Annex to 3.4.1 Description Of Proposed Measures For Wastewater Collection, Treatment And Disposal

Contents

17. WADI ESSIR TREATMENT PLANT

Wadi Essir Treatment Plant receives sewage from the town Wadi Essir only. However, only about 10 % of the town drains to the Wadi Essir Treatment Plant, while the other 90 % discharge their sewage to Amman (As Samra). Figure 17.1 shows the existing sewerage system of Wadi Essir Sewerage System.

The plant was put in operation in 1996 to a capacity of 4,000 m^3/d. Presently only less than a quarter of its capacity is used. For details of the existing system it is referred to Section 17 of Annex 3.1. Primary treatment facilities consist of screens without grit chambers. Biological wastewater treatment is done in two trains of 2 anaerobic ponds (parallel), 2 aerated ponds (parallel) and 4 maturation ponds (2 parallel and 2 in series). Presently, only one anaerobic pond is in operation. Submersible pumps lifting water and jetting it back to the water surface do aeration of the aerobic ponds. Treated wastewater may be chlorinated, if required.

Figure 17.2 shows the existing and future treatment system. The projection of the wastewater production is shown in the following table (acc. to Consultant's Study Report). The plant will reach its final capacity not before

2020: 3,700 m^3/d (32,000 connected inhabitants)

if not additional villages will be connected. Therefore, an extension is not required before 2020.

Receiving water is the Wadi Essir downstream of its confluent with the Wadi El Bakhath discharging finally into the Kafrein Reservoir. From there water will flow to the Jordan Valley for ultimate reuse.

Without chlorination of the plant's effluents the fecal coliform count was found as 1,600 in 100 ml in 1999. Therefore, the effluent could be reused for unrestricted irrigation, if safety chlorination would be provided. However, if other water quality parameters of the effluent would allow unrestricted irrigation, due to the helminthes eggs content the effluent can be reused for restricted irrigation only.

Suitable irrigation areas are identified east of the existing treatment plant (see Figure 17.3). The effluents could supply irrigation water for an area of about 40 ha in 2020 taking into account the demand for plantation of olive and forest trees (see following table). Irrigable land (downstream of the plant) may be supplied by gravity flow.

Consultant's Study Report:

TYPSA, Symonds Travers Morgan and Universal Engineering Consulting: "Wastewater collection, treatment, disposal and/or reuse systems project for the catchment area of Yarmouk River and Jordan River. Interim Report", July 1998

Melyepterv: "Wadi Essir sewage treatment plant. Final Engineering", July 1987

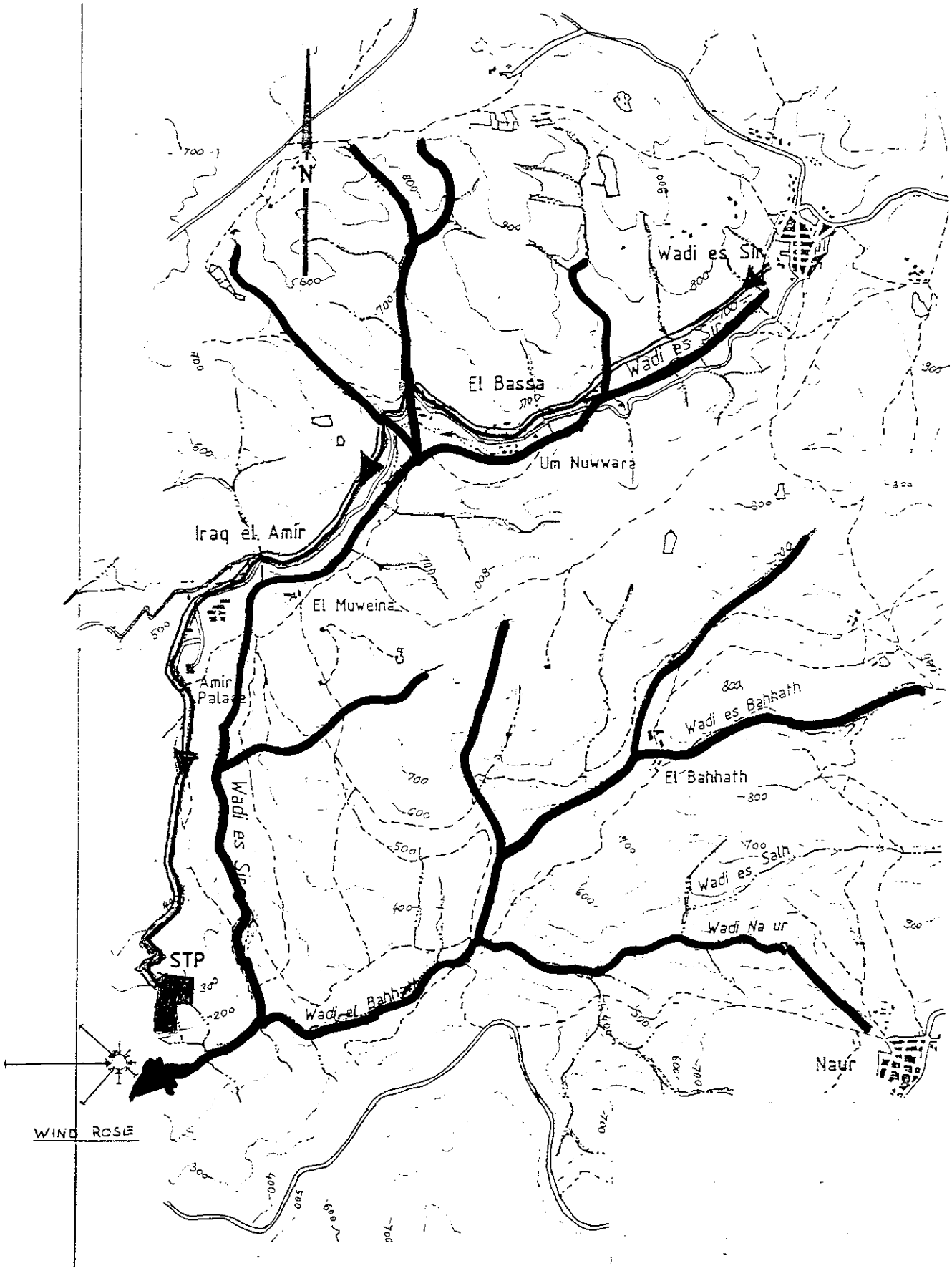


FIGURE 17.1: General Layout of Sewerage System - WADI ESSIR

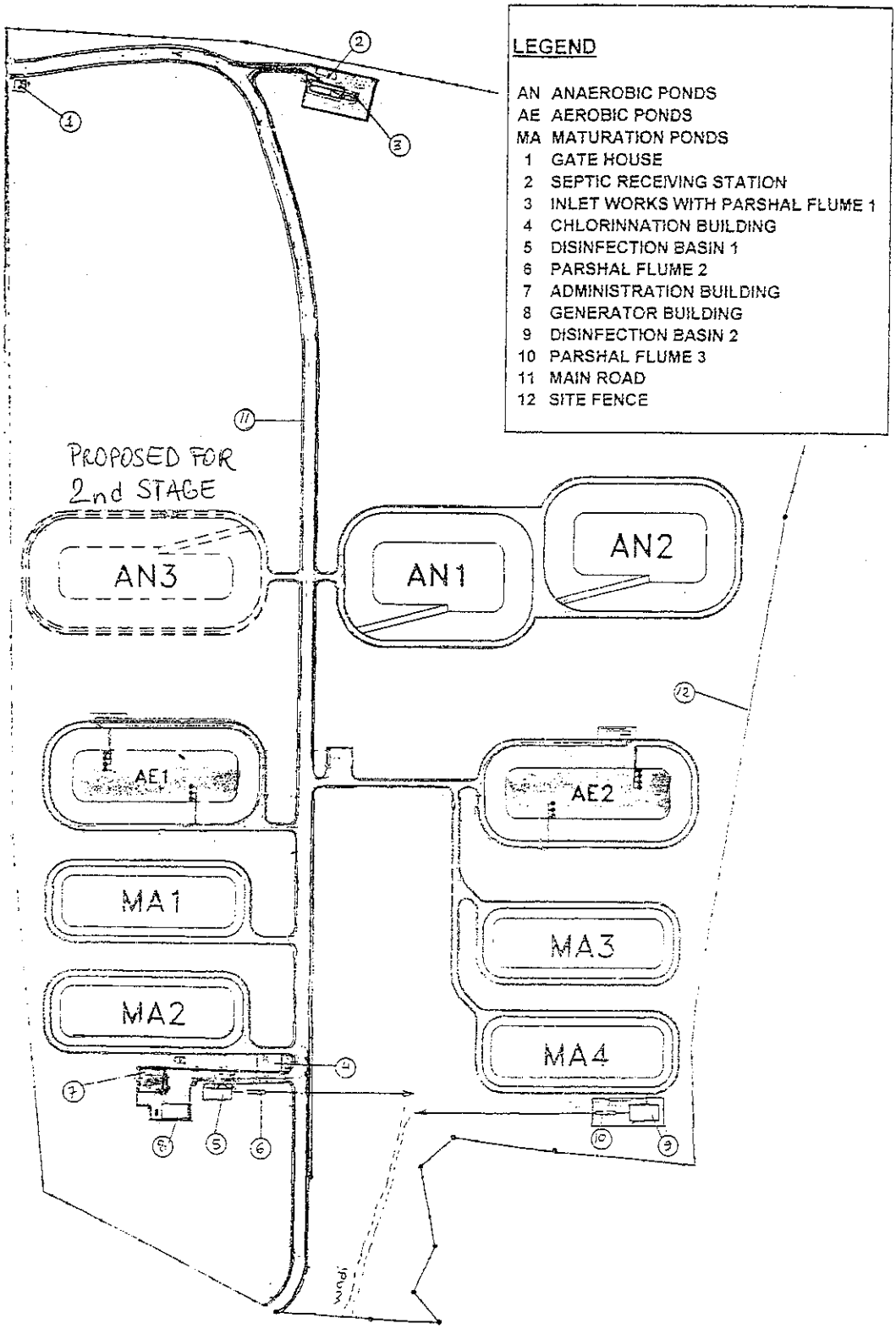


FIGURE 17.2: Layout of Existing and Proposed Wastewater Treatment Plant - WADI ESSIR

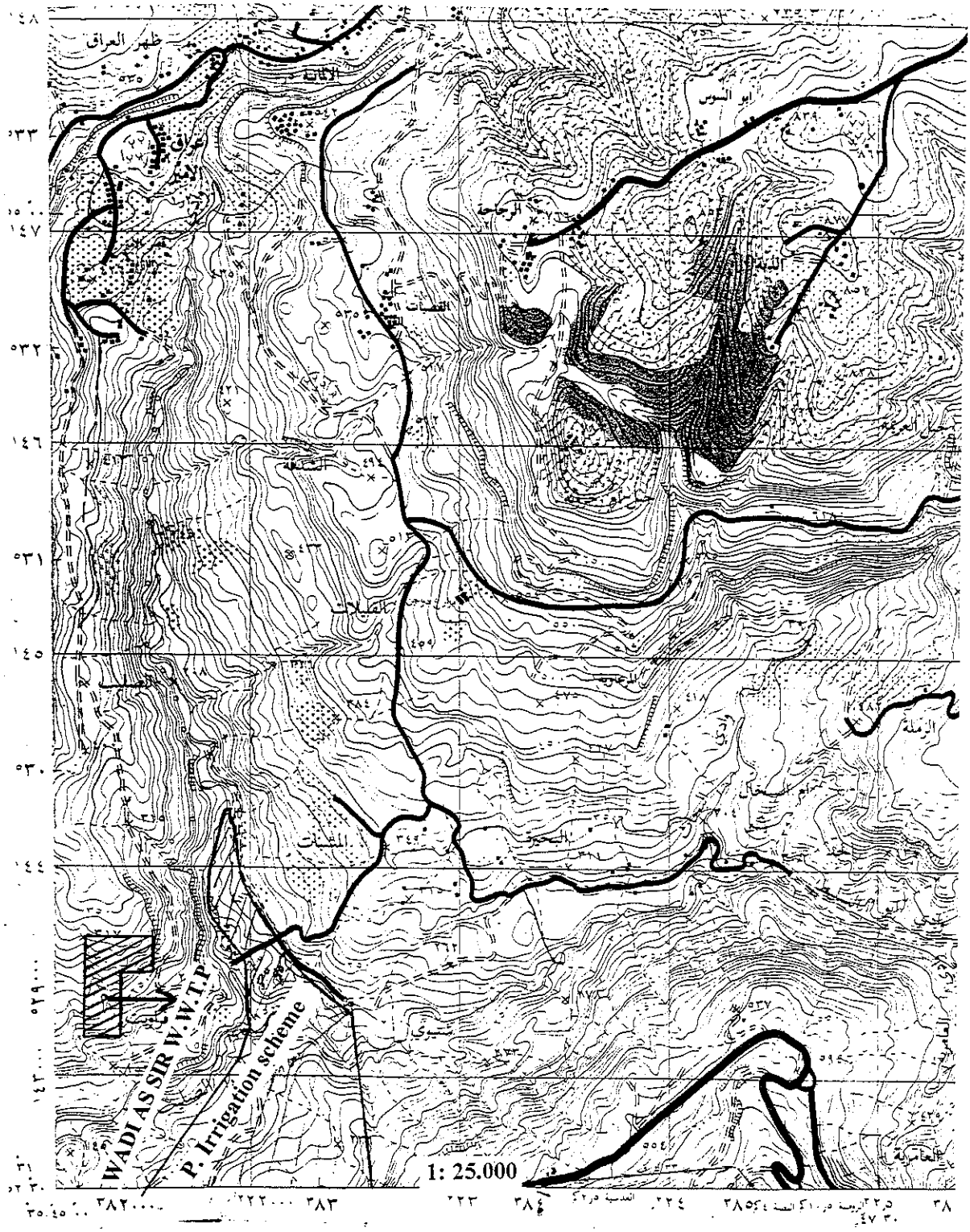


FIGURE 17.3: Potential Reuse Areas - WADI ESSIR

PROJECTION OF WASTEWATER PRODUCTION OF TREATMENT PLANT:
17 WADI ESSIR

SCENARIO 0 "Consultants' Study" (acc. to Consultant's Study Report)

Basic data:

Population in 1994: 11.000 (living in service zone of Wadi Essir Treatment Plant)

	Unit	1994	2000	2005	2010	2015	2020
Growth rate (previous period)	%	-	3,24	3,24	3,24	3,24	3,24
Spec.water demand	l/c/d	90	110	115	130	143	143
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Coverage	%	0	80	80	85	85	85
Return factor	-	0,8	0,8	0,8	0,8	0,8	0,8
Losses/inflow	%	0	0	0	0	0	0
Specific pollutional load	gBOD_5/c/d	65	65	65	65	65	65

	Unit	1994	2000	2005	2010	2015	2020
Population	c	11.000	13.319	15.621	18.321	21.488	25.202
Connected (sewerage)	c	0	10.655	12.497	15.573	18.265	21.422
Not connected (sewerage)	c	11.000	2.664	3.124	2.748	3.223	3.780
Water demand							
Domestic demand	l/c/d	90	110	115	130	143	143
	m³/d	990	1.465	1.796	2.382	3.073	3.604
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Total	m³/d	990	1.465	1.796	2.382	3.073	3.604
Wastewater production							
Return flow (w.demand)	m³/d	0	938	1.150	1.620	2.090	2.451
Losses/inflow	m³/d	0	0	0	0	0	0
Total	m³/d	0	938	1.150	1.620	2.090	2.451
	m³/month	0	28.130	34.492	48.589	62.685	73.520
	m³/a	0	342.252	419.654	591.161	762.673	894.496
Pollutional load							
Poll. load (dom.demand)	kgBOD_5/d	0	693	812	1.012	1.187	1.392
Poll. load (com.demand)	kgBOD_5/d						
Poll. load (small ind.)	kgBOD_5/d						
Others	kgBOD_5/d						
Total load	kgBOD_5/d	0	693	812	1.012	1.187	1.392
Reuse of wastwater							
Inflow to the treatment plant	m³/a	0	342.252	419.654	591.161	762.673	894.496
Losses in treatment plant	%	10	10	10	10	10	10
(due to infiltr./evap.)	m³/a	0	34.225	41.965	59.116	76.267	89.450
Effluent of treatment plant	m³/a	0	308.027	377.689	532.045	686.406	805.046
Net water demand per ha	m³/d/ha		60	60	60	60	60
Irrigable reuse area	ha	0	14	17	24	31	37

Water demand for irrigation Olives 60 m³/d/ha (peak period demand)

18. WADI HASSAN TREATMENT PLANT (under construction)

Wadi Hassan Treatment Plant is part of the sewerage system considered by the long-term development in Greater Irbid Area (compare description of the Treatment Plant Irbid Central under Section 6). It will receive wastewater from An Nu'ayyma, Kitm and Shatana.

The plant will be completed end of 2000, while the sewage collection network will be put into operation not before 2001 (for details of the existing system refer to Section 18 of Annex 3.1). The projection of the wastewater production shows that the capacity of the plant (1,600 m^3/d) will be reached in about 2010 (acc. to Consultant's Study Report, see following table).

At present there are no specific plans to implement a reuse scheme for the effluents of Wadi Hassan Treatment Plant. However, the Consultant proposes to reuse the treated effluent in agricultural land north of the plant's side (see Figure 18.3). The effluents could supply irrigation water (gravity flow) for an area of about 50 ha in 2020 (see following table) taking into account the irrigation demand for alfalfa and barley.

A further possibility of reuse could be the reuse of the treated wastewater at the Jordan University of Science and Technology (JUST). Wastewater could be discharged by gravity from the Wadi Hassan Plant to JUST.

In July 2000 the Ministry of Water and Irrigation prepared Terms of Reference for a study for reuse of treated wastewater for the Greater Irbid Area. It is proposed that the German Development Bank (Kreditanstalt fuer Wiederaufbau, KfW) will finance this study.

Consultant's Study Report:

RRI, DAR and Sigma: "Technical, economical and financial Feasibility Study. Phase B. Feasibility study of preferred alternatives for wastewater collection and treatment systems in the Greater Irbid area", March 1992

RRI, DAR and Sigma: "Wastewater collection and treatment systems in the Greater Irbid area. Stage II. Reuse of treated wastewater and utilization of stabilized sludge", March 1995

DAR: "Update of the feasibility study. Wastewater collection and treatment systems in the Greater Irbid area. Stage 2. Wadi Shallala." November 1998.

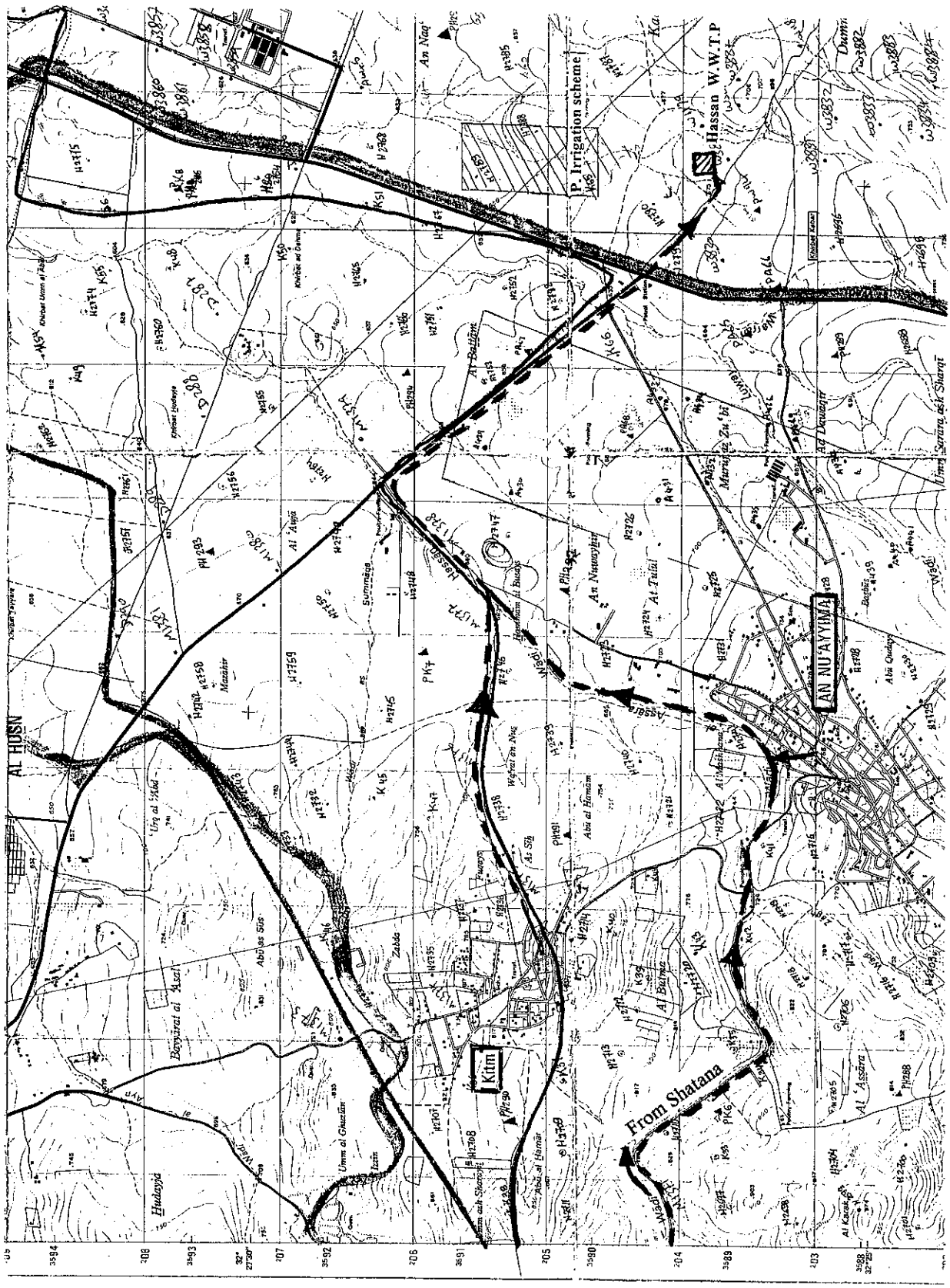


FIGURE 18.1: General Layout of Proposed Sewerage System - WADI HASSAN

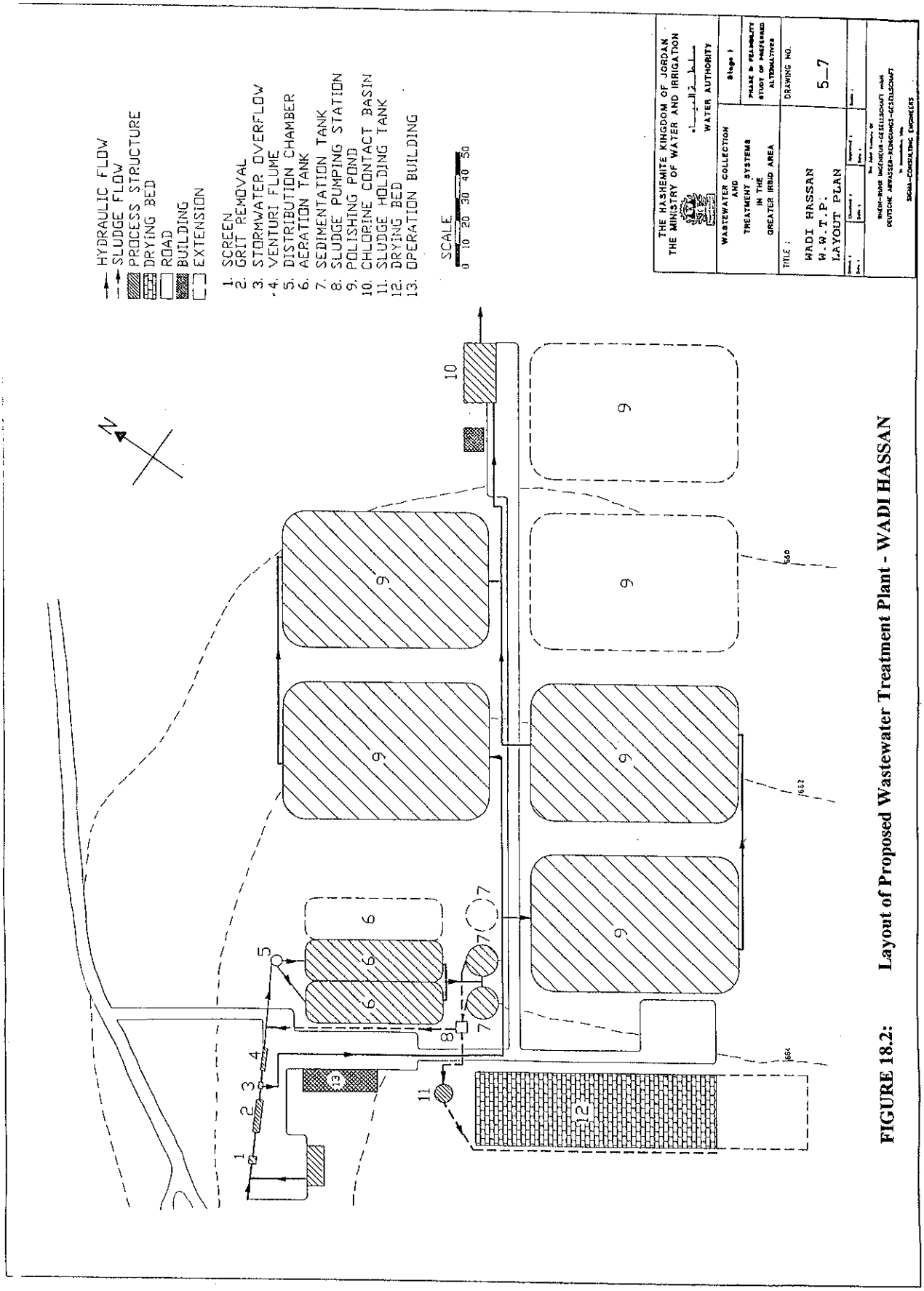


FIGURE 18.2: Layout of Proposed Wastewater Treatment Plant - WADI HASSAN

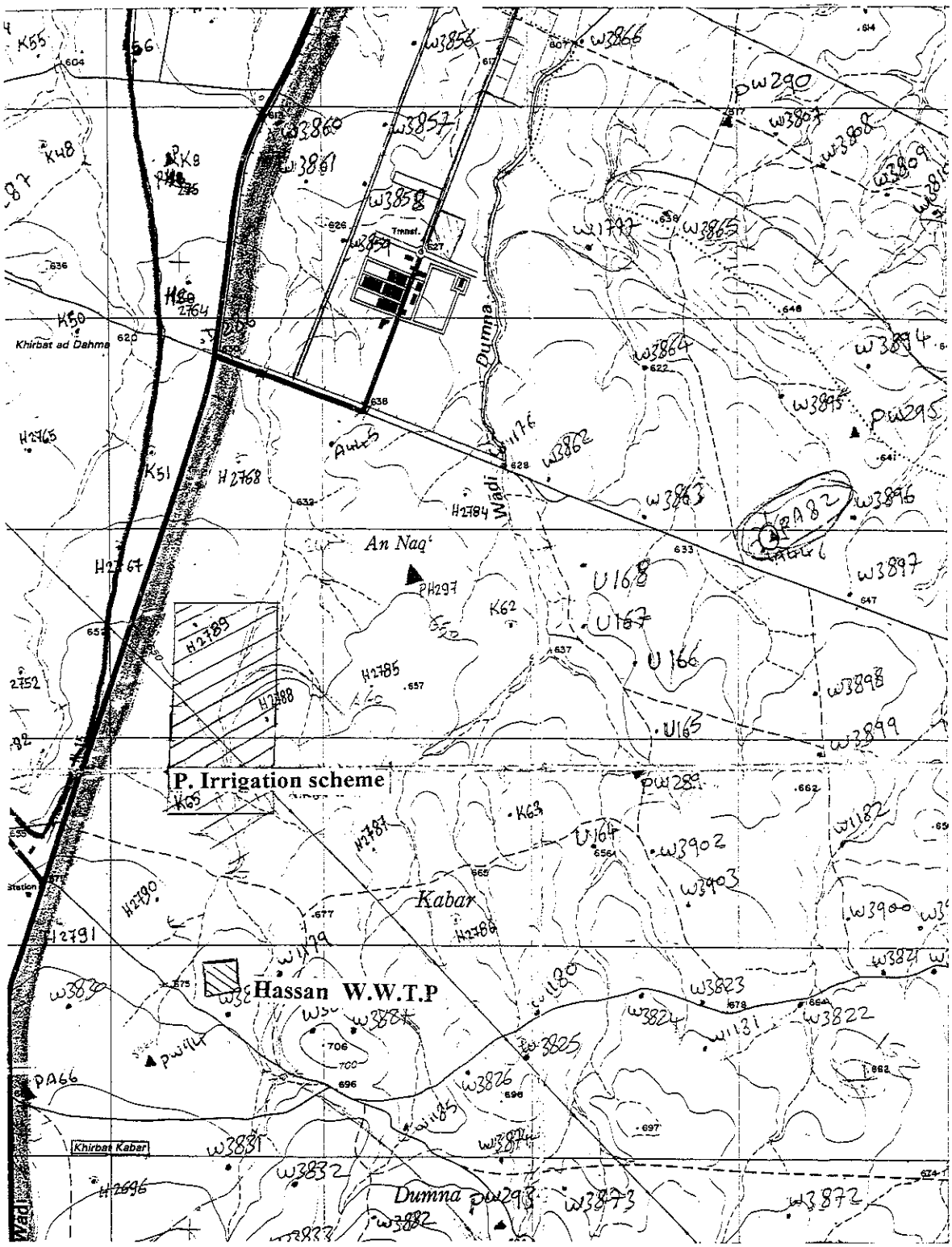


FIGURE 18.3: **Potential Reuse Areas – WADI HASSAN (acc. to Min. of Agriculture)**

PROJECTION OF WASTEWATER PRODUCTION OF TREATMENT PLANT:
18 WADI HASSAN

SCENARIO 0 "Consultants' Study" (acc. to Consultant's Study Report)

Basic data:

Population in 1994: 0 Population in 2000: 18.300

	Unit	1994	2000	2005	2010	2015	2020
Growth rate (previous period)	%	-	-	3,50	3,50	3,25	3,25
Spec.water demand	l/c/d	-	85	90	95	100	105
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Coverage	%	0	85	85	85	85	85
Return factor	-	0,8	0,8	0,8	0,8	0,8	0,8
Losses/inflow	%	0	0	0	0	0	0
Specific pollutional load	$gBOD_5/c/d$	65	65	65	65	65	65

	Unit	1994	2000	2005	2010	2015	2020
Population	c	0	18.300	21.735	25.814	30.290	35.543
Connected (sewerage)	c	0	15.555	18.474	21.942	25.747	30.212
Not connected (sewerage)	c	0	2.745	3.260	3.872	4.544	5.331
Water demand							
Domestic demand	l/c/d	-	85	90	95	100	105
	m³/d	0	1.556	1.956	2.452	3.029	3.732
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Total	m³/d	0	1.556	1.956	2.452	3.029	3.732
Wastewater production							
Return flow (w.demand)	m³/d	0	1.058	1.330	1.668	2.060	2.538
Losses/inflow	m³/d	0	0	0	0	0	0
Total	m³/d	0	1.058	1.330	1.668	2.060	2.538
	m³/month	0	31.732	39.905	50.027	61.792	76.133
	m³/a	0	386.075	485.509	608.667	751.808	926.288
Pollutional load							
Poll. load (dom.demand)	$kgBOD_5/d$	0	1.011	1.201	1.426	1.674	1.964
Poll. load (com.demand)	$kgBOD_5/d$						
Poll. load (small ind.)	$kgBOD_5/d$						
Others	$kgBOD_5/d$						
Total load	$kgBOD_5/d$	0	1.011	1.201	1.426	1.674	1.964
Reuse of wastwater							
Inflow to the treatment plant	m³/a	0	386.075	485.509	608.667	751.808	926.288
Losses in treatment plant	%	0	10	10	10	10	10
(due to infiltr./evap.)	m³/a	0	38.608	48.551	60.867	75.181	92.629
Effluent of treatment plant	m³/a	0	347.468	436.958	547.801	676.627	833.660
Net water demand per ha	m³/d/ha		45	45	45	45	45
Irrigable reuse area	ha	0	21	27	33	41	51

Water demand for irrigation Alfalfa, barley 45 m³/d/ha

19. WADI MOUSA TREATMENT PLANT (under construction)

The sewerage scheme of Wadi Mousa (presently under construction) is located close to the ancient Nabataean city of Petra in the southern part of Jordan. The communities of Wadi Mousa, Taiba, B'doul and Beida will be connected to the proposed scheme. Figure 19.1 shows the layout of the proposed sewerage system.

Due to the vicinity to the ancient Nabataean city of Petra the development of tourism in Wadi Mousa is expected to contribute significantly to the resident population. The contribution will be two-fold, directly through attracting new residents to the town and indirectly by increasing the number of hotel visitors. The projection of the wastewater production takes into account this fact (acc. to Consultant's Study Report, see following table).

The project foresees the construction of a Treatment Plant designed for the wastewater production in 2020. The biological process selected includes nitrogen removal and is a modification of the activated sludge process known as modified Ludzack-Ettinger (MLE). This MLE process differs from conventional activated sludge in the configuration of the reactor sections. The process consists of a biological reactor followed by secondary settling. The activated sludge removed by the secondary settling tank is returned to the biological reactor to maintain process dynamics. The reactor for the proposed process consists of two zones: an "anoxic" zone without aeration, followed by an aerated or "oxic" zone. In addition, some treated effluent known as "mixed liquor" from the end of the aerobic zone is recycled to the head of the anoxic zone. Polishing (maturation) ponds serve for tertiary treatment. Produced sludge will be treated by sludge holding tanks (for thickening and anaerobic stabilization) followed by drying beds. Figure 19.2 shows the proposed treatment system.

The projection of the wastewater production is shown in the following table (acc. to Consultant's Study Report). The plant will be implemented in two phases, whereby the final capacity will be reached

in 2020:	4,900 m³/d	(24,000 connected resident inhabitants plus peak season tourists: 4,500 hotel guests and 2,700 day visitors)

Construction works of sewerage system and treatment plant will be completed early 2001.

According to the Consultant's proposal a storage basin (6,800 m³) is required to equalize seasonal differences in supply and demand for irrigation. Such areas have been identified north of the Sad Um El Hiran plant site shown in Figure 19.3. In 2020 about 80 ha may be irrigated with treated effluent, forest trees and olives as well as about barley as winter crop (see following table).

It is discussed to involve the private sector in a management contract in operation and maintenance the water supply and wastewater system of Wadi Mousa (see ABT Report of 1999). This contract would include 86 km of wastewater collectors, 4 sewage pumping stations and the treatment plant of a present capacity of 3,400 m³/d.

Consultant's Study Report:

CDM: "Wadi Mousa water supply and wastewater project. Stage II. Final design report", September 1996.

ABT: "Technical review meeting. Management contract water supply and wastewater system Wadi Mousa", November 1999.

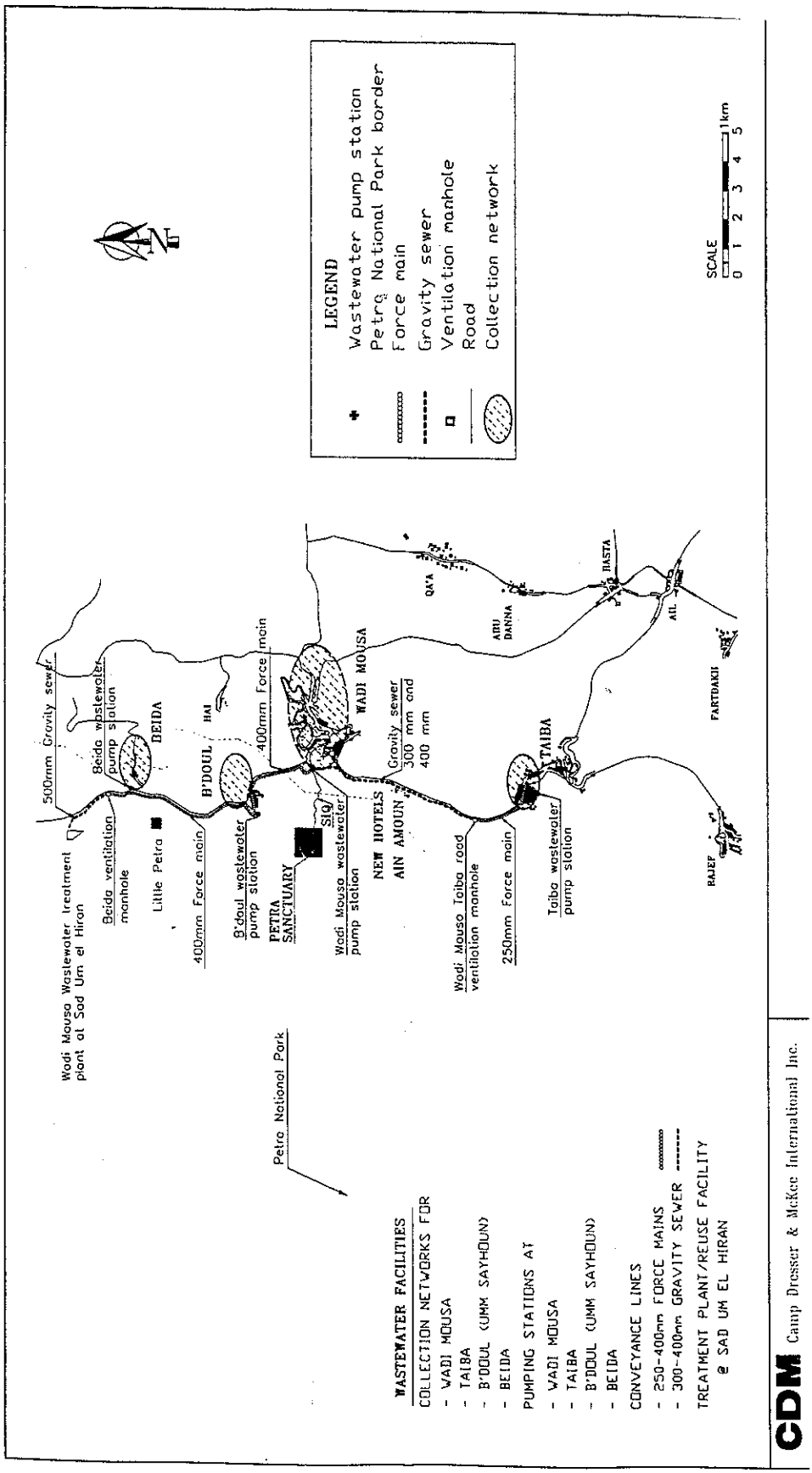


FIGURE 19.1: General Layout of Proposed Sewerage System - WADI MOUSA

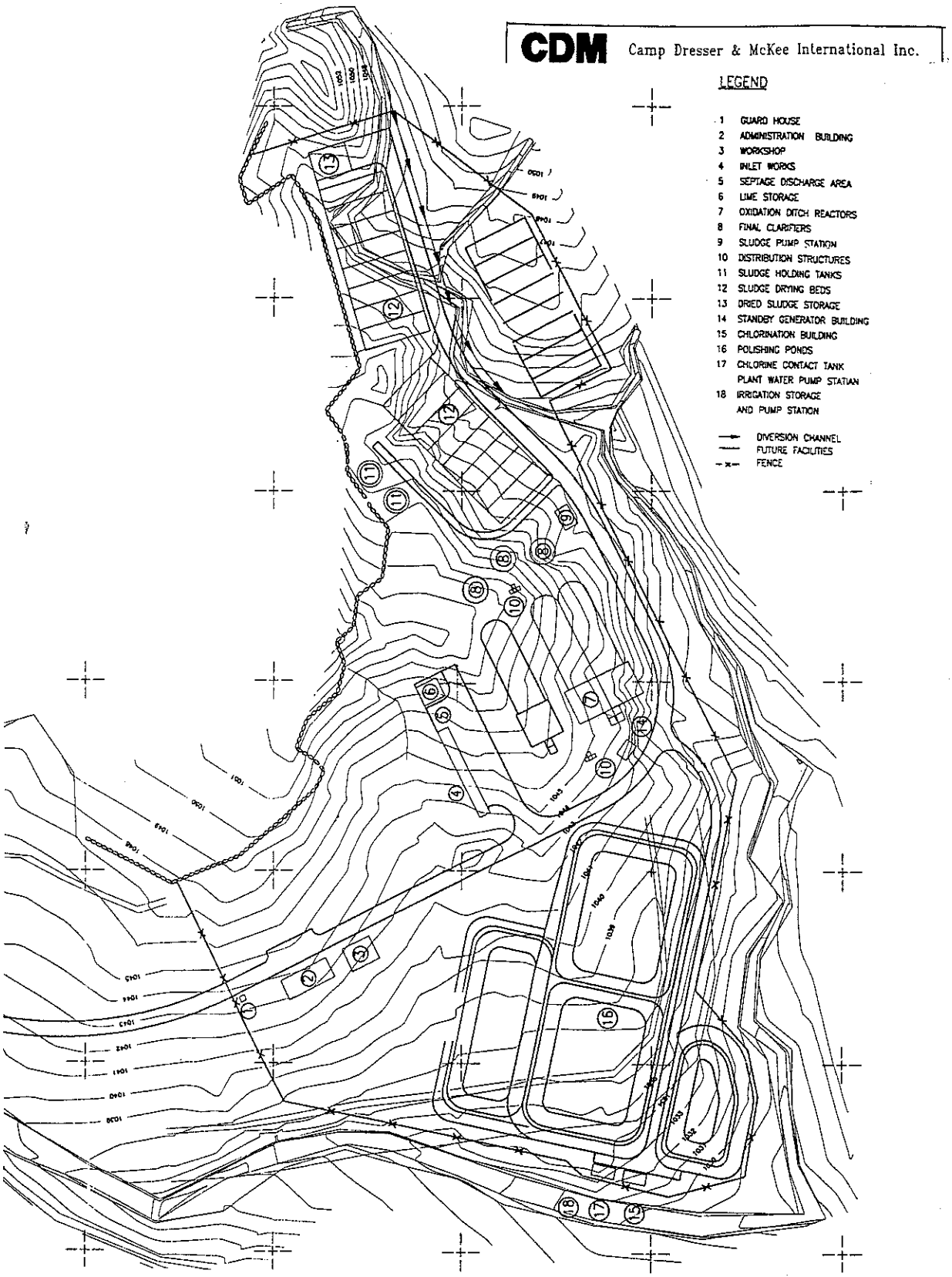


FIGURE 19.2: Layout of Proposed Wastewater Treatment Plant - WADI MOUSA

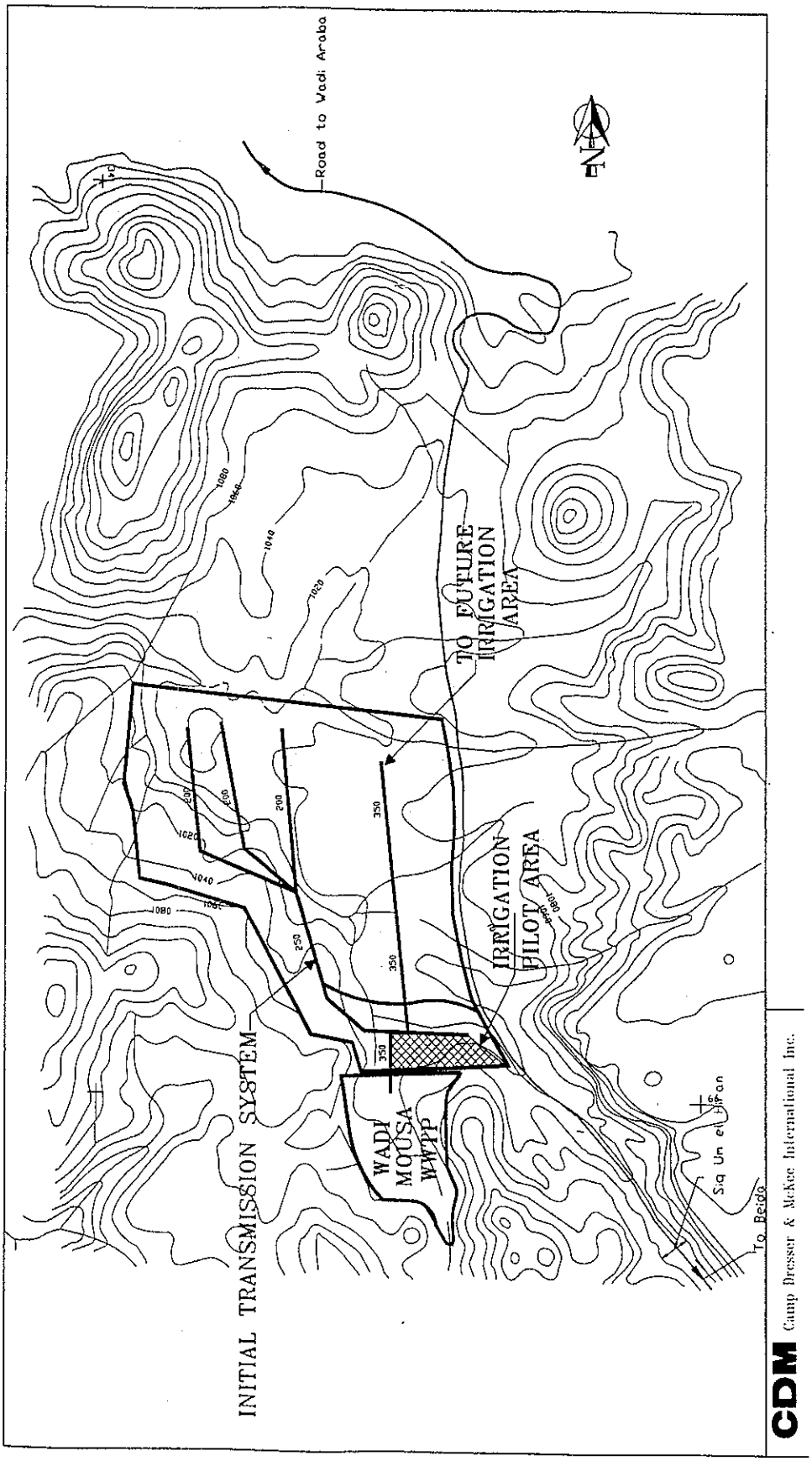


FIGURE 19.3a: Potential Reuse Areas - WADI MOUSA (acc. to CDM Consultant)

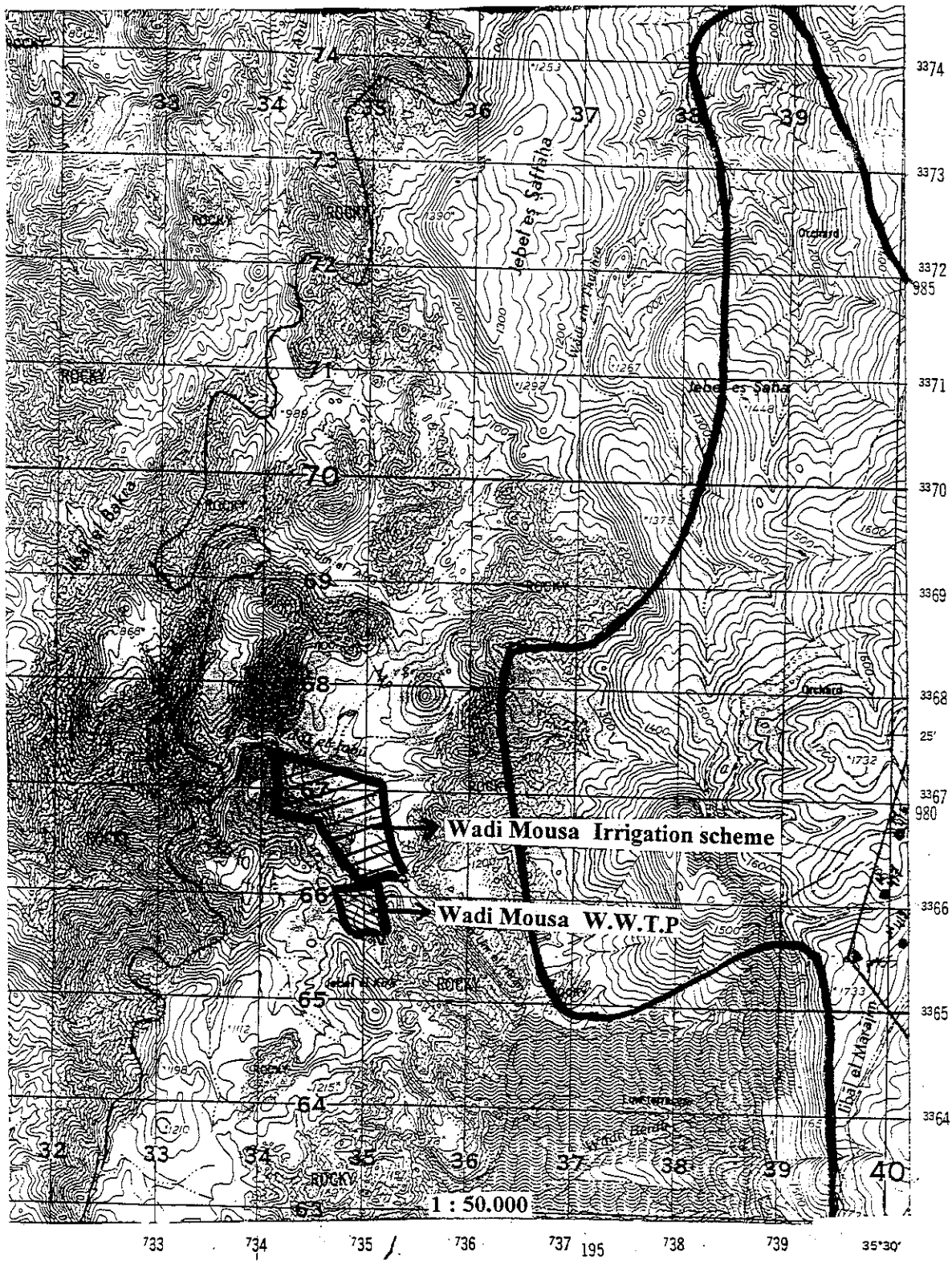


FIGURE 19.3b: Potential Reuse Areas - WADI MOUSA (acc. to Min. of Agriculture)

PROJECTION OF WASTEWATER PRODUCTION OF TREATMENT PLANT:
19 WADI MOUSA

SCENARIO 0 "Consultants' Study" (acc. to Consultant's Study Report)

Basic data:

Population in 1994 16.850

	Unit	1994	2000	2005	2010	2015	2020
Growth rate (previous period)	%	-	3,44	3,44	3,44	2,52	2,52
Spec.water demand	l/c/d	-	141	150	159	168	177
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Coverage	%	0	46	53	60	63	65
Return factor	-	0,8	0,8	0,8	0,8	0,8	0,8
Losses/inflow	%	0	0	0	0	0	0
Specific pollutional load	$gBOD_5/c/d$	65	65	65	65	65	65

	Unit	1994	2000	2005	2010	2015	2020
Population	c	16.850	20.641	24.444	28.948	32.776	37.119
Connected (sewerage)	c	0	9.495	12.955	17.369	20.649	24.127
Not connected (sewerage)	c	16.850	11.146	11.489	11.579	12.127	12.992
Hotel guests and day visitors	c		5.700		6.250		7.200
Water demand							
Domestic demand	l/c/d	-	141	150	159	168	177
	m³/d	-	2.910	3.667	4.603	5.506	6.570
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Tourist demand	m³/d	-	2.070	2.270	2.470	2.660	2.840
Total	m³/d	0	4.980	5.937	7.073	8.166	9.410
Wastewater production							
Return flow (w.demand)	m³/d	0	1.833	2.517	3.395	4.116	4.893
Losses/inflow	m³/d	0	0	0	0	0	0
Total	m³/d	0	1.833	2.517	3.395	4.116	4.893
	m³/month	0	54.983	75.514	101.847	123.475	146.797
	m³/a	0	668.965	918.750	1.239.138	1.502.279	1.786.030
Pollutional load							
Poll. load (dom.demand)	$kgBOD_5/d$	0	617	842	1.129	1.342	1.568
Poll. load (com.demand)	$kgBOD_5/d$						
Poll. load (small ind.)	$kgBOD_5/d$						
Others	$kgBOD_5/d$						
Total load	$kgBOD_5/d$	0	617	842	1.129	1.342	1.568
Reuse of wastwater							
Inflow to the treatment plant	m³/a	0	668.965	918.750	1.239.138	1.502.279	1.786.030
Losses in treatment plant	%	0	10	10	10	10	10
(due to infiltr./evap.)	m³/a	0	66.896	91.875	123.914	150.228	178.603
Effluent of treatment plant	m³/a	0	602.068	826.875	1.115.224	1.352.051	1.607.427
Net water demand per ha	m³/d/ha		53	53	53	53	53
Irrigable reuse area	ha	0	31	43	58	70	83

Water demand for irrigation Forest trees, olives, barley 53 m³/d/ha

20. AL JEEZA TREATMENT PLANT

1. Long term development in South Amman Area

According to the Consultants Study Report the long-term strategy for the South Amman Area foresees two independent sewerage schemes and two wastewater treatment plants:

- *North Queen Alia Airport Treatment Plant (eastern drainage area)*
  This treatment plant will receive the wastewater of the eastern drainage area.

- *Al Jeeza Treatment Plant (western drainage area)*
  This treatment plant will receive the wastewater of the western drainage area.

Details of proposed North Queen Alia Airport system are given under Section 28.

2. Proposed Al Jeeza Treatment Plant

Figure 20.1 shows the layout of the proposed sewerage system, which will be implemented in 3 Phases.

The project foresees the construction of the Al Jeeza Treatment Plant designed for the wastewater production in 2020. It will be based on an extended aeration process including maturation ponds for tertiary treatment. Produced sludge will be treated by sludge holding tanks and drying beds. Figure 20.2 shows the proposed treatment system. The projection of the wastewater production is shown in the following table (acc. to Consultant's Study Report). The plant will be implemented in two phases, whereby the final capacity will be reached

in 2020: 8,800 m³/d (87,300 connected inhabitants)

The effluents could supply irrigation water for an area of about 60 ha in 2020 taking into account the demand for alfalfa as summer crop, and barley as winter crop (see following table). Suitable land for irrigation was identified in the direct southwestern surroundings of the treatment plant. A pump station together with feeder mains to the irrigation areas will be constructed. Proposed wastewater reuse areas are presented in the Figure 28.3.

The investment costs (Phase 1, 2 and 3) based on 1994 prices are:

Treatment plant	3.91 million JD
Local sewerage	7.76 million JD
Collector sewerage	2.89 million JD
Trunk sewerage	3.30 million JD
Irrigation facilities	1.02 million JD
Total capital costs	18.88 million JD

Investment costs subdivided in Phases 1 (2002/11), 2 (2012/20) and 3 (2021/26) are as follows:

(price basis 2000, in mio. JD)

	Phase 1	Phase 2	Phase 3
Treatment plant	3.90	3.46	1.91
Local sewerage	1.69	0.69	1.07
Collector sewerage	3.58	0.35	0
Trunk sewerage	2.80	1.87	0
Subtotal capital costs	11.98	6.37	2.98
Engineering +Contingencies (30 %)	3.59	1.97	0.89
Total	15.57	8.28	3.87

Consultant's Study Report:
Montgomery Watson: "Technical and economic Feasibility Study and detailed Final Design of the collection, treatment and reuse of wastewater from communities South of Amman. Feasibility Study", June 1995

Volume I: Main Report
Volume II: Drawings

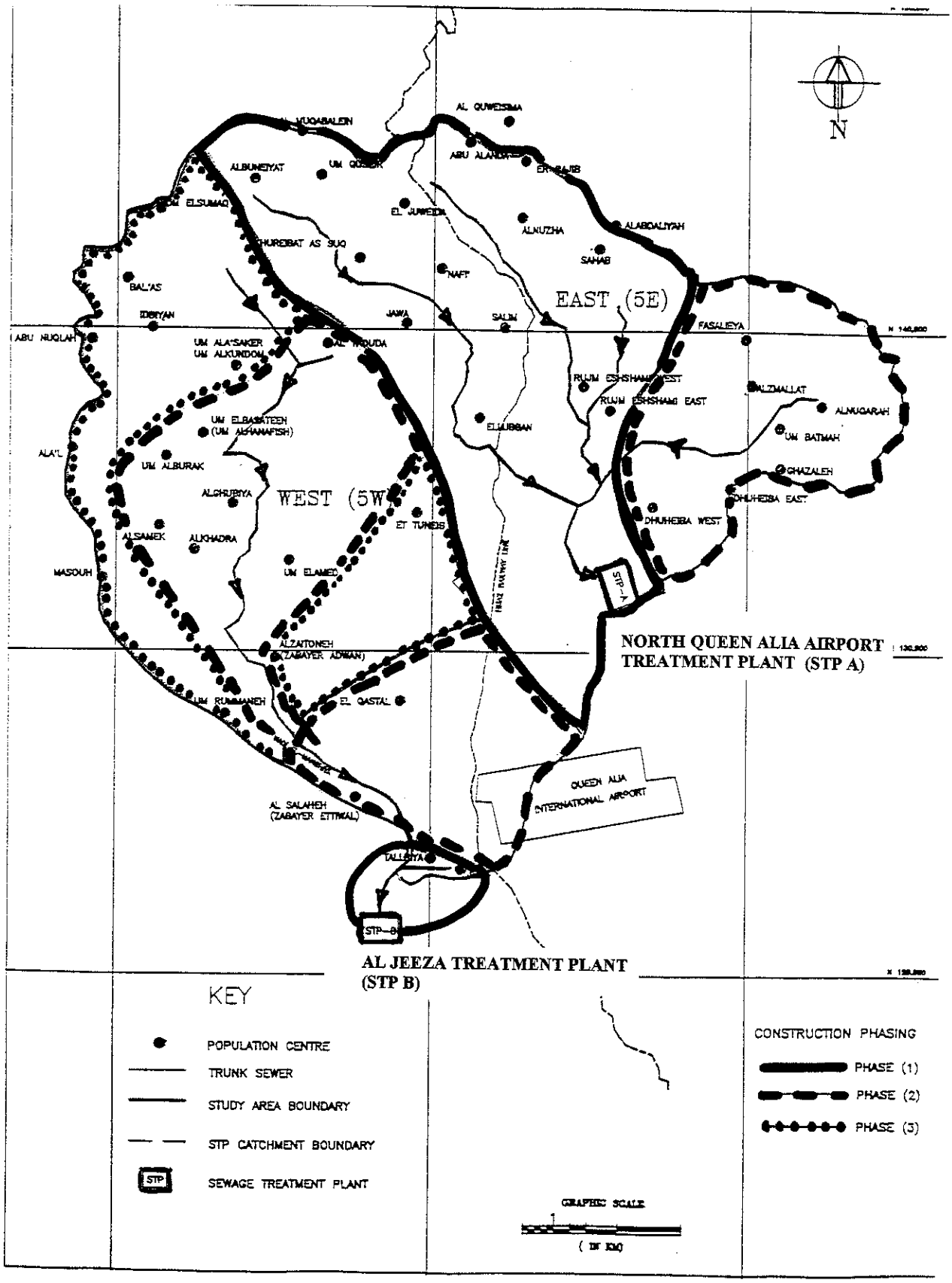
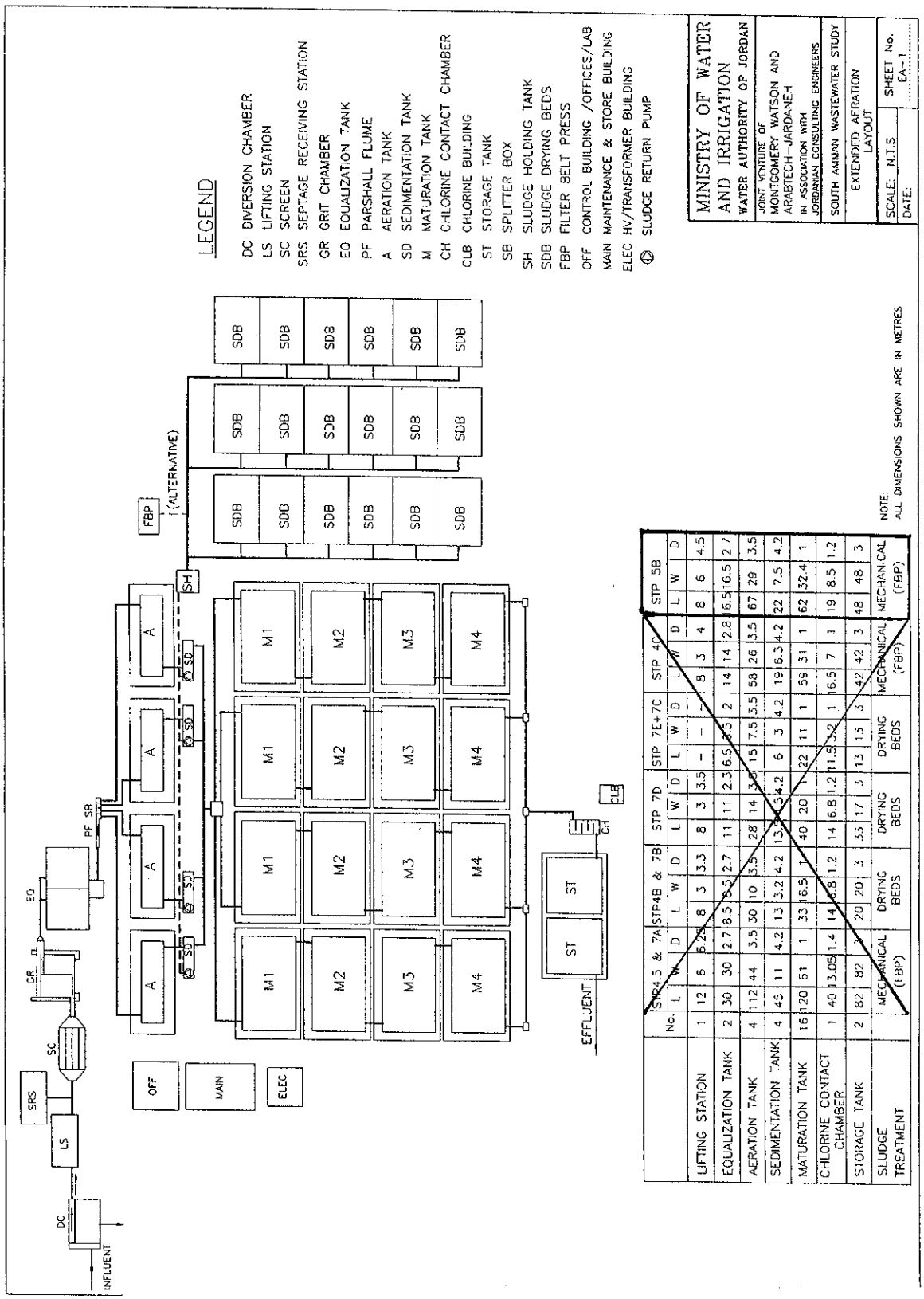


FIGURE 20.1: General Layout of Proposed Sewerage System - AL JEEZA



	No.	STP 4,5 & 7A			STP 4B & 7B			STP 7D			STP 7E+7C			STP 4C			STP 5B		
		L	W	D	L	W	D	L	W	D	L	W	D	L	W	D	L	W	D
LIFTING STATION	1	12	6	6.25	8	3	3.3	8	3	3.5	–	–	–	8	3	4	8	6	4.5
EQUALIZATION TANK	2	30	30	2.7	8.5	6.5	2.7	11	11	2.3	6.5	6.5	2	14	14	2.8	16.5	16.5	2.7
AERATION TANK	4	112	44	3.5	30	10	3.5	28	14	3.5	15	7.5	3.5	58	26	3.5	67	29	3.5
SEDIMENTATION TANK	4	45	11	4.2	13	3.2	4.2	13.5	5	4.2	6	3	4.2	19	6.3	4.2	22	7.5	4.2
MATURATION TANK	16	120	61	1	33	16.5	1	40	20	1	22	11	1	59	31	1	62	32.4	1
CHLORINE CONTACT CHAMBER	1	40	3.05	1.4	14	6.8	1.2	14	6.8	1.2	11.5	5.2	1	16.5	7	1	19	8.5	1.2
STORAGE TANK	2	82	82	1	20	20	3	33	17	3	13	13	3	42	42	3	48	48	3
SLUDGE TREATMENT		MECHANICAL (FBP)		DRYING BEDS				DRYING BEDS			DRYING BEDS			MECHANICAL (FBP)			MECHANICAL (FBP)		

FIGURE 20.2: Layout of Proposed Wastewater Treatment Plant - AL JEEZA

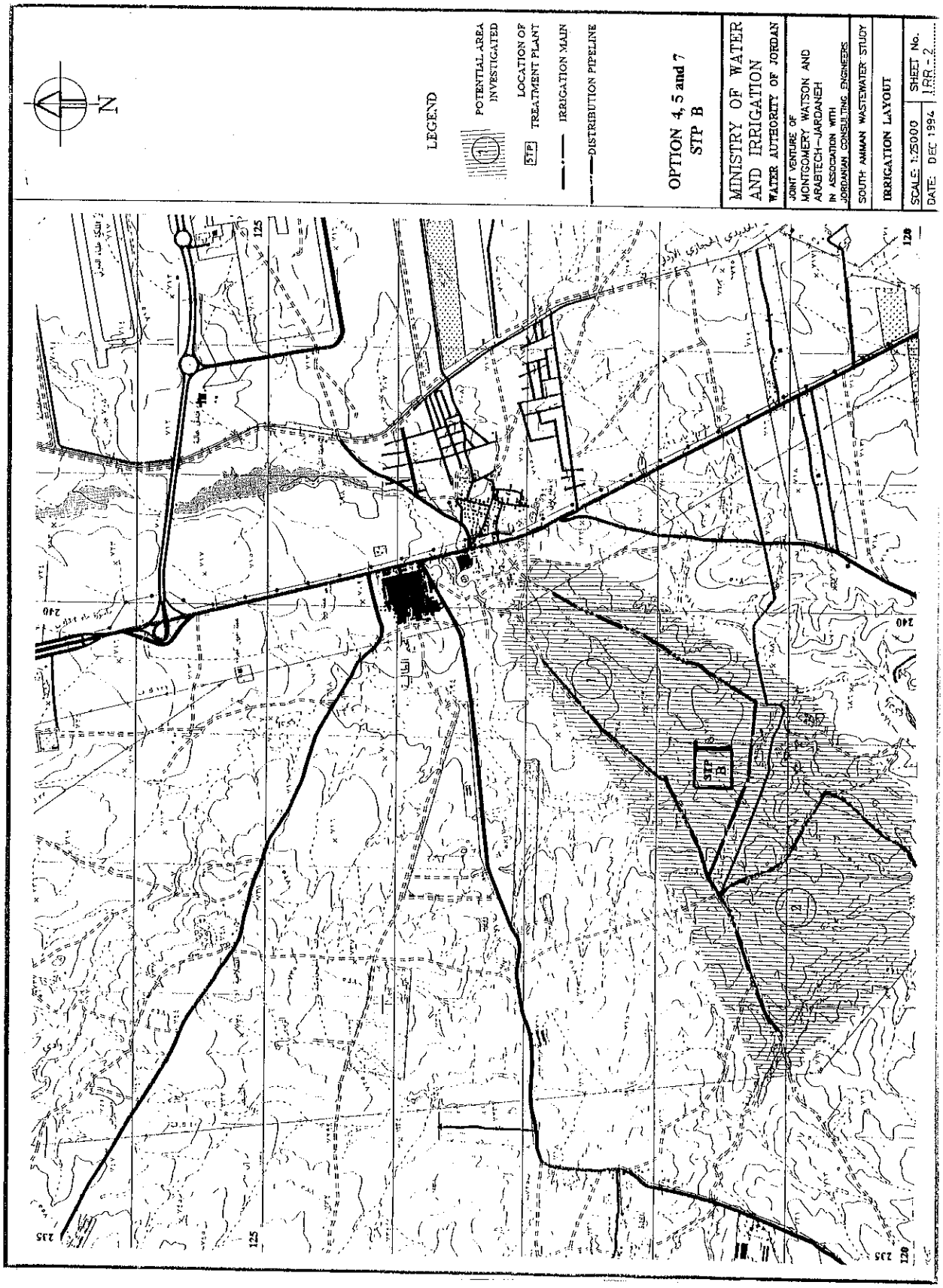


FIGURE 20.3a: Potential Reuse Areas - AL JEEZA (acc. Montgomery/Watson)

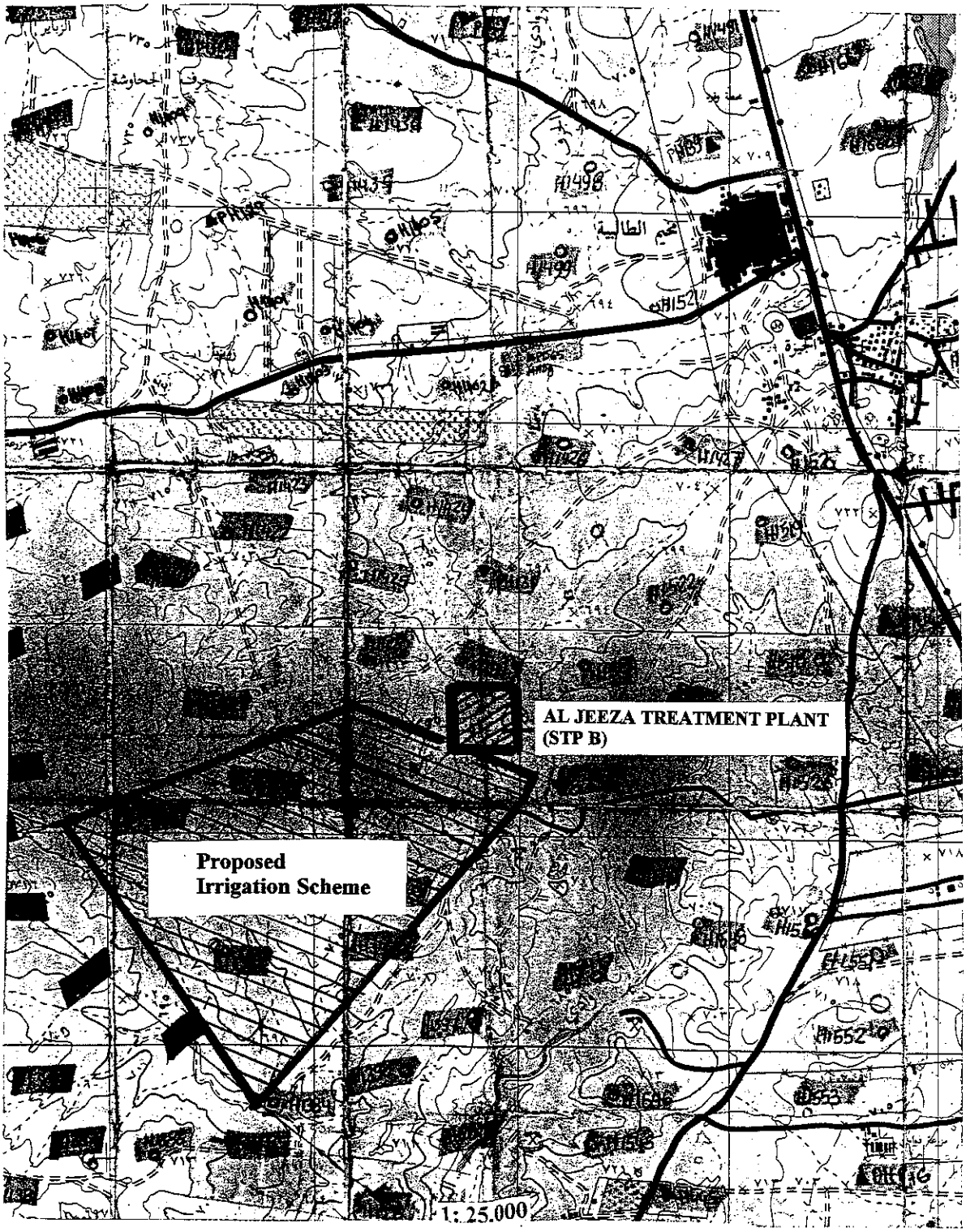


FIGURE 20.3b: Potential Reuse Areas - AL JEEZA (acc. Min. of Agriculture)

PROJECTION OF WASTEWATER PRODUCTION OF TREATMENT PLANT:
20 AL JEEZA

SCENARIO 0 "Consultants' Study" (acc. to Consultant's Study Report of Montgomery Watson 1995)
Option 5: Sewage Treatment Plant B (STP B)

Basic data:

Population in 1994: 41.700

	Unit	1994	2000	2005	2010	2015	2020
Growth rate (previous period)	%	-	2,82	2,90	2,90	2,90	2,90
Spec.water demand	l/c/d	76	89	97	105	113	121
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Coverage	%	0	0	100	100	100	100
Return factor	-	0,85	0,85	0,85	0,84	0,84	0,83
Losses/inflow	%	0	0	0	0	0	0
Specific pollutional load	$gBOD_5/c/d$	65	65	65	65	65	65

	Unit	1994	2000	2005	2010	2015	2020
Population	c	41.700	49.272	56.843	65.578	75.654	87.279
Connected (sewerage)	c	0	0	56.843	65.578	75.654	87.279
Not connected (sewerage)	c	41.700	49.272	0	0	0	0
Water demand							
Domestic demand	l/c/d	76	89	97	105	113	121
	m³/d	3.169	4.385	5.514	6.886	8.549	10.561
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Total	m³/d	3.169	4.385	5.514	6.886	8.549	10.561
Wastewater production							
Return flow (w.demand)	m³/d	0	0	4.687	5.784	7.181	8.765
Losses/inflow	m³/d	0	0	0	0	0	0
Total	m³/d	0	0	4.687	5.784	7.181	8.765
	m³/month	0	0	140.602	173.518	215.433	262.963
	m³/a	0	0	1.710.654	2.111.139	2.621.096	3.199.377
Pollutional load							
Poll. load (dom.demand)	$kgBOD_5/d$	0	0	3.695	4.263	4.918	5.673
Poll. load (com.demand)	$kgBOD_5/d$						
Poll. load (small ind.)	$kgBOD_5/d$						
Others	$kgBOD_5/d$						
Total load	$kgBOD_5/d$	0	0	3.695	4.263	4.918	5.673
Reuse of wastwater							
Inflow to the treatment plant	m³/a	0	0	1.710.654	2.111.139	2.621.096	3.199.377
Losses in treatment plant	%	0	0	10	10	10	10
(due to infiltr./evap.)	m³/a	0	0	171.065	211.114	262.110	319.938
Effluent of treatment plant	m³/a	0	0	1.539.588	1.900.025	2.358.986	2.879.440
Net water demand per ha	m³/d/ha		60	60	60	60	60
Irrigable reuse area	ha	0	0	70	87	108	131

Water demand for irrigation	Alfalfa, barley		60	m³/d/ha
MOA's proposal:	Summer crops:	alfalfa		
	Winter crops:	barley		

21. AL MAZAR AL SHAMALI TREATMENT PLANT TREATMENT PLANT

The proposed Scheme of Al Mazar Al Shamali area is located southeast of Irbid. Presently, there exists no sewerage system. The following communities will be connected to the proposed scheme: Mazar Al Shamali, Dair Yousef, Johfiah, Habka, Hofa El Mazar and Samad. Figure 21.1 shows the layout of the proposed sewerage system.

The project foresees the construction of a Treatment Plant designed for the wastewater production in 2020. It will be based on an extended aeration process including slow sand filtration as tertiary treatment. Gravity thickeners and decanter centrifuge will treat produced sludge. Figure 21.2 shows the proposed treatment system. The projection of the wastewater production is shown in the following table (acc. to Consultant's Study Report). The plant will be implemented in two phases, whereby the final capacity will be reached

in 2020: 4,500 m^3/d (40,100 connected inhabitants)

Due to the very steep flanks of the valley of Wadi Jurum there are no substantial areas of agricultural land available for irrigation without extremely high pumping costs. Therefore, it is recommended to discharge all treated effluent to the Wadi Jurum without any reuse.

The investment costs based on 1998 prices are:

Treatment plant (primary and secondary treatment)	3.85 million JD
Networks	8.07 million JD
Tertiary treatment and pipeline	0.56 million JD
Dam/storage (pond for reuse)	0 million JD
Total base costs	12.49 million JD
Physical contingencies	1.25 million JD
Engineering	1.37 million JD
Total investment costs	15.11 million JD

According to the Consultant's Study Report implementation of proposed construction measures were foreseen during the years 2007 to 2009 (Phase I).

Consultant's Study Report:
TYPSA, Symonds Travers Morgan and Universal Engineering Consulting: "Wastewater collection, treatment, disposal and/or reuse systems project for the catchment area of Yarmouk River and Jordan River. Final Report", December 1998

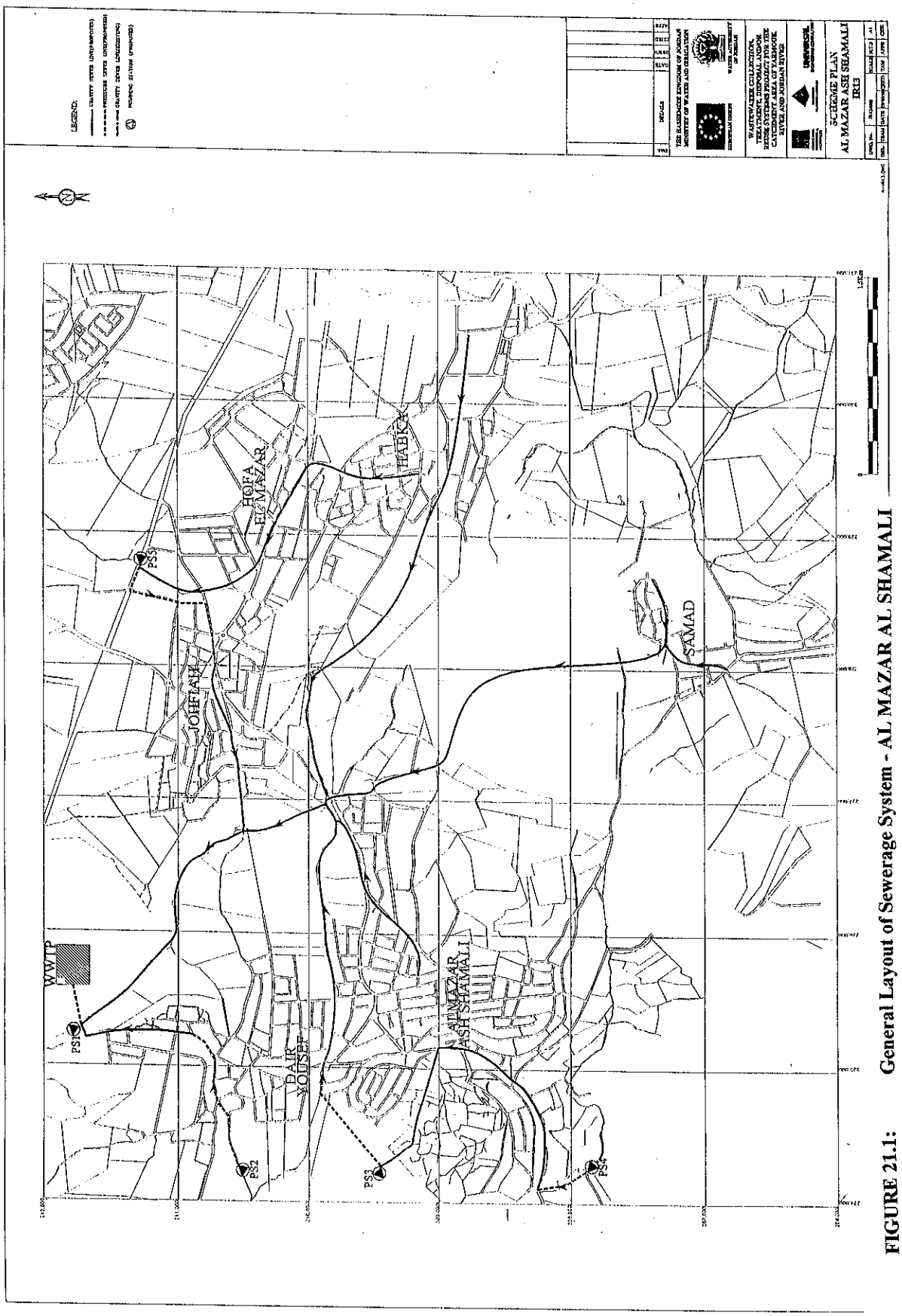


FIGURE 21.1: General Layout of Sewerage System - AL MAZAR AL SHAMALI

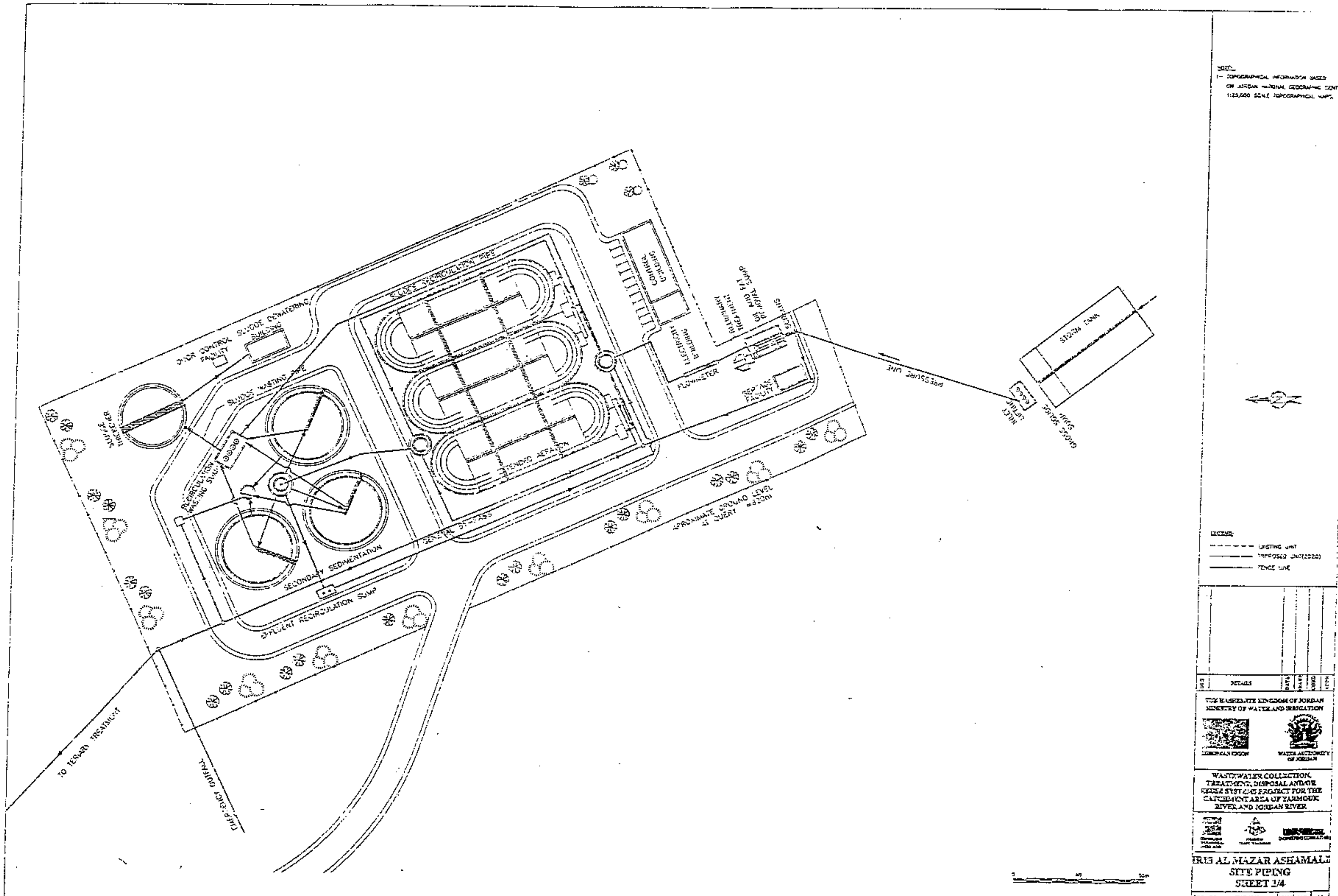


FIGURE 21.2: Layout of Proposed Wastewater Treatment Plant - AL MAZAR AL SHAMALI

PROJECTION OF WASTEWATER PRODUCTION OF TREATMENT PLANT:
21 AL MAZAR AL SHAMALI

SCENARIO 0 "Consultants' Study" (acc. to Consultant's Study Report)

Basic data:

Population in 1994: 21.228

	Unit	1994	2000	2005	2010	2015	2020
Growth rate (previous period)	%	-	3,12	3,12	3,12	3,12	3,12
Spec.water demand	l/c/d	-	141	141	141	141	141
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Coverage	%	0	0	0	85	85	85
Return factor	-	0,8	0,8	0,8	0,8	0,8	0,8
Losses/inflow	%	0	0	0	0	0	0
Specific pollutional load	$gBOD_5$/c/d	65	65	65	65	65	65

	Unit	1994	2000	2005	2010	2015	2020
Population	c	21.228	25.525	29.763	34.705	40.468	47.187
Connected (sewerage)	c	0	0	0	29.499	34.398	40.109
Not connected (sewerage)	c	21.228	25.525	29.763	5.206	6.070	7.078
Water demand							
Domestic demand	l/c/d	-	141	141	141	141	141
	m³/d	0	3.599	4.197	4.893	5.706	6.653
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Total	m³/d	0	3.599	4.197	4.893	5.706	6.653
Wastewater production							
Return flow (w.demand)	m³/d	0	0	0	3.328	3.880	4.524
Losses/inflow	m³/d	0	0	0	0	0	0
Total	m³/d	0	0	0	3.328	3.880	4.524
	m³/month	0	0	0	99.826	116.402	135.729
	m³/a	0	0	0	1.214.553	1.416.221	1.651.374
Pollutional load							
Poll. load (dom.demand)	$kgBOD_5$/d	0	0	0	1.917	2.236	2.607
Poll. load (com.demand)	$kgBOD_5$/d						
Poll. load (small ind.)	$kgBOD_5$/d						
Others	$kgBOD_5$/d						
Total load	$kgBOD_5$/d	0	0	0	1.917	2.236	2.607
Reuse of wastwater							
Inflow to the treatment plant	m³/a	0	0	0	1.214.553	1.416.221	1.651.374
Losses in treatment plant	%	0	5	5	5	5	5
(due to infiltr./evap.)	m³/a	0	0	0	60.728	70.811	82.569
Effluent of treatment plant	m³/a	0	0	0	1.153.825	1.345.410	1.568.805
Net water demand per ha	m³/d/ha	-	-	-	-	-	-
Irrigable reuse area	ha	-	-	-	-	-	-

Water demand for irrigation no reuse system proposed