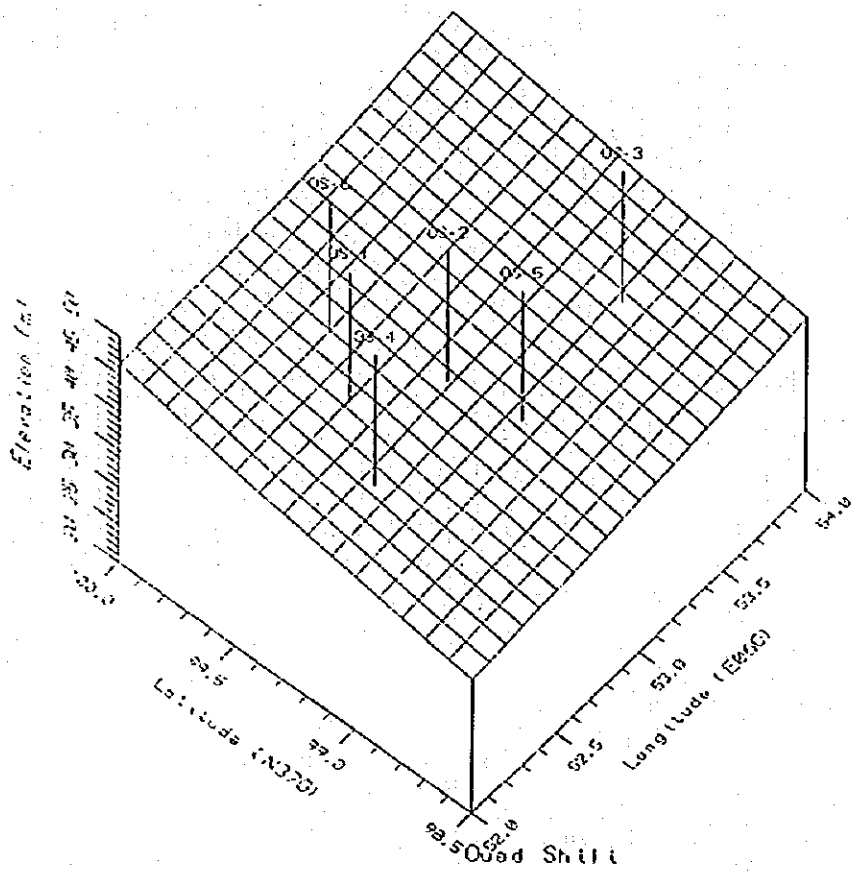


Figure 4.2.16.

Guide Map of Oases Surveyed (Tozeur and Draa Sud, Tozeur)

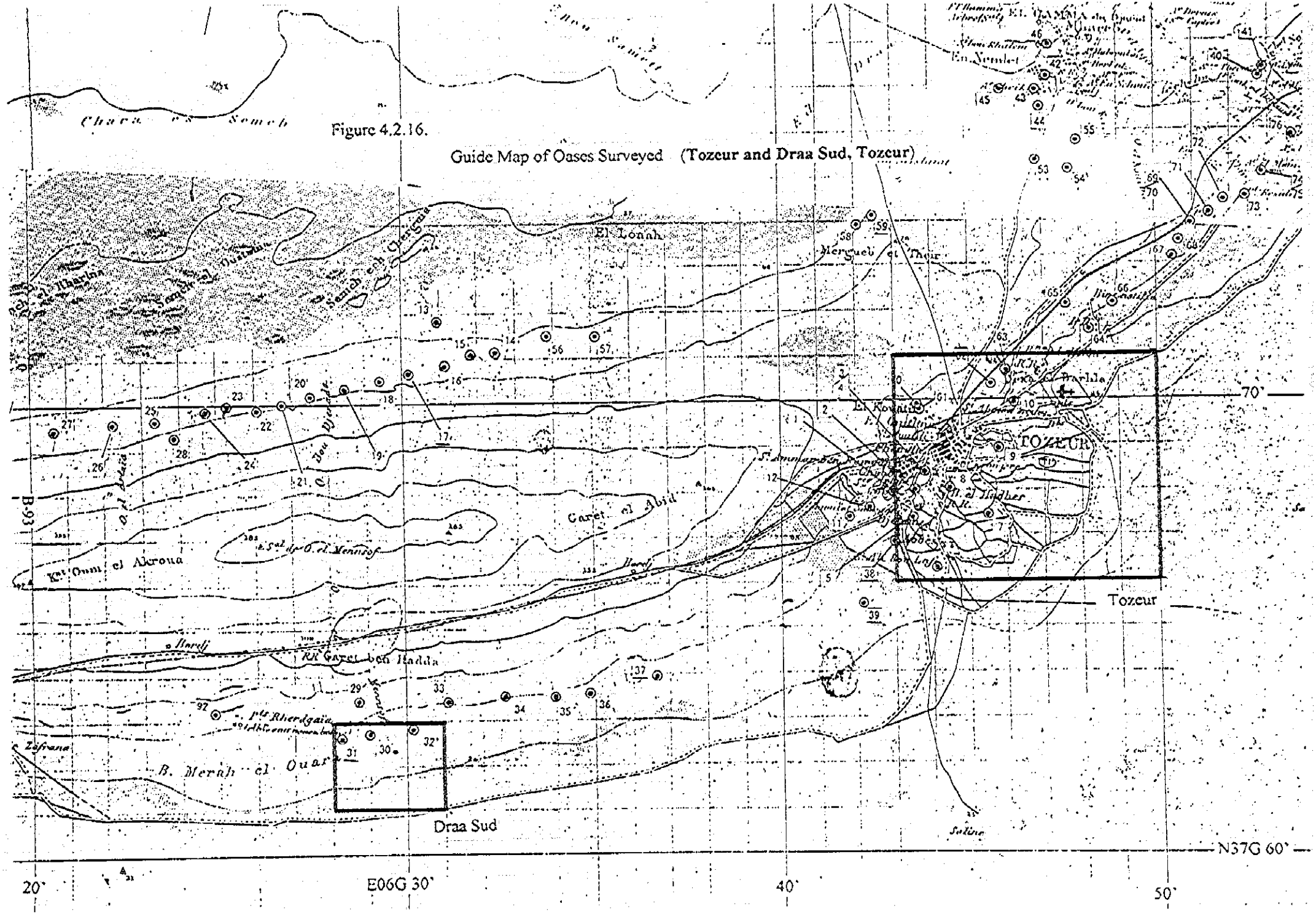


Figure 4.2.17. (a) Location Map of Hand-Auger

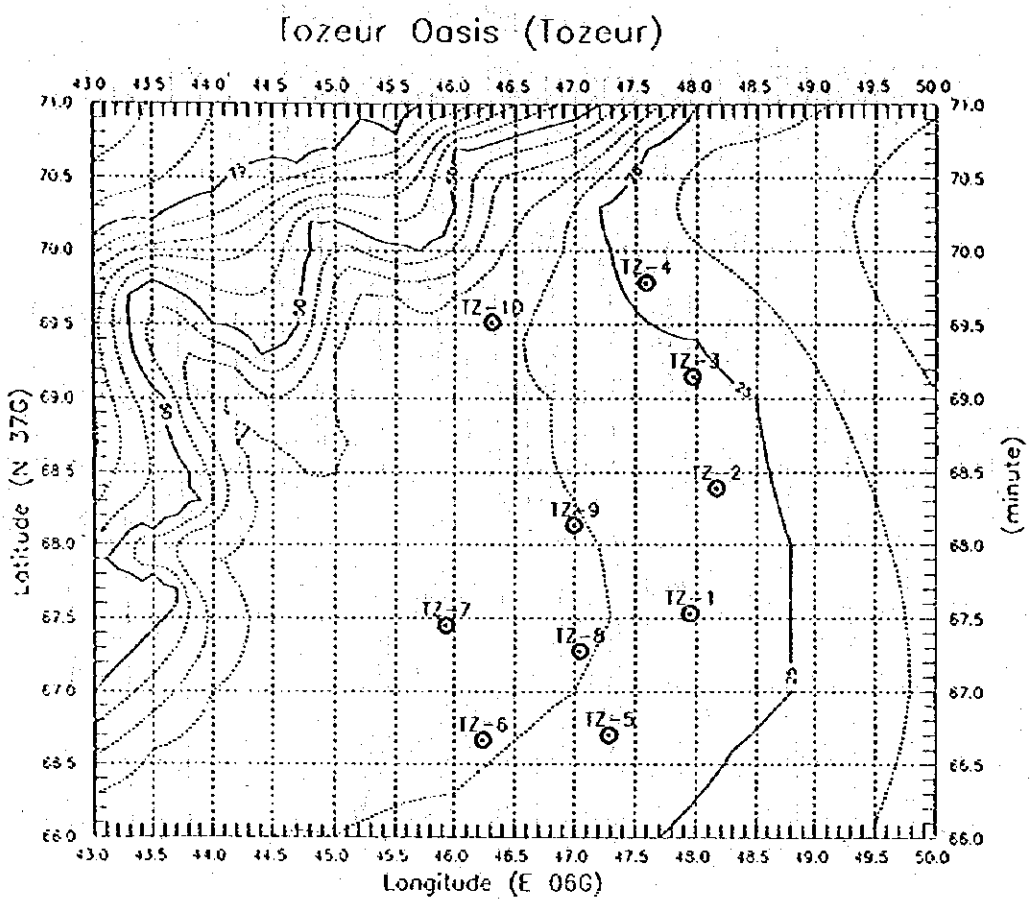


Figure 4.2.17. (b) Bird Eye's Figure

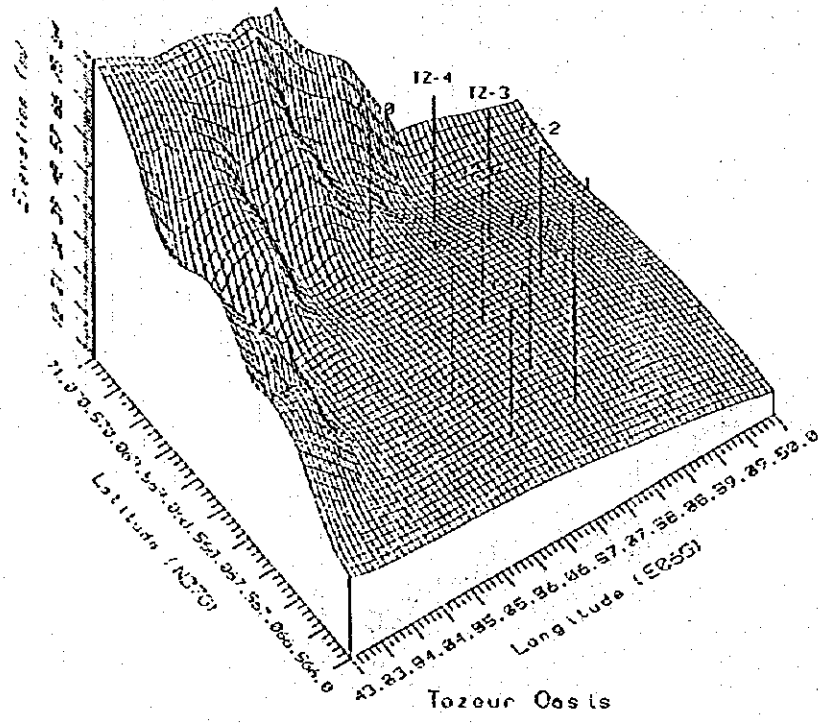


Figure 4.2.18. (a) Location Map of Hand-Auger

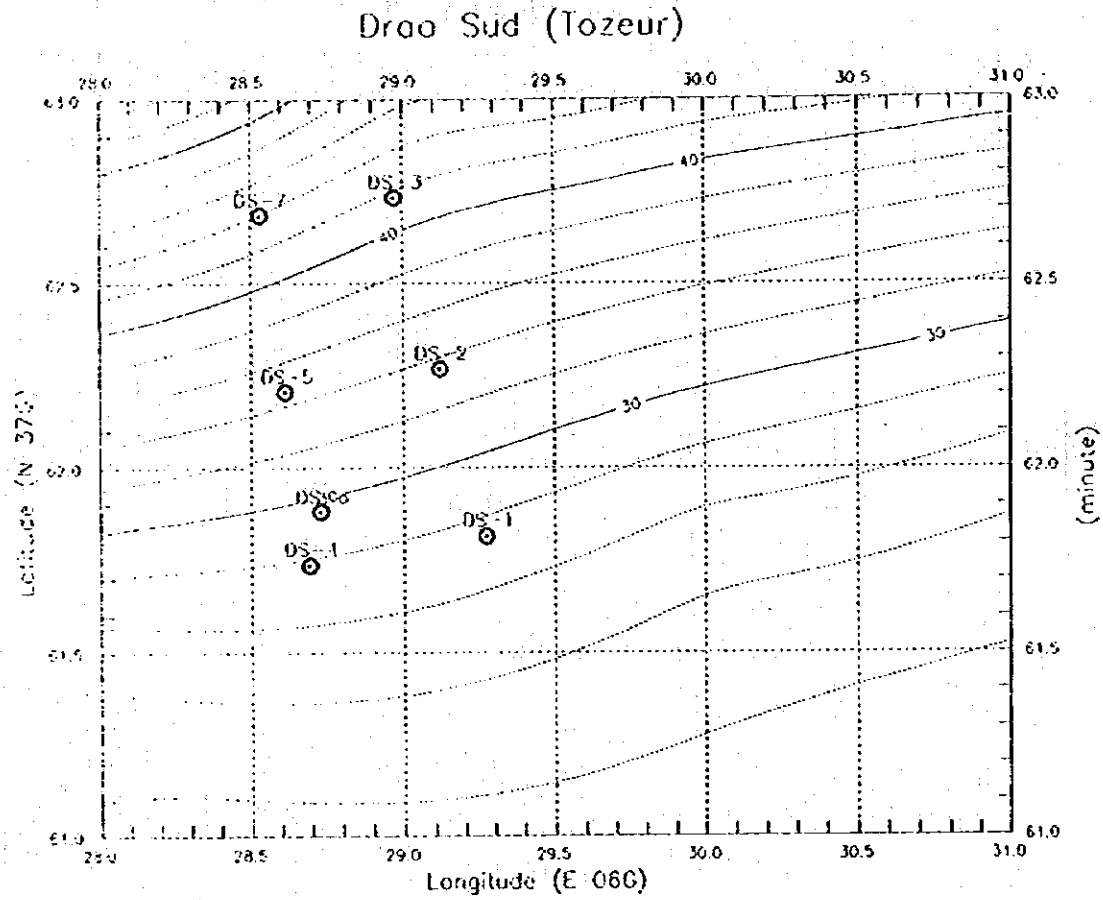
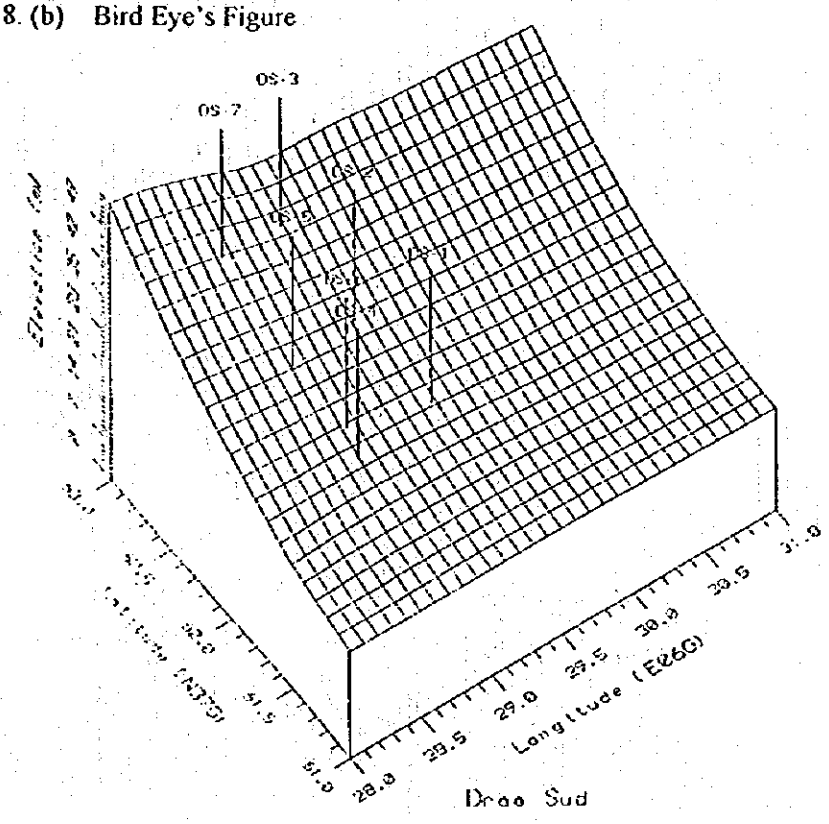


Figure 4.2.18. (b) Bird Eye's Figure



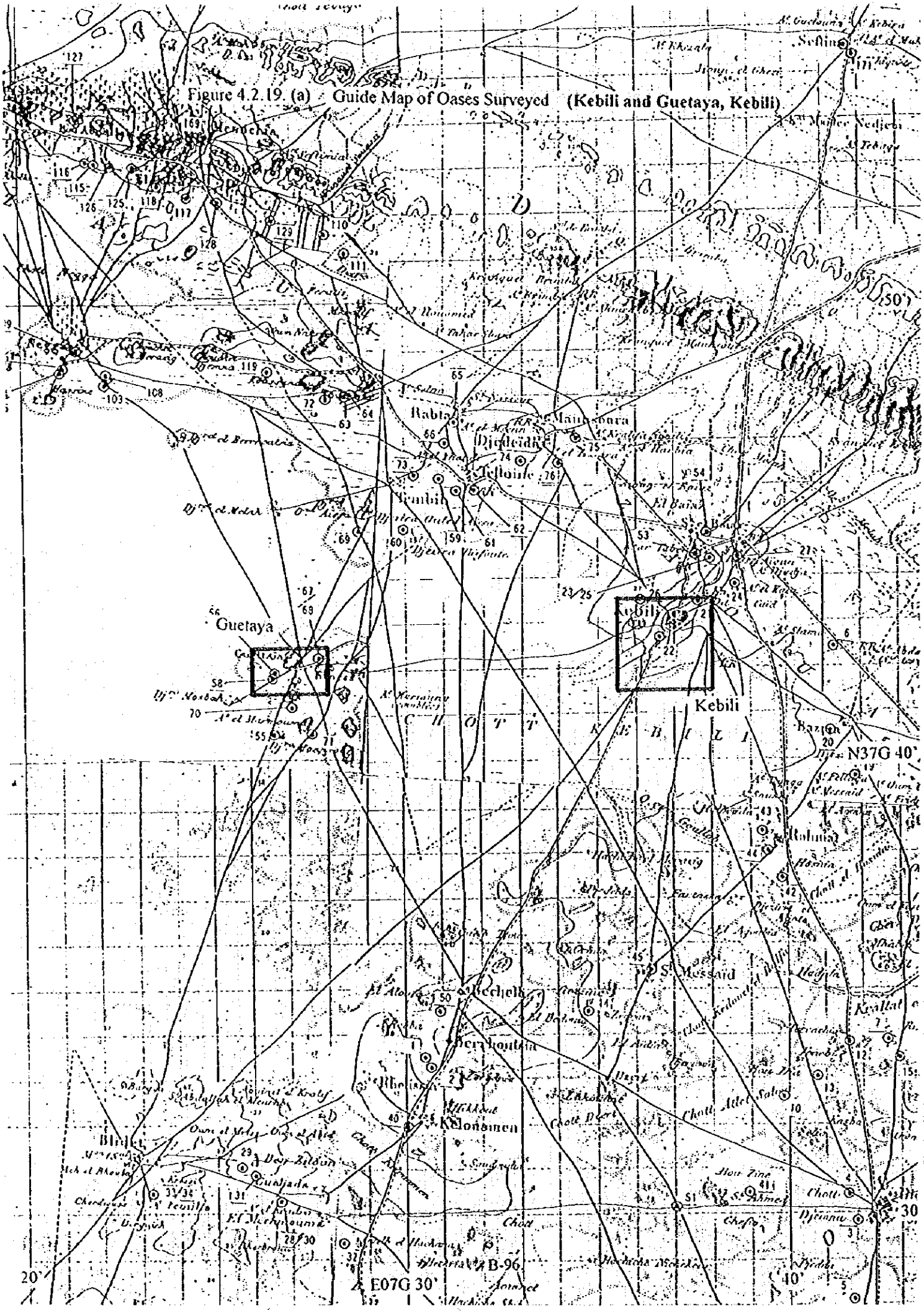


Figure 4.2.19. (a) Guide Map of Oases Surveyed (Kebili and Guetaya, Kebili)

Figure 4.2.19. (b) Guide Map of Oasis Surveyed (Mazraa Neji, Kebili)

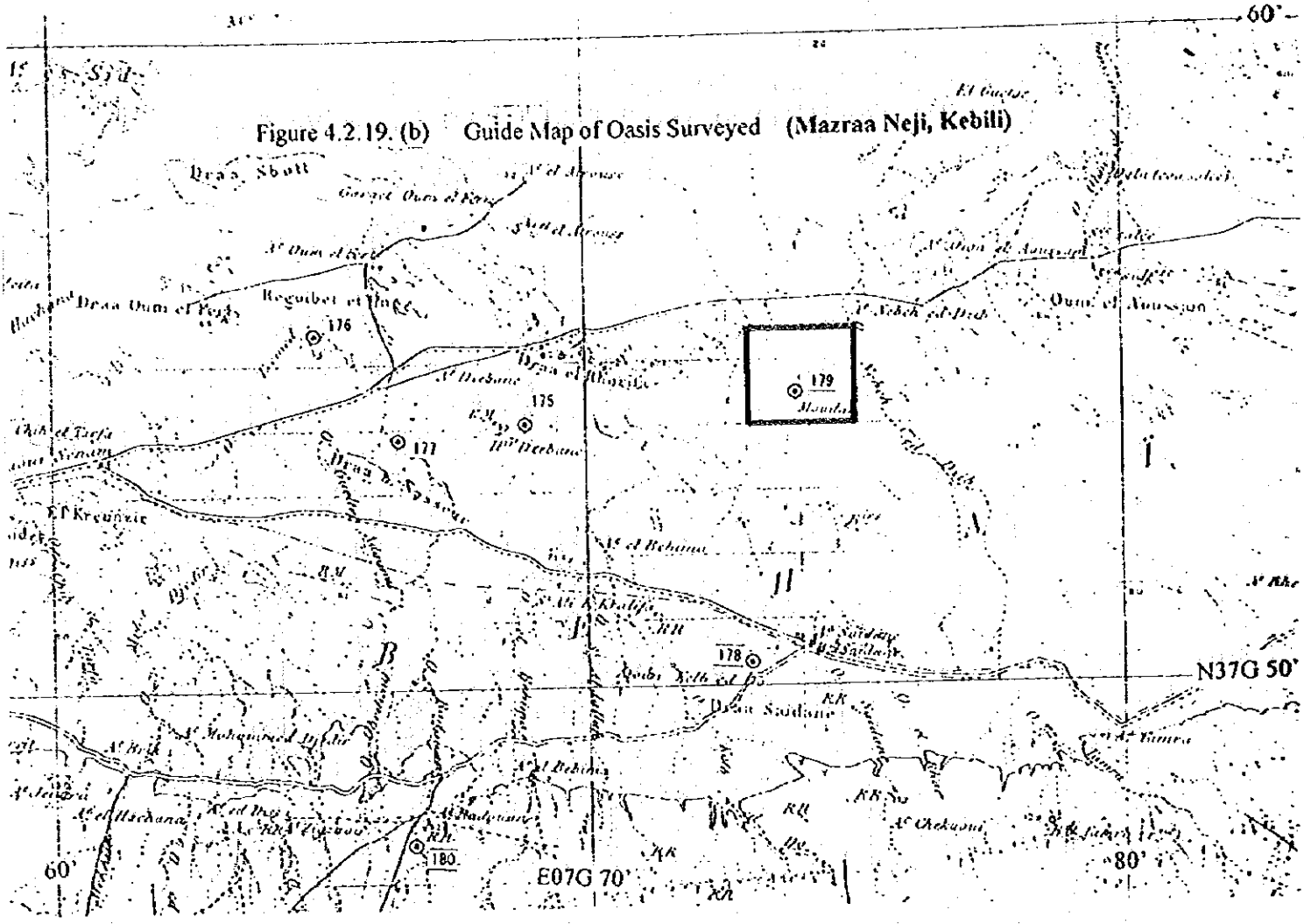


Figure 4.2.19. (c) Guide Map of Oasis Surveyed (Regim Matoug 2, Kebili)

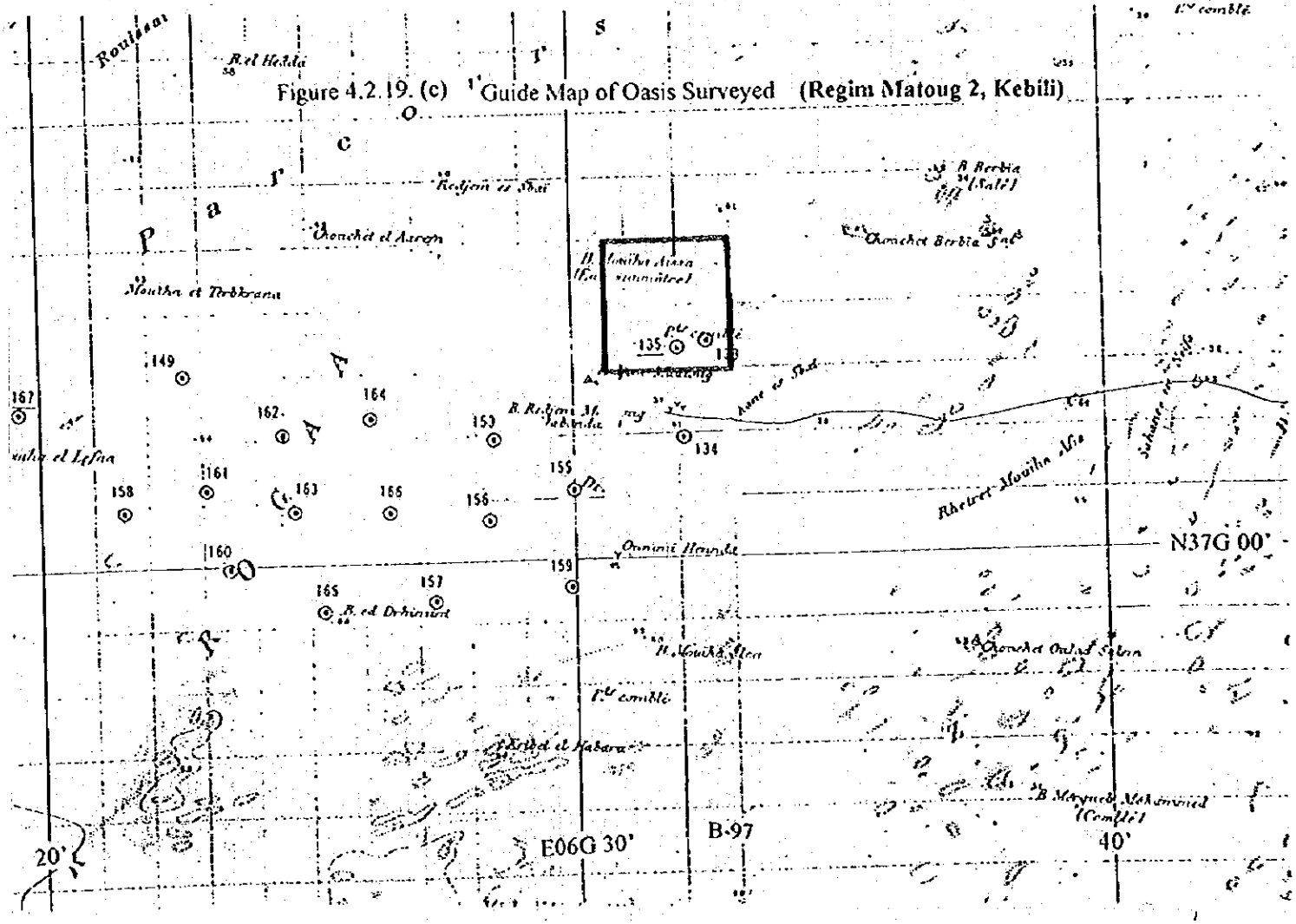


Figure 4.2.20. (a) Location Map of Hand-Auger

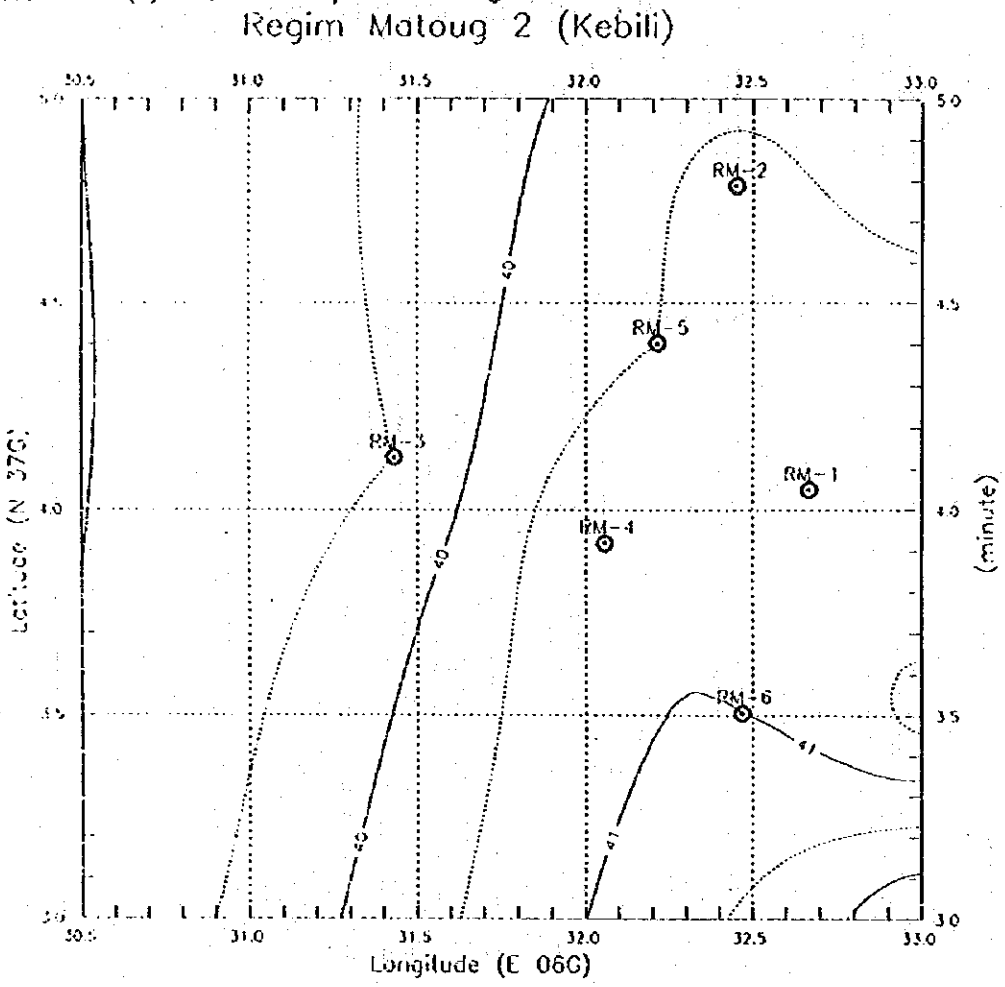


Figure 4.2.20. (b) Bird Eye's Figure

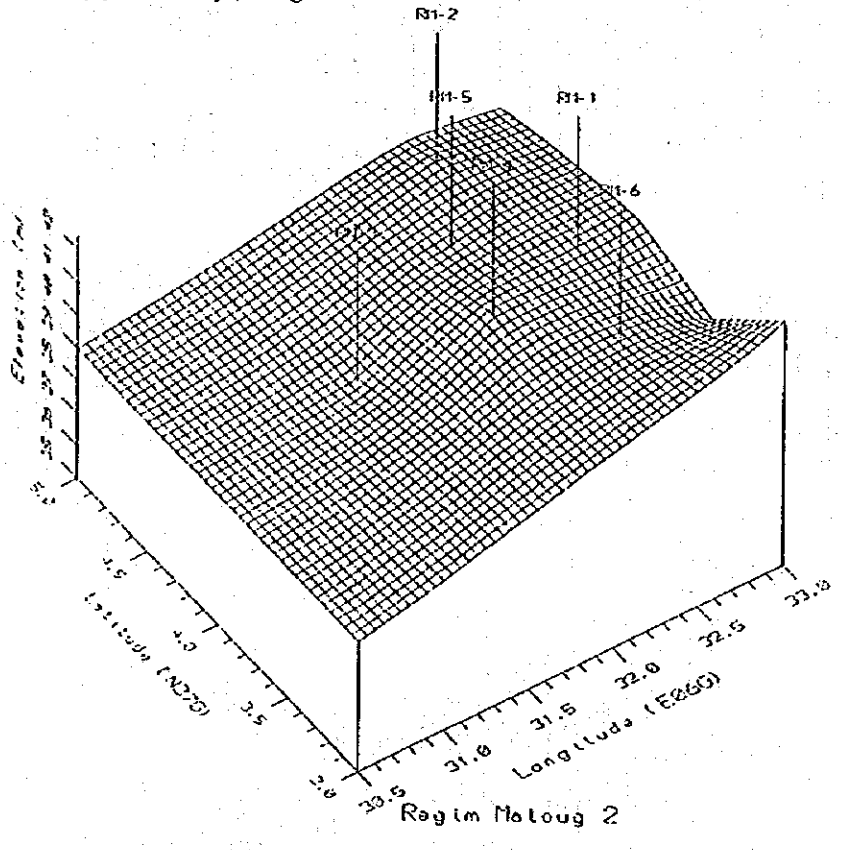


Figure 4.2.21. (a) Location Map of Hand-Auger

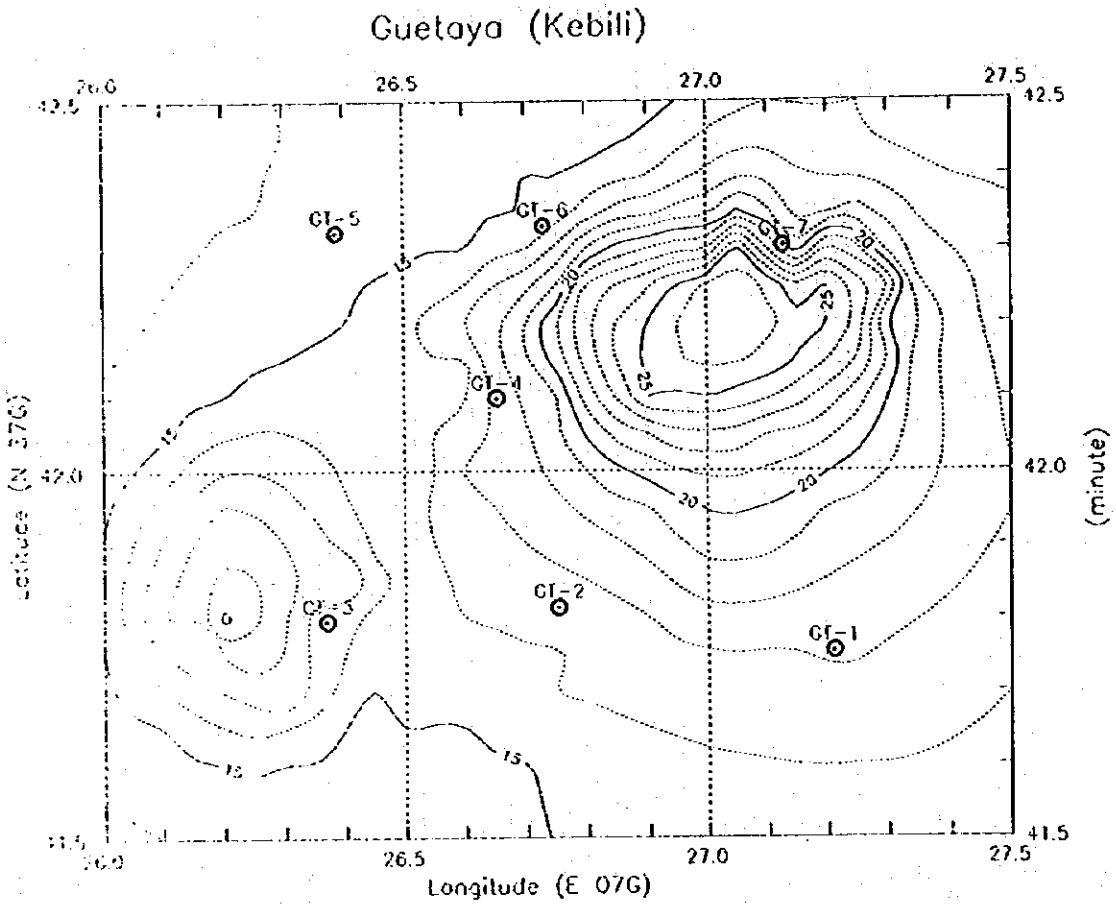


Figure 4.2.21. (b) Bird Eye's Figure

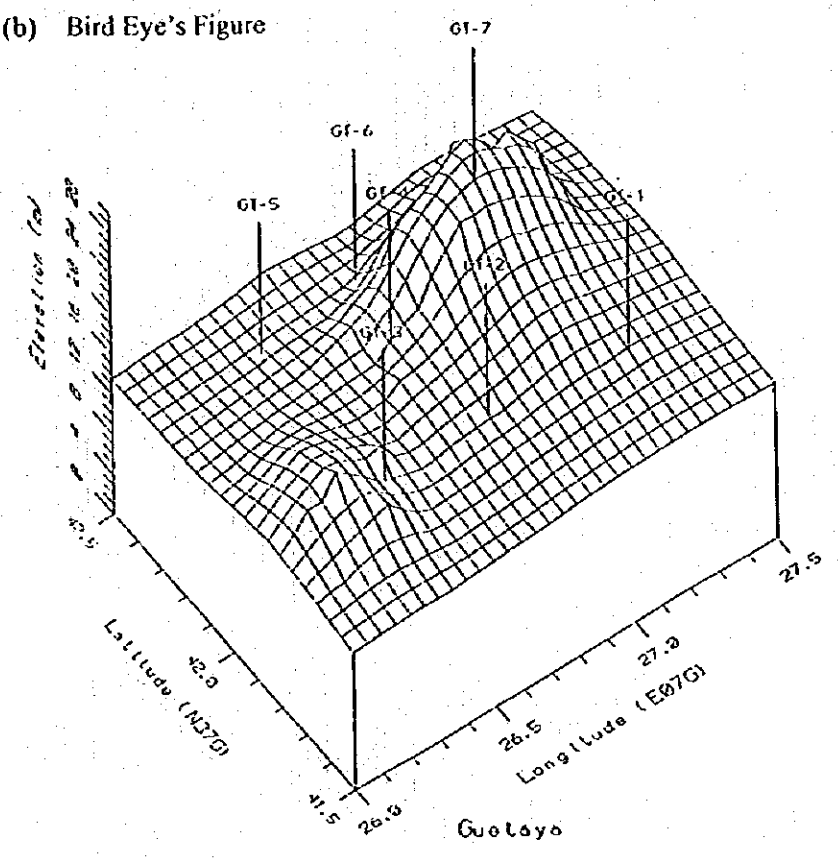


Figure 4.2.22. (a) Location Map of Hand-Auger

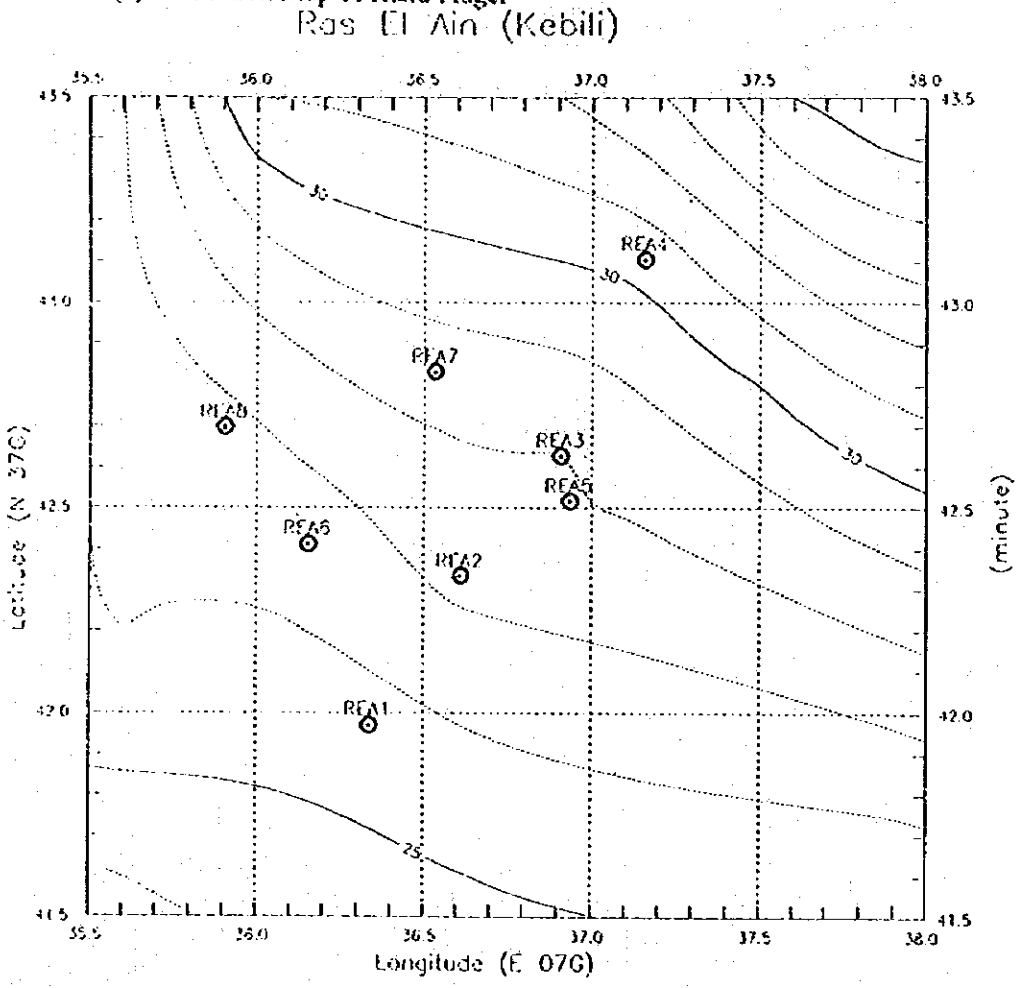


Figure 4.2.22. (b) Bird Eye's Figure

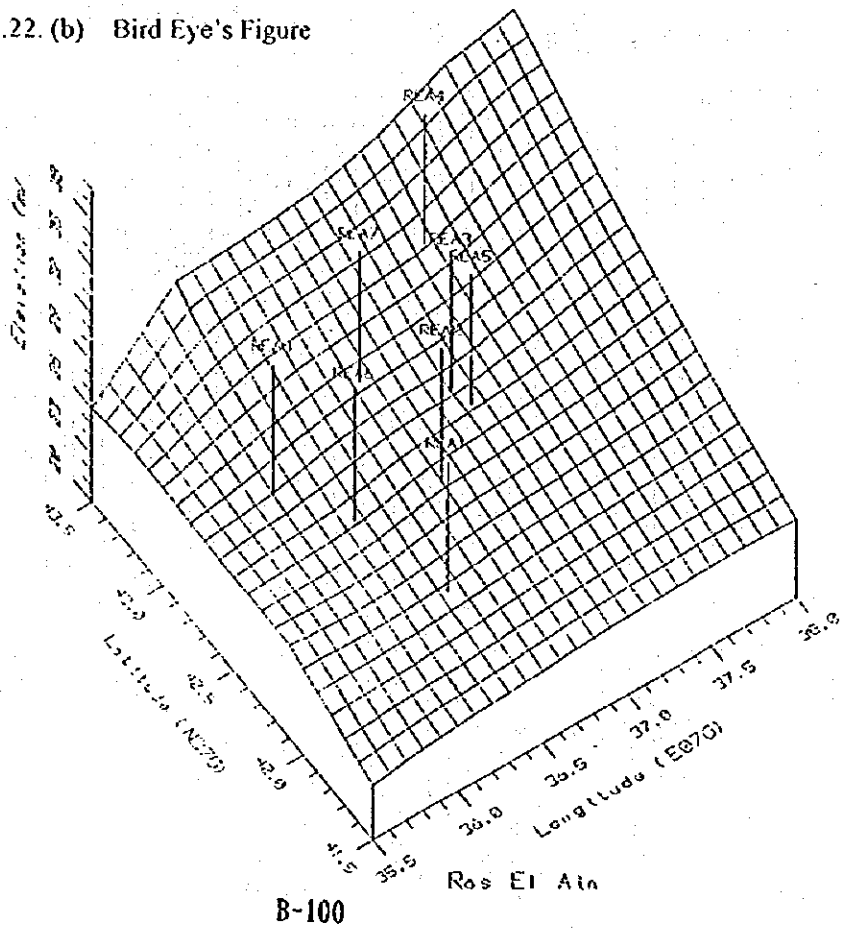


Figure 4.2.23. (a) Location Map of Hand-Auger

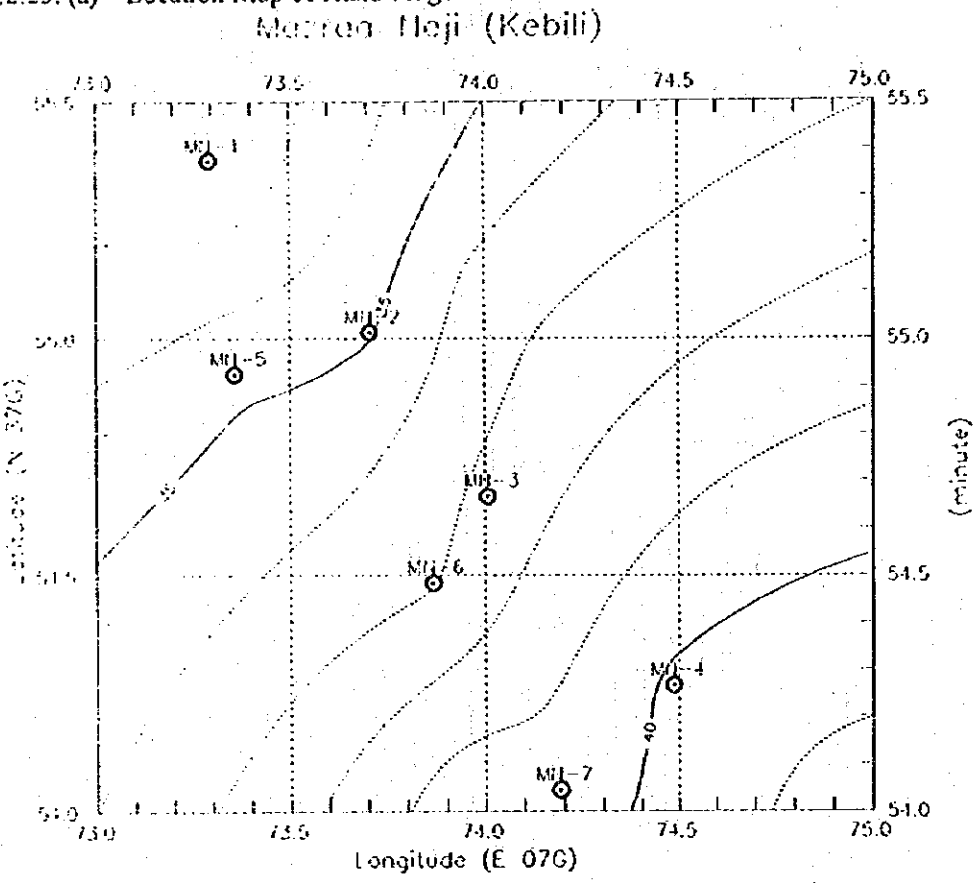


Figure 4.2.23. (b) Bird Eye's Figure

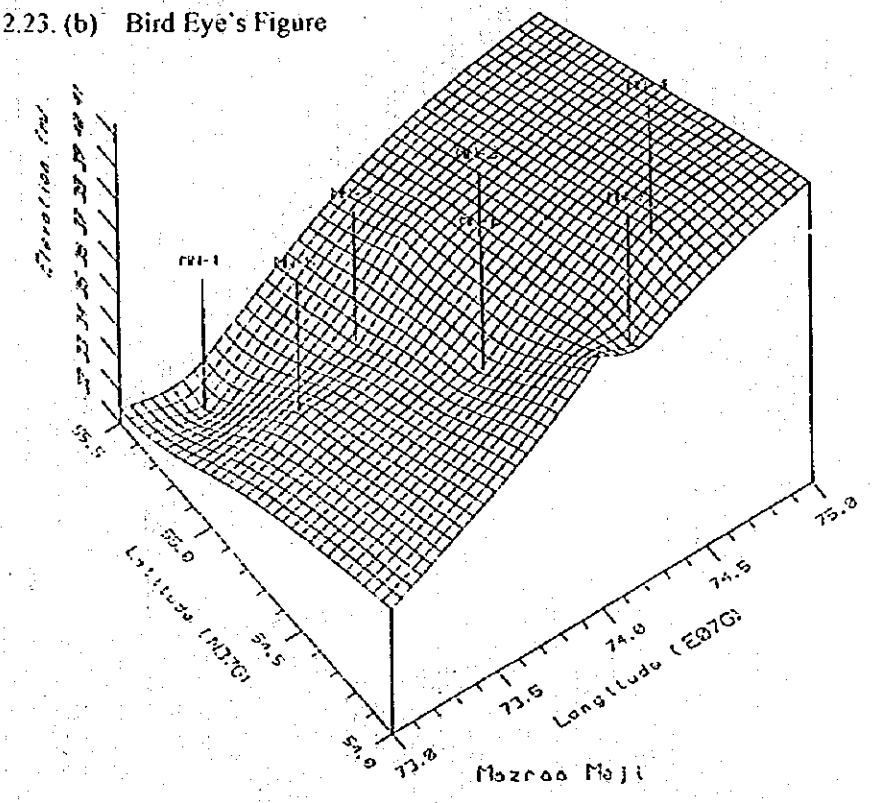


Figure 4.2.24.
Guide Map of Oases Surveyed (Gabes Province)

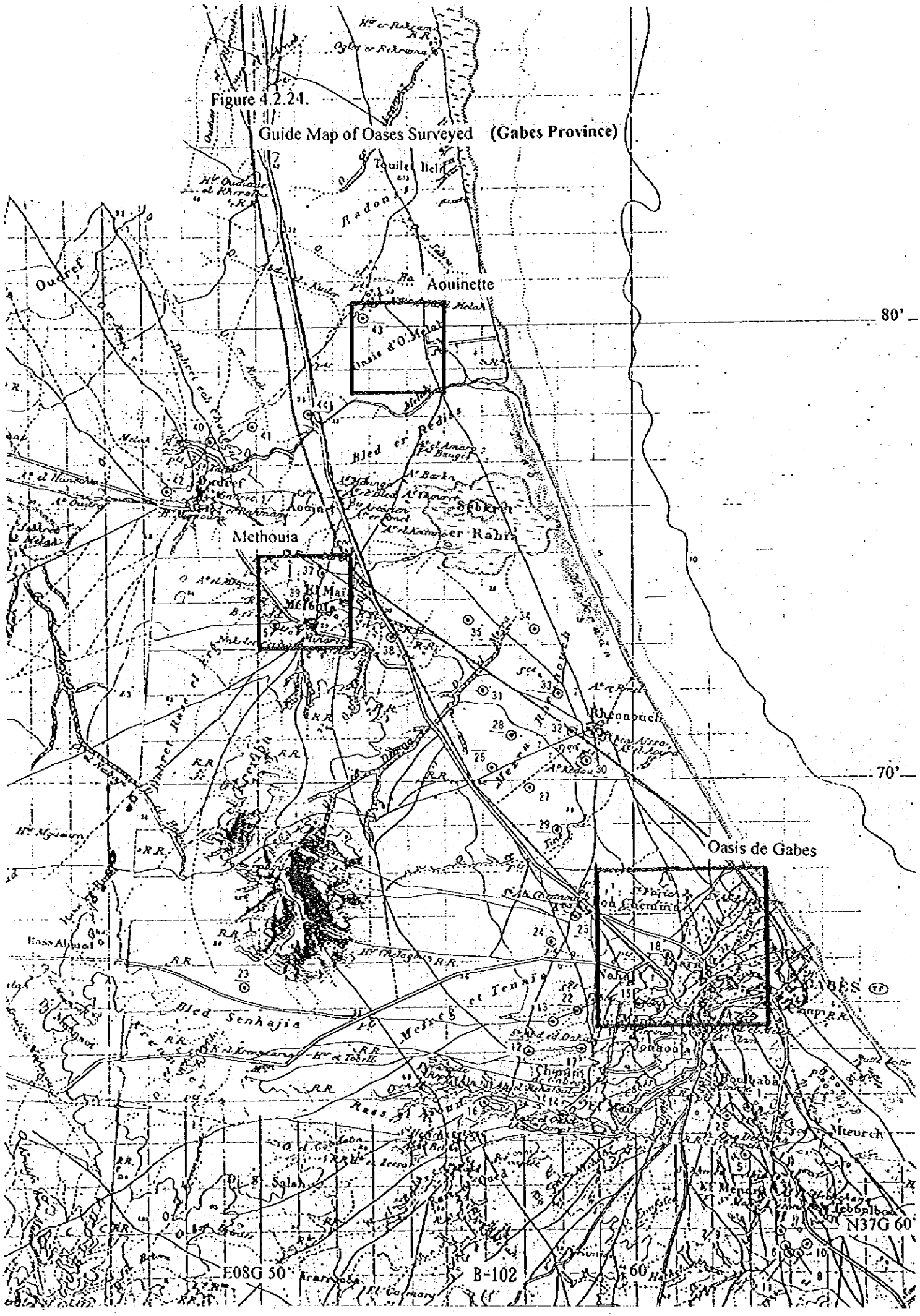


Figure 4.2.25. (a) Location Map of Hand-Auger

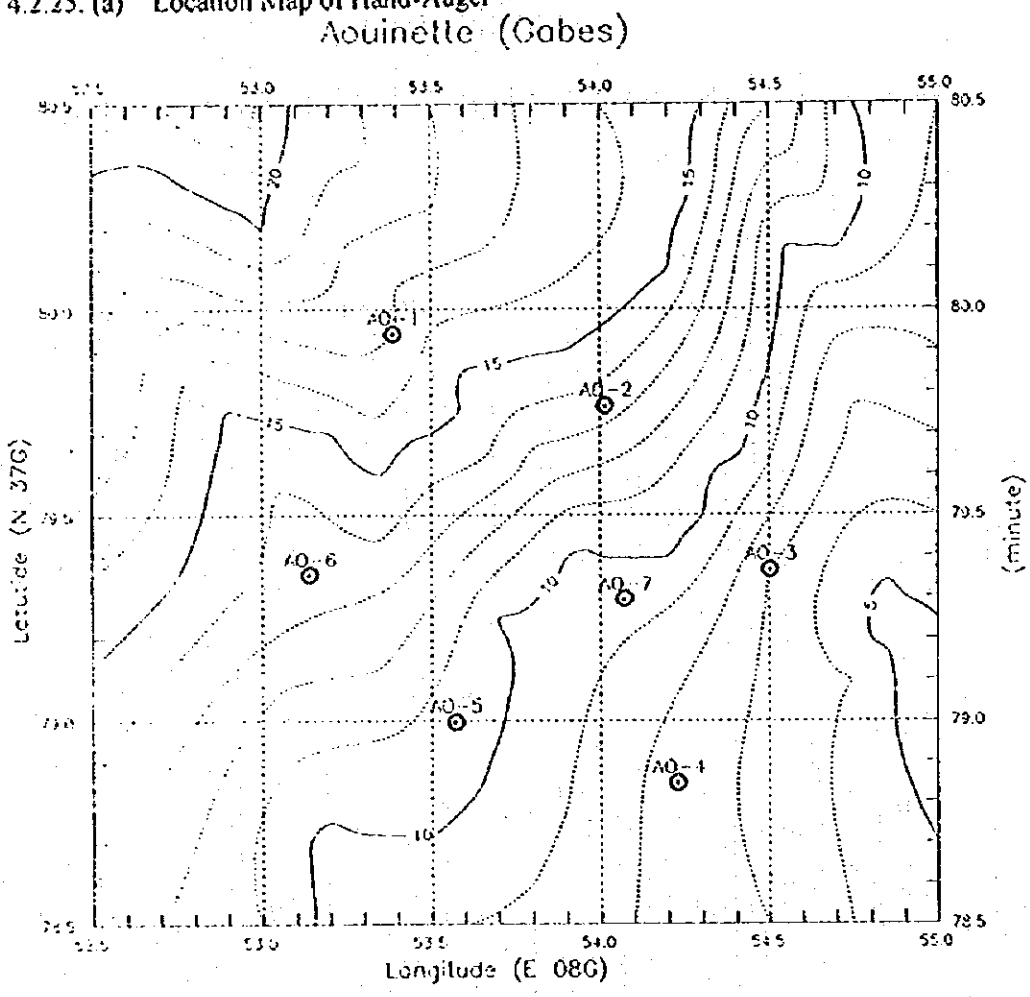


Figure 4.2.25. (b) Bird Eye's Figure

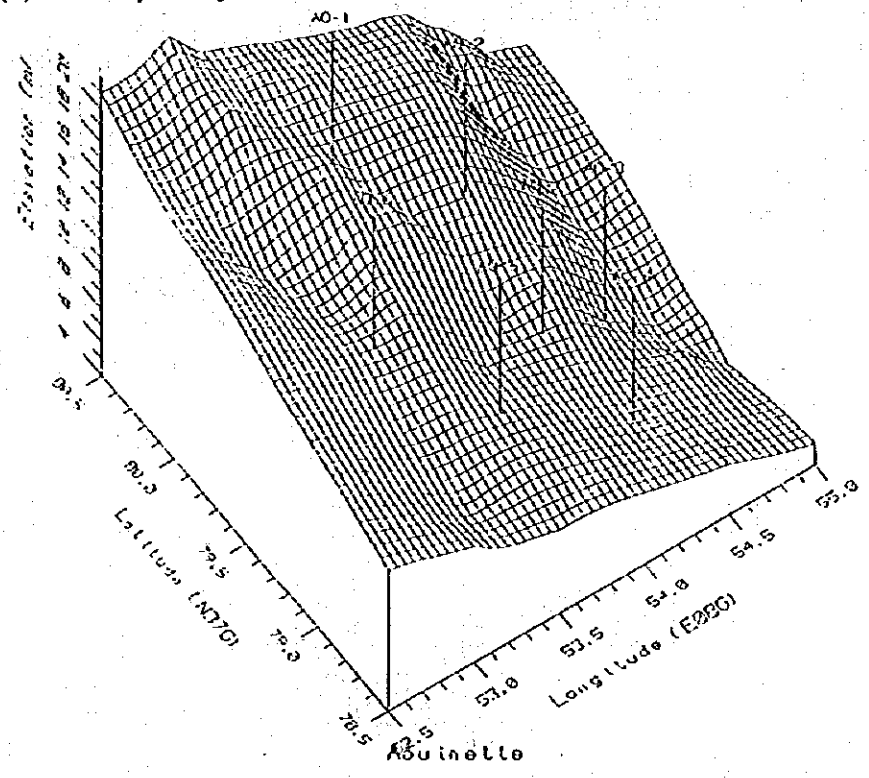


Figure 4.2.26. (a) Location Map of Hand-Auger

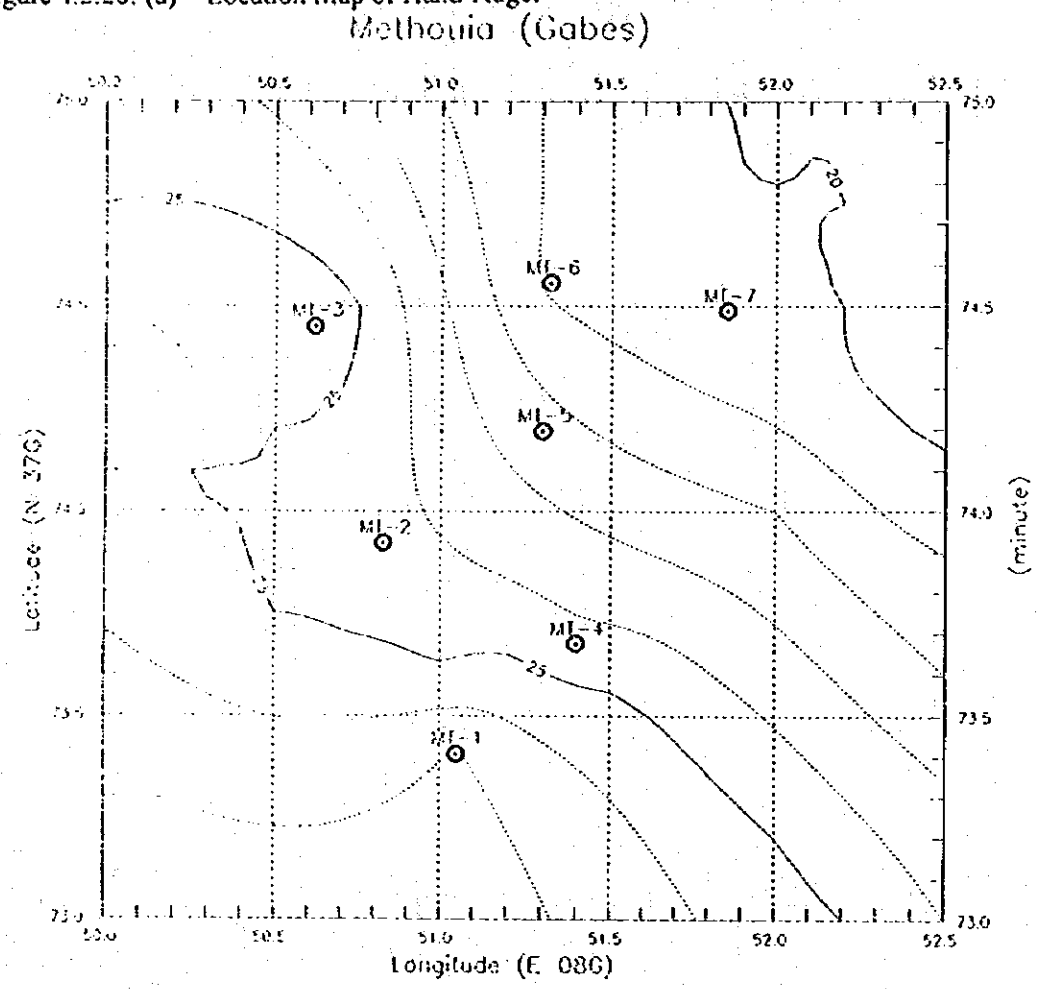


Figure 4.2.26. (b) Bird Eye's Figure

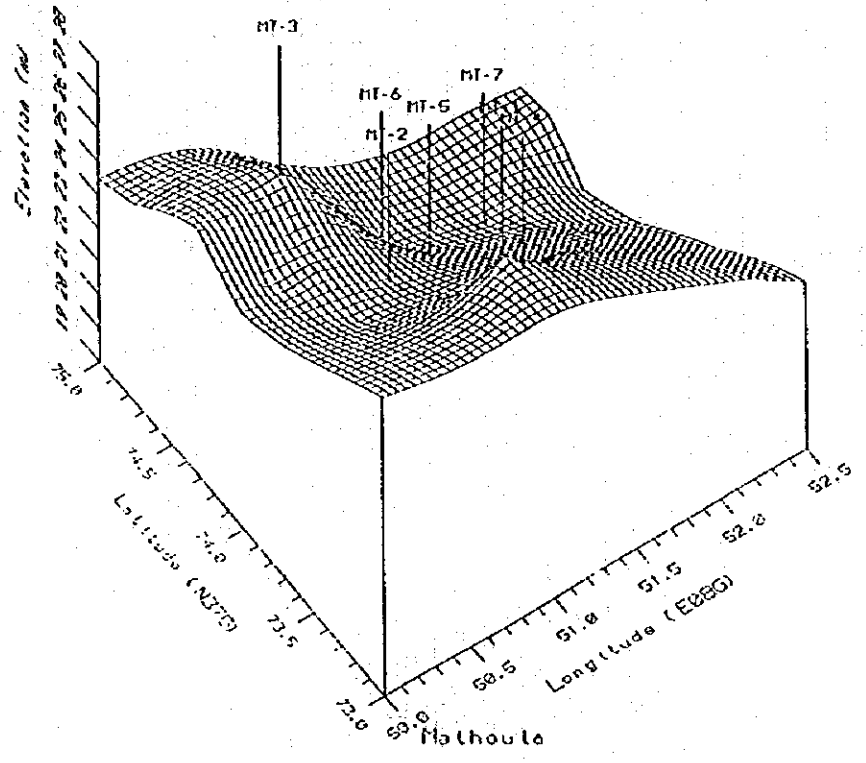


Figure 4.2.27. (a) Location Map of Hand-Auger

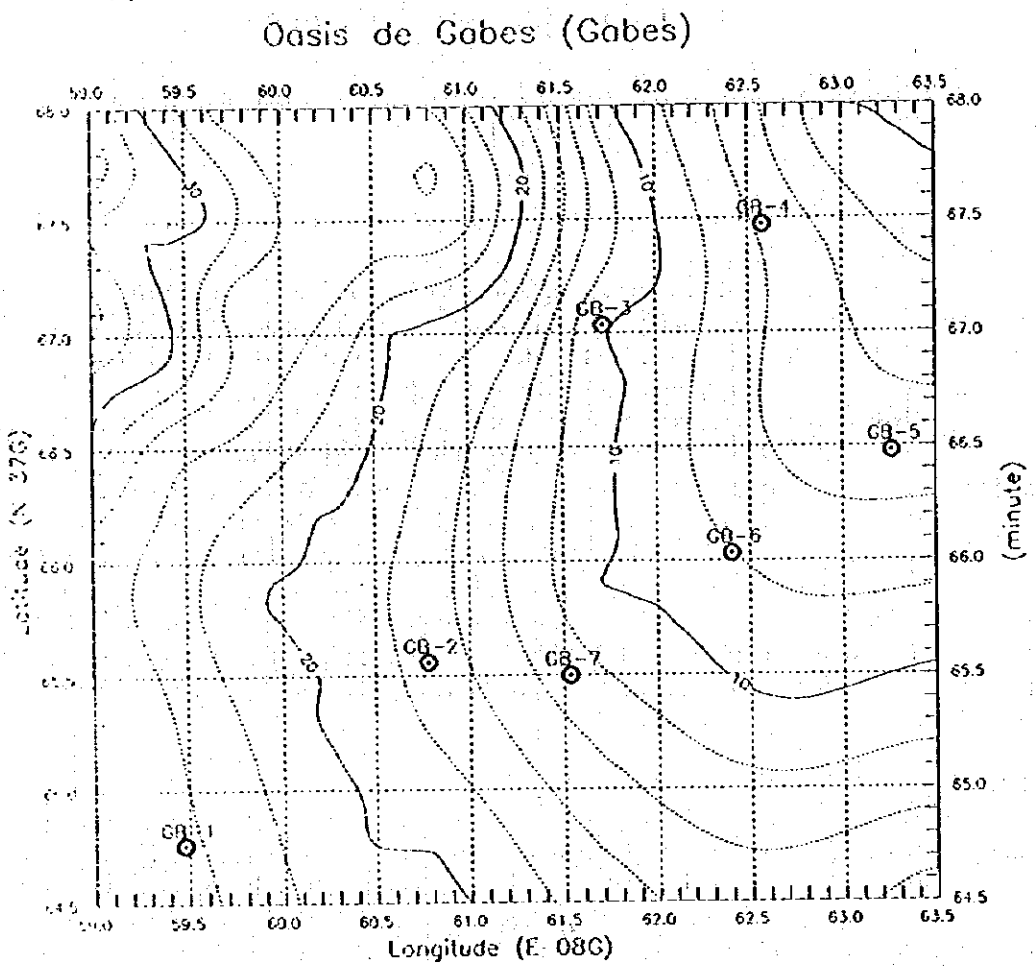
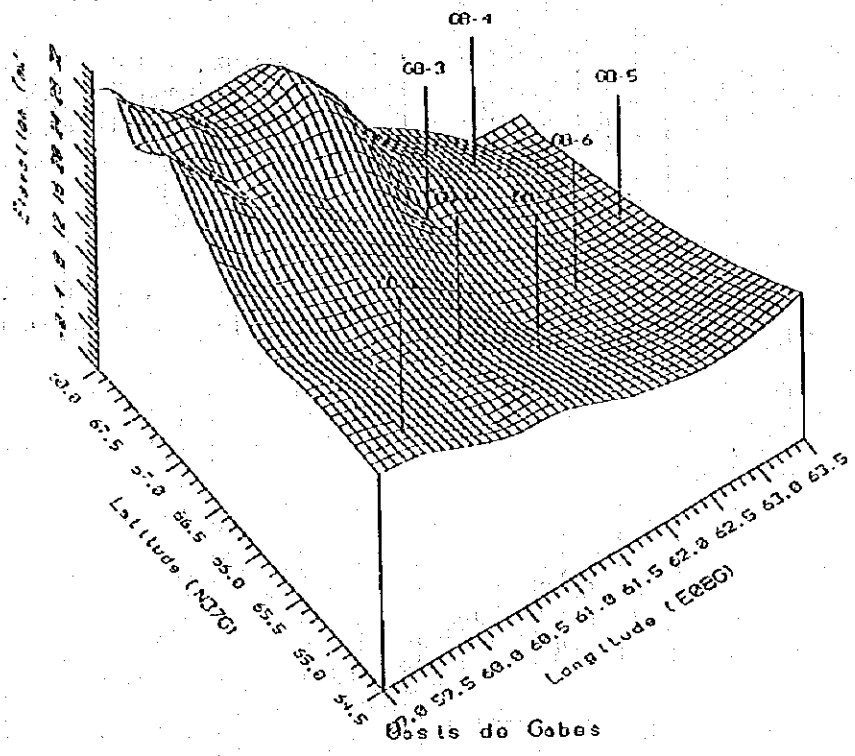


Figure 4.2.27. (b) Bird Eye's Figure



4.3. Permeability Test

4.3.1. Methodology

The permeability of the ground shall be checked by simple in-situ permeability test using the auger boring hole.

At each test point, a test hole is to be drilled by the hand-auger up to around 5 meters or about 1 meter below the groundwater table, and a set of strainer pipe with an inner diameter of 83 mm shall be installed when the hole is collapsible. When the hard layer is encountered within 5 meter, the boring shall be given up at the depth, as same with the procedure explained in the section of gypsum survey.

In the case the groundwater table is enough high compared to the available depth of hand auger, an Auger Hole Test (or Recovery Test) shall be taken. And when the groundwater table is lower than the drilled depth of the hole, the in-situ permeability test shall be given up. Although a Pouring Method can be applicable in this case, the accuracy of the test shall be far inferior than the recovery method. The difference between those two is whether to withdraw groundwater from the hole or to pour some water into the hole, and the following procedure shall almost be same, that is to observe the water level for a certain time period in proper time interval. Permeability coefficient of the ground is roughly calculated from the trends of changing water levels.

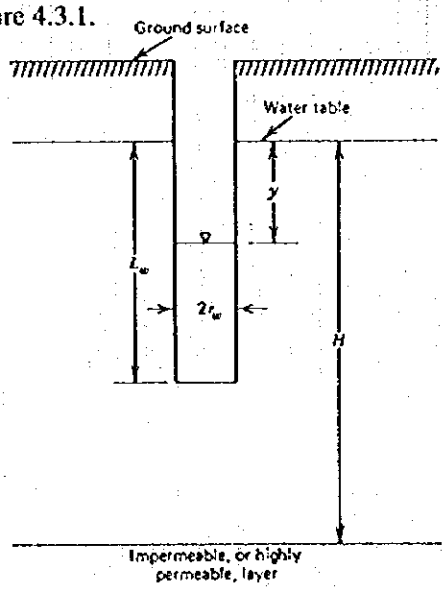
4.3.2. Auger Hole Tests

The auger hole method involves the measurement of the change in water level after the rapid removal of a volume of water from an unlined cylindrical hole. If the soil is loose, a screen may be necessary to maintain the hole. The method is relatively simple and is most adaptable to shallow water table conditions. The value of permeability K obtained is essentially that for a horizontal direction in the immediately vicinity of the hole.

Figure 4.3.1. illustrates an auger hole and the dimensions required for the calculation. It can be shown that hydraulic conductivity is given by

$$K=(C/864) \cdot (dy/dt)$$

Figure 4.3.1.



Dimensions of Auger Hole Test

where *dy/dt* is the measured rate of rise in cm/sec and the factor 864 yields K value in m/day. When K value in cm/sec is required, it is no need to divide by 864. The factor C is a dimensionless constant given by the Table 4.3.1. The table is an original given by Boast & Kirkham (1971), and the extension of them to meet to the actual survey is attached in the end of this section.

Table 4.3.1. Value of the Factor C

L_w/r_w	y/L_w	$(H - L_w)/L_w$ for Impermeable Layer								$H - L_w$	$(H - L_w)/L_w$ for Infinitely Permeable Layer			
		0	0.05	0.1	0.2	0.5	1	2	5	∞	5	2	1	0.5
1	1	447	423	404	375	323	286	264	255	254	252	241	213	166
	0.75	409	450	434	408	360	324	303	292	291	289	278	248	198
	0.5	555	537	522	497	449	411	386	360	379	377	359	324	264
2	1	186	176	167	154	134	123	118	116	115	115	113	106	91
	0.75	196	187	180	168	149	138	133	131	131	130	128	121	106
	0.5	234	225	218	207	188	175	169	167	167	166	164	156	139
5	1	51.9	48.6	46.2	42.8	38.7	36.9	36.1		35.8		35.5	34.6	32.4
	0.75	54.8	52.0	49.9	46.8	42.8	41.0	40.2		40.0		39.6	38.6	36.3
	0.5	66.1	63.4	61.3	58.1	53.9	51.9	51.0		50.7		50.3	49.2	46.6
10	1	18.1	16.9	16.1	15.1	14.1	13.6	13.4		13.4		13.3	13.1	12.6
	0.75	19.1	18.1	17.4	16.5	15.5	15.0	14.8		14.8		14.7	14.5	14.0
	0.5	23.3	22.3	21.5	20.6	19.5	19.0	18.8		18.7		18.6	18.4	17.8
20	1	5.91	5.53	5.30	5.06	4.81	4.70	4.66		4.64		4.62	4.58	4.46
	0.75	6.27	5.94	5.73	5.50	5.25	5.15	5.10		5.08		5.07	5.02	4.89
	0.5	7.67	7.34	7.12	6.88	6.60	6.48	6.43		6.41		6.39	6.34	6.19
50	1	1.25	1.18	1.14	1.11	1.07	1.05			1.04			1.03	1.02
	0.75	1.33	1.27	1.23	1.20	1.16	1.14			1.13			1.12	1.11
	0.5	1.64	1.57	1.54	1.50	1.46	1.44			1.43			1.42	1.39
100	1	0.37	0.35	0.34	0.34	0.33	0.32			0.32			0.32	0.31
	0.75	0.40	0.38	0.37	0.36	0.35	0.35			0.35			0.34	0.34
	0.5	0.49	0.47	0.46	0.45	0.44	0.44			0.44			0.43	0.43

4.3.3. Result of the test

a) Analysis

The field measurement data were arranged in the data sheet and attached at Appendix. And the analysis chart to calculate (dy/dt) is shown as Figure 4.3.2.
At first, the value of (dy/dt) was calculated based on the figure 4.3.2. Then the calculation factor C was read from the table (attached at the end of section). The permeability of the site is, then, easily calculated as multiplied (dy/dt) by C when it is required to show in cm/sec, or again divided by 864 to show in the unit of m/day.

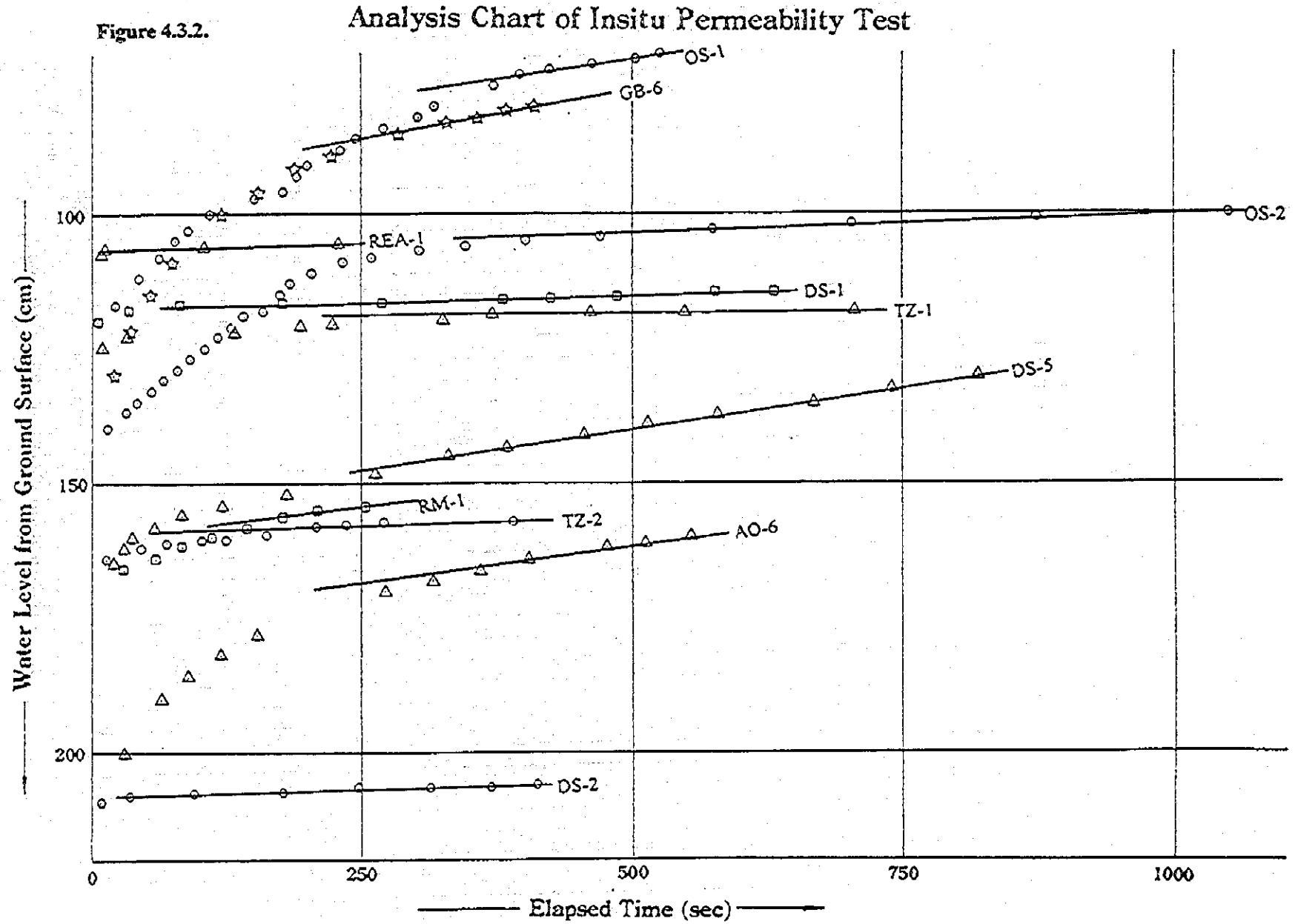
b) Results

The result of tests, thus calculated, are shown as Table 4.3.2.

Table 4.2.3. RESULTS OF IN-SITU PERMEABILITY TEST

Province	Oasis Name	Auger Hole	L_w (cm)	r_w (cm)	H (cm)	y (cm)	L_w/r_w (cm)	y/L_w (cm)	$H-L_w$ (cm)	$(H-L_w)/L_w$	C	dy/dt (cm/s)	K (cm/sec)	Soil Tex.
GAFSA	Oued Shili	OS-1	150	5.2	210	122	29	0.8	60	0.4	2.73	1.8E-1	4.9E-1	Sand
		OS-2	210	5.2	210	140	40	0.7	0	0	1.99	1.6E-1	3.2E-1	Sand
TOZEUR	Tozeur	TZ-1	260	5.2	350	125	50	0.5	90	0.3	1.48	4.5E-2	6.7E-2	Clayey Sand
		TZ-2	220	5.2	220	164	42	0.7	0	0	1.99	5.3E-2	1.1E-1	Sand
	Draa Sud	DS-1	220	5.2	800	120	42	0.5	580	2.6	2.04	3.0E-2	6.1E-2	Clayey Sand
		DS-2	250	5.2	500	209	48	0.8	250	1.0	1.12	5.0E-3	5.6E-3	Clayey Sand
		DS-5	230	5.2	230	165	44	0.7	0	0	1.67	7.0E-2	1.2E-1	Sand
KEBILI	Ras El Ain	REA-1	210	5.2	330	107	40	0.5	120	0.6	2.08	6.0E-2	1.2E-1	Silty Sand
	Rejim Maatoug 2	RM-1	270	5.2	800	166	52	0.6	530	2.0	1.26	7.5E-2	9.5E-2	Sandy Clay
GABES	Oasis de Gabes	GB-6	330	5.2	330	130	63	0.4	0	0	1.31	1.6E-1	2.0E-1	Sand
	Aouinette	AO-6	250	5.2	800	200	48	0.8	550	2.2	1.12	1.3E-1	1.5E-1	Sand

Figure 4.3.2.


Analysis Chart of Insitu Permeability Test
OS-1
GB-6
OS-2
REA-1
DS-1
TZ-1
DS-5
RM-1
TZ-2
AO-6
DS-2
100
150
200
0
250
500
750
1000
Water Level from Ground Surface (cm)
Elapsed Time (sec)

4.4. Summary and Conclusion

4.4.1. Summary

Gypsum soils do occur in several desert regions of the world, and Tunisia is well known as one of the countries extensively covered by them. In the South and a part of the Central Tunisia, especially in the low-lying zone from Chott El Djerid to Gulf of Gabes, the gypsum soil is rather commonly observed. Among the 153 of target oases for the Study, around 90 oases are said to be underlain or covered by gypsum soil, seriously or slightly. Thus, a gypsum survey using Hand Auger was conducted at 11 oases in the four provinces.

The total numbers and the linear length of the hand auger boring conducted in this period are shown below.

Table 4.4.1. Work Volume of Hand Auger Boring

Province	Oasis Name	Number of Boring	Linear Length (m)
Gafsa	Sud Ouest	6	10.8
	Oued Shili	6	16.5
Tozeur	Tozeur	10	40.1
	Draa Sud	7	20.8
Kebili	Ras El Ain	8	39.3
	Guetaya	7	29.6
	Mazraa Neji	7	26.8
	Regim Maatoug 2	6	14.5
Gabes	Oasis de Gabes	7	29.1
	Methouia	7	30.7
	Aouinette	7	15.8
Total	11 Oases	78	274.0

As results of the survey, following matters are revealed:

i) In most of the oases in the South, gypsum soils are rather commonly distributing because of the existence of enough source materials.
ii) The major source of gypsum is rock gypsum/anhydrite contained in the mountain ranges surrounding the Chotts.
iii) The minor source is evaporites newly born in the salt lake deposits.
iv) Most commonly, a gypsum is contained in the ground as fluvial gypsum sand deposits and it exists as gypsum sand when it is moisture but form a hard gypsum crust when it has lost humidity.
v) The area covered by a hard gypsum crust, another crust underlying at shallow depth in most of the cases.
vi) In some portions, a calcium sulfate is still crystalline out in clay or loamy soils under the saturated circumstance.
vii) The situation of gypsum soil is rather severe in the newly developed oases than the traditional ones as a general.

Almost in parallel with the gypsum survey, an in-situ permeability tests by so called Auger Hole Tests were carried out total 11 times at 7 oases in four provinces, to grasp the permeability of the soil. As the results, most of the soils show the high permeability of 10^{-1} to 10^{-3} cm/sec order.

4.4.2. Conclusion

Gypsum is very much soluble by water. In the traditional oases, there is no hard gypsum crust because of a leaching phenomenon through long time of irrigation. While in the newly developing oases, they still exist as a hard crust. Usually the surface crust was

excavated out by heavy equipment prior to the plantation though, the second (the lower) hard crust exists again at 1.0 to 2.0 m below the first one. The farmer must crush it spotty for palm tree plantation. Even in these oases, the gypsum crusts shall be melting away gradually when enough irrigation water is supplied.

The problem is, exactly saying, not the gypsum sand or hard crust but impervious layer which obstructs the irrigation water to drain out, and it is usually a clay or a loam layer underlain the gypsum soil. In most of the cases, this clay is a main body of the lake deposits, and rather thick in/around the Chott Djerid. It is almost impossible to take off the clay layer, so that, there is no other way to select the area to where such clay underlies at the enough deep depth if it is required to develop oases newly. Most of the traditional oases satisfied this condition, and only the modern oases have still trouble on drainage. If it has come from the hard gypsum crust, it will be solved soon, but it may not be solved when it has come from the clay.

In a total view, oases underlain by gypsum soil are 90, nearly 60% of all target oases. However, the oases at where a gypsum soil underlies thickly or widely are 34, about 22% of the total, concentrated in Kebili Province. And the oases severely affected by gypsum, by hard gypsum crust(s) or thick clayey gypsum soil, are only 15 oases, around 9.8% of all. These situation is shown in the Inventory of Oasis Water Resources , at the column of Gypsum Soil by the marks of (+), (++), and (+++) in accordance with the grade of gypsum affection.

For a permeability of the ground inside of oases, the permeability coefficient obtained through the field tests ranges between 1.0×10^{-1} and 4.1×10^{-3} cm/sec. This value is almost conformable to the design permeability coefficient adopted in the design of drainage system in this area.