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Republic of Iraq

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ASSESSMENT PROJECT OF THE WATER AND SANITATION SECTOR IN IRAQ

Draft Final Report

June 2001

SAFEGE
Consulting Engineers

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Subject: Draft Report of the Safege Consultant Group on Water Sector Assessment

With compliments,
Dorothee Klaus

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EXECUTIVE SUMMARY

Presentation of a Sector Assessment for WES

Background and Objectives of the Study

- The outcome of the study aims to establish a national reference for drawing up action plans and defining standards for the WES Sector till 2010.
- This Sector Assessment Project is one of the components of UNICEF's programme of co-operation with the Government of Iraq for the year 1999-2000.
- The execution of the agreement, dated 16th December 1999, started on January 24th, 2000 with an overview of available information and the drawing up of questionnaires to be used in a complementary sector survey; the corresponding data was gathered by a UNICEF team from February to July 2000. An Inception Report was issued in August 2000.
- The scope of work was reviewed with UNICEF during the Inception Phase, emphasising UNICEF's interest in developing a National Information System, with the aim of facilitating the structuring of integrated strategic action plans for the WES sector.
- A series of site visits was carried out by Safege's technical specialists from November 2000 to February 2001.

Project Components

The Assessment Project covers the range of public services related to drinking water supply, wastewater collection and disposal, and garbage collection and disposal. This study comprises (i) the assessment of public utilities, which will be covered by Chapters 1, 2 and 3 of the DFR, and (ii) the preparation of guidelines for Sector Development Planning, integrated in Chapters 4, 5 and 6. In addition, the assessment includes an overall evaluation of the water quality control system (chapter 7 of the DFR).

The document we are presenting below is a Draft version of the Final Report (DFR) of the study. The DFR is broken down into 7 Chapters; the assessment is based on data collected by UNICEF and provided by the WES Authorities of Iraq in Year 2000. As requested by UNICEF, the collected data was organised in a database, which was structured in co-ordination with UNICEF in a way that will allow updating and facilitate its integration into the general information system developed by this entity (UNICEF).

A nucleus of MIS was structured, allowing relevant synthetic outputs to be produced related to Sector Performance Indicators. These outputs were included to assist the relevant WES planning departments in structuring development strategies and co-ordinating WES action plans.

Center-South Region
Autonomous Region Northern Iraq
Mayoralty of Baghdad

Table 2. Technical Features of Water Supply Utilities

Parameter	CSR	MdB	ARNI	Units
Population served (in 2000)	11 183 708	4 760 000	2 915 000	
Including	26%	0.33%	36%	in rural areas
Number of service connections	1 284 000	567 551	232 590	Units
Including	82%	66%	91%	are domestic connections
Personnel	11 044	1 420	3 354	Employees
Including	14%	14%	NA	For sanitation services
Pipe network length (km)	19 940	7 750	1 775	Km
Average Diameter	176	213	214	Mm
Age of pipes (years)	22	24	16	Years
Average production capacity	5 517 317	2 299 855	306 560	m^3/d
Average effective production	1 053	648	90	Million cubic meters in 2000
Average supply	708	389	47	Million cubic meters in 2000

The *Adequacy* of the water supply service measures how far the service provided by the water utilities manages to satisfy the requirements of the population:

- **The Service Coverage (WSC)**, which evaluates the percentage of the population receiving enough potable water from public networks to satisfy their needs.
- **The Rate of Supply (WSR)**, which evaluates the average quantity of potable water supplied to all categories of service connections expressed in litre per capita per day (lpcd) in relation to the served population.
- **The Shortage Rate (SHR)**, which evaluates the proportion of the served population receiving an inadequate quantity of water (deemed insufficient to address their actual needs).
- **The Production Capacity Rate (PCR)**, which evaluates the production capacity of water projects related to the total population in lpcd. This indicator expresses the intensity of public investment in the sector.

Table 3: Water Supply Coverage Indicator in Iraq in Year 2000 (WSC)[1]

Water Authority	Urban population SUP2000	Coverage in urban areas UWSC	Rural population SRP2000	Coverage in rural areas RWSC
Mayoralty of Baghdad	4 753 379	100%	15 694	100%
Total GCWS	8 234 575	88%	2 926 598	43%
Total ARNI	2 190 136	87%	749 160	73%
Average Iraq WES	15 178 090	91%	3 691 452	48%

[1] From Database – Query IP1

Table 4: Average Water Supply Rates in 2000[2]

Water Authority	UPC-2000 m³/d	UWSR lpcd	RPC-2000 m³/d	RWSR lpcd
Mayoralty of Baghdad	1 772 140	224	2 240	83
Total GCWS	2 549 881	208	334 773	76
Total ARNI	245 248	59	(³)	
Average Iraq WES	*4 567 269*		*337 013*	

Compliance with the adequacy line is evaluated by a shortage indicator, which measures the % of population served by public utilities, which does not receive adequate service according to the Adequacy Line Criteria established by the GOI water authorities.

The efficiency of the water sector can be evaluated by the following indicators:

Table 5: Comparison of The Main Efficiency Parameters

	BWA	GCWS	ARNI
Intensity of investment effort measured by the Depreciation Cost (DC ID 1999)/served population[1]	12.21	20.13	
· Productivity of service production resources:			
o O&M costs ID/population served	256.18	572.25	
o The productivity of the personnel is evaluated by considering the following ratios:			
§ Personnel expenditure (ID/m³ produced)	0.47	1.53	
§ Population served per employee	2 145	1 195	868
§ Length of pipes per employee (km/employee)	3.48	2.35	0.53
§ Installed production capacity (m³/d per employee)	1 090	552	68

Sanitation sub-sector

The sanitation (including garbage) sub-sector falls far short of GOI objectives. The assessment is presented with a view to elaborating a development planning tool.

The performance of the sanitation sub-sector is evaluated by performance indicators including:

- Adequacy indicators such as coverage and level of service.
- Dependability indicators. These indicators are primarily related to external factors that have an impact on defining or prioritising sector development. They comprise parameters such as: size of sub-district (urban or rural population), groundwater level, river sensibility to pollution.
- Efficiency indicators. These describe the condition of the existing infrastructure and are used to assess rehabilitation requirements. They are not used for prioritisation, however, since rehabilitation is the main priority.

[2] From database, Query WSR/DSR

[3] The relevant data was not available for this study. In rural areas the utilities are operated by the communities and the production records were not available.

Table 6 : Sanitation Adequacy Performance Indicators

Parameter	CSR	MdB	ARNI	Comment
Percentage of urban population with sewers and treatment	10%	80%	0%	
Percentage of urban population served by on-site sanitation	79%	20%	66%	
Percentage of rural population served by on-site sanitation	36%	100%	38%	No rural area is provided with sewers and treatment
Garbage collection performance indicator	2%	25%	8%	Defined as the value of recent equipment/value of needed equipment

Sector Planning Framework

In ARNI, UNICEF assists the local governments of the Autonomous Region in developing WES policies, and co-ordinates the public investment programmes; the financing of these programmes relies on the Oil-for-Food 6-month programmes agreed between the GOI and the UN. Technical Sector Planning activities and co-ordination rely on local UNICEF agencies.

In Centre South, WES Sector policies and tariff setting are established by the central GOI, which allocates public funds from the annual budgets for capital expenditure. The Planning Commission decides how these funds are to be allocated to the two regional WES Authorities, according to 5-year sub-sector development plans. Capex Planning is the main effective instrument used to implement WES development policies.

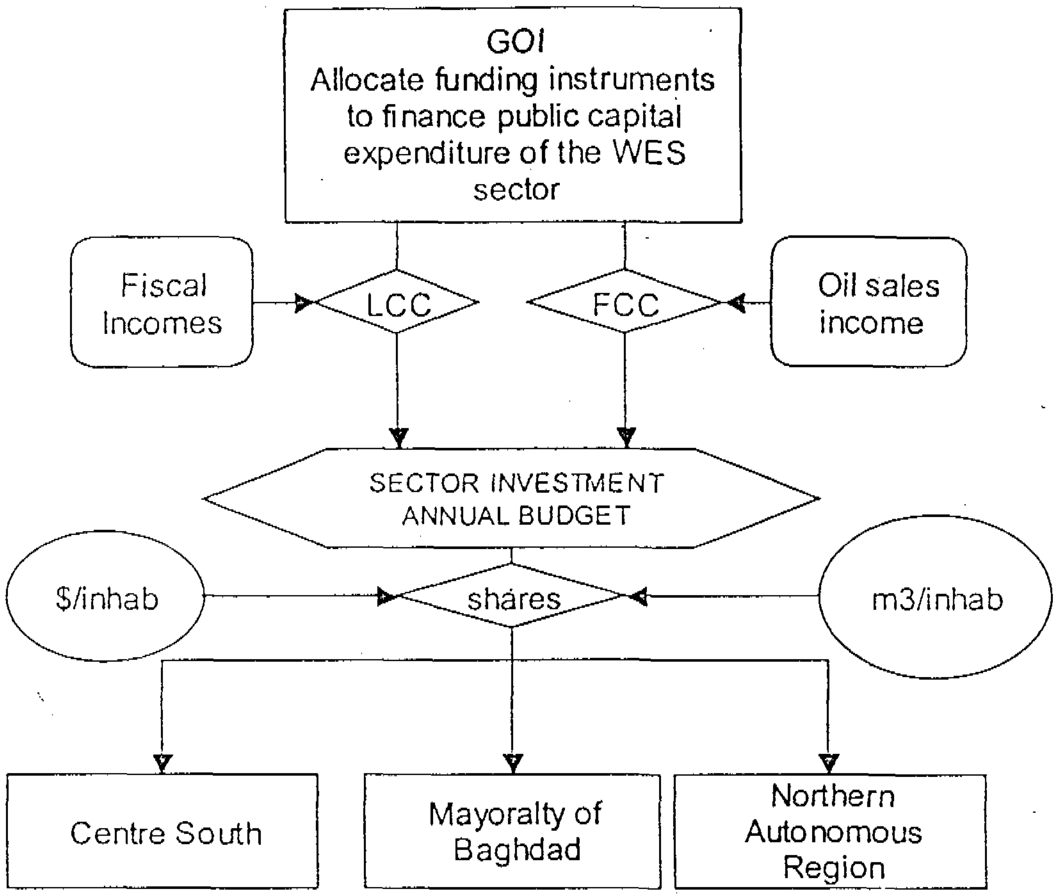
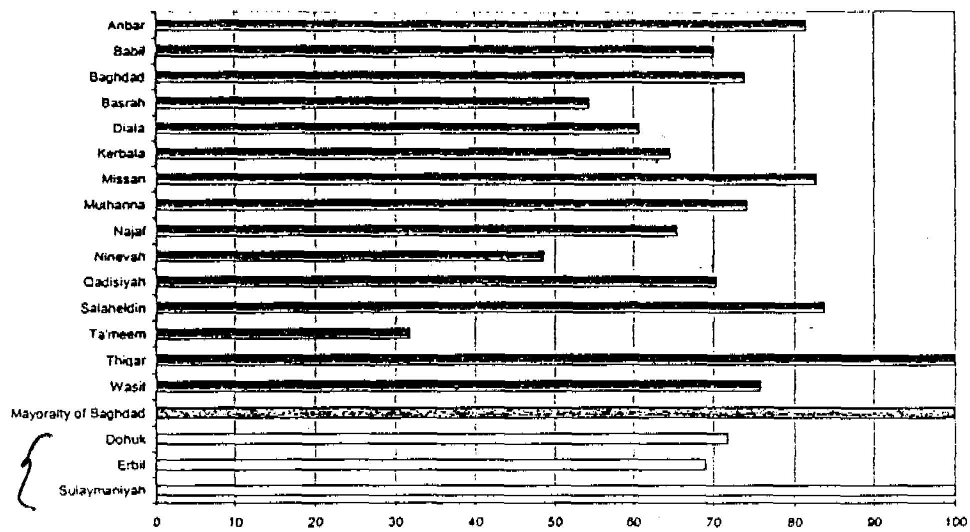


Chart 1. Budget Planning Framework

O&M expenditure is to be charged to users through a National Tariff Setting; the operating Water Directorates are responsible for billing and collecting WES revenue, which will be shared by the other operating sub-sector Directorates to cover their specific expenditure.

Water sector Action Plans are related to 3 key performance indicators which reflect the GOI's WES policies:

- The coverage of services related to the 2010 target.
- The rates of compliance with the targeted 2010 level of service.
- The efficiency indicator related to the targeted UFW rate in 2010.
- The indicators are weighted to be evaluated from 0 to 100; the most critical situation is rated 100.
- In the water sector the ranking of the Governorates' needs in the 3 Authorities is evaluated in the chart below:



The GOI's primary aim with regard to the Sanitation sub-sector is to ensure the hygienic disposal of all liquid and solid waste.

The development plans of the sanitation sector are related to:

- The coverage of services in relation to the 2010 target.
- In urban areas, the increase of the share of sewerage versus on-site sanitation.
- In urban areas, meeting garbage collection needs.

The Governorate's needs with regard to sanitation were evaluated by defining global performance indicators:

- Urban sewage indicator
- Rural sewage indicator
- Urban garbage indicator.

These performance indicators consist in the weighting of adequacy and dependability indicators at sub-district level.

Water Sector Development Planning

The Ideal Option consists in achieving GOI objectives for 2010:

- Coverage of 100% urban population and 90% rural population.
- Delivering targeted rates of supply.
- Achieving an efficiency rate of production facilities of 90%.
- Achieving an efficiency rate of distribution networks as scheduled by the Water Authorities for 2010 (about 15%).

The action plans are evaluated at Governorate level, resulting in the following needs:

REGION	REHAB		EXTENSION & UPGRADING		TOTAL		TOTAL	CAPEX/ CAPITA
	FOREIGN (M$)	*LOCAL (MID)*	*FOREIGN (M$)*	*LOCAL (MID)*	*FOREIGN (M$)*	*LOCAL (MID)*	*(M$)*	*($/INH.)*
Centre-South Iraq	746	89 310	2 429	267 589	3 175	356 900	3 353	160
Mayoralty of Baghdad	513	49 643	1 355	74 407	1 868	124 049	1 930	301
Autonomous Northern Region	70	5 399	779	924	849	6 323	1 133	241
TOTAL	1 329	624 861	4 563	425 193	5 892	1 050 054	6 417	200
REGION		*FOREIGN (M$)*	*LOCAL (MID)*		*OPEX (US$/m)*	*OPEX (ID/ m³)*		*OPEX ID/Capita*
Centre-South Iraq		13.9	23 283		0.009		8.1	1 112
Mayoralty of Baghdad		6.2	7 066		0.008		5.6	1 103
Autonomous Northern Region		3.4	44		0.008		0.1	9.32
TOTAL		23	34 296		0.008		7.1	1 070

The "Minimum" Option consists in achieving a set of minimum targets, which are listed below:

- To maintain the current rates of coverage until 2010
- To achieve 90% production efficiency by rehabilitating the existing facilities
- To deliver the GOI rates of supply for 2010 to the population served by the public utilities
- To achieve 25% UFW, which represents a 40% reduction with respect to the existing situation. This option does not include leakage detection campaigns.

REGION	REHAB		EXTENSION & UPGRADING		TOTAL		TOTAL	CAPEX/ CAPITA
	FOREIGN (M$)	*LOCAL (MID)*	*FOREIGN (M$)*	*LOCAL (MID)*	*FOREIGN (M$)*	*LOCAL (MID)*	*(M$)*	*($/INH.)*
Centre-South Iraq	648	83 929	1 830	190 001	2 478	273 930	2 615	172
Mayoralty of Baghdad	513	43 110	1 355	74 313	1 869	117 423	1 928	301
Autonomous Northern Region	61	4 613	742	860	808	5 473	1 054	262
TOTAL	1 228	542 169	3 927	341 731	5 155	883 900	5 597	219
REGION		*FOREIGN (M$)*	*LOCAL (MID)*		*OPEX US$/M3*	*OPEX ID/ m3)*		*OPEX ID/Capita*
Centre-South Iraq		12.2	20 215		0.009		8.1	1 333
Mayoralty of Baghdad		6.2	7 034		0.008		5.6	1 099
Autonomous Northern Region (NID)		3.3	43		0.008		0.1	10.62
TOTAL		22	31 100		0.008		7.0	1215

A comparison of the various options shows the advantages of an aggressive UFW management programme.

Sanitation Sector Development Planning

The ideal option consists of:

- Coverage of 100% of the urban population by sewers connected to treatment plants.
- Coverage of 100% of the sedentary rural population with individual septic tanks or pit latrines.
- Coverage of 100% of the urban population with garbage management.

The action plans are evaluated at Governorate level, resulting in the following needs:

REGION	URBAN Sanitation		RURAL Sanitation		URBAN Garbage		TOTAL
INVESTMENTS	*FOREIGN (M$)*	*LOCAL (MID)*	*FOREIGN (M$)*	*LOCAL (MID)*	*FOREIGN (M$)*	*LOCAL (MID)*	*(M$)*
Centre-South Iraq	1 196	475 949	167		163		1 764
Mayoralty of Baghdad	704	402 766	0		451		1 357
Autonomous Northern Region	287	424	26		101		434
REGION	*URBAN Sanitation*		*RURAL Sanitation*		*URBAN Garbage*		
OPERATING COSTS Year 10		ID/ Connection	ID/ Cesspit		ID/ Inhabitant		
Centre-South Iraq		905	1 205		216		
Mayoralty of Baghdad		3 624	1 106		213		
Autonomous Northern Region		NID 31	NID 10		NID 2.5		

Considering that the sector presently falls far short of the GOI's objectives, rather than defining a minimum option involving a combination of factors that are not known and are subject to rapid changes, such as the yearly capacity to extend the sewer network, the methodology consists in proposing criteria for prioritisation. The limits to sector developments are set by financial and technical constraints.

Institutional Framework of Water and Sanitation Sector

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1. Institutional Framework of Water and Sanitation sector

1.1 General Overview

The institutional framework of the water and sanitation (WES) sector depends on geographic differences. There exist three main frameworks related to the following areas:

- Mayoralty of Baghdad (MBG), with the nine (9) main municipalities of the Baghdad Governorate.
- Center-south Region (CSR), comprising 15 Governorates, and
- Autonomous Region of Northern Iraq (ARNI), created by Law on March 11, 1974.

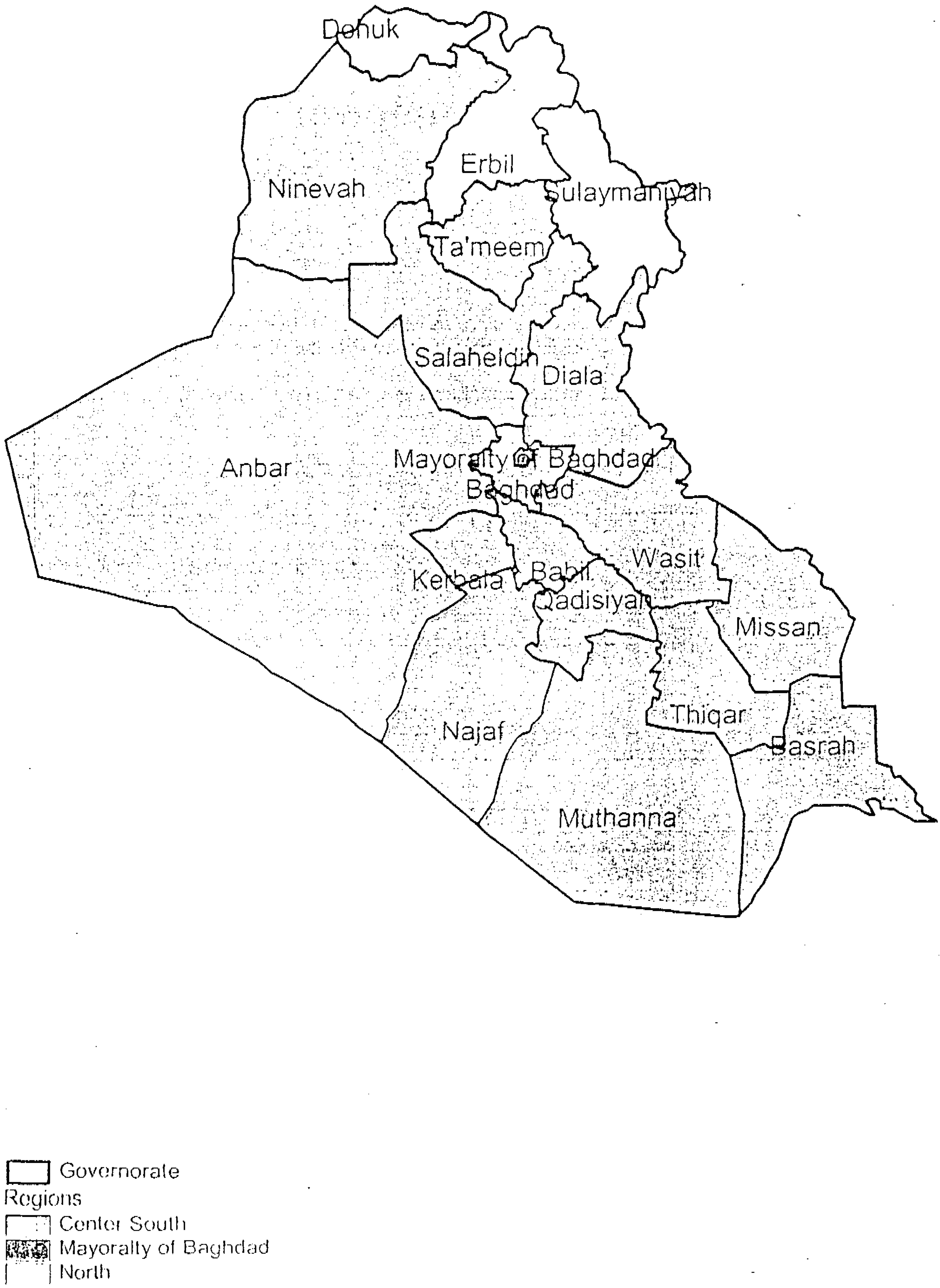
The Government of Iraq (GOI) establishes sector performance policies and standards, tariff setting, and provides financing for the capital expenditure. Regional Authorities are responsible, within the boundaries of the geographic units, for development planning, execution of public works, and the operation of public utilities: The Mayoralty of Baghdad (MBG), and the General Corporation of Water and Sewerage (GCWS) in the other 15 Governorates of the Center-South Region.

The boundaries of the 3 operational geographic units are represented hereafter in Map 1. Geographic Organization of WES Sector Administration.

Table 1-1: Regional Authorities & Geographical Sector Management Units

	Sector Administrative Structure			
Functions	**Baghdad City**	**Center South**	**Autonomous Gov. of Erbil & Dohuk**	**Autonomous Gov. of Sulaymaniyah**
Sector Management	Mayoralty of Baghdad	Min. of Interior	MMT & MRD	MMT & MWR
Water Supply & Sewerage Operation	BWA BSA	GCWS	MMT & MRD	MMT & MWR
Solid Waste Collection & Disposal	Deputy Mayor of Municipalities	General Directorate of Municipalities	MMT	MMT

Map 1-1: Geographic Organization of WES Sector Administration



There is no such specific entity with overall authority on the sector development and management in the ARNI; the Governorates of Erbil and Dohuk on one side, and Sulaymaniyah on the other, have each one their own organization, staffing and policies.

The sections below describe the organization of the sector in each geographical unit, and the institutional boundaries, financial features and staffing of the sector authorities and public operators.

Besides the Ministries that directly oversee the sector institutions, other Governmental institutions are indirectly involved in the sector:

- The Hydrology Department of the Ministry of Irrigation in charge of monitoring the water quality in the rivers and lakes. Water resources are classified into four categories: (i) rivers, streams and their branches; (ii) canals; (iii) lakes and water bodies; and (iv) springs, wells and ground water. Water quality for these categories is specified. Also the effluent standards are defined according to four categories of receiving bodies: (i) rivers; (ii) sewer systems; (iii) agricultural drainage system; and (iv) marshes (Law 25/1967).

- The Ministry of Health in charge of double-checking the quality of drinking water supplied to the population according to standards issued in 1974, in accordance with WHO and other international standards. The Ministry of Health is also in charge of monitoring the site selection and the operation of sanitary landfills according to 1980 specifications. However, landfills are generally not well maintained because of lack of equipment and proper staffing, and limited numbers of dump sites suitable for sanitary landfills.

- The Ministry of Industry monitoring the effluents and solid waste disposed of by the industries.

- The National and Provincial Environmental Councils established under Law No 2 of 1997, in charge of protecting and improving the environmental conditions in the country.

- The main Non Governmental Organizations (NGO's) involved in the sector are:

  - The General Federation of Iraqi Women (GFIW), involved in advising women, especially in rural areas, in the field of water supply and sanitation.

  - The Iraqi Society for Environment Protection and Improvement (ISEPI), involved in developing low cost technology for waste treatment and recycling.

1.2 Population

The CSO provides population data corresponding to the last 3 censuses: 1977, 1987 and 1997. Population data corresponding to 1997 were provided by CSO, broken down into rural and urban population, per sub-district.

Table 1-2: Population Historical Data

Governorate	Area km²	1977	1987	1997
Anbar	138 501	466 059	820 690	1 020 695
Babil	6 468	592 016	1 109 574	1 186 015
Baghdad	734	3 189 700	3 841 268	994 665
Basrah	19 070	1 008 626	872 176	1 569 385
Diala	19 076	587 754	961 073	1 130 504
Dohuk	6 553	250 575	293 304	335 300
Erbil	14 471	541 456	770 439	1 130 504
Kerbala	5 034	269 822	469 282	594 616
Mayoralty of Baghdad	Included within Baghdad Gov.			4 385 038
Missan	16 072	372 575	487 448	645 731
Muthanna	51 740	215 637	315 816	429 233
Najaf	28 824	389 680	590 078	806 597
Ninevah	35 899	1 105 671	1 479 430	2 120 923
Qadisiyah	8 153	423 006	559 805	779 588
Salaheldin	26 175	363 819	726 138	905 105
Sulaymanyiah	17 023	690 557	951 723	1 361 800
Ta'meem	10 282	495 425	601 219	777 811
Thiqar	12 900	622 979	921 066	1 185 679
Wasit	17 153	415 140	564 670	786 150
Total/Average	**434 128**	**12 000 497**	**16 335 199**	**22 186 313**

The population in year-2000 was extrapolated from 1997-Census records using Governorate population growth rates, which were first assumed as the average of PGRs corresponding to 1977-1987 and 1977-1997 periods respectively.

The above population data respecting Northern Governorates (ARNI) are based on the population data provided by the local water authorities. According to urban and rural population records provided by the Northern Governorates (ARNI), the region experienced large migration flows : Dohuk authorities reported a population of 211 380 in rural areas and 398 150 in urban areas, corresponding to an average increase rate of 22% over the 3-year period 1997-2000. This information was incorporated in the database and the Governorates' PGR were finally adjusted in order to reach the global PGR of Iraq as estimated by the CSO.

In the database, the 2000-population estimates are broken down into urban and rural population and distributed amongst the sub-districts keeping the same distribution structure as in 1997. The assessment of the sector and utility profiles is based on this 2000-population.

Map 1-2: Distribution of Population in Iraq in 2000

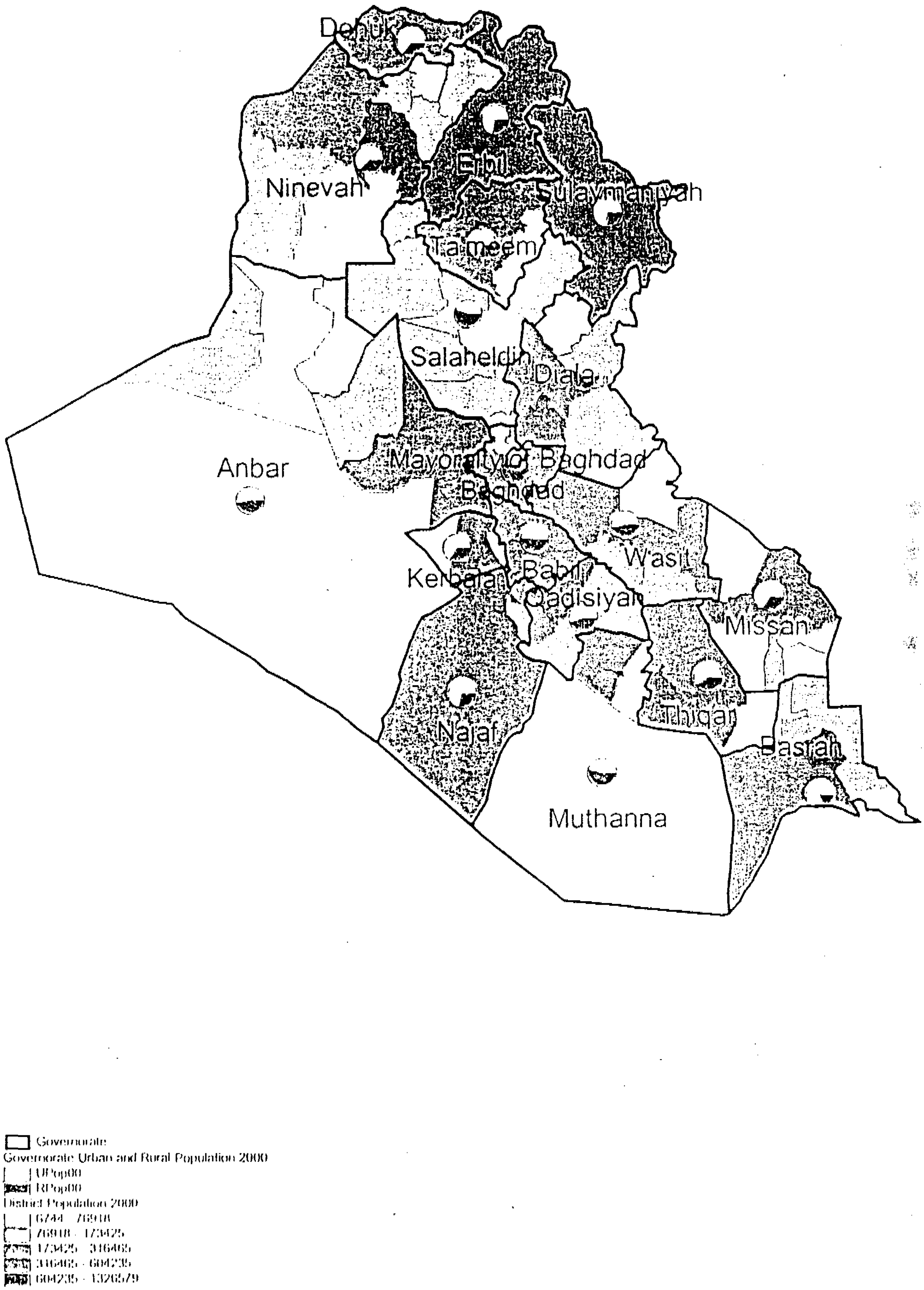


Table 1-3: Estimated Population by Late Year 2000

Sector Authority	Governorate	Urban	Rural	Total
MB	**Mayoralty of Baghdad**	**4 753 379**	15 694	4 769 073
Center South Region (CSR)	Anbar	578 700	512 686	1 091 386
	Babil	577 754	632 775	1 210 529
	Baghdad	485 023	608 887	1 093 910
	Basrah	1 331 889	347 713	1 679 602
	Diala	504 501	683 799	1 188 300
	Kerbala	423 279	216 164	639 443
	Missan	465 895	236 721	702 616
	Muthanna	216 998	254 636	471 634
	Najaf	631 832	256 006	887 838
	Ninevah	1 449 849	894 122	2 343 971
	Qadisiyah	468 595	387 704	856 299
	Salaheldin	435 103	533 349	968 452
	Ta'meem	594 147	239 437	833 584
	Thiqar	759 794	521 479	1 281 273
	Wasit	464 022	403 089	867 111
	Total CSR	**9 387 381**	**6 728 567**	**16 115 948**
ARNI	Dohuk	434 603	211 380	645 983
	Erbil	878 786	346 133	1 224 919
	Sulaymaniyah	1 206 841	463 193	1 670 034
	Total ARNI	**2 520 230**	**1 020 706**	**3 540 936**
Total		**16 660 990**	**7 764 967**	**24 425 957**

1.3 Legal Framework

The WES sector's operation is governed by the following laws:

- Law 25/1967, classifying water resources management criteria.
- Law No 2 of 1997, establishing the National and Provincial Environmental Councils.
- Law 148 dated August 12 1999, transforming the General Establishment of Water Sanitation (GCWS) in a State owned Corporation.
- The Constitution of BWA.
- The Constitution of BSA.
- Drinking water quality standards issued in 1974 by MOH.
- Law of March 11, 1974, creating the Autonomous region of Northern Iraq.

1.4 Mayoralty of Baghdad (MBG)

1.4.1 Institutional Boundaries and Organization

The main institutions of the sector are:

- The Baghdad Water Authority (BWA), in charge of the main water intakes, treatment plants, transmission lines, storage reservoirs and water distribution network pipes with diameter of 250 mm and larger in Baghdad..
- The Baghdad Sewerage Authority (BSA) in charge of the main sewage collectors, sewage treatment plants, and outfalls in Baghdad; and
- The Municipality Directorates, established in each of the nine main municipalities that constitute Baghdad Mayoralty. They are in charge, among other duties, of the operation and maintenance of the water supply distribution networks (pipes of diameter below 250 mm), distribution reservoirs, sewage collection networks and pumping stations, solid waste management and street cleaning.

The Mayoralty has also Departments, outside the sector management entities, in charge of Administration, Assets, Design, Planning, Pre-cast concrete construction, Construction, Nursery and Entertainment, Computer and Graveyards.

The BWA and BSA are under the responsibility of a Deputy Mayor especially in charge of these entities. The nine Municipal Directorates are under the responsibility of a Deputy Mayor for Technical Aspects and another Deputy Mayor for Administration and Finances. BWA and BSA were created respectively in 1921 and 1945 as Government-owned entities entirely composed of Government officials without any other representatives of users. Their constitutions were amended in 1995. Before 1995 the whole of the water supply system was under BWA and the whole of the sewerage system was under BSA. In 1995 the water distribution networks and the sewer networks were transferred to the municipalities. Since 1995 all the sewage pumping stations (586) have been transferred to the municipalities. The institutional framework of the sector in the Baghdad Mayoralty is represented in the Chart 1-1.

In the nine Municipal Directorates of the Baghdad Mayoralty, the main commercial roads are cleaned and solid waste is collected under contract with the private sector. Solid waste concessions are tendered and the lowest price offer of qualified contractors is selected. Commercial institutions are charged according to a pre-defined tariff. The Baghdad Mayoralty gets a fee from the solid waste concessionaires. Road users can see that main commercial roads are cleaner than other roads.

Chart 1-1: WES Organization in the Mayoralty of Baghdad

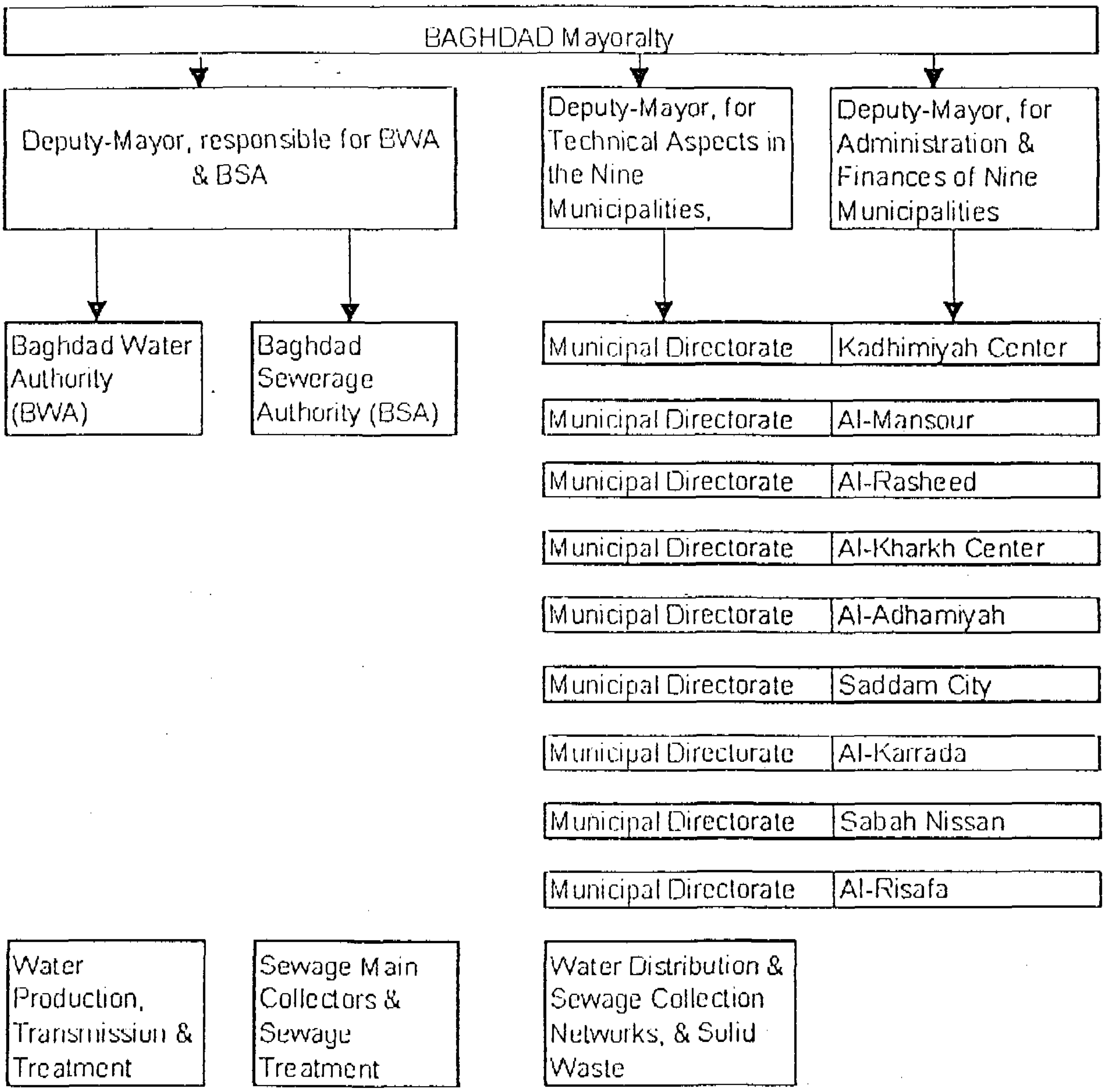


Table 1-4: Water and Sewerage Utility Profile in the Mayoralty of Baghdad

Profile Parameter	Mayoralty of Baghdad	BWA & BSA
Type of Activity	Water supply and sewerage services	Except operation and maintenance of the tertiary networks (below 250 mm) and the sewage pumping stations, which are delegated to
Type of Organization	Public entities integrated in Mayoralty of Baghdad Administration	Public Institutions reporting to the Deputy Mayor for technical matters (with legal basis, sector management responsibilities, limited financial autonomy for operation and maintenance expenditure)
Population Served (In 2000)	4 719 349	Inhabitants
Including	0.33%	In rural areas
Number of Service Connections	567 551	Units
Including	66%	Domestic connections
Personnel	1 420	Permanent staff
Including	14%	In sewerage tasks
Pipe Network Length		
Water	7 750	km, of pipes
Including	85.6%	Corresponding to pipes Dia <=250 mm maintained by municipalities on municipal budget
Average Production	818	Million cubic meters per year[1]
Average Supply Billed	314	Million cubic meters in 2000
Total Operating Income	2 010	M' ID in 1999
S/Total for Water Supply	1 324	M' ID in 1999
S/Total for Sanitation	686	M' ID in 1999
Total Operating Expenditure	1764	M' ID in 1999
S/Total for Water Supply (BWA)	1139	M' ID in 1999
S/Total for Sanitation (BSA)	625	M' ID in 1999

1.4.2 Financial Situation

Government sets tariffs after recommendations of the BWA and BSA Boards. In principle the tariffs are the same as in GCWS. However, the new tariff increase scheduled for January 1, 2000 was not implemented, pending the results of an analysis of the water bills over the first semester of 2000, including an evaluation of illegal connections. The new tariff setting was not made available for the purpose of the present study.

About 20% only of the water bills are based on actual meter readings since only about 135,000 connections are metered out of 650,000 connections. The collection rate of the water and sewerage bills was said to be only 55 to 60% .

In addition to drinking water revenues, BWA has raw water revenues since it provides raw water to part of the city. Also, BWA has revenues from the water that it supplies in bulk to adjacent areas in the Governorate.

Subsidized loans without interest are obtained from Government to finance capital expenditure. BWA transferred the proceeds of the sewerage surcharge to the BSA. A share of the water and sewerage bills should also be transferred to the directorates of municipalities, but in practice this

[1] Estimated from the Efficiency survey and complementary data collection carried out by UNICEF in 2000-2001

is not fully performed. Operating costs of the water distribution and sewerage networks, including operating the pumping stations are deemed to be financed by the municipalities.

According to its 1999 accounts, BWA was covering its operating costs, since it had a net income of ID 152 million , representing 12% of its expenditures. However its 1999 accounts were not yet audited; reported revenues include the whole of the water revenues while a share of them should have been transferred to the Municipal Directorates, which support the maintenance expenditures of the water distribution pipe network (Dia. < 250 mm), and the operation and maintenance of the sewerage collection and pumping systems.

Table 1-5: Baghdad Water and Sewerage Authorities Income Statement in 1999

		ID Million	%	ID Million	%	ID Million	%
		Water Supply		*Sewers*		*TOTAL*	
	Expenditures						
310	Total Salaries & Wages	324.0	24%	111.8	8%	435.8	16%
320	Total Materials	610.9	44%	232.1	17%	843.0	31%
330	Total Services Required	145.5	11%	280.3	21%	425.9	16%
370	Total Depreciation	58.2	4%	1.3	0%	59.5	2%
380/360	Total Miscellaneous Expenses	4.8	0%	7.0	1%	11.8	0%
390	Total Other Expenditures	78.3	6%	78.3	6%	156.6	6%
	Grand Total Expenditures	1 221.8	89%	710.9	53%	1 932.6	71%
	Revenues						
416	Water & Sew. Sales	1 288.1	94%	685.9	51%	1 974.1	73%
425	Other Operating Income	0.0	0%	0.0	0%	0.0	0%
430	Total Income from Services Provided	36.3	3%	0.0	0%	36.3	1%
441	Revenues from Operating for Others	0.0	0%	0.0	0%	0.0	0%
462	Rentals of Land	13.1	1%	2.7	0%	15.9	1%
483	Transferred Revenues, Penalties	3.6	0%	2.8	0%	6.5	0%
490	Total Other Income	33.0	2%	645.7	48%	678.7	25%
	Grand Total Income	1 374.3	100%	1337.2	100%	2 711.5	100%
	Net Income (Operating Deficit)	152.5	11%	626.3	47%	778.8	29%

BSA' operation experienced a net operating deficit of M' ID 113 in 1998, representing 22% of the Operating Income. In 1999 BSA could cover the operating costs since its net operating income was M' ID 63, representing 10% of the operating expenditures. The consolidated accounts of both BWA and BSA operations were reported to present a Net Operating Income of M' ID 215.6 in 1999, representing 12% of total operating expenditure. However, it is to be noted that these consolidated accounts do not include the entire operating expenditure borne by the municipalities (i.e.: personnel, wastewater pumping energy, general maintenance of vehicles and small repairs of networks and WW pumping facilities); the acquisition of chemicals through OFFP is not accounted for as operating expenditure in the above statements.

Small capital expenditures are self-financed while larger capital expenditure is financed by grants from Government upon approval of the Planning Commission. In 1999, capital expenditure totaled M'ID 75 for water and M'ID 276 for sewerage.

Table 1-6: Capital Expenditures of BWA and BSA in 1999

	Million ID
Laying of Drinking Water Networks	25
Laying of New Water Networks	50
Total BWA Capital Expenditures	**75**
Rehabilitation & Extension of Sewerage networks	200
Two New Sewerage Systems for Small Areas	76
Total BSA Capital Expenditures	**276**

Table 1-7: Summary of Expenditure financed under OFFP until December 2000

Category	Total Distributed to Governorates	Total Distributed to Projects	Total Installed
Auxiliary Vehicles(*)	61 033 344	45 580 000	3 293 214
Batteries & Tires	434 439	168 696	3 704
Jetting & Drain Cleaning Machine	5 270 919	5 019 554	4 395 794
Chemical Dosers	921 345	597 997	311 881
Chemicals	2 920 036	2 864 965	1 160 182
Complete Water Project & Compact Units	8 557 905	8 470 188	7 104 687
E & M Equipment & Spare Parts	2 507 034	2 035 772	1 237 119
Generators & Power	742 482	742 482	269 474
Miscellaneous	45 070	15 545	8 927
Sewage Pumps	8 371 534	3 703 513	2 203 422
Sewerage Spare Parts	225 491	98 979	68 030
Water & Sewerage Network	4 364 087	1 664 853	906 372
Water Pumps	3 347 669	3 344 342	2 137 421
Water Spare Parts	4 032 231	2 561 440	1 019 189
Water Tankers & Spare Parts	630 000	630 000	630 000
Total (US$)	103 403 585	77 498 326	24 749 416

It is to be noted that 12% of implemented expenditure corresponds to spare parts related to maintenance works and 4.7% corresponds to operating expenditure (chemicals). Using the commercial exchange rate, these expenditures would represent roughly M' ID 5 000 and 2 000 respectively, that should be added to the M' ID 2 000 registered in 1999 in order to reflect the real cost of services.

According to information provided by the Planning Commission, the GOI budgeted M ID 700 for capital investment in the Mayoralty of Baghdad for 2001 with a view to supporting rehabilitation works with implementing capital expenditure funded by OFFP allocations. By 1997-2000, UNICEF arranged financing 2.4 M'US$ rehabilitation works including 1.4 M'US$ from OFFP supplies.

Few auxiliary vehicles were put into use. Excluding this item, we note that 3/4 of the imported material supplied to the Mayoralty of Baghdad were transferred to the operating units, and that these operational units had put into use only 2/3 of the imported supply received by MB.

1.4.3 Manpower

In the Baghdad Mayoralty the number of vacancies reaches the high percentage of 54% of the approved positions, as shown in the following table. The sewerage activity has many vacant positions due to the low level of Government salaries and the low desire of Iraqi personnel to work in the sewerage sector.

Table 1-8: Staffing Situation in the Baghdad Mayoralty

Staffing	Baghdad Mayoralty	BWA	BSA
Approved Positions	12 954	2,223	597
Positions Filled	5 954	1 223	197
Vacancies	7 000	>1 000	>1 000
Vacancies as % of approved	54%	>45%	> 67%

BWA and BSA recruit managerial and technical staff from the universities and colleges. MB' reported that 552 mayoralty staff received in-house training in 1999, while 205 employees received training outside the Mayoralty.

The staff from the Municipal Directorates clean residential roads. As in the Center and Southern Governorates, a garbage charge of ID 100/household is added to the water bills since April 1st, 2000.

1.4.4 Institutional and Financial Management Issues

Splitting of Both Water Supply System and Sewerage System into Two Different Institutions

In Baghdad Mayoralty, the separation of responsibility of the water supply and sewerage systems between BWA/BSA for the off-site or large facilities on one side and the Municipality Directorates for the networks and pumping stations on the other side leads to diffusion of responsibility. It creates problems of coordination, possible disputes, and confusion in the minds of the customers regarding the entity which should ultimately be responsible of the services.

This issue will be critical to manage efficiently UFW reduction programmes, which involves the overall operation of the distribution system.

Sanctions

They slow down the importation of spare parts, chemicals, reagents and transportation means, which are required to provide safe water supply and effective sanitation services. They contribute to impoverishing State-owned institutions, civil servants and generally most of the population. This prevents the hiring and training of sufficient staff, the increase of water tariffs, the performing of adequate preventive maintenance, and the undertaking of proper capital expenditures. The water supply and sanitation systems have been continuously deteriorating for the last ten or fifteen years and require urgent rehabilitation works.

The lifting of sanctions will concentrate sector development and planning functions in the Planning Commission.

Low Level of Metering

The percentage of metered connections, and consequently the percentage of water billed through metered consumption are steadily declining. A flat-water charge would not encourage the consumer to save water, and would lead to more water wastage, and consequently to oversizing infrastructure and capital expenditure. Using a flat rate is also unfair to consumers that use less water than others do. The constraints regarding increasing water metering are:

- The relatively long period of time needed to implement a full metering program. This increased cost resulting from misunderstanding and service billing may not balance the revenue increase and lower material costs.
- The low incentive for water directorates to install meters when the household tariff is so low.

Too High Difference Between Domestic and Non-Domestic Tariffs

The non-domestic customer ends up paying more than 20 times as much for its cubic meter of water as the domestic customer. This is leading to unfairness when the customer is not clearly in one of these categories. It gives opportunities for cheating. The higher is the flat rate for the non-domestic customer, the more it is unfair to the customer that consumes less. This strengthens the concept of public water supply being a duty of GOI institution ; the domestic customers are entitled to receive water for a symbolic charge.

Cash Operating Deficits

The water revenues do not cover the true operating expenditures. The average water price is too low to cover all material supplies ; imported chemicals and spare parts are paid by GOI.

Garbage Charge on Water Bill

Financing the garbage collection through a surcharge on all water bills is not appropriate since the costs of garbage collection are unrelated to water consumption. Garbage collection costs would be better recovered through a special item on the local property tax, as is generally done throughout the world.

Contracting out Garbage Collection

Only a few cases of formal contracting out of garbage collection to the private sector have been identified. There is one in Baghdad Municipal Directorates. The good results should be better disseminated throughout the Governorates.

1.5 Center South Iraq (CSR)

1.5.1 Sector's Institutional Boundaries

In the 15 Central and Southern Governorates, except in Baghdad City, the General Corporation for Water and Sewerage (GCWS) provides water supply and sewerage services in urban and rural areas.

In each Governorate, solid waste management and street cleaning is under the responsibility of a Directorate of the Municipality in each capital city, and of a separate Directorate of Municipalities for all other municipalities of the Governorate. The institutional framework in the Central and Southern Governorates is schematized in the following scheme:

The organization of the water supply and sewerage services is heavily centralized. According to Law 148 dated August 12 1999, the former GCWS was transformed from a Governmental Establishment into a state-owned corporation, with higher financial and administrative autonomy in managing water supply and sewerage. It is to provide water supply, sewerage and sanitation services in the 15 Central and Southern Governorates, except the nine municipalities of Baghdad Governorate that constitutes the Baghdad Mayoralty. GCWS is placed under the Ministry of Interior. Its General Director reports to a Deputy Minister for Technical Affairs in charge of overseeing this institution. GCWS is entitled to levy user charges, to take loans and to receive grants. GCWS's headquarters are located north of Baghdad.

In headquarters the GCWS's General Director oversees General Services and two separate Directorates, one for water supply, dealing with urban and rural water supply, the other for sewerage, dealing with sewerage when such systems exist and storm-water drainage, which often collects sewage more or less legally. According to Law 148, these two Directorates are also legal entities.

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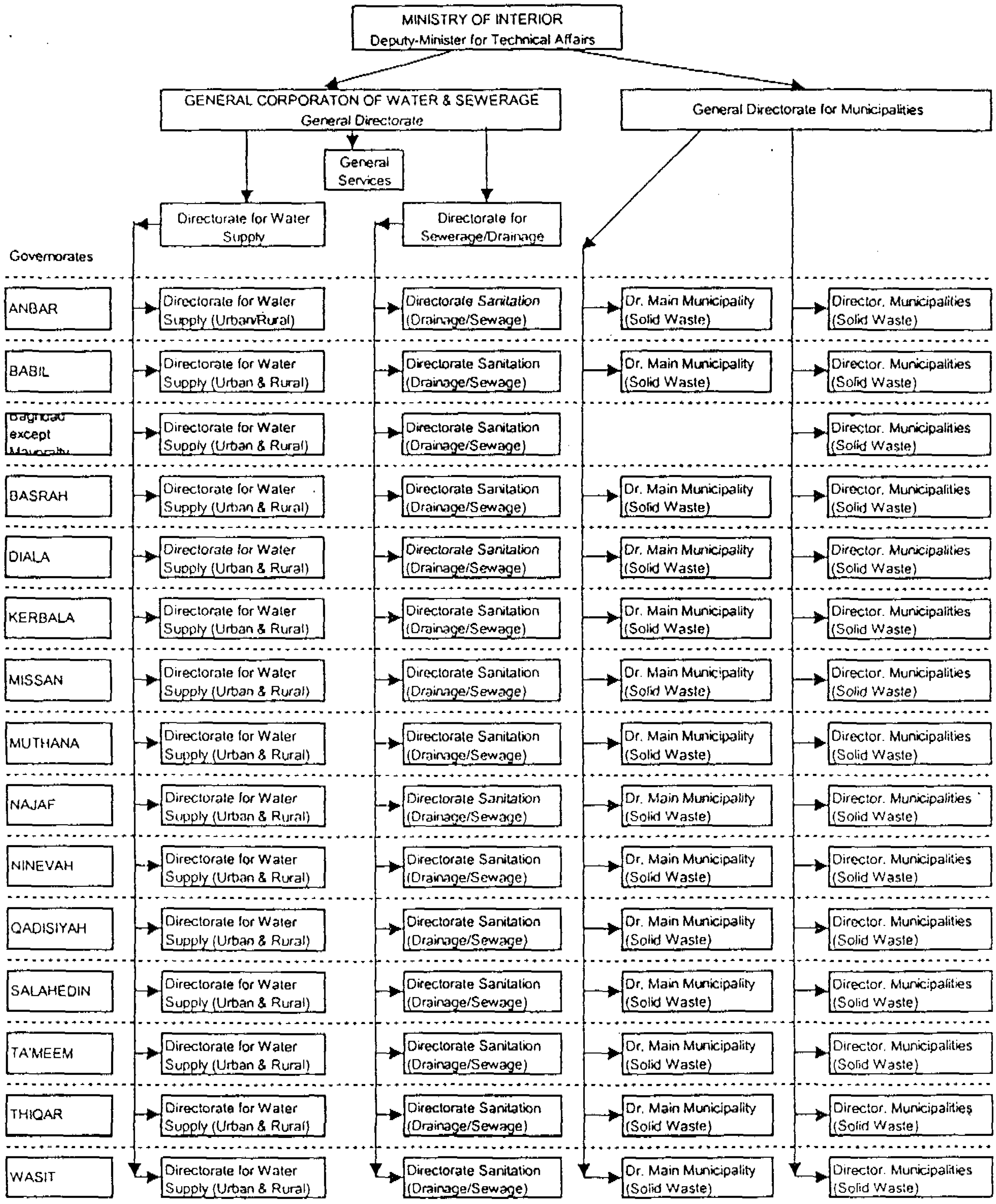
Chart 1-2: General Organization of WES Sector in Center-South Region



The organizational structure of a Directorate in a Governorate is the same in all Governorates and reflects the structure of the corresponding Directorate in Headquarters. All local managers at the district level report directly to the Director of the Directorate. The local manager at the sub-district level does not report to the district manager but directly to the Director, because the district manager lacks administrative resources, due to the shortage of staff. This creates a burden for the Director of the Directorate.

Chart 1-3: GCWS Headquarters Organization Chart

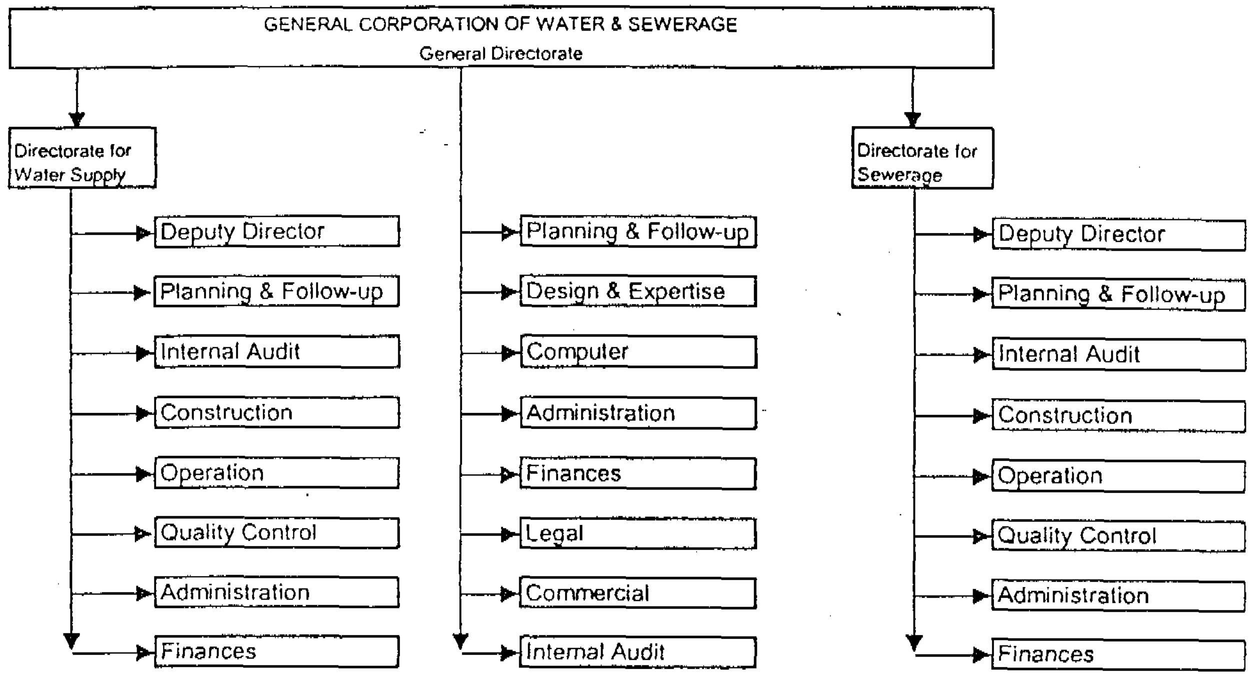
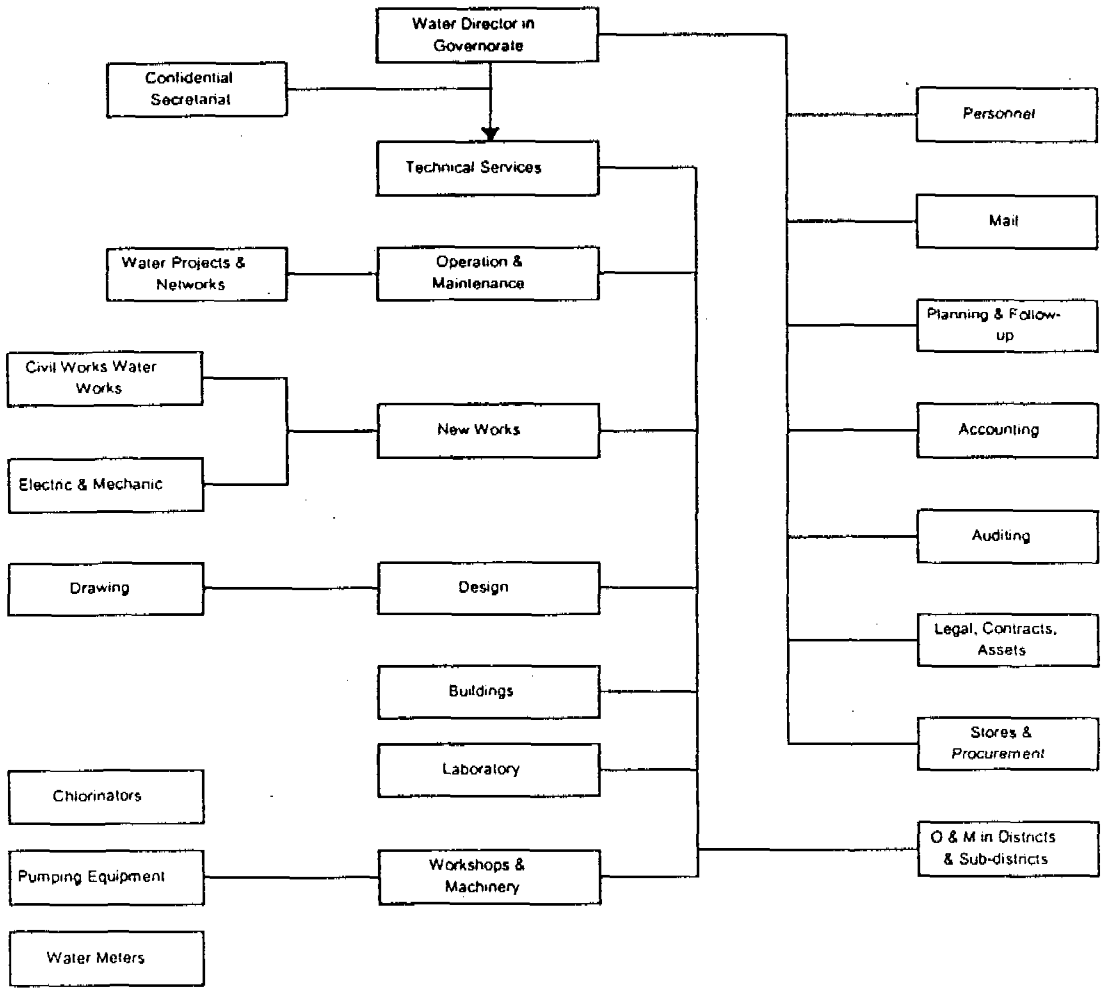


Chart 1-4: Typical Organization of a DWS



In each Governorate, a Directorate for Municipality (corresponding to the main city of the Governorate) and a Directorate for Municipalities (ruling the other urban areas of the Governorate) operate garbage collection and disposal. They all report to a General Directorate for Municipalities based in Baghdad, reporting to the Deputy-Minister for Technical Affairs in the Ministry of Interior.

Table 1-9: Water and Sewerage Utility Profile in the Center South Region

Water Utility Identification	General Corporation of Water and Sewerage			GCWS
Type of Activity	Water supply and sewerage services			
Type of Organization	State-owned Corporation			Comprises Headquarters office in Baghdad, 15 Directorates of water supply and 15 Directorates of Sewerage corresponding to the 15 Governorates of CSR
Population Served (In 2000)			11 183 708	Inhabitants
Including			26%	In rural areas
Number of Service Connections			1 284,000	Units
			991 000	Are in urban areas
Of Which Including			88%	Domestic connections
Personnel			11 044	Permanent staff
Including			14%	In sewerage
Pipe Network Length Water			23 122	km, of pipes
Including			82%	Corresponding to pipes Dia <=250 mm maintained by municipalities on municipal budget
Average Production			1 043	Million cubic meters per year[2]
Average Supply Billing				Million cubic meters in 2000
Year	1998	1999	2001	
Total Operating Income	3 264	6374	10 002	M' ID
S/Total for Water Supply			8 552	M' ID
S/Total for Sanitation			1 450	M' ID
Total Operating Expenditure	3 289	5 115	9 237	M' ID
S/Total for Water Supply			7 737	M' ID
S/Total for Sanitation			1 372	M' ID

1.5.2 Financial Situation

Tariff Setting

Water tariffs are established by decision of the GOI. They are applicable in all the Governorates supplied by the GCWS and in the Mayoralty of Baghdad.

When water meters exist and operate normally, water is charged every two months according to the volumes consumed and with the following block tariff structure for households. New rates were applied on January 1, 2000. Tariffs are very low, but service is also very poor since maintenance expenditure is delayed, spare parts are not available in the national market and their purchasing relies on OFFP procedures, and frequent power cuts during the day reduce operational efficiency. Raising the tariff is difficult as long as the level of service is not improved.

[2] Estimated from the Efficiency survey and complementary data collection carried out by UNICEF in 2000-2001

Table 1-10: GCWS Water Tariffs for Households in 2000

Household Consumption Block	1998 & 1999 Rates Iraqi Dinars/m³	2000 Rates Iraqi Dinars/m³
1 to 30 m³	0.66	2
31 to 60 m³	1.5	5
61 to 90 m³	1.5	7.5
Above 90 m³	10	20

Offices were and are charged at the following flat tariff rates.

Table 1-11: GCWS Non-Domestic Water Tariffs

Categories of Users	1998 & 1999 Rates Iraqi Dinars/m³	2000 Rates Iraqi Dinars/m³
Public Institutions	5	20
Private Commercial Sector	15	30

However, most of the connections are not metered. The percentage of water charged through metering is not known, but it is probably low. For instance, in the Ninevah Governorate, the percentage of metered water is now about 20 to 25 %, while before the sanctions it was more than 40%. Practically in the Ninevah Governorate no new meters were installed after the sanctions. The Directorates feel that the water tariffs are so low compared with the cost of metering that metering is not worthwhile.

In practice the consumption is estimated and billed by a commission according to the following rules:

Table 1-12: Estimated Water Consumption of Households[3]

Households	Estimated Consumption
1 to 4 rooms	1.5 m³/day
5 to 6 rooms	2 m³/day
6 to 7 rooms	3 m³/day
Above 7 rooms	3.5 m³/day
For every 50 m² of garden	0.5 m³/day

[3] According to GCWS criteria for non metered connection billing purposes

Table 1-13: Estimated Water Consumption for Commerce and Institutions[4]

Type of Institution	Estimated Consumption
Coffee House w/area < 30 m²	4 m³/day
Coffee House w/area > 30 m²	6 m³/day
Restaurant w/area < 30 m²	4 m³/day
Tourist Coffee/Restaurant <100 m²	6 m³/day
Tourist Coffee/Restaurant >100 m² and Schools	8 m³/day
Car Service & Wash and Ice Factory	60 m³/day

As a result, commerce and institutions are far more charged than households.

When households are connected to a sewerage system, a 100% sewerage surcharge is added to the water bill. Where there is no sewerage system there was no surcharge on water bills, except for customers, such as coffee-houses and restaurants, which are allowed to dispose of their washing effluents into the storm drainage system.

Starting January 1st, 2000, the DWS were instructed to provide financial resources to the Sewerage Department by transferring monthly part of their water revenues to the newly created Directorates. This part should amount to the total of :

- Salaries and staff incentives for the Sewerage Directorate.
- Power bills related to the sewerage facilities.
- 20% of the water revenues net of salaries, incentives and power cost for both water and sewerage activity.

The Sewerage Directors indicate that the 20% transfer would only cover the cost of temporary labor, without much left for heavy maintenance.

A proposal is under examination by the Government to establish a 50% or 100% surcharge on all water bills, whether buildings are connected to the drainage system or not, to be transferred to the Sewerage Directorate to finance overdue drainage rehabilitation.

Solid Waste

A garbage fee of ID 100 per household was created on April 1st 2000. It is being collected through a surcharge on the water bill rather than a surcharge on the local property tax. It is said that the proceeds of the new tax would be just sufficient to pay incentives to the solid waste staff.

Other Water and Sewerage Revenues

They consist of very moderate connection fees (ID 10 per connection), penalties for illegal connections and customer contributions for distribution pipes. Reconnection fees for customers that have been cut off for unpaid bills and want to be re-connected have been determined, but they are practically not applied. Disconnection may occur, but the decision is at the Governorate level. Other water revenues are generally low compared to water sales. For instance, in Diala Governorate, other water revenues totaled only 10% of water sales.

[4] According to GCWS criteria for non metered connection billing purposes

The Water Directorates do not get revenues related to rural water supply since local communities operate directly rural water supply facilities. However, the Directorates are sending assistance when a breakdown occurs.

The proceeds of the sewerage surcharge are generally very low compared to water revenues (less than 10%) because sewerage systems are very rare.

Billing is prepared manually in the Governorates. Bills are not sent by post. Instead, bills are presented and collected directly by Directorate collectors, which is said to be faster and easy for the customers. To avoid possible collusion between collector and customer, collectors routes are rotated periodically. The collection rate for 1999 is good since it reaches about 92%, as calculated from the amount of unpaid bills. However, it should be noted that this figure does not appear in the audited accounts.

Accounting

Accounts are computerized in headquarters, based on input data provided by the Directorate at the Governorate level. In 1999, there were no separate accounts for the sewerage activity. Accounting is still in transition from government cash accounting to commercial accounting, and is still rudimentary. Cash-flow statements are not prepared. The amounts shown in the accounts as water revenues are not the billing amounts, but the billing amounts that have been cashed-in. Unpaid billings are not shown in the accounts, but are recorded separately from the formal accounts. This does not permit the calculation of the collection rate from the accounts. Depreciation of assets is used, but assets are not periodically revalued. Accordingly depreciation amounts are insufficient and are not enough to finance the replacement of assets. Finally, when imported assets (such as vehicles, excavators) are incorporated in the list of assets, their costs are accounted for using the official rate of exchange (US$1 = ID 0.3109), regardless of what the market rate is[5]. The use of this rate and the non-re-evaluation of assets give an unrealistic value of assets.

Although a tentative commercial accounting system is prepared in headquarters, the accounting prepared in the Directorates is cash accounting. There is no statement of revenues and expenditures prepared at Governorate level. The water supply Directorates transfer 10% of their revenues to GCWS Headquarters' account. They keep the remaining revenues in a local account. Spares and equipment received from headquarters through the Oil for Food program are not recorded as expenditures at the Governorate level. Directors aim to balance their operating costs with water revenue while depreciation on revalued assets, materials provided free or at a subsidized cost from central administration is not taken into account. Sometimes, even power bills may be cancelled with a subsidy from the Government[6]. GCWS headquarters usually cover cash deficits of decentralized directorates whenever they occur.

Income Statements

In 1998 and 1999 GCWS had a net operating deficit of respectively $0.33 million and $0.45 million, equivalent to about 13% of total expenditures in each of these years. The 2001 budget is compared to 1998-99 accountings records in Table 1-14.

To finance its operating deficits in 1998 and 1999, GCWS temporarily used funds provided by the Government for new investments, re-allocating savings made on project costs from reducing the scope of budgeted projects.

It is to be noted that most of the spare parts and chemical expenditure are paid within the OFFP and accounted for in GCWS financial statements with the very subsidized rate of ID 0.3109 per

[5] In July 2000: US$1 = 2000 ID

[6] That was the case for the Nivenah Water Directorate, which had to pay retroactively a major bill for office electricity of 247 million ID out of gross water revenues of 715 million ID for 1999.

US$ compared to ID 1 850 /US$ free market price, or even to the ID 100 /US$ under protocol arrangements with certain countries. This results in low depreciation costs assumed by the directorates.

Table 1-14: GCWS. Incomes and Expenditures Statement and Budget in current M' ID

		1998	1999	2001			
	Concepts	*W&S*	*W&S*	*Water*	*Sewerage*	*HQ GCWS*	*Total*
	Expenditures						
310	Total Salaries & Wages	919	1 492	1800	410	81	2 291
321	Materials	78	206	300	32	0	332
322	Fuel & Lubricants	188	174	400	43	0	443
323	Spares	309	195	300	48	0	348
325	Miscellaneous	26	46	90	35	7	132
327	Electric Power	329	1 601	1 610	267	0	1 877
320	Total Materials	929	2 221	2 700	424	7	3 131
331	Maintenance	1 743	2 129	2 427	291	23	2 741
332	Studies, Consultancy	3	3	1	1	0	2
333	Press, Advertisement, Hospitality	51	42	114	52	12	178
334	Transport, Communications	58	44	190	40	2	232
335	Renting of Fixed-Assets	50	131	130	72	0	202
336	Other Services	38	42	88	20	4	112
330	Total Services Required	1 943	2 390	2 950	475	40	3 465
370	Total Depreciation	221	225	224	52	0	276
380/360	Total Miscellaneous Expenses	13	46	63	11	0	74
390	Total Other Expenditures	12	13	15	0	0	15
	Grand Total Expenditures	**4 036**	6 387	7 752	**1 372**	**128**	**9 252**
	Revenues						
416	Water & Sew. Sales	2 691	3 451	8 000	1 300	0	9 300
425	Other Operating Income	1	0	552	150	0	702
430	Total Income from Services Provided	442	748	0	0	0	0
441	Revenues from Operating for Others	129	884	0	0	0	0
483	Transferred Revenues, Penalties	24	32	0	0	0	0
490	Total Other Income	197	432	0	0	0	0
	Grand Total Income	**3 486**	5 547	**8 552**	**1 450**	**0**	**10 002**
	Net Income (Operating Deficit)	**-551**	-840	**800**	78	**-128**	750

Capital Expenditures

Since 1996, most of the capital expenditure was financed by Oil-for-Food program under consecutive 6-month MOUs.

In 1999, the local cash component of capital expenditures amounted to ID 2 954 million. They were financed under the Government investment budget prepared by the Planning Commission. Most of them were related to deferred maintenance.

In 1999, in the Ninevah Governorate, the local cash capital expenditure amounting to ID 230 million was actually corresponding to replacement.

During the period 1997-2000, rehabilitation works, amounting to $3.2 million were executed with UNICEF funding (66%) and OFFP supplies.

In addition, $61.8 million were implemented by the Directorates of water and sewerage including $6.8 million in chemicals for water treatment. This amount represents 82% of the total imported material distributed to on-going projects in the Directorates under GCWS administration. Less than 30% of the sewerage pumps were installed in December 2000 while more than 90% of the other equipment were implemented.

It is to be noted that a large part of equipment requiring transport and logistical support could not be delivered to operational units: 70% of auxiliary vehicles, 69% of power generators, 75% of pipe networks, 74% of water spare parts were still pending for delivery at the Governorate level.

Table 1-15: Summary of GCWS' Expenditure financed under OFFP until December 2000 in US$ [1]

Category	Total Distributed to Governorates	Total Distributed to Projects	Total Installed
Auxiliary Vehicles	42 657 252	12 879 228	11 789 168
Cesspit, Jetting & Drain Cleaning Machine	15 226 673	13 009 498	12 522 737
Chemical Dosers	911 258	874 940	826 571
Chemicals	8 146 539	7 116 480	6 833 410
Complete Water Project & Compact Units	3 745 660	826 450	826 450
Electrical & Mechanical Equipment & Spare Parts	2 025 162	1 454 383	1 054 892
Generators & Power	5 207 598	1 609 987	1 418 503
Miscellaneous	248 635	163	0
Sewage Pumps	4 484 439	3 917 539	3 698 543
Water & Sewage Network	43 124 720	10 946 775	3 215 635
Water Pumps	16 669 717	14 787 699	13 549 047
Water Spare Parts	937 348	239 523	209 025
Water Tankers & Spare Parts	10 291 885	7 901 081	5 861 645
Total	**153 676 885**	**75 563 746**	**61 805 625**

Municipalities

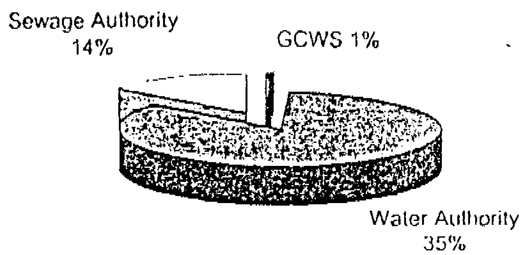
The Municipal Directorates are financed through budgets channeled through the Ministry of Interior. The solid waste management constitutes sometimes the major part of the total budget of the Directorate. However, when the *Municipality* has extensive parks, entertainment and tourist attractions, this would not be the case. Municipal revenues other than those received from the Ministry of Interior's budget are limited. Industry may be charged for removal of their wastes.

Very little investment expenditure can be afforded and would require the approval of the Planning Commission. Machinery (such as garbage collectors, graders, sewage emptier to clean swamp areas) was received in limited numbers under the Food for Oil program. But they are far from meeting the needs.

[1] Source UNICEF Baghdad

1.5.3 Human Resources

GCWS is short of higher-level management staff. In the Governorate, the staffing of the Water Supply Directorate outnumbers substantially the staffing of the Sewerage Directorate. At the Governorate level, GCWS's regional Directorates have difficulty in recruiting staff due to the low level of the Government salary scale and for the sewerage Directorate, due to low taste for this sub-sector.



GCWS employs 11 044 permanent staff which represents 55% of the positions created for the operation of the Corporation.

The average age of the staff is on the high side and the number of staff going into retirement is high. The vacant positions are relatively senior. The shortage occurs especially in the technicians and managerial categories. The Directorates lessen the problem of shortage of permanent staff by contracting out some maintenance works and by hiring temporary staff. The temporary staff, mainly in the laborers and technicians categories, is hired at a salary level above the government scale.

Table 1-16: Staffing Structure of GCWS Head Office [a]

Categories	Position	Number
Administrators	*Occupied*	54
	Vacant	75
	Total	***129***
Managers & Engineers	*Occupied*	37
	Vacant	73
	Total	***110***
Operators	*Occupied*	5
	Vacant	20
	Total	***25***
Technicians	*Occupied*	3
	Vacant	41
	Total	***44***
Unskilled laborers	*Occupied*	2
	Vacant	32
	Total	***34***
Grand Total for Occupied		***101***

[a] Source GCWS

Table 1-17: Staffing Structure of Regional DWS

Directorates	Administrators	Managers & Engineers	Operators	Technicians	Unskilled laborers
Maqar WA	38	28	11	6	
Anbar	92	39	329	48	101
Babil	160	30	279	62	355
Baghdad	74	15	284	32	56
Basrah	263	44	380	104	358
Diala	145	22	448	104	186
Kerbala	126	19	200	58	171
Missan	93	13	236	43	104
Muthana	71	18	88	16	73
Najaf	176	23	164	48	129
Ninevah	193	53	448	80	227
Qadisia	112	25	161	39	172
Salahelden	40	16	236	36	17
Tameem	121	30	165	49	30
Thiqar	211	21	283	48	88
Wasit	84	10	251	50	98
Grand Total	1999	406	3963	823	2165

Monthly premiums are given to staff as incentives, but the amounts are limited. For technicians, the premium was about ID 10 000 /month, but it was recently raised to ID 20 000 /month. This reduces the remuneration differences between permanent and temporary staff.

Table 1-18: Staffing Structure of Regional Directorates of Sewerage

	Administrator	Managers & Engineers	Operator	Technicians	Unskilled
Maqar WA	17	19	11	5	4
Anbar	10	6	329	7	5
Babil	32	9	279	3	52
Baghdad	8	4	284	6	5
Basrah	38	15	380	19	96
Diala	30	9	448	6	6
Kerbala	24	4	200	7	19
Missan	49	5	236	15	133
Muthana	7	4	88	2	5
Najaf	21	7	164	5	21
Ninevah	25	15	448	4	10
Qadisia	14	8	161	8	16
Salahelden	13	5	236	4	23
Tameem	6	3	165	2	2
Thiqar	26	8	283	12	48
Wasit	19	6	251	9	39
Grand Total	339	*127*	3 963	*114*	*484*

Training

Since the 1991 war, only a little training has been provided to GCWS staff. The CARE International NGO, through UNICEF, provides three-day training courses in one of the small training centers shared out among several Governorates. The courses are directed towards basic operating skills, like use of pumps and chlorinators. The training courses are very useful but quite insufficient compared to the needs.

In the municipalities, the staff in charge of solid waste management perform street cleaning as well since, in the local context, the two activities are closely connected to each other. The permanent staff for both activities represents nearly 20 to 25% of the total staff of local directorate. However, solid waste management and street cleaning activities require hiring daily labor that may triple the permanent staff assigned to the activity. Lack of adequate equipment and low salary levels make it sometimes difficult to perform satisfactorily. In the Diala Directorate for Municipalities, it was reported that 80% of the machinery is out of order. The Directorates may also contract out garbage collection and street cleaning for commercial streets to private contractors, upon approval of the Governor. In addition, the inhabitants who can afford it, can appoint informally third parties to clear away the garbage in front of their door.

1.5.4 Institutional and Financial Management Issues

Centralization of The Water Supply and Sewerage Institutions in The Central and Southern Governorates

In these Governorates, the water supply and sewerage institutions are too centralized. It is now admitted throughout the world that local water supply and sewerage systems are better managed when they are operated by autonomous institutions overseen by local authorities. The constraint towards full decentralization is the economy of scale lost by not sharing qualified managerial and expert human resources. A compromise would be gradual decentralization by encouraging a few Governorates to establish a common corporation for both water supply and sewerage.

Storm Water System under GCWS

In the Central and Southern Governorates, to have the urban storm water drainage systems under the responsibility of the GCWS will create problems. Storm water drainage is intimately linked to road maintenance and construction, which is a typical municipal service, while sewerage operation and construction is very similar to a water supply activity. Sewage production is closely linked to water consumed and should be charged for accordingly, while drainage costs are normally recovered through local property taxes. It would be more appropriate to have the storm water system under the responsibility of the Municipal Directorate, already in charge of roads and solid waste management.

Sanctions

Sanctions are slowing down the importation of spare parts, chemicals, reagents and the means of transportation required to provide good water supply and sanitation services. They contribute to impoverishing government-owned institutions, civil servants and generally most of the population. This prevents the hiring of sufficient staff, the increase of water tariffs, preventive maintenance, and proper capital expenditures. The water supply and sanitation systems are generally deteriorating.

Low Level of Metering

Since the sanctions, the percentage of metered connections, and consequently the percentage of water charged through metered consumption are steadily declining. A flat-water charge fails to encourage the consumer to save water, and leads to water wastage. Using a flat rate is also unfair to consumers that use less water than others do. The constraints regarding increasing water metering are:

- The relatively long period of time needed to implement a full metering program.
- The low incentive for water directorates to install meters when the household tariff is so low.

Too High Difference Between Domestic and Non-Domestic Tariffs

The non-domestic customer ends up paying more than 20 times as much for its cubic meter of water as the domestic customer. This leads to unfairness when the customer is not clearly in one of these categories. It gives opportunities for cheating. The higher is the flat rate for the non-domestic customer, the more it is unfair to the customer that consumes less.

Cash Operating Deficits

The water revenues do not cover the true operating expenditures. The average water tariff is too low. Instead of subsidizing water services, it would be better to subsidize directly the population (through reduction of taxes for instance).

Financing of the Sewerage Directorate

Asking the Water Directorate to pay for the salaries, incentives and power bills of the Sewerage Directorate does not motivate the latter to save personnel and power costs. It defeats the separation between the water supply activities and the sewerage activity. The proposal to finance the Sewerage Directorates, which are actually mainly involved in storm water activity, through a surcharge on all water bills is not appropriate since the cost of drainage is unrelated to water consumption. Drainage costs would be better recovered through a special item on the local property tax, as is generally done throughout the world.

Garbage Charge on Water Bill

Financing the garbage collection through a surcharge on all water bills is not appropriate since the cost of garbage collection is unrelated to water consumption. Garbage collection costs would be better recovered through a special item on the local property tax, as is generally done throughout the world.

Contracting out Garbage Collection

Only a few cases of formal contracting out of garbage collection to the private sector have been identified. There is one in the Diala Governorate, at least for the main commercial roads. The good results of the above mentioned case should be better disseminated throughout the Governorates.

1.6 Autonomous Region of Northern Iraq (ARNI)

1.6.1 Sector's Institutional Boundaries

Two separate Governments administer the autonomous region of the Northern Governorates. The Erbil and Dohuk Governorates are administered by a government controlled by the PDKI party, while the Sulaymaniyah Governorate, and the recently created New Kirkuk Governorate, are administered by a separate government body controlled by the PUK party. Each government has its own organization structure. Accordingly the water supply, sewerage and solid waste sector is organized somewhat differently. For instance in the Sulaymaniyah and New-Kirkuk

Governorates there exists only one Municipal Directorate covering all urban centers, including the capital of the Governorate.

In each Northern Governorate, urban water supply and sewerage is under the responsibility of a Directorate for Water and Sewerage placed under supervision of the Ministry of Municipalities and Tourism. Rural water supply and sanitation is under the responsibility of a Directorate of Reconstruction and Development, under the Ministry of Reconstruction and Development in the Erbil and Dohuk Governorates, and a Directorate for Works and Reconstruction, under the Ministry of Works and Reconstruction in the Sulaymaniyah and New-Kirkuk Governorates.

A Municipal Directorate controls solid waste management and cesspit emptying. While in the Erbil and Dohuk Governorates there are two Municipal Directorates, one for the capital of the Governorate and another for the other urban areas of the Governorate, these two Directorates have been combined in the Sulaymaniyah and New-Kirkuk Governorates. The institutional framework in the Northern Governorates is schematized in Annexes 3.5 and 3.6.

The organizational charts of the Water & Sewerage Directorates show two separate sections, for water revenues on one side and expenditures on the other side. Normally, the same manager responsible for all financial aspects should head these two sections. This anomaly reflects that there is no correlation between water revenues and expenditures.

Since portions of a sewerage system exist only in Sulaymaniyah City, the Directorates are mainly dealing in water supply in urban centers. Their involvement in sewerage is consequently very limited, especially considering that, although water customers are sometimes illegally connected to drainage system, they are not in charge of the municipal drainage system.

The Directorates in charge of rural water supply and sanitation have also the responsibility of rural infrastructure including, schools, dispensaries, roads and bridges. They have been created by decree in 1992. They are not in charge of operating rural water supply systems, which are operated by local communities. However, they carry out repairs and equipment replacement, and they implement new projects. Sanitation services include mainly the construction of pit latrines.

Table 1-19: Sector Utility Profile in the Autonomous Region of Northern Iraq

Water Utility Identification	Autonomous Region of Northern Iraq	
Type of Activity	Water supply and Sewerage	
Type of Organization	Directorates of Ministries	The technical coordination and planning is provided by UN officers
Population Served (In 2000)	2 914 186	Inhabitants
Including	26%	In rural areas
Number Of Service Connections	232 590	Units
of Which	64%	are in urban areas
Including	91%	Domestic connections
Personnel	3 354	Permanent staff
Including		In sewerage tasks
Pipe Network Length		
Water	1 774 143	km, of pipes
Including	1 425 402	of pipes Dia <=250 mm
Average Water Production	182 900	Million cubic meters per year

In the rare cases where a rural water system serves several villages, there is no formal arrangement between the villages to establish an operating entity.

The municipal directorates in charge of solid waste management and cesspits emptying are also in charge of sweeping streets, drainage systems, road maintenance, and in the main urban centers of parks, road traffic engineering and slaughterhouses. Consequently, there exists a difference with the Central and Southern Governorates where municipal drainage systems are not under the municipal directorates, since they are under a separate Sewerage Directorate.

While in the main urban centers, private contractors for emptying septic tanks and cesspits are available, this is not the case in semi-urban areas. Consequently, in the semi-urban areas the municipal directorate is the only entity involved in emptying septic tanks and cesspits.

1.6.2 Financial Situation

1.6.2.1 Water and Sewerage Tariffs

Water meters are not used. Water supplied is generally billed every two months according to the size of the household area and the number of taps existing in the households. There is no uniform tariff structure throughout the Governorate. Tariffs are quite different from the rest of Iraq, which should not be a surprise since the Northern Iraqi Dinar (NID) is worth, in the market in July 2000, a lot more than the normal Iraqi Dinar (US$ = 18 Northern Iraqi =2000 Iraqi Dinar). Sewerage exists only in Sulaymaniyah where a sewerage surcharge of 100% is applied to those connected. The current water tariffs are given in the following table:

Table 1-20: Water Tariffs in Urban Areas in Northern Governorates

Erbil Governorate	Area of household	NID / month[9]
Households	1 to 200 m²	7.5
	201 to 300 m²	10
	301 to 400 m²	12.5
	401 to 500 m²	15
	Above 500 m²	17.5
Restaurants and Buildings		50
Dohuk Governorate		
Household in Semi-Urban Areas		10 to 15
Household in Urban Areas		25
Commerce/Institutions		50 to 700
Sulaymaniyah Governorate		
Household Tariff is Function of Area & Number of Taps	30 fils/m² adjusted by number of taps	5 to 12
Commerce and Institutions		15 to 300

[9] 1 ID = 0.009 NID

1.6.2.2 DWS Financial Management

Accounting

Accounts are kept in each Governorate according to the cash accounting used by Governments, but without differentiation between operating and investment expenditures. However, it should be noted that beyond the projects implemented through the Oil for Food program, there were practically no capital expenditures for the last few years. The directorates do not keep records of the costs of materials and equipment received through the Oil for Food Program. The Government, without proper recording in the Directorate accounts, sometimes pays electricity and fuel bills. In Erbil Water Directorate, the bills for electricity, supplied by the rival Government in Sulaymaniyah, are not paid. There is no depreciation on revalued assets. This undervalues the real operating costs. Directors at the Governorate level do not have a proper accounting to know how far their revenues are covering their operating expenditures.

The sector directorates have no financial autonomy at all. Contrary to the water supply directorates in the Center-South Governorates, the water supply directorates in the Northern Governorates have no control on their revenues. The Government Treasury collects the revenue. In exchange, the directorates receive routine monthly allowances from the Ministry of Finances, free equipment from Oil for Food program, and sometimes, emergency funds for urgent works. The Directorates for water supply and sewerage see no relation between the amounts they collect from water bills and the monthly allowances from the Ministry. Accordingly, there is little motivation to bill and collect properly. At the end of the year, a supplemental allowance is sent by the Ministry of Finances to cover all the expenditures not covered by the monthly allowances. For instance, In the Sulaymaniyah Governorate, the water revenues for 1999 were only about 64% of the total operating expenditures of about 13.4 million Northern ID .

1.6.2.3 Financing Rural Water Supply and Sanitation

The Directorates do not charge for their services to the local communities. The consumers in the local communities share the costs of routine operating costs and staff placed under the control of the village head.

The Oil for Food Program provided first materials and later full project construction assistance for new projects through UNICEF, WHO, HABITAT. Local NGOs, such as KRO, KRA are also involved in rural water supply and sanitation. Yearly expenditures for new projects are not recorded at the level of the directorates.

1.6.2.4 Municipal Directorates' Financing

The municipal directorates have very small revenues of their own. They consist of fees from renting shops, fees from collecting solid waste from commerce and industry. These revenues are collected directly by the Government Treasury and the Directorates have no control on the application of their resources. For running expenditures, the directorates get monthly allowances from the Ministry of Municipalities and Tourism. Operating expenditures for solid waste management, including street cleaning constitute the major part of the total expenditures in the Governorate capital city, and a lesser part in the directorate for semi-urban areas (see following table). This is because garbage generation is less in semi-urban areas than in the main cities.

Table 1-21: Weight for the Solid Waste Activity in Municipal Directorates

DOHUK Governorate	Monthly Budget Allowance for All Operation. Northern ID	Monthly Budget Allowance Used for Solid Waste. Northern ID	Solid Waste Expenditures as % of Total Expenditures
Directorate of Municipality	650 000	600 000	92%
Directorate of Municipalities	603 000	250 000	41%

For capital expenditures more than a certain threshold (NID 30 000 for Erbil Governorate), a special allowance is obtained from the Ministry of Finance. Yearly expenditures for new projects are not recorded at the level of the directorates.

1.6.3 Manpower

Staff used by local communities to operate the rural water systems, are slightly trained but they do not really belong to the sector and do not take their orders from sector professionals. This leads to poor maintenance of the facilities. Considering the numerous activities of the directorates and the fact that they are not involved in the operation of rural water systems, the percentage of their staff involved in the sector is relatively small. In the Sulaymaniyah Governorate, sector staff represent 150 out of 1 620, i.e. only about 9%.

The average age of the staff in the Directorates of Water and Sewerage is high (48 years on average). This is due to the high average age of the workers (50 years in the Dohuk and Sulaymaniyah Directorates). Training of staff in the three main Governorates is completely inadequate since it averages only 3.8 staff-weeks for 100 staff, as shown in the following table.

Table 1-22: Directorates of Water & Sewerage. Staffing and Training

Category of Staff	Managers	Technicians	Workers	Total	Staff-weeks of Training	Average staff-week 100 staff
DWS Erbil						
Number of Staff	27	180	551	758	43	5,7
Average Age	Not available					
DWS Dohuk						
Number of Staff	34	168	657	859	79	9,2
Average Age	40	35	50	46,7		
DWS Sulaymaniyah						
Number of Staff	35	160	1542	1737	5	0,3
Average Age	46	37	50	48,7		
Total Staff	96	508	2750	3354	127	3,8
Weighted Average Age for Dohuk and Sulamaniyah	43	36	50	47,7		

The staff in charge of solid waste management cannot be separated from street cleaning since, in the local context, the two activities are intimately connected. Although solid waste collection and disposal in uncontrolled landfill involve only a small percentage of the permanent staff of the directorates, these activities require generally the hiring of a considerable number of temporary staff. Including temporary staff, the solid waste management activity becomes generally a major percentage of the total staff of the directorate. For instance in the case of Erbil Directorate of Municipalities, permanent solid waste staff number is 78, i.e. 10% of the total permanent staff of 783, while temporary solid waste staff total 500. However, this pattern is not the case in the Sulaymaniyah Directorate where 99% of the solid waste staff is permanent. The solid waste staff does not effectively have training (2 weeks of training for the Dohuk Directorate for Municipality).

1.6.4 Institutional and Financial Management Issues

Total Financial Dependence of Water and Sewerage Directorates in Northern Governorates

Preventing the Water and Sewerage Directorates from using the water revenues they collect to cover their expenditures does not encourage them to sell more water and to improve collection of the bills. It does not incite them to control their costs. It does not lead to gains of productivity.

Assessment of Water Supply Sub-Sector

SAFEGE
Consulting Engineers

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2. Assessment of Water Supply Subsector

2.1 Water Sources and Production Facilities

2.1.1 Introduction

The Euphrates and Tigris Rivers have their sources in the mountains of eastern Turkey then converge in Iraq as the Shatt-al Arab, which empties into the Persian Gulf. On its way to Iraq from Turkey the Euphrates passes through Syria, while the Tigris flows there directly from Turkey.

The two rivers receive most of their water from rain and snowfall from outside Iraq and are almost fully constituted near their sources before widening then narrowing on approaching the sea. Both rivers are characterised by extremely high seasonal and multi-annual variations in flow and high seasonal variations in the volume of water carried. Peak flow is in spring and early summer, while low flow conditions occur between July and October with a range of variation of 1 to 8.

Annual renewable water resources in Iraq fluctuate between 90 to 100 billion m^3/year (96 billion m^3/year in 1997). Total withdrawal volumes are between 45 and 50 billion m^3 (42 billion m^3/year in 1990) broken down as follows:

- Domestic use 5 %
- Industrial use 8 %
- Agricultural use 87 %

Withdrawal volumes represent about 50% of the total volume of renewable water resources. The cumulative water stress for the river basins of a given country is measured by the ADB water indicator. Water stress conditions are considered to be reached when withdrawals of fresh water exceed 10% of renewable resources. Medium to high stress translates as water use that exceeds 20% of the available water sources and high water stress as withdrawals amounting to more than 40% of renewable resources. At the withdrawal levels found in Iraq, current patterns of use may not be sustainable and water scarcity is likely to become the limiting factor to economic growth[1].

[1] Water in the 21st century. © 2000 Asian Development Bank

2.1.2 Main Sources of Water

Most of Iraq's population is located nearby sources of a permanent water courses including the Euphrates, Tigris and other rivers, natural and artificial lakes and open irrigation channels supplied from existing dams.

Figure 2-1: Main Water Supply Sources

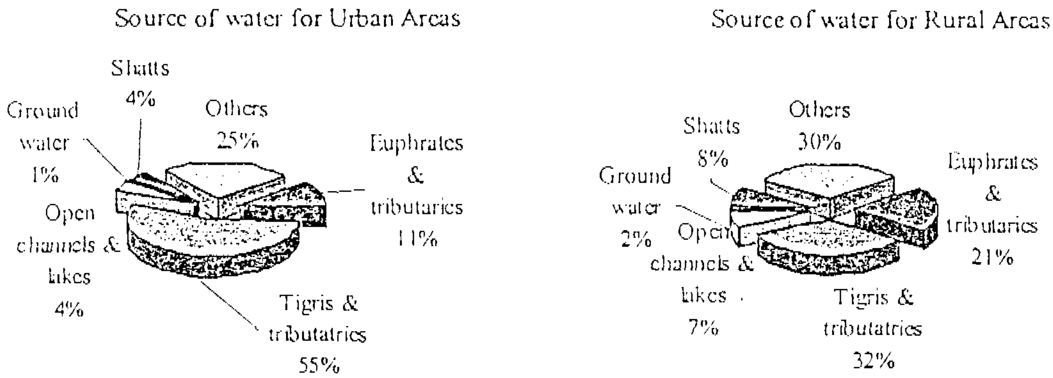


Table 2-1: Supply Sources in Year 2000

Watershed	Nb of Projects	Urban Production (m^3/d)	Rural Production (m^3/d)	Total (m^3/d)
Euphrates & tributaries	290	799445	210485	1 009 930
Tigris & tributatries	350	3947252	341700	4 288 952
Open channels & lakes	195	266345	68320	334 665
Ground water	88	64405	15500	79 905
Shatts	92	268200	85730	353 930
Others	503	1751885	304465	2 056 350
Total	**1 518**	7 097 532	1 026 200	**8 123 732**

The above table does not include sources used for ARNI rural water supply systems. These consist of springs and wells which need no specific form of treatment except disinfection with chlorine.

The following sections focus on Iraq's two main rivers: the Euphrates and the Tigris.

2.1.2.1 The Euphrates River

The Euphrates River begins in Turkey and flows through Syria before joining the Tigris in Iraq to form the Shatt al Arab. Together with the Tigris, it provided much of the water crucial to the development of the early Mesopotamian civilizations.

The Euphrates is about 2 700 km (about 1 700 miles) long and drains an area of about 444 000 sq km (roughly 171 430 sq mi). Although less than 30 percent of the river's drainage basin is in Turkey, roughly 94 percent of the river's water comes from the Turkish uplands. Annual flow averages 28 billion m^3 and peaks in the months of April and May. Major cities on the Euphrates include Kerbala, Al Hillah, and Najaf.

The river is the source of acute political tensions, as Turkey, Syria, and Iraq all compete for its waters for their irrigation and hydropower needs. Turkey has plans to divert large amounts of Euphrates water as part of a long-term scheme for the development of rural Anatolia. The scheme, known as the Southeast Anatolia Project, involves the construction of 22 dams and 19 power plants by 2005 to capitalize on the steep descent of the Euphrates from the Anatolian mountains. The centre-piece of the SAP is Atatürk Dam completed in 1990 and one of the largest dams in the world.

Subjected to an extremely arid climate, agriculture in Iraq is highly dependent on water from the river system. Fluctuations in flow, whether from month to month or year to year, make Iraqi agriculture particularly vulnerable to drought and supply shortages. A dam completed in 1986 at adithah in central western Iraq was to provide a water reserve for the country but has proved to be of only limited use. Since the 1950s a flood-control project on the Tigris has allowed water from the river basin to be diverted through the Tharthar depression in central Iraq and into the Euphrates but this too has had a limited impact. Iraq must also deal with high salt content in the Euphrates as a result of leaching and chemical discharges from upstream areas. The Euphrates River has two main tributaries, the Karasu and Murat rivers, formed primarily by rainfall from Eastern Turkey (89% of annual flow), with an 11 % rainfall input from Syria and negligible input from Iraq.

Table 2-2: Water Potential of the Euphrates Basin (as Bm^3)

Countries	Water Potential	Consumption Target
Turkey	31.58 (89 %)	18.42 (51%)
Syria	4.00 (11 %)	11.30 (32%)
Iraq	0.00 (0 %)	23.00 (65%)
Total	35.58 (100%)	52.72%

The above table attests to potential source of conflict related to international water resource management policies.

2.1.2.2 The Tigris River[1]

The Tigris is 1 900 km long and drains an area of more than 110 000 km². The river starts in the eastern Anatolian highlands of Turkey and flows southeast to Iraq after briefly running along the extreme eastern part of the Syria-Turkey border. Once in Iraq, the river valley flattens and widens and the river zigzags slowly to the southeast, finally merging with the Euphrates in southern Iraq to form the Shatt al Arab.

Major tributaries of the Tigris are Botan, Batmansu, Karpansu and the Greater Zab rivers emerging from Turkey, the lesser Zab and Diala emerging from Iran, and finally Uzayam whose source is in Iraq's northern mountains. Major Iraqi cities on the river include Mosul and Baghdad. The Tigris is too shallow for navigation by all but very small boats, particularly south of Baghdâd where the river fans out and meanders through dense marshland.

More than half of the river's annual flow occurs between March and May, often causing significant flooding as the river swells with melting winter snows from the uplands or late winter and early spring rains. The construction of the Sâmarrâ' Dam in the 1950s allowed for diversion of Tigris waters to the Tharthar depression in central Iraq to assist in flood control. In the past the Tigris carried significant quantities of silt into the Shatt al Arab, contributing to the

[1] The general information was taken from MS Encarta 99.

extension of the delta into the Persian Gulf. Flood control projects, as well as the construction of dams on the major tributaries of the Tigris for irrigation purposes, have decreased silt deposits and the flow of freshwater to southern Iraq. This, combined with greater levels of pollution, has increased the salinity of the lower Tigris and robbed the soil of nutrients, harming local agriculture.

Virtually 48 % of the Tigris waters come from Iraq, including a significant amount from its tributaries below Baghdad.

As a result, Iraq's supply of water from the Tigris is much less vulnerable to events upstream than is the case with the Euphrates. Like the Euphrates, the volume of water in the Tigris also varies significantly from year to year and from season to season.

Table 2-3: Water Potential of the Tigris Basin (as Bm^3)

Countries	Water Potential	Consumption Target
Turkey	25.24 (52 %)	6.87 (14 %)
Syria	0.00 (0 %)	2.6 (5 %)
Iraq	23.43 (48 %)	45.0 (93 %)
Total	48.67 (100 %)	54.47(100%)

2.1.3 Raw Water Quality

2.1.3.1 Growing Salinity

As it flows from Turkey towards the Gulf, the quality of the water of the Tigris changes significantly. The TDS of the river water varies between 280 mg/l where the river crosses the border with Turkey at Zakho and 1 500 mg/l at Amara.

In the Euphrates, TDS variations are even greater, ranging between 600 mg/l in Al-Qaim at the border with Syria to 3 000 mg/l at Nassiriyah.

The water of the Shatt Al-Arab is saline (3 500 mg/l TDS) and cannot be used to produce potable water, either as such or with only conventional treatment.

Chemically, the water in the northern and central regions of Iraq, is conform with WHO guidelines. *In the southern part of the country*, however, concentrations far exceed guideline levels. Desalinisation by RO, though at first sight costly, is the most practical solution. MSF distillation is another alternative which, in cost terms, merits comparison with the RO solution.

Another solution to address the problem of salinity consists in transferring water from Tigris catchments to the river basins of the Euphrates. This option has been adopted in several southern schemes - including Nassiriyah - with pumping of raw water from the Tigris to drinking water treatment plants in the Euphrates Valley in the vicinity of the urban areas served.

2.1.3.2 Organic Pollution

This question needs to be addressed, since no recent urban waste facilities exist, despite population growth and greater volumes of sewage. Several major cities like Mosul either discharge their sewage untreated to the river or operate overloaded facilities which release poor-quality effluents resulting in the localized build up of organic loads.

During Safege's site visits, the local operator reported two situations which clearly point to contamination:

- In Faris 50 heads of cattle were lost further to contamination due to deficient operation of the local urban treatment facility.
- In Baghdad, treated effluent discharges from the Rustamiyah plant are so great in comparison with the flow of the receiving river that the neighbouring community filed complaints, forcing the Municipality to investigate the feasibility of intercepting discharge from the plant, pumping it to the desert and leaving it in a man-made lake.

Contamination is an issue affecting both the Euphrates and the Tigris and surveys should be carried out to measure organic pollution along their respective courses, locate sensitive spots and monitor the river over long periods to determine seasonal variations. Urban population growth and large dam projects in the upper stretches of the two rivers undoubtedly have a major influence upon the levels and seasonal variations of organic pollution – another particularity of the two rivers, which may impact on the long-term planning of the conservation and use of water in Iraq.

2.2 Production Facilities

2.2.1 Introduction

The water production facilities consist of wells and compact or conventional treatment plants. The associated production capacities (U/R PC-2000), as summarized in the table below, represent the actual design capacities of the existing facilities, assuming an annual average of 20 working hours per day.

Table 2-4: Design Production Capacity of Existing Facilities

Production Technology	Nb. of Projects	Urban Production (m^3/d)	Rural Production (m^3/d)	Total Production (m^3/d)	Production per Unit ($m^3/d/unit$)
Water Treatment Plants	226	6 524 999	621 067	7 146 066	31 620
Compact Units	1 205	508 123	389 633	897 761	745
Wells	88	64 405	15 500	79 905	908
Total	1 519	7 097 532	1 026 200	8 123 732	5 348

Conventional treatment plants provide 92% of the water allocated to urban areas and 61% of rural supply.

2.2.2 Conventional Plants

2.2.2.1 Introduction

More than 226 water treatment plants were inventoried in the country as a whole, representing an installed production capacity of 7 million m^3/day:

- Mayoralty of Baghdad : 6 plants (30 % of the installed capacity)
- Centre South : 211 plants (60% of the installed capacity)
- Northern Iraq : 9 plants (10% of the installed capacity)

The technical performance of the various components of these facilities was assessed by the UNICEF WES team with the aim of determining efficiency. The survey put the average efficiency of the treatment facilities at 67%.

2.2.2.2 Design Considerations

The design of water treatment plants processing surface water is virtually standard and composed of the following units:

- Raw water pumping: for small/medium capacity, horizontal centrifugal pumps draw the river water directly through pipes protected by submerged plain strainers. In some cases, the pump units are at a considerable distance from the river. Larger plants feature an intake structure protected by a single stage of manual screen (automatic screens are the exception) and discharging into a wet well housing vertical pumps.
- Flash mixing.
- Circular scraped clarifiers with a flocculation zone in the Centre. These are designed for a rising velocity of 1 to 1.5 m/h. The sludge is blown continuously (sequenced blow down is exceptional) back to the river.
- Rapid gravity sand filters washed by scour air and water. These operate at a rising velocity of 5 m/h. The wash water is not recycled.
- Dosing plant: alum is the only chemical used for flocculation. In most modern plants polymer is used in case of emergency.
- Chlorine is injected into the raw water at the flash mixing unit and into the filtered water at the inlet of the treated water reservoir.
- Treated water reservoir. This is usually large with a storage capacity of 12 to 24 hours; several sections are provided for maintenance purpose.
- High-lift pumping unit. This is normally composed of horizontal, split case, centrifugal pumps. Generally they are installed with flooded suction to prevent priming problems (very few exceptions to this rule).

2.2.2.3 Efficiency Survey Criteria

UNICEF and Care International undertook a comprehensive survey of the efficiency of the existing treatment facilities, firstly in the Centre South region and secondly in the Mayoralty of Baghdad. The efficiency of the treatment facilities is based on the evaluation of the appropriateness of the following components and their status with regard to maintenance:

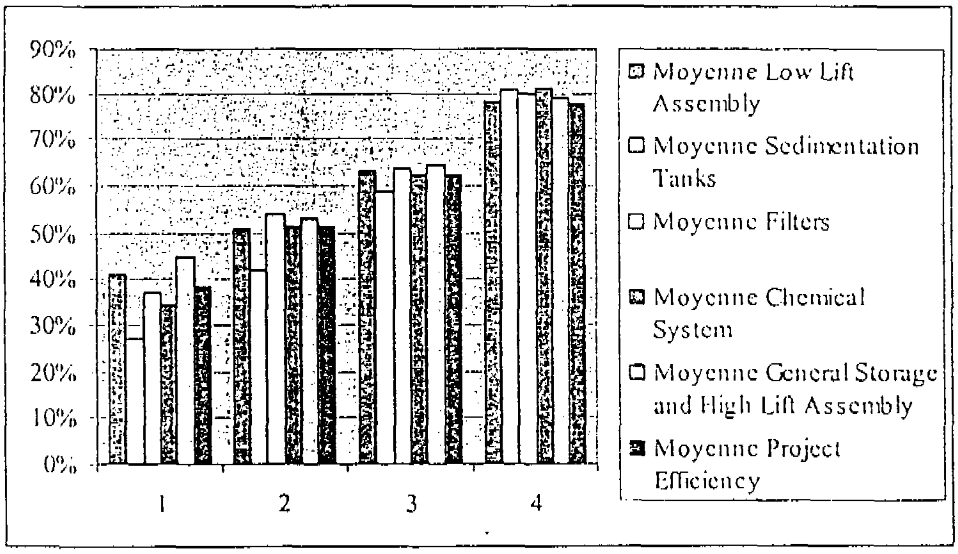
- Low-lift assembly: appropriateness of the intake structure, pumps and control panels, extent to which regular maintenance is performed and general cleanliness of the installation.
- Sedimentation tanks, appropriateness of sludge handling, flash-mixing, flocculators and clarifying facilities.

- Filters.
- Chemical systems (Alum and Chlorine preparation, dosing and injection facilities). The regular maintenance and cleanliness of this sensitive equipment represent 25% of the evaluation criteria.
- General Storage and High-lift assembly, including metering instrumentation and control panels.

The Project Efficiency Indicator (PE) was designed to evaluate the effective production capacity (EPC, labelled "Effectivprod" in the database outputs) by factoring the design capacity of each installation by the efficiency, the latter being estimated by weighting the efficiency of the various components of the facility. On the basis of the criteria used in the WES efficiency survey, maximum efficiency is evaluated at 90%.

The "power-factored efficiency" (PFE) is then calculated by incorporating the effect of power supply shortages and the availability of emergency generators. The actual production capacity (APC) is then calculated as the product of the PFE and the design capacity, and represents the actual supply to the distribution facilities.

Figure 2-2: Efficiency Structure of Existing Conventional Water Treatment Plants



The above graph illustrates the efficiency profile of categories of existing production facilities with respect to their current efficiency level (grouping by quartiles as in Table 2-5 below; the production facilities are listed by order of estimated project efficiencies). It can be seen that of the lower-efficiency groups of projects, sedimentation tanks are particularly deficient. This can be attributed to the poor results obtained in the disinfection process, despite the high concentrations of residual chlorine observed.

Table 2-5: Effective Production Capacity of Existing Water Treatment Plants per Efficiency Group

Quartiles of Efficiency	Actual Production Capacity in m³/d	Cumulated % of Actual Production
First Quartile	248 059	5%
Second Quartile	408 376	9%
Third Quartile	1 097 177	23%
Fourth Quartile	3 039 393	63%
Total	4 793 006	100%

In many of the DWTPs visited, raw water pumping facilities are affected by inefficient removal of solids from the intake facilities. This situation may impact on maintenance and replacement costs for low-lift pumping units and the effectiveness of the sedimentation and filtration stages of the treatment process. In most cases additional screening, grids and sand trap facilities are recommended.

2.2.2.4 Assessment of Civil Works

The concrete structures built before the war with Iran are generally of good quality. During the war and since the embargo, the situation has been very different due to the shortage of cement (and more specifically the sulphate-resistant variety), the difficulties involved in importing suitable equipment and the lack of skilled labor. Since that time, the quality of the civil works has been poor.

Rehabilitating these post-war projects will involve extensive repair work and certain structures must be partially or totally rebuilt.

Of the 18 sites visited, two plants should be completely shut down:

- RASHEEDIYAH: This is so old and so unsuited to the present situation that its replacement by a modern unit will be more cost effective than altering the existing plant and building an extension.
- KERBALA: The site is subject to considerable differential settling which impacts operation and constitutes a safety hazard. Repair work is unlikely to solve the problem as there is no guarantee of ensuring proper leveling of the structures and long-term stability. The most judicious solution is to build a new plant and demolish the old one once the new plant is fully commissioned.

UNICEF and Care International undertook an extensive survey in Centre South Iraq to assess the efficiency of the existing facilities. Unfortunately, the civil works were not covered by the survey, though an evaluation was made of the condition of the intake pipes and treated water storage facilities and data furnished on the performance of these facilities.

2.2.2.5 Plant Serviceability

The efficiency of treatment may be affected by a number of factors, including defective design, lack of spare parts and consumables, lack of management capacity and lack of skilled labor.

Defective Design

This aspect was not evaluated in the efficiency survey carried out by UNICEF and Care International in 1999-2000. A summary of the systematic design errors observed during Safege's site visits is given in the following.

- Screening

  Very few plants are equipped with screening facilities. Where it exists, screening is manual - even at very large plants like KARKH - which renders the operation difficult and in some cases hazardous.

  In the one case observed where an automatic screen was installed, this was out of order because there was no protection against bulky floating debris. The expected beneficial effect was transformed into a defect, impacting on the operation of the downstream units.

- Grit Chambers and Sand Traps

No such treatment stage exists although both the Tigris and the Euphrates carry significant volumes of sediment.

The direct consequence was observed at most of the sites visited:

- Rapid onset of abrasion of R.W. pumps: need to replace impellers and casings,
- Settling in main connection piping,
- Choking of flash mixers resulting in extremely poor chemical dispersion altering the flocculation,
- Choking of flocculators, which together with the choking of flash mixers severely impacts on treatment,
- Obstructed sludge extraction in clarifiers: this is due to excessive levels of sand in the settled sludge, exacerbated by continuous sludge blow down; this impacts on clarifier operation with progressive carry over of floc to the outlet as the sludge blanket rises,
- Excessive loads transported to filters due to poor flocculation and the accumulation of sludge in clarifiers, which affect, separately or in combination, the filter runs then over all the net production of filtered water.

- Clarifiers

  Sludge blow down is in most cases continuous. This increases the risk of choked pipes (see above) and augments water consumption. Both drawbacks could be eliminated through automatic sequenced blow down.

- Layout

  On several sites the chemical dosing plants are located too far from the injection point resulting in choking of pipes and rendering the dosing facility unusable.

  The operators have to dump the chemicals manually directly into the flash mixers This results in Reagents are fed into the flash mixers manually, resulting in an additional disruption to operation and in the inefficient control of dosing, as well as poor flocculation and poor efficiency of treatment in general.

- Quality of Equipment

  At the sites visited, it was noted that the low-grade equipment has a short lifetime and cannot be serviced locally. On the contrary the high-quality more sturdy equipment continues to function after many years. At the MOSUL right bank unified plant for example, the dosing pumps have been in continuous operation for the past 20 years, a fact which is remarkable given that dosing equipment is one of the most fragile components of any treatment plant.

Lack of Spare Parts

This is a general feature in Iraq, valid for all sites. The effect is a steady decline in production capacity at all plants, including the most modern and best-operated facilities like KARKH, whose capacity is gradually decreasing owing to the unavailability of roller bearings for the T.W. pumps.

Spare parts represent 2% of the equipment distributed to Governorate WATSAN operators under the OFF Programmes.

On the basis of the results of the site investigation, the equipment may be classified in three categories corresponding to their vulnerability in terms of the lack of spare parts:

- Equipment which is systematically out of order:
  - measuring instruments
  - chlorination equipment
  - dosing equipment
  - automation equipment such as filter monitoring.
- Equipment frequently out of order:
  - valve actuators
  - flash mixers and flocculators
  - scraper bridge drives.
- Equipment functioning satisfactorily:
  - low lift pumps
  - high lift pumps.

Lack of Management

Plant managers have limited technical knowledge and are not trained to program operation and maintenance tasks. The lack of planning may be a reason for the tardiness in ordering spare parts.

At half of the plants visited, cleanliness and maintenance were nevertheless relatively good, despite the lack of imported spare parts. In these instances, the plant managers tended to be dynamic and to succeed in obtaining from senior management the means necessary to monitor their service as effectively as possible. It was clear that the personality and personal commitment of the plant manager made a significant difference.

Lack of Skilled Labour

Except for a few big projects, the vast majority of projects lack sufficient numbers of staff to maintain continuous operation and sufficiently qualified staff to perform repairs on sensitive equipment. Skilled workers are scarce in Iraq and prefer to work in private companies where wages are far higher than those offered by the public sector.

This situation can not be expected to improve, since Iraq can not resort to foreign labor under the present circumstances.

2.2.3 Compact Units

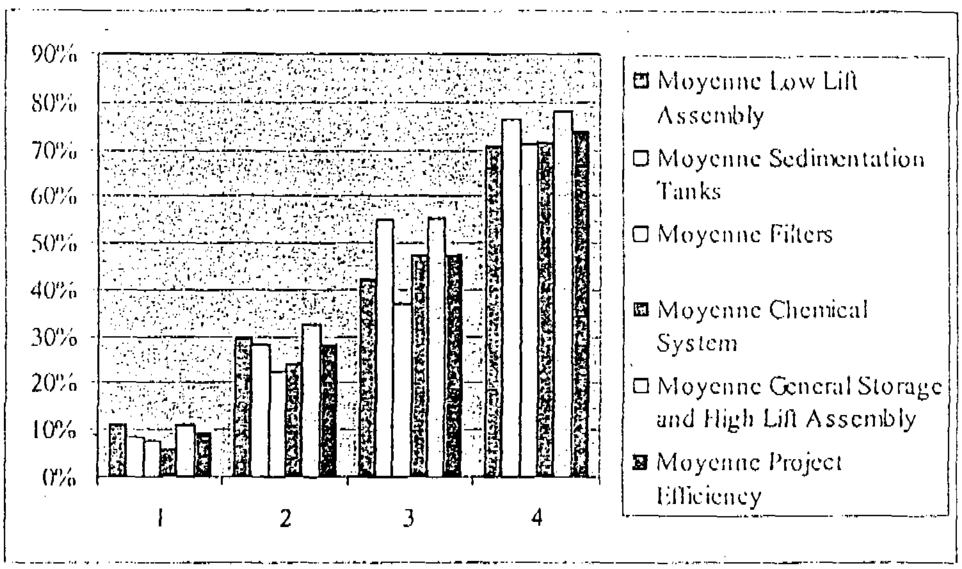
2.2.3.1 Efficiency Survey Criteria

UNICEF and Care International undertook a comprehensive survey of the efficiency of the existing treatment facilities. The efficiency of the treatment facilities is based on the evaluation of the appropriateness of the following components and their status in terms of maintenance:

- Low-lift assemblies: appropriateness of the intake structure, pumps and control panels, extent to which regular maintenance is performed, and the general cleanliness of the installations.
- Sedimentation tanks: appropriateness of sludge handling, flash-mixing, flocculators and clarifying facilities.
- Filters.
- Chemical systems (Alum and Chlorine preparation, dosing and injection facilities). The regular maintenance and cleanliness of this sensitive equipment represents 25% of the evaluation criteria.
- General storage and high-lift assemblies, including metering instrumentation and control panels.

The resulting Project Efficiency Indicator was designed to evaluate the effective production capacity, corresponding to an average of 20 working hours per day, by factoring the design capacity of each installation by the project efficiency.

Figure 2-3: Efficiency Structure of Existing Water Treatment Plants per Efficiency Groups



Filtration and chemical addition are the weakest components and impact heavily on the effectiveness of the disinfection processes.

Table 2-6: Effective Production Capacity of Existing Water Treatment Plant per Efficiency Groups

Quartiles of Efficiency	Effective Production Capacity in m3/d	Percentage of Effective Production Capacity
First Quartile	5 878	1%
Second Quartile	56 201	7%
Third Quartile	149 765	18%
Fourth Quartile	611 042	74%
Total	822 886	100%

50% of the existing compact units operate at less than 37% efficiency and produce 18% of the total amount of water supplied by compact units.

2.2.3.2 Operation

There are about 1 200 compact units operating in Iraq, representing a total effective production capacity of 823 000 m³/d.

High-efficiency compact units can be found in conventional plant projects where the units are used as an additional treatment facility. Efficiency is high in these cases due to the simple fact that the units are managed by the operators of the main sites and as such are properly monitored and serviced.

Wherever the compact units are operated by communities of users, efficiency is very poor, i.e. 34% as opposed to 61% for the units operated by DWS.

2.2.3.3 Equipment

Compact units are popular in Iraq, however, because they provide an administrative solution to water supply problems at the local level. For this reason many more units will be imported to replace those worn out by time and mis-operation and to equip those villages which are not yet connected to a water supply system.

A promising start has been made through the U.N. M.O.U., whereby a number of new compact units have already been purchased, delivered and commissioned.

The quality of these compact units is questionable however, since they have been selected purely on the basis of price without any consideration given to design, workmanship and serviceability.

These low-cost compact units will ultimately be very costly to run given that the design, construction and grade of equipment selected are unsuited to long service in the highly adverse conditions (in terms of manpower, climate, etc.) prevailing in Iraq at present. The units will almost certainly have to be replaced rapidly - hopefully by units of better quality.

The true efficiency of these low cost, low grade compact units must be considered in the light of the initial expenditure involved and the additional outlay required to repair and replace the units.

2.2.4 Tube wells

Groundwater provides 1% of the potable water supplied by the public utilities in 6 Governorates of the Centre South region.

Table 2-7: Water Projects Supplied from Groundwater Facilities in Year 2000

Governorate Location	Nb. of Projects	Design Capacity (m^3/day)
Anbar	3	5 600
Muthanna	2	650
Najaf	1	540
Ninevah	12	29 945
Salaheldin	4	25 600
Ta'meem	66	17 570
Total	88	79 905

Other well and spring projects have been developed in depressed rural areas of ARNI. These projects were reflected in the table 2-7 as long the data were not provided in a format that would make it easy to incorporate in the sector database.

The efficiency of these utilities has been estimated at 59% for an approximate production of only 47 000 m^3/d. The requirements in terms of rehabilitation works would involve the replacement of pumping and chlorination facilities.

2.2.5 Treated Water Quality

The adequacy of treatment depends on the ability to reduce turbidity to less than 5 NTU. This limit dictates the efficiency of the disinfecting process.

The field visits indicated that the treatment unit operators have difficulty in respecting this guideline for the following reasons:

- Raw water turbidity varies considerably.
- Quality of alum is inadequate.
- Sand filters are inefficient.
- Means of monitoring turbidity are insufficient (see water quality control).
- Lack of staff to monitor and properly operate the treatment plants.

Regarding chlorination, most production units are equipped with chlorinators and residual chlorine is monitored in most DWTPs. Smaller projects however (compact units and wells) lack the staff and means to measure chlorine levels (see water quality control). At the same time, the operators maintain high chlorine residual concentrations (frequently above 2 mg/l) given the poor condition of the distribution systems. Furthermore, unreliable supply of chlorine and poor maintenance of chlorinators affects the efficiency of the disinfecting process

2.2.6 Actual Production Capacity (PC)

Most of the production facilities experience severe power shortages. The Effective Production Capacity can not be met in many cases and in areas affected by water shortages, emergency generators are used to increase the daily working time of production units.

The actual production capacity (UPC and RPC in urban and rural areas respectively) [3], is estimated as the product of the urban/rural shares of the design capacity (assuming an average of 20 hours per day) and the Power Factored Efficiency (PFE), which associates the design capacity and the average working time, and allows for the possible use of emergency generators.

In central Iraq, where UNICEF conducted an efficiency survey during the period 1999-2000, the production capacity was estimated at 63% of DWTP installed production capacity with 7% of the supply attributable to generators. In the Centre South region, the situation is more critical with production capacity at 55% of DWTP installed capacity, while 13% of DWTP supply relies on generators.

Table 2-8: Efficiency of the Production Units

Categories of Infrastructure	Installed Capacity m³/d	Actual Production Capacity m³/d	Projects efficiency	Power Factored Efficiency	Share of Production Relying on Generators
Urban Areas	7 097 532	4 567 269	68%	64%	7
DWTP	6 524 999	4 238 117	68%	65%	6%
Compact units	508 128	310 447	65%	61%	5%
Wells	64 405	18 705	60%	29%	47%
Rural Areas	1 026 200	337 013	50%	33%	15%
DWTP	621 067	271 216	56%	44%	18%
Compact Units	389 633	63 443	41%	16%	2%
Wells	15 500	2 354	53%	15%	38%
Total	8 123 732	4 904 282	66%	60%	7%

In rural areas, the generators provide 18% of the production, as in Diala Governorate where 80% of water supply relies on emergency generators, which are consequently an essential component of the water supply facilities.

The compact units rely on generators for 5% of their output. It should be noted that, owing to power cuts, only 38% of the effective production capacity relying on compact units in rural areas can be mobilized while only 2% rely on emergency generators.

A brief diagnosis of power supply systems is presented below, with reference to site visits made in November 2000.

2.3 Power Supply Facilities

2.3.1 Availability of Power from the Electrical Power Grids

In most regions, booster stations and water treatment plants operate more than 16 hours a day. In the main cities such as Baghdad and Basrah, power is available 24h/24h. In other Governorates such as Diala, power cuts of more than 10 hours a day may be experienced.

[3] In the database, UDWTPPC, UWTCUPC, and UwellPC, referring to UPC from Drinking water treatment plants, water treatment compact units and from wells respectively, and RDWTPPC, RWTCUPC, and RwellPC referring to rural shares.

The power supply to urban compact units is generally superior (more reliable) than that supplied to rural units. For other water facilities, the difference is negligible.

The reliability of the power supply is often jeopardized by the following problems:

- Electrical power grid
  - power plant regulation failures
  - aging cables
  - voltage drops (increasing loads on grid) and, by extension, over-currents causing motor protection trips
  - failure of power transformer tap changers.
- Generating sets
  - faulty or inoperative injectors and radiators
  - faulty or inoperative control, regulation and synchronization panels
  - corrosion
  - aging batteries and rectifiers/chargers
  - oil and fuel leakages
  - no standby generator can operate more than 12 hours a day
  - lack of maintenance and tests

2.3.2 High- and Low-voltage Equipment

The main problems are associated with faulty, inoperative accessories and aging switchgear. While certain low-voltage components can be replaced, the high-voltage components must be furnished by the original supplier.

The malfunctioning and inoperative equipment is listed below :

- High-voltage Equipment
  - batteries and rectifiers/chargers
  - voltage transformers
  - current transformers
  - protection relays
  - low-insulation or non-armored cables without ducts or cable trays
  - power transformers filters, tap changers, and oil leakage from casings.
- Low-voltage Equipment
  - batteries and rectifiers/chargers
  - molded case circuit breakers

- switch-fuses
- contactors, relays and timers
- low insulation or non-armored cables without ducts or cable trays
- current transformers
- indicators and warning lamps

• Pump Drivers

This covers existing pump starters and inventory problems on pump drivers, including motors and starting devices.

- Squirrel-cage Motors

  This is the most widely used motor in Iraq (and worldwide) in the last 20 years, owing to its high efficiency and long lifetime. It is the only type of motor installed outdoors (valve actuators, aerator motors). However, due to the harsh climate, the chemically-aggressive environment and lack of maintenance, many outdoor motors are out of order.

- Slip-ring Motors

  This motor is also used extensively because of its low starting current. The main drawback is that the rotoric starting device and motor carbon bushings required for this type of motor are not commonly (or poorly) manufactured in Iraq.

- Starting Devices for Squirrel-cage Motors

  The characteristics of starting devices are listed below:

  ➢ Direct-on-line starter: only motors of less than 18.5 kW start directly .

  ➢ Star-delta starter: this device reduces the starting current to 3[4] by nominal motor current, but the intermediate current peak can damage the motor. This device is widely used in Iraq. Certain pumps installed recently are equipped with new-generation star-delta starters featuring intermediate resistances that allow smoother starting.

  ➢ Autotransformer starter: this device reduces the starting current to 2 to 3 by nominal motor current. Only a few autotransformer starters are installed in Iraq.

  All three starting devices use standard parts. The spare parts lacking are of standard low-voltage type.

- Electronic starter: this device reduces the starting current to less than 3 by nominal motor current. Only a few electronic starters have been installed - by ICRC among others. In case of failure of the electronic card and without any on-line or by-pass contactor, the starter cannot function.

- Starting Devices for Slip-ring Motors

- These starters are of the rotoric-resistance type (metallic or electrolytic). Both the electronic starter and the slip-ring motor starter reduce starting current to less than 2 by nominal motor current.

[4] Instead of 6 to 7 by nominal current when direct starting

- Certain aging electrolytic mixers have been replaced by local ones, mainly reducing the lifetime of the rotoric starter.
- Miscellaneous
- In a few cases, following the replacement of a motor, the pump rated power is no longer suitable (or vice-versa)..

The assessments of low-lift and high-lift pumps, valves, air-blowers, compressors, wash pumps, mixers, dosing pumps, sludge recycling pumps, aerators, etc, were performed by the hydraulic experts and water treatment specialists.

- Control, Measurements and Data Transmission
  - Man-Machine Interfaces

    Many accessories - including lamps, push-buttons and multi-position switches, light emitting diodes, analog indicators, wiring, batteries/rectifiers/chargers, ammeters and voltmeters, sensor converters, etc. - are faulty or inoperative.
  - Data Transmission

    Several plants built during the 1980s were designed to function with remote motor control and hydraulic data (flow, level, pressure) acquisition systems incorporating wireless equipment such as programmable and logical controllers, radio devices, etc. None of this equipment is functioning at present owing to the lack spare parts and exodus of skilled manpower.

    Only a few plants are equipped with an internal phone network.
- Main Conclusion

  The question of missing spare parts and lack of maintenance are very often called up by the managing and operating staff.

  Nevertheless, the design of the electrical installations is sound and the electrical equipment (lifetime) installed during the seventies and eighties of good quality. The main short-term objective is thus the provision of spare parts.

2.3.3 Miscellaneous

2.3.3.1 Safety

Only a few machines and control boards are fitted with protective covers. Cables often trail on the ground or in water without any warning paint or protection. Steel plates between and around pump frameworks are often characterized by corrosion and poor fixtures.

Motors and boards are seldom connected to earth.

2.3.3.2 Ventilation and Lighting

Almost all vent fans and extraction fans are inoperative.

Many lamps and lighting fittings are missing or in a very poor state.

2.3.3.3 Workshops

Where they exist, the workshops are neglected. No multimeters or insulation controllers were seen during the visits.

2.3.3.4 Cleanliness

Almost all control boards, fittings and electrical and technical rooms are dirty (dust, oil, etc.).

To prevent overheating heating, control boards are left open and in some cases uncovered, posing an obvious hazard to operating staff and equipment (leaky pumps in the vicinity of rotoric resistances, etc.)

2.3.3.5 Documents

Practically no as-built single-line diagrams, electrical plans or technical and maintenance specifications are available, and no operating manuals were seen during the visits.

2.3.4 Manpower

Manpower is clearly inadequate in terms of both skills and numbers. Where there is a skilled electrician on the site, this is often the site manager.

With a few exceptions, motivation among operators is poor given that they are often aging, uneducated and underpaid.

2.4 Distribution Systems

2.4.1 System Configuration

The water supply distribution systems consist in pipe networks serving urbanized settlements in urban or in rural areas. Extensive data collection was undertaken by UNICEF in the year 2000 through local water authority agencies. The results of the survey cover the pipe networks of the distribution systems serving 82% of the Iraqi population served.

Table 2-9: Pipe Materials in Water Supply Networks (in Meters)

Governorate	Material						
	ASB	*DUC*	*IRO*	*OTH*[5]	*PVC*	*STE*	*Total*
Mayoralty of Baghdad	3 700 000	2 400 000	800 000		556 000	290 000	**7 746 000**
Anbar	36 350	297 340	24 900		227 800		**586 390**
Babil	204 850	120 600	130 500		432 074	32 900	**920 924**
Baghdad					555 800		**555 800**
Basrah	327 350	628 890			1 879 200	58 480	**2 893 920**
Diala	167 000	211 800	219 000		868 629	128 500	**1 594 929**
Missan	70 500	43 500	191 000		206 000	1 000	**512 000**
Muthanna	215 600	161 800	5 000		252 800	32 050	**667 250**
Najaf	313 000	280 000	39 000		683 000	3 000	**1 318 000**
Ninevah	119 900	5 130 252	1 113 510	38 260	1 253 210	319 797	**7 974 929**
Qadisiyah	202 635	92 200	17 840		634 850		**947 525**
Salaheldin	82 500	39 500	95 000		335 486		**552 486**
Centre South	1 739 685	7 005 882	1 835 750	38 260	7 328 849	575 727	**18 524 153**
Dohuk	48 829	141 918	27 587		38 703	153 433	410 470
Erbil	20 500	183 910	47 100	243 640	185 790	35 630	716 570
Sulaymaniyah	47 350	225 217	62 750	19 390	151 083	140 006	645 796
Total	5 556 364	9 956 927	2 773 187	301 290	8 260 425	1 194 796	28 042 989
Average Diameter (mm)	137	258	120	148	130	401	188

Steel and ductile iron pipes are used for transmission lines and mains, while distribution systems pipes are in asbestos-cement, ductile cast iron, cast iron, steel or PVC, with diameters ranging between 50 and 1 600 mm.

The Average Diameter is defined as follows:

$$\text{Dia (mm)} = \sum L_i \text{ (m)} * D_i \text{ (mm)} / \sum L_i \text{ (m)}$$

More than 12.5% of these pipes are more than 35-years old and 40% are less than 20-years old.

Amongst the pipes of 50 mm in diameter and above, 85% of cast iron pipes are more than 35 years old and 95% of ASB pipes are more than 20 years old.

[5] Other materials refer to unknown pipe material

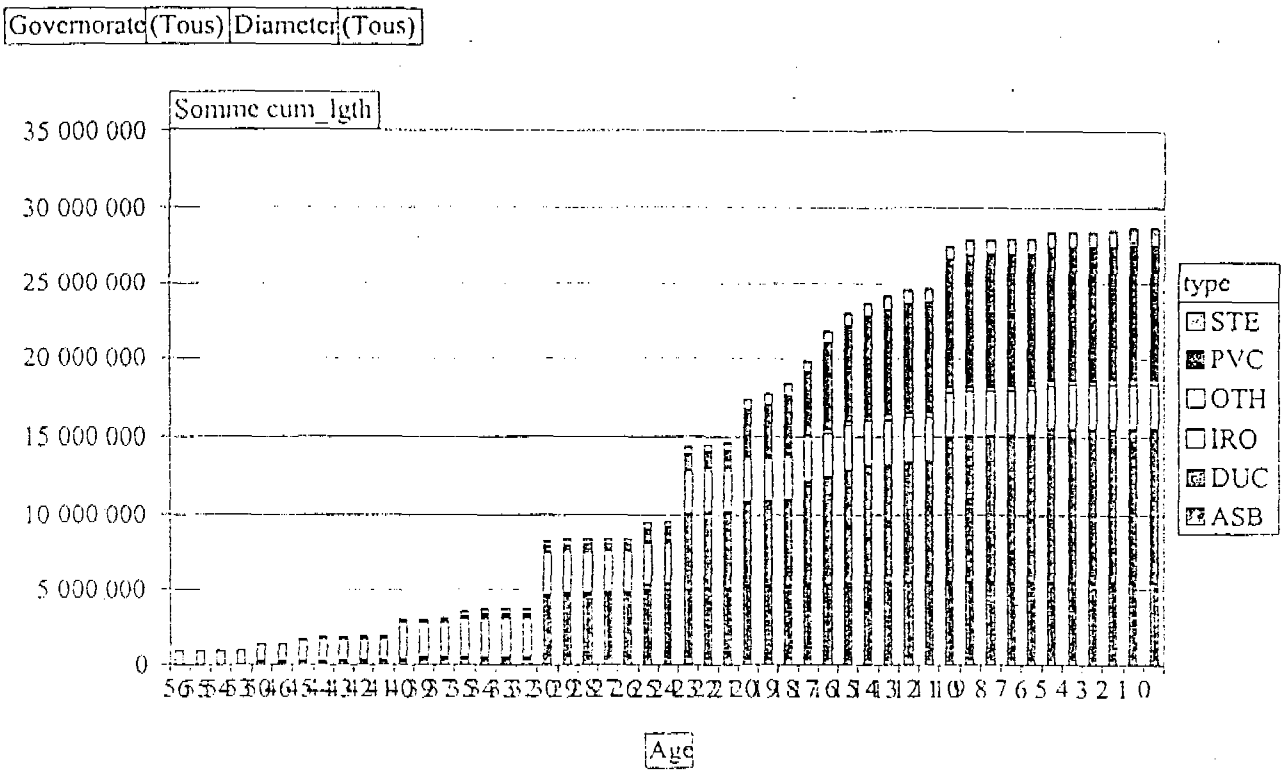


Figure 2-4: Total Lengths of Different Types of Piping by Age of Installation (in Years)

The distribution networks are pressurized by high-lift pumping facilities located at the out[illegible] the production units and equipped with booster stations. High-lift pumping facilities i[illegible] Centre South region were evaluated by WES technical specialists from UNICEF and [illegible] International; the efficiency of these facilities is evaluated by the Project Efficiency Indica[illegible], while the current status of the boosting stations (BS) was determined from questionnaire responses.

2.4.2 Water Quality

The lack of resources and staff has over the past decade severely undermined maintenance of the distribution networks. The networks are reported to be leaking and cannot cope with growing demand. The elevated tanks are bypassed and water is boosted directly into the distribution system.

This situation results in low pressures and illegal connections which increase the risk of contamination from sewage, particularly where the water table is high (as in Baghdad and the southern governorates). The risk of contamination is also increased by power cuts.

To limit the risk of contamination residual chlorine levels are set very high - in most governorates at 0.5mg/l – though this level may still be insufficient if turbidity is above 5 NTU.

All these problems are accentuated in rural areas where the community is responsible for operation and maintenance.

2.5 Water Quality Management

Of the 18 sites visited, 8 are equipped with a laboratory. These laboratories perform only basic analyses such as pH, alkalinity and hardness which do not require sophisticated equipment.

Some are equipped to perform jar-tests which are of little use in the case of inaccurate dosing of coagulants and poor flocculation!

In general, no analytic data was produced, making assessment of treated water quality impossible.

Given the general state of the chemical dosing facilities, which are severely affected by lack of maintenance and spare parts as well as faulty design, the result of treatment is presumed to range from direct filtration at worst, to "almost-conform" treatment in the few places like Baghdad and Mosul which enjoy relatively good maintenance. Disinfection remains an almost universal issue however, since at almost all plants visited the dosing equipment was in very poor condition. This observation held true even for the largest and most modern of the plants visited.

Doubts about the effectiveness of treatment are reinforced by the lack of analytic records reported by the experts.

2.6 Service Performance

2.6.1 Service Level Indicators

Sector policies are broadly outlined in the MOUs related to the purchase of equipment under the Oil For Food Program. These policies can be summarized as follows:

- All the population should be supplied with sufficient water to cater for their needs.
- The impact of any water shortage (seasonal peaks) should be shared equally among users.
- The water supplied is deemed potable.

Service performance is evaluated by 3 basic parameters:

- **The Service Coverage (WSC)**, which evaluates the percentage of population receiving enough potable water from public networks to satisfy their needs.
- **The Rate of Supply (WSR)**, which evaluates the average quantity of potable water supplied for domestic uses in terms of liters per capita per day (lpcd).
- **The Shortage Rate (SHR)**, which evaluates the proportion of the served population receiving an inadequate quantity of water (deemed insufficient to address their actual needs)

An Adequacy Line is established by GOI policies that sets at 150 and 80 lpcd the acceptable minimum supply for households supplied by urban and rural water systems respectively.

Water quality records show that the quality of the water supplied is deteriorating. Treated water becomes polluted during its transit through network pipes due to operational deficiencies. This can pose a severe threat to public health owing to the presence of fecal coliforms in the water supplied. The quality of treated water should be consistently monitored together with the frequency of waterborne diseases.

2.6.2 Service Coverage (WSC)

This parameter reflects the access of the population to a safe source of water. The service coverage (WSC) can be evaluated by comparing against the total population the population receiving sufficient quantities of potable water from public facilities (population served).

The concept of "sufficient quantity of water" will make reference to the concept of the Adequacy Line (WSAL), which defines the baseline below which the basic needs of the population are not deemed to be satisfied: the population served by hand pumps, public wells and standpipe facilities should not be considered as "served population" as long as this category of service does not achieve WSAL supply rates.

The census provides data relevant to the evaluation of WSC, in the form of: the number of people, households and dwellings which receive water from treatment facilities (WTP); and other categories of water supply facilities include public wells, public standpipes and other sources. WSC can be evaluated as either:

- WSC1 = (Population receiving water from WTP)/(Total Population)

or

- WSC2 = (Number of dwellings receiving water from WTP)/(Number of dwellings)

WSC1 reflects more particularly the achievement of the Sector Strategic Goals concerning the provision of sufficient quantities of potable water to the population.

WSC2 is a useful indicator of service connection levels (average number of dwellings served by a given service connection).

UNICEF, in coordination with the Watsan Sector authorities, have evaluated coverage (in terms of population served) for each sub-district of the Centre South region. The population served was estimated according to the number of domestic service connections registered by local DWS and assumed connection levels (average population per service connection), which were evaluated by DWS officials.

Table 2-10: Water Supply Coverage Estimated from Census Data[6]

Governorate	Area	Coverage from CSO97 WSC1	Coverage from CSO97 WSC2	Coverage from UNICEF 2000
Anbar	Urban	93%	97%	92%
	Rural	51%	52%	51%
Babil	Urban	96%	96%	89%
	Rural	34%	37%	47%
Baghdad	Urban	97%	97%	99%
	Rural	43%	44%	30%
Diala	Urban	95%	96%	82%
	Rural	53%	55%	70%
Kerbala	Urban	96%	96%	90%
	Rural	41%	43%	36%
Missan	Urban	94%	94%	84%
	Rural	18%	19%	14%
Muthanna	Urban	95%	95%	90%
	Rural	27%	28%	38%
Qadisiyah	Urban	99%	98%	99%
	Rural	31%	31%	60%
Salaheldin	Urban	86%	85%	79%
	Rural	36%	36%	39%
Ta'meem	Urban	93%	93%	87%
	Rural	44%	45%	56%
Thiqar	Urban	84%	84%	91%
	Rural	14%	15%	25%
Wasit	Urban	97%	97%	92%
	Rural	24%	26%	49%

In Baghdad Governorate (excluding the sub-districts operated by the Mayoralty of Baghdad), Kerbala and Missan, WES estimates of coverage in rural areas are more pessimistic that CSO statistical data, while their estimates of service coverage in Thiqar and Baghdad are higher than those of CSO.

Statistics on access to safe water are provided by the 1997 Census:

- Population receiving water from public networks, public wells and public standpipes
- Households receiving water from public networks, public wells and public standpipes
- Houses and flats receiving water from public networks, public wells and public standpipes

The above data provide an accurate estimate of the average population living in the dwellings served. As water supply networks are linked to housing infrastructure, it shall be assumed that service connections serve permanent housing only, permanent housing being considered as houses and flats.

[6] CSO provided data consolidated at Governorate level only. Some Governorates were not available so far. Therefore, this information is mentioned only for illustrating WATSAN estimates and to establish a reasonable statistical framework to evaluate coverage levels.

In this study, service coverage is based on DWS estimates for sub-district rural and urban areas. For Centre South Iraq, UNICEF have constituted a database indicating population coverage. In the 3 Governorates of the Autonomous Northern Region of Iraq (ANRI), the water authorities provided data on rural and urban populations served; these data had to be prorated in order to ensure consistency with population estimates for the year 2000.

For the sub-districts, which were not surveyed by UNICEF, we have assumed the following default figures:

Table 2-11: Water Use Default Figures for the Year 2000 (Percentage of Water Supply)

	Water Consumption by Non-domestic Urban Users (%)	Water Consumption by Non-domestic Rural Users (%)	UFW in Urban Projects (%)	UFW in Rural Projects (%)	Urban Consumption by Domestic Users (%)	Rural Consumption by Domestic Users (%)
Capital of Governorates	25	10	35	45	40	45
Other Urban	15	10	35	45	50	45

Served Population is evaluated at the sub-district level by:

$$SUP_i = UP_i * UWSC_i$$
$$SRP_i = RP_i * RWSC_i$$

where:

- i: refers to the sub-district
- u: refers to urban areas
- r: refers to rural areas
- SUP_i: Served population of the sub-district "i" in urban area
- SRP_i: Served population of the sub-district "i" in rural area
- UP_i: Urban population of the sub-district "i"
- RP_i: Rural population of the sub-district "i"
- $UWSC_i$: Service coverage (% of population) in urban areas of the sub-district "i"
- $RWSC_i$: Service coverage (% of population) in rural areas of the sub-district "i"

An indicator of service coverage is defined by:

$$WC = [(1+aw)\ \Sigma\ SUP_i + (1-aw)\ \Sigma\ SRP_i] / [(1+aw)UP+(1-aw)RP]$$

Where "aw" is a weighting parameter reflecting the priority to be given to the needs of urban areas with respect to rural areas.

Table 2-12: Water Supply Coverage Indicator in the Year 2000

Water Authority	Urban Population SUP2000	Coverage in Urban Areas UWSC	Rural Population SRP2000	Coverage in Rural Areas RWSC
Mayoralty of Baghdad	4 753 379	100%	15 694	100%
Total GCWS	8 234 575	88%	2 926 598	43%
Total ARNI	2 190 136	87%	749 160	73%
Average Iraq WES	15 178 090	91%	3 691 452	48%

From the above table, it can be seen that GCWS efforts are focused on urban areas. The WA's performance and needs evaluation can be adjusted by the aw weighting parameter reflecting the priorities defined in accordance with the GOI's urban development strategy).

2.6.3 Rate of Supply (WSR)

This parameter corresponds with the average quantity of potable water supplied for domestic purposes in liters per capita per day (lpcd).

Metering of water production and supply is limited and inaccurate. In the absence of proper metering of actual production levels, the production of water is estimated as follows:

$$PC_k = \Sigma\, DC_i * PFE$$
$$WSR_k = PC_k * (1-UFW_k)/SP_k$$

where:

- PC_k is the water production capacity in m³/d. UPC_k and RPC_k refer to urban and rural levels of production respectively.
- DC_i is the design capacity of production unit "i"
- PFE is the power-factored efficiency parameter of the production unit "i" evaluated according to the methodology developed by the WES task force for the Centre South region.
- WSR_k is the water supply rate in liters per capita per day (lpcd); $UWSR_k$ and $RWSR_k$ refer to urban and rural users respectively.
- UFW_k is the percentage of production lost in the distribution network. This parameter is used to evaluate the efficiency of the distribution networks. The UNICEF survey evaluated UFW_k% for each sub-district in the Centre South.
- SP_k is the population served, which can be broken down into served urban and rural populations (USP and RSP respectively).

Table 2-13: Summary of Rate of Supply in Iraq

Water Authority	UPC-2000 m³/d	UWSR lpcd	RPC-2000 m³/d	RWSR lpcd
Mayoralty of Baghdad	1 772 140	224	2 240	83
GCWS	2 549 881	208	334 773	76
ARNI	245 248	59	-	-
Total	4 567 269	192	337 013	(60)

In the northern Governorates, rural villages obtain water from sources which do not require treatment facilities. The supply services are not metered and are generally operated and maintained by local communities of users.

2.6.4 Water Shortage (SH)

Water shortage can be defined with respect to an Adequacy Line, which is established by the GOI as a bottom line below which the available rate of supply (including Non Domestic uses) is not acceptable:

A domestic supply rate is defined in order to assess the capacity of the public utilities to address the basic needs of the population

$$U(R)DSR_k = PC_k * (1 - UFW_k - NDC_k)/SP_k$$

NDC_k is the share of non-domestic consumption in percentage of the production.

The UNICEF survey provided estimates of $UFW_k\%$ and NDC_k in 2000, for each sub-district in the Centre South.

A shortage indicator SH is defined, which will evaluate DWS performance in addressing the basic needs of the population with reference to an Adequacy Line defined by the GOI, which establishes the minimum average rate of supply in lpcd.

Table 2-14: Adequacy Line (lpcd)

Adequacy Line	Centre South	ANRI[7]
UAL: is the adequacy line for urban areas	150	150
RAL: is the adequacy line for rural areas	80	50

$$USH_G = [\sum USP_k \text{ (with } UWSR_k < UAL)] / \sum USP_k$$
$$RSH_G = [\sum RSP_k \text{ (with } RWSR_k < RAL)] / \sum RSP_k$$

Table 2-15: Summary of Water Shortage in Iraq

Water Authority	USH %	RSH %
Mayoralty of Baghdad	56	100
GCWS	38	77
ARNI	97	100
Average Shortage in Iraq	-	-

[7] To be noted that ANRI's policies do explicitly refer to an adequacy line. Meanwhile, the new water supply systems, which are currently developed in the rural settlements by the incipient administration with the support of international agencies, are designed with targeting an average supply capacity of 50 lpcd.

2.7 Performance of the Water Supply Sector in the Mayoralty of Baghdad

2.7.1 Water Sources

The Total Installed Production Capacity (IPC) with regard to the "served population" is estimated at 201 m³/capita/year. This corresponds to an average production rate of 550 liters per capita per day.

All the production facilities are supplied from the Tigris River. (Certain CUs are supplied by raw water from existing raw water supply systems which themselves draw from the Tigris.)

2.7.2 Production Capacity

Table 2-16: Production Capacity

Area	No.	Source	Design Capacity (m³/d)	Actual Capacity (m³/d)	Efficiency	% of Total
Karkh North-West	1	Karkh WTP	1 365 000	1 150 000	84%	51%
	2	Karameh WTP	227 000	194 000	85%	9%
	3	Qadisiyah WTP	135 000	115 000	85%	5%
	4	Al Dawra WTP	115 000	100 000	87%	4%
	5	Compact units		4 500		0.2%
		Sub-Total	1 842 000	1 563 500	85%	70%
Rasafa South-East	1	7th of April WTP	540 000	500 000	93%	22%
	2	Al Wathba WTP	78 000	70 000	90%	3%
	3	Al Wahda WTP	68 000	58 000	85%	3%
	4	Al Rasheed WTP	68 000	50 000	74%	2%
	5	Compact units		20		0.0%
		Sub-Total	754 000	678 020	90%	30%
		Total	2 596 000	2 241 520	86%	100%

The efficiency of the treatment facilities is relatively good in terms of production rates which are estimated at 86% of the total IPC.

The average volume of water effectively produced was estimated at 475 liters per capita per day (lpcd).

2.7.3 Distribution Capacity

2.7.3.1 System Configuration

2.7.3.1.1 Overview

The existing water supply system in the Mayoralty of Baghdad serves a population of approximately 4.72 million with a current supply of 818 million m³/annum. The backbone network, consisting of pipes of 100 mm and 1 400 mm in diameter, is approximately 7 190 km long. The networks are relatively old and pipe materials include ductile iron, asbestos cement, cast iron, steel, PVC, polyethylene and galvanized iron.

The Master Plan developed by Binnie & Partners in 1982 provided for a several water supply schemes with the aim of increasing the production capacity and facilitating the transfer of water from north to south and from east to west. The plan also proposed a restructuring of the network system which entailed splitting the network into pressure zones, each supplied by gravity from a terminal reservoir. All terminal reservoirs were designed to be interconnected through a trunk main system covering the entire city.

Most of the works proposed in the Master Plan were either never implemented or postponed. Among the projects postponed was the construction of a large treatment plant at Rasafa designed to solve the problem of water shortage on the east side of the city. Only 4 terminal reservoirs were effectively constructed and most of the proposed pipelines and boosting stations were never implemented.

Although the area is mostly flat and does not require any sophisticated form of pressure management, the poor sectorization of the existing system combined with the limited conveyance capacity and lack of storage reservoirs and boosting stations, complicate the operation of the system and have a significant impact on service pressures (high pressures at sources to supply remote areas and large pressure variations due to direct pumping into the network, etc.).

2.7.3.1.2 Pipe Networks

The breakdown of the pipe networks (of 100 mm in diameter and above) according to diameter material and age is shown in the following tables.

Table 2-17: Breakdown of Pipe Network Length according to Diameter and Material

DN	Length	% of Total	Ductile Iron	Steel	Asbestos Cement	Cast Iron
1600	25	0.3%	25			
1500	25	0.3%	25			
1400	25	0.3%	25			
1200	100	1.4%	100			
1000	75	1.0%	75			
900	40	0.6%	25	15		
800	100	1.4%	75	25		
700	150	2.1%	125	25		
600	225	3.1%	125	100		
500	25	0.3%	25			
450	125	1.7%	50	75		
400	125	1.7%	75	50		
300	75	1.0%	75			
250	75	1.0%	75			
200	800	11.1%	200		500	100
150	1600	22.3%	400		1000	200
100	3600	50.1%	900		2200	500
Total	**7190**	**100.0%**	**2400**	**290**	**3700**	**800**

Table 2-18: Breakdown of Pipe Network Length according to Age and Material

Average Age	Length (km)	% of Total	Ductile Iron (km)	Steel (km)	Asbestos Cement (km)	Cast Iron (km)
10 years	1500	21%	1500			
17 years	870	12%	870			
25 years	30	0.4%	30			
30 years	3700	51%			3700	
35 years	290	4%		290		
40 years	800	11%				800
Total	**7190**	**100%**	2400	290	3700	800
% of Total			*33%*	*4%*	*51%*	*11%*

- More than 83% of the network is comprised by distribution pipes of 200 mm or less in diameter and average diameter is around 220 mm.

- 62% of the pipe network is in asbestos cement (51%) or cast iron (11%) and has past its normal lifetime which may be a factor of further deterioration. The average age of the network is 25.5 years which, in a network which is poorly operated and maintained (as is effectively the case), can be considered as old.

2.7.3.1.3 Storage Capacity

Most of the existing service reservoirs have been abandoned. At only 19 750 m^3, the existing storage capacity represents less than half a minute's average daily production (2 241 520 m^3/day) and clearly cannot cater for daily demand variations, nor situations of acute shortage (power shutdowns, major bursts, etc.).

Most of the consumers connected to the network are equipped with roof tanks and ground reservoirs which serve their needs in the case of more routine supply stoppages. This private storage capacity is significant and could exceed 600 000 m^3.

2.7.3.1.4 Pumping & Booster Stations

At present, water is pumped from the pumping stations located at the outlet of the treatment plants into the trunk mains leading to the distribution networks. Pump heads were originally designed with a view to delivery via service reservoirs. As most of these reservoirs were never constructed or put into operation, pressures in trunk mains are directly affected by distribution network head losses.

A further problem is that the existing booster stations are not sufficient to cover the whole area and additional booster stations on the distribution network would seem to be required as suggested in the Binnie & Partners Master Plan (45 booster stations were proposed for the whole of the Mayoralty). Current practice among consumers located in low-pressure areas is to install small pump units on the service connections to pump the water to their roof tanks. This practice is very difficult for the Operator to control and has a significant impact on the operation of the system as a whole.

2.7.3.1.5 Service Connections

Service connections number about 567 551. They are generally in very poor condition and represent a major source of leakage (see Table 2-19).

Recent service connections are not constructed according to proper design standards and are generally in poor-quality plastic without any use of saddles, clamps and stop cocks to branch from service mains.

2.7.3.2 Physical Status of Networks

With the events of the last 10 years, the water supply system has developed on an ad hoc basis and largely in response to emergency situations. The distribution networks were constructed in a piecemeal fashion without any real planning or respect of proper design standards and principles. As well as being relatively old, the networks are subject to continuous deterioration leading to widespread leakage.

The average number of leaks repaired is currently about 1 000 per month on the distribution network and about 200 per month on the trunk mains. These figures are very approximate and should be viewed with caution. The true number of bursts and reported leaks is almost certainly higher. It should be noted that almost all present leakage repair is presently conducted in the winter because summer season supply stoppages are virtually prohibited.

Leaks are naturally found on the older parts of the pipe network which are constructed mainly in cast iron, asbestos, galvanized steel and steel. BWSA is currently in the process of replacing some of the old leaking pipes (in asbestos or cast iron) by polyethylene pipes manufactured locally. The quality of these polyethylene pipes would appear to be very poor.

On the other hand, a large number of valves are damaged or leaking because of the regular throttling mechanism necessary to control network flows and pressures. The site visit also revealed that none of the large butterfly valves were equipped with gear boxes.

2.7.3.3 Unaccounted-for-Water

2.7.3.3.1 Production and Consumption Metering

In the Mayoralty of Baghdad, both the volumes of water delivered into the network and those consumed by the consumers connected to the network are estimated rather than evaluated according to metered volumes. Production unit flow meters are generally out of order and only 10% of the 567 551 consumers connected to the network are currently equipped with water meters. Table 2-19: Water Supply Services in Baghdad Mayoralty by 2000. The reliability of the existing data is therefore questionable and the data should be viewed with caution. It should be noted that BWSC recently procured 300 000 Class B water meters as part of a program to meter consumption at the consumer level. These meters are considered unsuitable in the present circumstances, and more specifically in view of the roof tanks installed on consumer properties, requiring meters with a higher level of accuracy (Class C).

The following table gives the breakdown of categories of user connected to the water supply network.

Table 2-19: Water Supply Services in Baghdad Mayoralty by 2000

Consumer Category	Total	%	Metered	Unmetered
Domestic	376 280	66%	48 219	328 061
Indust. And Commercial	53 474	9%	10 469	43 005
Government	121 899	21%	0	121 899
Public (Places of worship & others)	15 898	3%	0	15 898
Total consumers	567 551	100%	10%	90%
Total consumers billed	551 653	97%	NA	NA

Comments:

- The category "Industrial and Commercial" represents less than 10% of the total number of consumers but most certainly more than 35% of total consumption. Metering of this category of consumer (industries, commercial entities and administrations, etc.) is highly profitable and more cost-effective than domestic metering. It can also contribute to significantly reducing wastage.
- At 97%, the level of consumers billed is highly satisfactory. However water bills are often the subject of claims as a result of billing errors.
- Collection seems to be less effective than billing.

2.7.3.3.2 Evaluation of UFW and Wastage

Unaccounted-for-Water is usually defined as the difference between the net production (volume of water delivered to the network) and consumption (volume of water that can be billed to consumer as legitimate consumption, whether metered or not).

Because of the lack of metering at both the production and consumption levels, it is impossible to obtain accurate figures for UFW and its physical (leakage) and commercial constituents (illegal connections and under-estimation of consumption). Indeed, leakage cannot be quantified without the necessary flow and pressure measurements in the various supply sectors. At the same time, wastage and over-consumption cannot be assessed without performing a consumer survey.

However, a rough estimate of UFW can be obtained using the following figures provided by the Authority:

- Average amount of water produced (m^3/month) = 67 245 600 m^3/month
- Average amount of water billed (m^3/month) = 26 179 274 m^3/month
- Average amount of UFW (m^3/month) = 41 066 326 m^3/month
- Percentage of UFW = 62%
- Estimated physical losses (based on UNICEF and BWSA estimates): 50%
- Estimated metering and billing errors or inaccuracies: 20% of UFW representing nearly 50% of the amount of water billed.
- UFW (m^3/km/day) = 192

The very high per km and per day UFW levels can be explained by the high ratio of water production per capita which is presently around 436 l/c/d. Given observations in the field and our experience of similar network configurations, it is assumed that a large amount of the total volume of Unaccounted-for-Water is accounted for by leakage and other physical losses.

Wastage is also assumed to be significant due to the fact that water is not billed according to true consumption. The use of air coolers in summer constitutes a considerable source of wastage and over-consumption (about 1.5 m^3/day/user) representing one third of production and seriously affecting service levels in the Mayoralty.

2.7.4 Performance Level

The technical characteristics of water supply systems influence the capacity of public utilities to provide the volume of water required by the population. The water supplied should meet the quality standards for drinking water. Service levels will be evaluated according:

- Coverage provided by water supply utilities in terms of the percentage of population (urban/rural) connected to BWA systems.
- Continuity of supply, which ensures the total satisfaction of demand of the users connected, and helps to maintain positive pressures in the distribution network preventing pollution in empty pipes.
- Service pressure; which should be maintained at positive levels within an predefined range of water heads determined by the characteristics of the facilities at the user end.

Table 2-20: Water Supply Coverage in Baghdad

District	Sub-district	Population		Population Served	
		Urban	*Rural*	*Urban*	*Rural*
Al-Karkh	Al-Karkh Centre	111 381		111 381	0
	Al-Mansour	418 496		418 496	0
	Al-Ma'moon	840 526		840 526	0
Al-Risafa	Al-Risafa Centre	139 994		139 994	0
	Al-Karrada Al-Sharqiyah	226 300		226 300	0
	Baghdad Al-Jedeeda	736 682		736 682	0
Saddam	Saddam Centre	1 117 177		1 117 177	0
Al-Adhamiyah	Al-Adhamiyah-Centre	238 615		238 615	0
	Al-Fahama	359 306		359 306	0
Al-Kadhimiyah	Al-Kadhimiyah Centre	515 342		515 342	0
	That Al-Salasil		15 530	0	15 530
Total		4 703 819	15 530	4 703 819	15 530

User satisfaction is not measured precisely, but estimated with respect to predefined standards or target levels, which are evaluated in Baghdad:

- Production of 500 lpcd
- An Adequacy Line of 150 lpcd is defined for domestic consumption.

As a result of the events of the last 10 years, the water supply system has evolved on an ad-hoc basis and largely in response to emergencies situations and the distribution networks have been constructed in a piecemeal fashion without any real planning or proper design standards and principles. The networks are progressively deteriorating leading to widespread leakage. Most of the integrated water supply schemes proposed in the 1982 Binnie & Partners' Master Plan with a view to increasing the production capacity and facilitating the transfer of water from north to south and from east to west, were either never implemented or postponed. Among the works postponed was the construction of a new large treatment plant at Rasafa designed to offset water shortages on the east side of the city.

The main objective targeted in day-to-day operation is the equitable distribution of water with respect to the different users. The main problems observed during the site visits were as follows:

- A decrease in the amount of water supplied to consumers because of the lack of spare parts at the production units (WTP and CU).
- A very poor knowledge of the water supply situation in the different areas of the Mayoralty (levels of service and satisfaction, demand requirements, pressures, etc.).
- The absence of updated drawings and measurements on the primary and distribution networks (flows and pressures) resulting in heavy reliance on the experience of the operating staff, emergency-focused operation and unequal distribution of the water available between east and west, north and south.
- The unstructured nature of the system and direct pumping into the distribution networks generating high pressure variations and leading to a non-optimized mode of operation (valve throttling is widely practiced at pumping facilities and inside distribution sectors). It should be noted that the Master Plan provided for the division of the city into 20 separate distribution zones, each supplied by gravity from a terminal reservoir. All reservoirs were to

be interconnected through a trunk main system covering the entire city. Only 4 reservoirs were ever constructed and the pipeline system was for the most part never implemented.

- Very low storage capacity estimated at 19 750 m^3 and representing less than half a minute's average daily production (2 241 520 m^3/day). Such operating capacities are clearly unable to cater for seasonal demand variations and to secure the water distribution system against crisis situations (power shutdowns, major bursts, etc.).

- Existing metering facilities at water sources are out of order and need to be replaced and only 10% of consumers are currently equipped with water meters.

According to the production and population figures, the lpcd allowance in the Mayoralty of Baghdad is presently around 436 l/c/d, which conforms to Iraqi standards.

According to estimates provided by BWA, the average billed consumption in 2000 was 26 179 274 m^3/month, corresponding to an average billing of 47 m^3/month/connection billed or 185 lpcd.

This estimate does not take into account seasonal shortages or different categories of connections, meaning that household connections serving an average of 12.5 persons receive less than 47 m^3/month - only 126 lpcd - which is far below the Adequacy Line for Baghdad of 150 lpcd.

Water shortages still occur in the summer due to the use of air coolers, which represent a very large source of wastage (about 1.5 m^3/day/subscriber) - nearly one third of the amount of water produced.

The adequacy of water supply in terms of quality can be assessed by comparing samples of water with MOH regulations. Normally, this parameter is determined by quality of the raw water and the adequacy and efficiency of the treatment facilities. The DOH monitors compliance of water supplied with MOH regulations for drinking water, while the DWS monitors water quality in the distribution systems and at treatment plant outlets. Raw water quality is monitored by the Ministry of Irrigation. The results of DWS and DOH samplings were furnished to the UNICEF's WES team.

2.7.5 Performance Indicators

- The *Adequacy* of water sources with respect to demand can be assessed through the following indicators:

  - Coverage. According to BWSA data, 100% of the population receives water from BWA water systems.

  - Total installed production capacity in m^3/capita/year with respect to a so-called "served population". Technical characteristics of pipes and data on non-domestic activities and housing trends will be required to assess the adequacy of the installed production capacity with respect to the actual demand of the population.

PR(MB) = 476 lpcd

which is not much lower than the targeted production rate of 550 lpcd.

  - Annual percentage of water quality analyses (further to DOH monitoring) which exceed drinking water quality standards.

Data on raw water quality are poor and cover only turbidity, dissolved solids and hardness at treatment plant inlets. With regard to the different parameters monitored by the Ministry of Agriculture, we would display only the key relevant parameters.

- The ***Dependability*** of water sources will reflect the continuity of available supply sources and seasonal variations in quantity and quality:
  - Water sources: The breakdown of abstraction sources into Tigris/Euphrates sources, other surface water sources, groundwater sources and other sources as percentages of total abstraction capacity will reflect the sensitivity of water sources to seasonal climatic variations.
  - Seasonal flow variations may be represented by minimum/average monthly production percentages, or by the variations over a one-year period as indicated by monthly production records. As rainfall data are likely to be more accessible, the risk of drought could be assessed according to the covariance of annual rainfall.
  - Seasonal conditions posing a threat to public health could be determined on the basis of maximum percentages with regard to monthly water quality analyses.
  - Growing competition from irrigation could undermine the supply of water for domestic consumption. The indicators could be:
    - Amount of water abstracted for irrigation in m^3 (or irrigated surface area in ha)/capita/year against population served by water supply utilities.
    - The risk of water source conflicts could be mitigated by allocating water rights to the different categories of user (in m^3/capita/year).
- The *efficiency* will reflect the actual capacity of wells, low-lift and intake facilities with respect to design capacity.
  - This parameter was examined extensively by the UNICEF efficiency surveys of low-lift facilities of WTP and WTCU, wells and boosting stations. The global off-take capacity would be evaluated as the sum of the design capacities of WTPs, WTCUs, and wells[a].
  - Total production of water (with regard to under-control supply systems in urban and rural areas) in m^3/capita/year with respect to a "served population" as a percentage of the production capacity.
- As long as supply continues to be rationed, a more accurate indicator of demand would be the maximum monthly production in litres/capita/day during the rainy season.

With regard to continuity aspects of service performance, infrastructure sizing requirements will be determined by peak flow levels, namely:

- Seasonal peak flows in percentage of average annual consumption.
- Peak Day Demand as a percentage of average demand, which is to be used to design service reservoirs and pipe diameters.

[a] UNICEF survey does not cover the existing facilities in the 3 northern Governorates

2.8 Performance of the Water Supply Sector in Centre South Iraq

2.8.1 Water Sources

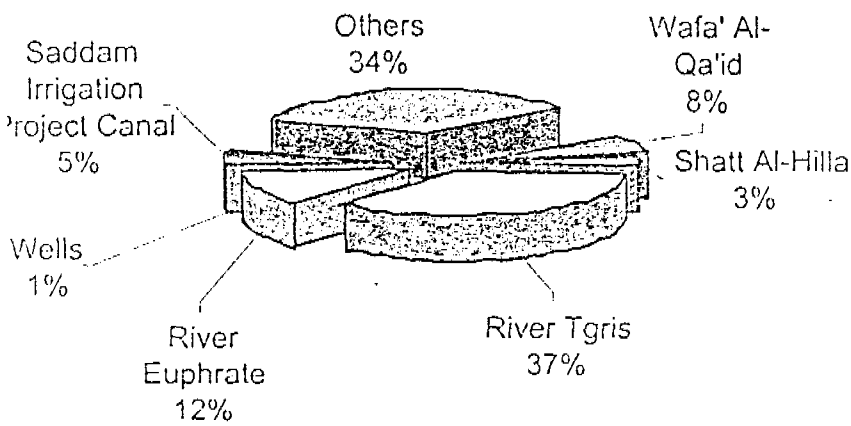


Figure 2-5: Water Supply Sources in the Centre South Region.

Water stresses on the Tigris River may affect 37% of the production capacity, while 34% of the production capacity relies on other sources, which may be exposed to risks associated with drought.

2.8.2 Production Capacity

The GCWS operates 1 460 water supply systems in 15 Governorates. Supply capacities for water supplied to the distribution system are summarized in the table below. The public water utilities providing services to both urban and rural areas are operated by 15 DWSs.

With regard to compact units, 75% of these are operated by local communities, such operation being characterized by low efficiency and poor maintenance practices.

Table 2-21: Installed Capacity of Production facilities in Centre South Region in (m^3/d) [*]

Governorates Directorates	Water Treatment Plants				Compact Units			
	Nb. of units	*Design Capacity*	*Nb*	*Design Capacity*	*Nb*	*Design Capacity*	*Nb*	*Design Capacity*
Anbar	20	390 800	127	78 300	3	5 600	150	474 700
Babil	15	270 380	90	58 300	0	0	105	328 680
Baghdad	15	546 000	86	26 300	0	0	101	572 300
Basrah	14	320 600	121	265 560	0	0	135	586 160
Diala	21	360 180	101	37 310	0	0	122	397 490
Kerbala	7	222 400	39	18 600	0	0	46	241 000
Missan	13	73 400	44	80 350	0	0	57	153 750
Muthanna	5	102 740	29	10 836	2	650	36	114 226
Najaf	8	372 800	53	22 200	1	540	62	395 540
Ninevah	18	730 758	66	46 950	12	29 945	96	807 653
Qadisiyah	15	212 600	61	24 400	0	0	76	237 000
Salaheldin	18	243 580	124	71 900	4	25 600	146	341 080
Ta'meem	8	451 968	33	15 670	66	17 570	107	485 208
Thiqar	15	124 600	81	41 750	0	0	96	166 350
Wasit	19	168 700	116	47 480	0	0	135	216 180
Total	211	4 591 506	1 171	845 906	88	79 905	1 470	5 517 317
%	*14%*	*82%*	*80%*	*16%*	*6%*	*1%*	*100%*	*100%*

2.8.3 Distribution Capacity

The distribution systems are described in terms of the length, material, average diameter and age of pipes with diameters above 75 mm. For the Centre South region, data were available for only 60% of the population served by GCWS. For the purposes of comparing infrastructure according to region, the above parameters are given as percentages of the total length of the distribution system in each Governorate.

[*] Queries 111 and 110

Table 2-22: Characteristics of Pipe Materials in GCWS Water Networks[10]

Governorate DWS	Material						
	ASB	*DUC*	*IRO*	*OTH*[11]	*PVC*	*STE*	***Total (km)***
Anbar	6%	51%	4%	0%	39%	0%	**586 390**
Babil	22%	13%	14%	0%	47%	4%	**920 924**
Baghdad	0%	0%	0%	0%	100%	0%	**555 800**
Basrah	11%	22%	0%	0%	65%	2%	**2 893 920**
Diala	10%	13%	14%	0%	54%	8%	**1 594 929**
Missan	15%	8%	37%	0%	40%	0%	**512 000**
Muthanna	32%	24%	1%	0%	38%	5%	**667 250**
Najaf	24%	21%	3%	0%	52%	0%	**1 318 000**
Ninevah	1%	58%	13%	0%	24%	4%	**8 922 079**
Qadisiyah	20%	10%	3%	0%	67%	0%	**954 525**
Salaheldin	15%	7%	17%	0%	61%	0%	**552 486**
Wasit	18%	15%	10%	0%	48%	9%	**461 800**
Centre South	10%	36%	9%	0%	42%	3%	**19 940 103**

A single DWS may operate up to 150 independent supply systems. A significant part of the water networks is comprised by transmission lines in steel or ductile iron.

Leakage is exacerbated by the large number of ASB and cast iron pipes, in particular those of more than 20 years in age.

Table 2-23: Average Age of Pipes in the GCWS Water Supply Networks (Percentage of Pipe Length)[12]

Governorate DWS	Material						
	ASB	*DUC*	*IRO*	*OTH[1]*	*PVC*	*STE*	*Significance*
Anbar	23	20	19		19		74
Babil	32	15	38		15	9	100
Basrah	33	9			18	6	100
Diala	29	16	43		15	22	100
Missan	23	21	45		23	10	94
Muthanna	34	33	30		26	21	100
Najaf	25	15	24		12	15	100
Ninevah	27	22	53	20	16	15	100
Qadisiyah	26	22	30		23		100
Salaheldin	28	19	42		19		40
Wasit	30	17	46		13	7	86
Centre South	29	20	48	20	16	15	60

The item "Significance" expresses the percentage of served population deemed to be connected to the networks recorded in the database.

The average diameter of the pipes tends to increase with project size and thus provides information about the size of the networks. At the same time, it indicates for what purposes the

[10] From Query 15

[11] The item "OTH" refers to unknown pipe materials

[12] From Query 12_Analyse_pipe_average_age_per

different materials are used: ductile iron and steel for transmission lines and primary networks, ASB for secondary networks and PVC and cast iron pipes for tertiary networks.

Table 2-24: Average Diameter in GCWS Water Systems (in mm)[13]

Governorate	Material						
	ASB	*DUC*	*IRO*	*OTH[1]*	*PVC*	*STE*	*Average*
Anbar	131	203	107		140		136
Babil	167	239	204		130	107	130
Baghdad					128		83
Basrah	197	485			138	765	221
Diala	163	243	119		132	258	141
Missan	191	347	184		146	150	209
Muthanna	146	259	95		158	734	176
Najaf	136	383	109		132	90	272
Ninevah	160	197	84	80	112	309	129
Qadisiyah	146	261	82		135		136
Salaheldin	122	426	218		140		176
Wasit	138	246	162		125	563	186
Centre South	158	236	115	80	129	368	258

The replacement of old cast iron and ASB pipes by PVC pipes may contribute significantly to reducing leakage, in particular in Missan, Muthanna and Qadisiyah. In Ninevah, extensive work began in 1980 to extend the use of ductile iron and PVC pipes. Considerable losses continue to be generated however by the remaining 13% of aging smaller iron pipes, resulting in severe water shortages despite a relatively high installed production capacity.

In both large urban areas where the pumping station is located on the main reservoir, at the outlet of the water treatment plant, and rural areas where a single treatment facility may serve several settlements, treated water is supplied through transmission lines by boosting stations. The UNICEF WES team evaluated the efficiency of 130 boosting stations as summarized in the table below.

The design boosting rate indicates the percentage of treated water which requires boosting to achieve the design supply objective. The efficiency rating indicates the true boosting capacity with respect to the design. The product of the design boosting rate and the efficiency can be considered to indicate the "transmission efficiency" of the supply systems. Inefficient boosting facilities may result in severe shortages, which could be evaluated as 20% of the actual production capacity (PC).

[13] From Query 11_Analyse_average_dia_per_mat

Table 2-25: Boosting Capacity in Transmission Lines and Sectorized Distribution Networks (m³/d)[14]

Governorates	Nb.	Design Capacity	Effective Boosting Capacity	Efficiency (%)	Design Boosting Rate
Anbar	16	153 600	94 640	62%	32%
Babil	3	102 000	75 803	74%	22%
Baghdad	6	193 000	107 788	56%	41%
Basrah	30	110 600	78 945	71%	23%
Diala	4	99 200	43 467	44%	21%
Kerbala	4	111 900	66 513	59%	24%
Missan	3	5 400	2 263	42%	1%
Muthanna	12	35 215	16 325	46%	7%
Najaf	2	215 000	118 860	55%	45%
Ninevah	41	346 472	223 569	65%	73%
Qadisiyah	4	81 700	43 374	53%	17%
Salaheldin	2	13 202	7 176	54%	3%
Ta'meem	1	115 200	58 710	51%	24%
Thiqar	2	3 800	1 794	47%	1%
Wasit					
	130	1 586 289	939 227	59%	31%

Table 2-26: Storage Capacities in GCWS Water Systems (m³)[15]

Governorate	In DWTP		Balancing Reservoirs		Other Storage		Total	
DWS	Nb of units	Storage capacity	Nb of units	Storage capacity	Nb of units	Storage capacity	Nb of units	Storage capacity
Anbar	17	39 512			18	2 070	35	41 582
Babil	8	13 974	8	6 750	11	1 606 500	27	1 620 474
Baghdad	26	28 854	19				45	28 854
Basrah	8	22 027					8	22 027
Diala	12	37 382	4				16	37 382
Kerbala	5	23 472	10				15	23 472
Missan	8	2 264	16		14	4 600	38	6 864
Muthanna	4	4 427	5	180	15	1 050	24	5 477
Najaf	5	24 852	6	3 794	10	53 550	21	78 402
Ninevah	18	65 455			2	80	20	65 535
Qadisiyah	9	20 085			36	46 770	45	66 855
Salaheldin	16	43 530	10	19 800			26	43 530
Ta'meem	8	2 892	3	150 000	3	150 000	14	152 892
Thiqar	7	3 856					7	3 856
Wasit	10	29 269	5	3 000			15	29 269
Centre South	161	361 851	86	183 524	109	1 864 620	356	2 226 471

The survey undertaken by UNICEF in 2000 under the guidance of the consultants provided information about the profile of service connections. This information was not considered as reliable, since the local authorities do not subscribe to a commercial approach whereby the service connection is considered as a relevant source of revenue.

[14] From Query II7

[15] From Query _II5

Table 2-27: Water Service Connections Profile as Recorded in the Database from the 2000 Survey

(Number of Connections)

Governorate	Service connections profile					Total
	Domestic	*Commercial*	*Industrial*	*Free*	*Others*	
Anbar	21 386	788	362	57		22 593
Babil	74 536	3 415	62	128	3	78 144
Baghdad	7 000					7 000
Kerbala	41 195	2 292	541			44 028
Missan	61 775	2 253	290	258		64 576
Muthanna	28 020	2 741	433	42		31 236
Najaf	57 632	11 524	1 349	268	27	70 800
Ninevah	169 870	13 728	2 022	1		185 621
Qadisiyah	53 114	2 965	876	96		57 051
Salaheldin	10 000	2 000	100	100		12 200
Total	**524 528**	**41 706**	**6 035**	**950**	**30**	**573 249**
% of total	*91,5%*	*7,3%*	*1,1%*	*0,2%*	*0,0%*	*100%*

For the purposes of the planning stage, the number of connections is calculated according to survey records as well as size of households and the average number of households living in a dwelling supplied by the public network.

In rural areas, the connection level with regard to billable services was assumed as 10 people per connection.

Table 2-28: Assumptions on the Average Connection Level of Domestic Users in Urban Areas

Governorate	Average Pop per housing[16] Inhab./Unit		Connection Level Inhab/Unit	
	Urban	Rural	From Survey	Planning Assumptions
Anbar	8.93	10.34	14.74	14.7
Babil	7.74	9.25	6.94	7.5
Baghdad	8.55	10.13	12.63	12.6
Basrah	8.3	10		8.3
Diala	7.91	9.58		7.9
Kerbala	7.87	9.96	7.95	7.9
Missan	9.33	10.12	7.96	9.0
Muthanna	7.99	10.08	6.96	8.0
Najaf	8.3	10	9.93	10.0
Ninevah	8.3	10	7.59	8.3
Qadissiah	8.27	10.3	8.47	8.3
Salahaddin	8.25	10.08		8.3
Tameem	7.58	10.35		7.6
Thiqar	9.03	10.11		9.0
Wasit	8.3	10.08		8.3

2.8.4 Performance of the Water Supply Sector

Table 2-29: Service Coverage WSC

Water Authority	Urban Population SUP2000	Coverage in Urban Areas UWSC	Rural Populations RP2000	Coverage in Rural Areas RWSC	Average WSC
Anbar	531 511	92%	262 023	51%	73%
Babil	517 051	89%	298 807	47%	67%
Baghdad	418 639	86%	169 123	28%	54%
Basrah	1 072 272	81%	160 296	46%	73%
Erbil	844 854	96%	254 006	73%	90%
Kerbala	380 302	90%	78 597	36%	72%
Missan	393 675	84%	33 647	14%	61%
Muthanna	195 117	90%	97 828	38%	62%
Najaf	572 099	91%	118 676	46%	78%
Ninevah	1 296 608	89%	327 880	37%	69%
Qadisiyah	463 964	99%	232 152	60%	81%
Salaheldin	366 717	84%	209 790	39%	60%
Ta'meem	516 304	87%	133 252	56%	78%
Thiqar	691 691	91%	128 666	25%	64%
Wasit	427 670	92%	198 050	49%	72%
CSR	8 688 474	89%	2 702 793	42%	71%

[16] From 1997 CSO Population Census.

Table 2-30: Supply Rates WSR and Production Rates PR and PCR in lpcd.

Governorates	No.	UPR lpcd	UAPCR lpcd	UWSR lpcd	UDSR lpcd	RPR lpcd	RAPCR lpcd	RWSR Lpcd	RDSR lpcd
Anbar	150	584	255	143	124	267	112	50	50
Babil	105	431	320	217	119	126	82	35	35
Baghdad	101	1044	826	504	306	108	172	112	82
Basrah	135	356	310	224	56	323	317	215	95
Diala	122	559	266	185	173	169	43	28	28
Kerbala	46	480	248	173	106	175	154	91	80
Missan	57	303	206	141	73	52	177	124	117
Muthanna	36	439	285	199	124	75	42	27	27
Najaf	62	553	338	187	154	180	146	107	100
Ninevah	96	448	317	244	130	176	223	196	169
Qadisiyah	76	388	192	113	106	143	79	33	28
Salaheldin	146	588	291	186	120	160	83	49	42
Ta'meem	107	737	532	413	234	197	123	100	94
Thiqar	96	196	109	53	22	34	23	14	12
Wasit	135	389	186	113	65	88	63	35	16
Total	1 470	479	309	208	120	152	114	76	61

Table 2-31: Shortage Indicators[17]

Governorates	USHR	USHDR	RSHR	RSHDR
Anbar	45%	53%	63%	63%
Babil	32%	93%	88%	88%
Baghdad	11%	28%	84%	84%
Basrah	22%	98%	42%	49%
Diala	68%	68%	91%	91%
Kerbala	5%	87%	77%	99%
Missan	23%	95%	62%	62%
Muthanna	31%	98%	100%	100%
Najaf	81%	81%	98%	98%
Ninevah	3%	91%	40%	47%
Qadisiyah	82%	92%	87%	87%
Salaheldin	43%	75%	79%	81%
Ta'meem	1%	6%	60%	67%
Thiqar	87%	100%	100%	100%
Wasit	85%	95%	84%	100%
CSR	38%	80%	77%	80%

[17] From Queries 18 and 19.

2.8.5 Efficiency Parameters

Table 2-32: Efficiency of the Production Units

Governorates	Installed Capacities in Urban Areas m³/d	Installed Capacities in Rural Areas m³/d	Average Project Efficiency	Average Power Factored Efficiency	Share of Production Relying on Emergency Generators
Anbar	337 900	136 800	49%	35%	33%
Babil	248 830	79 850	62%	58%	4%
Baghdad	506 600	65 700	66%	66%	2%
Basrah	473 883	112 277	63%	65%	0%
Diala	281 900	115 590	45%	33%	61%
Kerbala	203 070	37 930	63%	44%	17%
Missan	141 328	12 422	70%	57%	23%
Muthanna	95 198	19 028	59%	52%	4%
Najaf	349 375	46 165	64%	53%	17%
Ninevah	649 936	157 717	65%	60%	4%
Qadisiyah	181 750	55 250	57%	45%	34%
Salaheldin	255 671	85 409	56%	36%	15%
Ta'meem	438 071	47 137	65%	60%	4%
Thiqar	148 870	17 480	54%	47%	7%
Wasit	180 590	35 590	51%	43%	15%
Total	4 492 972	1 024 345	60%	52%	12%

Production rates are obtained by comparing the installed production capacity with the total population (UPR and RPR for urban and rural areas respectively). The actual production capacity rate indicates the actual production capacity destined for the supply of the served population (UAPRC and RAPRC respectively).

Significant improvements are to be expected further to the rehabilitation of the production facilities in many Governorates.

Other technical parameters and efficiency indicators are summarized in the table below

Table 2-33: Staff Management Efficiency

Governorates	Pop Served per Employee	Km of Pipes per Employee	m^3/D per Employee	Weighted Indicator % (Average)
Anbar	1 303	1.0	271.1	90%
Babil	896	1.0	186.3	69%
Baghdad	1 721	1.2	358.1	118%
Basrah	691	2.5	143.7	85%
Diala	877	1.8	182.4	81%
Kerbala	1 382	0.0	287.6	77%
Missan	1 623	1.0	178.1	84%
Muthanna	2 983	2.5	327.3	165%
Najaf	1 470	2.4	161.2	104%
Ninevah	793	8.9	87.0	198%
Qadisiyah	1 559	1.9	171.1	97%
Salaheldin	2 300	1.6	252.4	121%
Ta'meem	2 009	0.0	220.4	80%
Thiqar	1 219	0.0	133.7	48%
Wasit	1 610	0.9	186.6	83%
Total	1 272	2.6	191.9	1.0

The weighted indicator evaluates the level of the productivity of DWS' staff as the average of the three productivity components :

- Service Productivity = Pop. Served/Employee in the Directorate/Average GCWS
- Distribution productivity = km of pipe/Employee in the Directorate/Average
- Water Supply Productivity = APC/Employee/Average GCWS

2.9 Autonomous Region of Northern Iraq

2.9.1 Introduction

The situation in the water supply sector in the Autonomous Region of Northern Iraq is summarized in the following sections. The rural subsector is not addressed in the Survey-2000.

2.9.2 Production Capacity

Since the production data were provided by the water authorities for the purposes of the infrastructure survey undertaken by UNICEF in 2000, the efficiency assessment is not included. During the site visits, the rehabilitation step was reported to be completed.

Table 2-34: Production Facilities in ARNI (according to Survey-2000)

Gov_Loc	Dist_Loc	Name of Project	Design Capacity (m³/day)	Urban Share (m³/day)
Dohuk	Dohuk	Dohouk	40 000	40 000
	Zakho	Abasi	20 000	20 000
Somme Dohuk			60 000	60 000
Erbil	Erbil	Kalak W.P.	10 800	10 800
		new Ifraz	82 800	82 800
		Old Ifraz	50 960	50 960
	Koysanjaq	new Koysanjaq	12 000	12 000
	Soran	Sadeeq	12 000	12 000
Somme Erbil			168 560	168 560
Sulaymaniyah	Dukan	Dukan	60 000	60 000
	Kalar	Kalar	18 000	18 000
Somme Sulaymaniyah			78 000	78 000
Total			306 560	306 560

Based on the data sheet concerning the Old Khuluk treatment plant of Khabat (Erbil Governorate) and the Dohuk facilities, the project efficiency was assumed to range between 60% and 100%.

The information provided did not mention compact units or tube wells, nor any additional production facilities that would be used to supply the urban population.

No detailed data were made available on production facilities in rural areas.

Table 2-35: Assumed Project Efficiency in ARNI

Governorate	Urban Shares of Installed Capacity m³/d	Urban Actual Production Capacity (m³/d)	Project Efficiency	Power Factored Efficiency
Dohuk	60 000	48 000	80%	80%
Erbil	168 560	134 848	80%	80%
Sulaymaniyah	78 000	62 400	80%	80%

It should be noted that according to additional information provided by the water authorities of the Governorate of Dohuk, the actual supply rate of treated water in 1999 was 4 million cubic meters per month, representing an average of 135 500 m³/d, which is considerably higher than the production rate estimated from the database.

2.9.3 Distribution Facilities

Table 2-36: Characteristics of Pipe Networks in the Northern Region

Governorate	Material						
Length (m)	*ASB*	*DUC*	*IRO*	*OTH[1]*	*PVC*	*STE*	***Total***
Centre South	1 822 185	7 126 382	1 893 250	38 560	8 441 999	617 727	**19 940 103**
Dohuk	48 829	141 918	27 587	0	38 703	153 433	**410 470**
Erbil	20 500	183 910	47 100	243 640	185 790	35 630	**716 570**
Sulaymaniyah	47 350	225 217	64 210	19 390	150 930	140 006	**647 103**
Total	116 679	551 045	138 897	263 030	375 423	329 069	**1 774 143**
Age of Pipes in years							
Dohuk	17	15	27	0	16	13	**15**
Erbil	9	7	24	23	1	7	**12**
Sulaymaniyah	26	20	49	17	20	13	**21**
Total	19	14	36	23	10	12	**16**
Average diameter in mm							
Dohuk	134	205	137	0	123	312	**224**
Erbil	170	433	200	163	111	152	**220**
Sulaymaniyah	117	186	121	96	123	388	**200**
ARNI	133	273	150	158	117	327	**214**

Table 2-37: Pipe Density

Governorate	Total Length (m)	Total Population Served (inhab.)	Pop covered by Network (inhab.)	Network Density (m/inhab.)	Density Indicator %
Dohuk	410 470	541 625	541 625	0,76	1.17
Erbil	716 570	1 098 860	1 054 906	0,68	1.05
Sulaymaniyah	647 103	1 273 701	1 146 331	0,56	0.87
ARNI	1 774 143	2 914 186	2 742 862	0,65	1

2.9.4 Performance of the Water Supply Service in the ARNI

Table 2-38: Water Supply Service Coverage[18]

Governorate	Urban Population	Served Urban Population	Urban WSC	Rural Population	Served Rural Population	Rural WSC
Dohuk	398 150	384 360	97%	211 380	157 265	74%
Erbil	878 786	844 854	96%	346 133	254 006	73%
Sulaymaniyah	1 206 841	935 812	78%	463 193	337 889	73%
ARNI	2 483 777	2 165 026	87%	1 020 706	749 160	73%

[18] From Query IPI

Table 2-39: Water Supply Rates (lpcd)[19]

Governorate	Production Rate	Urban WSR	Urban DSR
Dohuk	150	81	62
Erbil	192	104	79
Sulaymaniyah	65	10	8
Average ARNI	123	59	45

The above data does not reflect the true situation, since the data provided during the data collection survey does not necessarily cover the entire set of assets. In these circumstances, the shortage indicator does not give a true idea of the situation.

2.9.5 Efficiency Parameters

According to the information provided by the water authorities, which pertains exclusively to the Governorate of Dohuk, the value of the assets of the Watsan sector is put at NIQD 7 million, 22% of which are comprised by water treatment plants, boosters, deep wells and water networks, for a population of 609 530 in 2000 (NIQD 2.7/inhab).

In 1999, the effective expenditure for Dohuk was IQD 17.8, representing IQD 33/population served, or IQD 1.57/m^3 supplied in urban areas. This is far below the actual cost of IQD 3.56/m^3 of water supply estimated by the water authorities.

In the same report dated February 2000, the staff of Dohuk DWS was put at 865 permanent employees, representing per employee a served population of 444, less than 0.5 km and an installed capacity of 55.5 m^3/d.

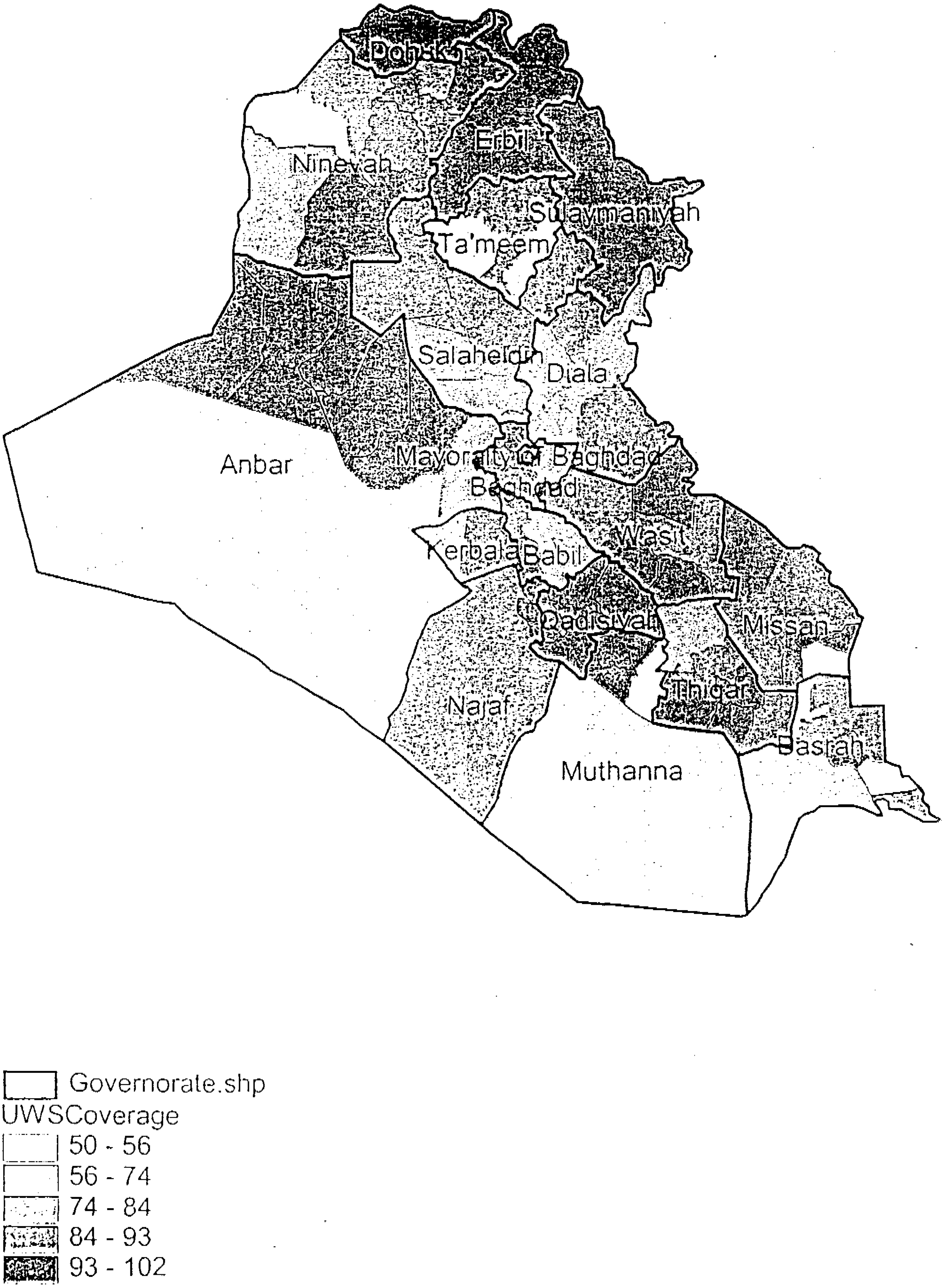
The production of 1 m^3 of treated water in Dohuk was estimated to need:

- 3.45 KWh
- 5.6 g of chlorine
- 2.74 g of alum sulfate

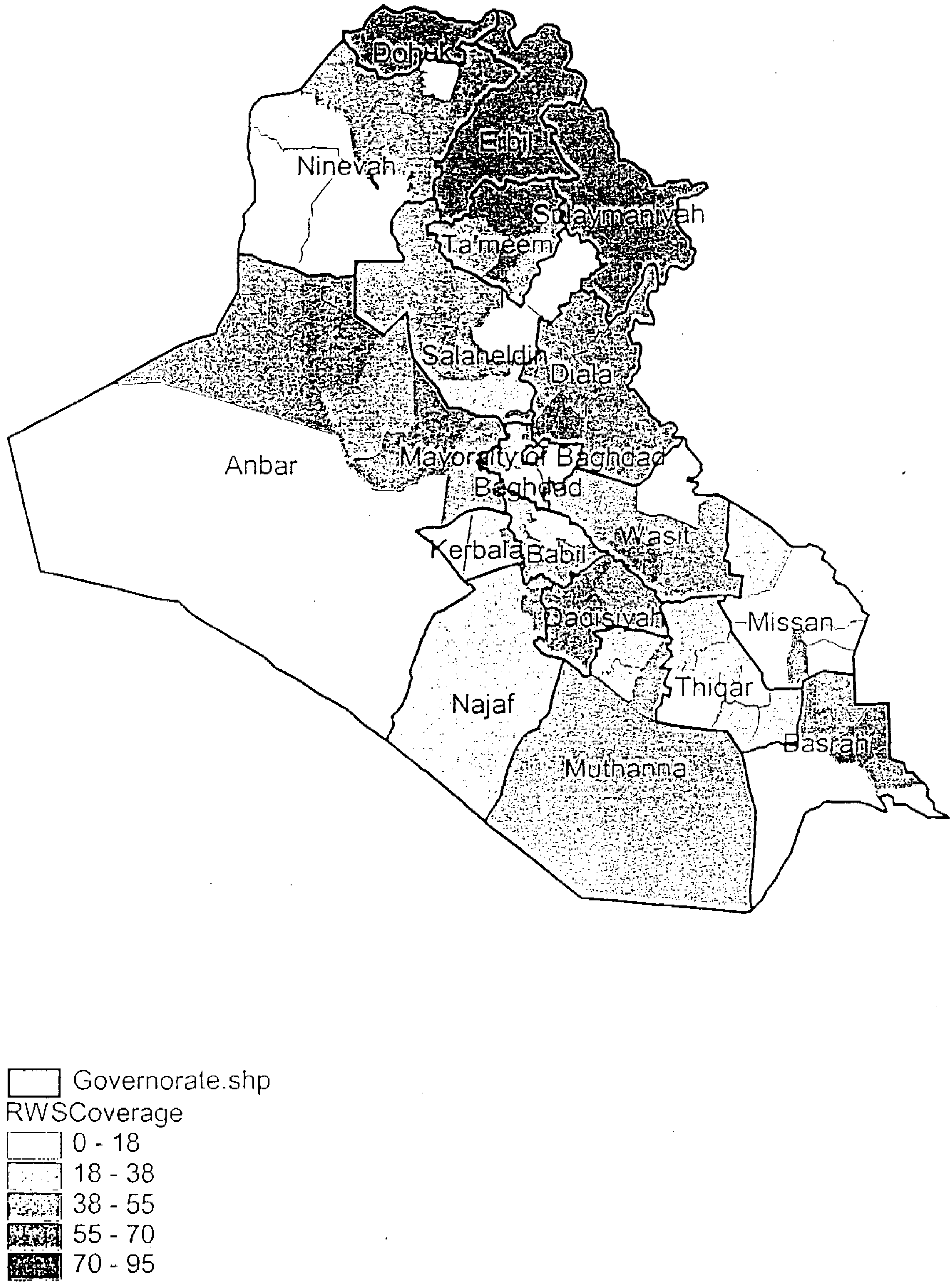
[19] From WSR/DSR Query

MAPS

Map 2.1: Water Supply Coverage in Urban Areas - 2000

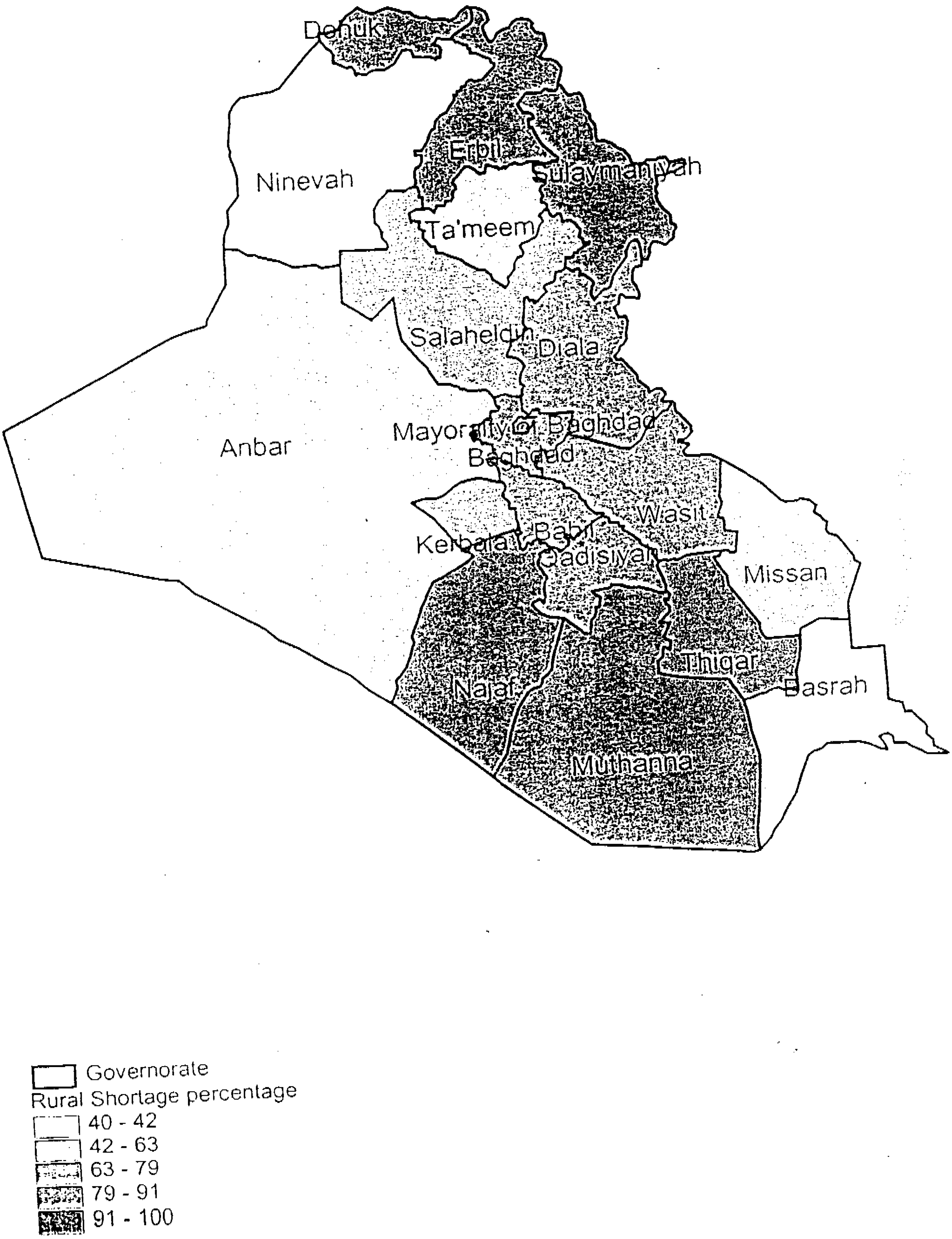


Ma 2.2: Water Supply Coverage in Rural Areas

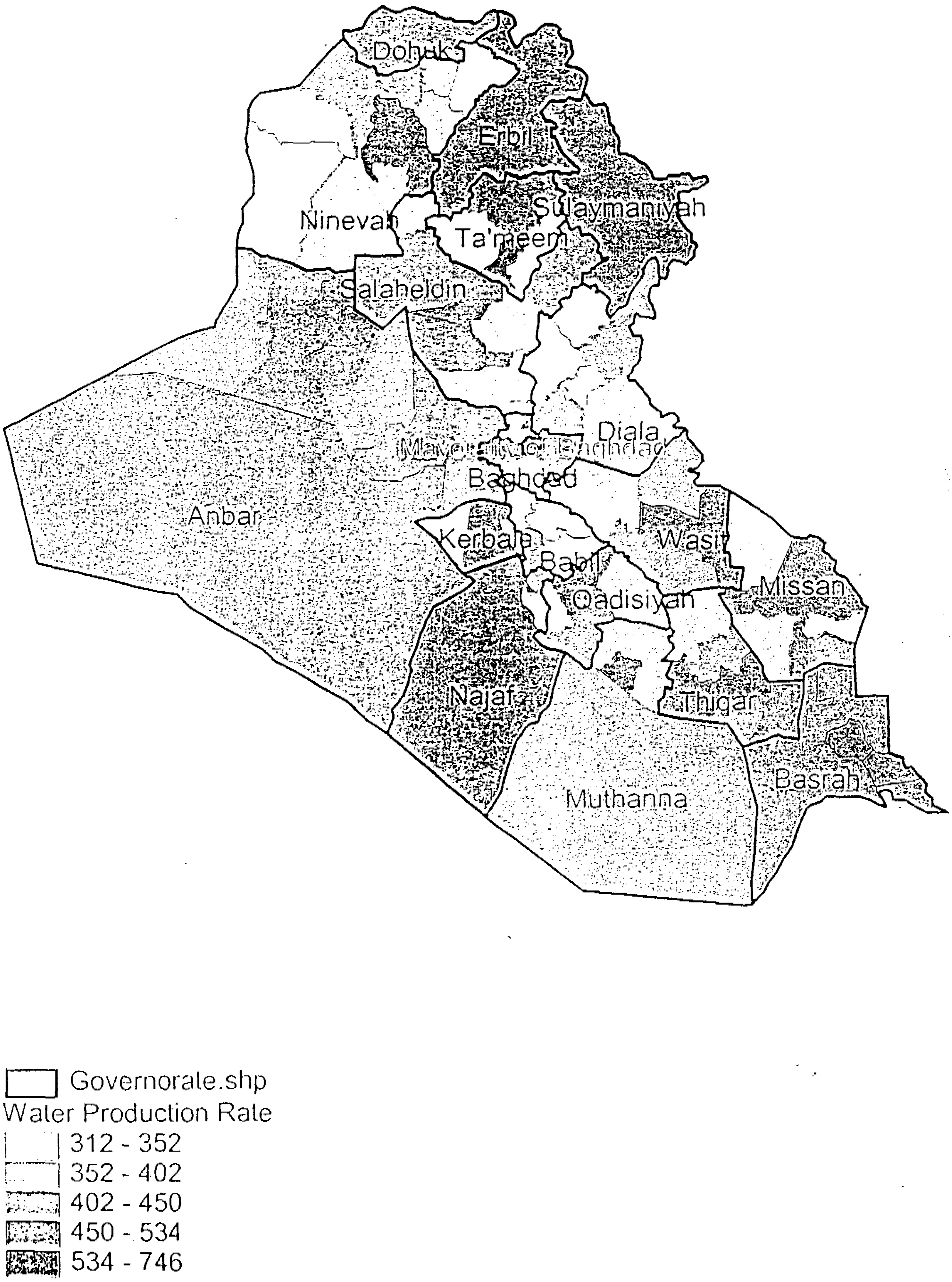


Map 2.3: Water Supply Rates in Urban Areas

Map 2.6: Shortage in Rural Areas – 2000



Map 2.7: Water Production Rates in lpcd



Assessment of the Sanitation Sub-Sector

SAFEGE
Consulting Engineers

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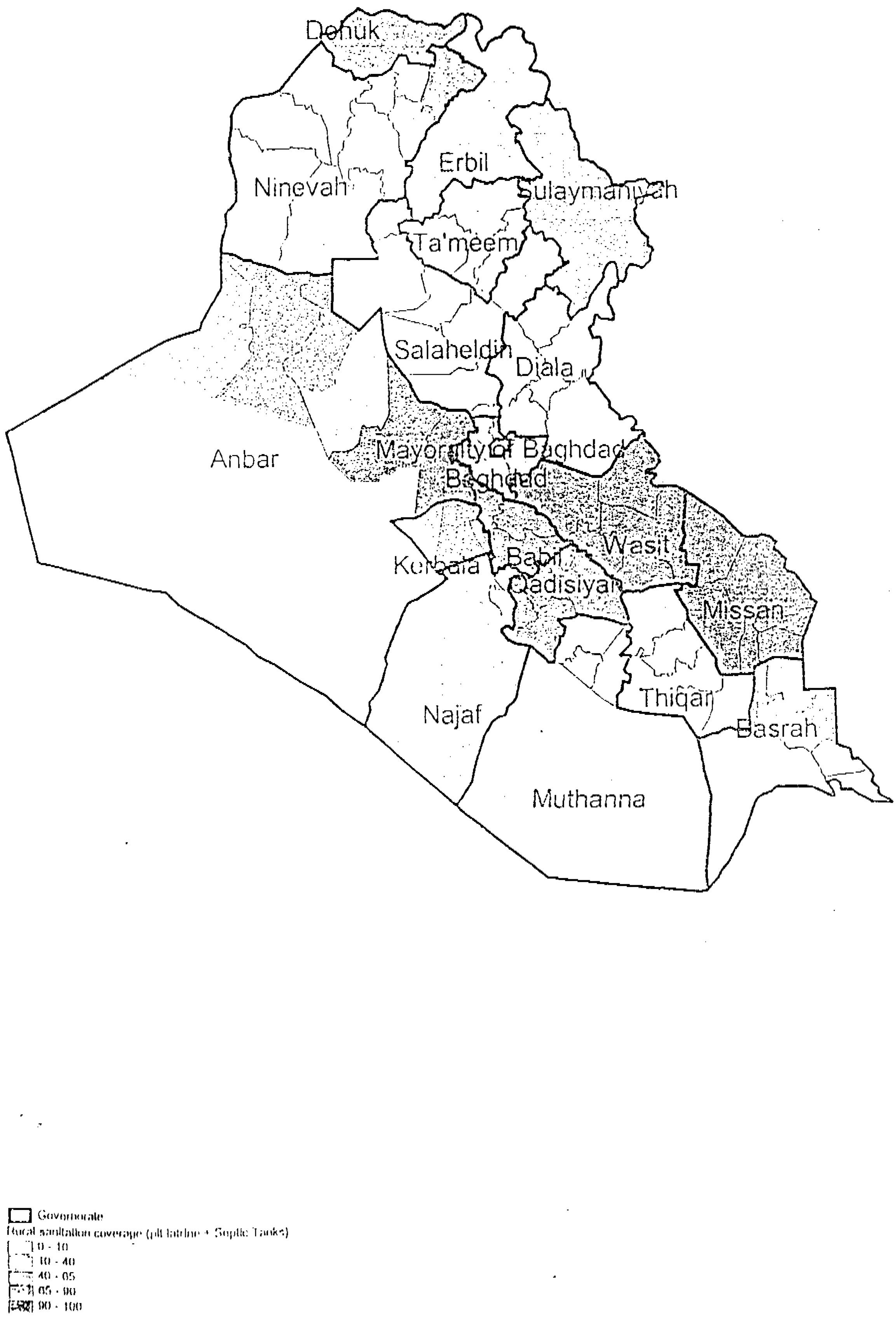
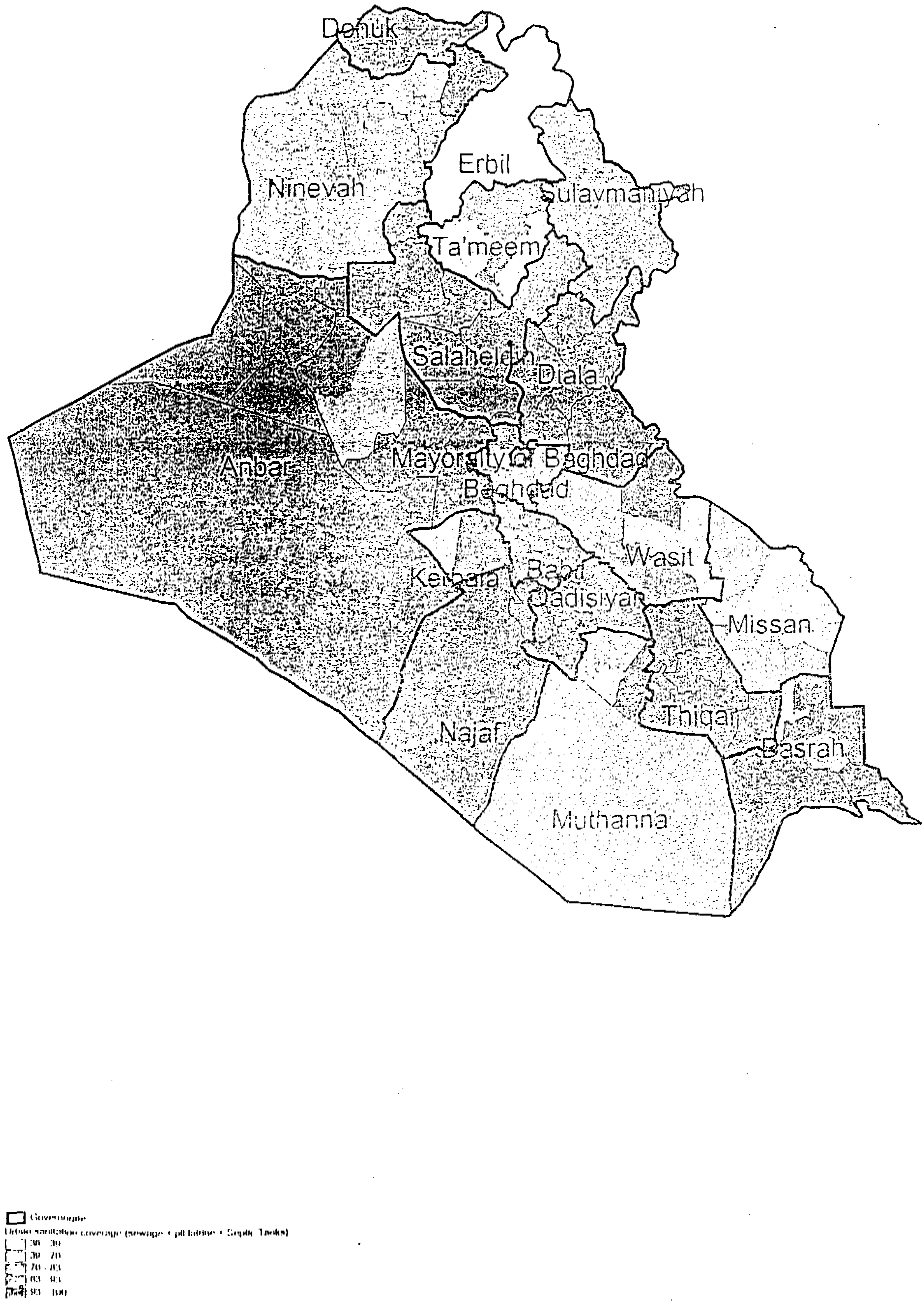
Map 3.1: Percentage of Rural Population Served by Safe Sanitation



Ma 3.2: Percentage of Urban Population Served by Safe Sanitation



Map 3.3: Percentage of Urban Population Served by Sewerage System (Sewers connected to treatment)

3. Assessment of the Sanitation Sub-Sector

3.1 Introduction

This assessment of the sanitation sub-sector addresses sewage and garbage issues.

The first section of this chapter deals with general aspects. The general methodology and approach are given together with definitions of relevant indicators and a discussion of issues affecting the country as a whole.

In the following section, indicators are given for the three main regions of Iraq: the Mayoralty of Baghdad, the Center South region and the Northern Autonomous Region. The indicators are presented primarily in the form of tables.

The general structure of the presentation is as follows:

- Sewage disposal systems, i.e. aspects related to sources of sewage and coverage by sewerage systems and on-site sanitation.
- Public sewerage infrastructure.
- Garbage management.

It should be pointed out that, in terms of service provided to users, the sanitation sub-sector falls far short of GOI objectives. Furthermore, the volume of data available is limited. This assessment was therefore understood as a means of structuring the main indicators with a view to elaborating the planning tool described in Chapter 5.

3.2 General Aspects

3.2.1 Sewage Disposal Systems

3.2.1.1 Assessment of Sewage Sources

3.2.1.1.1 General

The sewage comprises:

- Water supplied to consumers and ending up as wastewater.
- Groundwater infiltration into the sewer system. Allowances are generally expressed as a percentage of the total flow.

Sewage volumes are generally calculated according to:

- The anticipated volume of water supplied to users (anticipated demand).
- The anticipated return rate to sewers, i.e. the percentage of water supplied to users which ends up as wastewater.
- An allowance for infiltration water.

Official sewage per capita figures exist in Iraq and will not be subject to question since found consistent with target per capita water demand levels.

3.2.1.1.2 Per Capita Water Demand Levels

The official water demand figures, presented in chapter 4, are summarized in the following table.

Table 3-1: Per Capita Water Demand

	Baghdad (lpcd)	Municipality (lpcd)	Municipalities (lpcd)	Rural (lpcd)
Domestic Users	330	300	250	180
Industrial & Commercial.	40	30	20	0
Government	55	50	40	10
Total	425	380	310	190

3.2.1.1.3 Sewage Per Capita Levels

For GCWS, official per capita sewage levels are available and are broken down according to the categories Municipality, Municipalities and Rural.

The category "Municipality" refers to the capital cities of the various Governorate and is assessed according to the corresponding sub-district populations. "Municipalities" means the other cities within the Governorates and is also assessed by the corresponding sub-district populations. The category "Rural" applies to the sub-districts urban populations.

A comparison of per capita water demand and sewage levels shows that the latter can be derived from the former assuming a rate of return to sewers of approximately 60%.

Rates of return are generally considered to fluctuate between 60% to 80%, depending upon the local context. In hot countries, where per capita water demand is relatively high due to a variety of factors including water requirements for air conditioning, a rate of return of 60% is not unrealistic.

In European countries where per capita water demand levels are lower (less than 150 lpcd for domestic consumption and a maximum of 200 lpcd for all uses combined) the rate of return is higher, reaching around 80%.

Per capita sewage levels have been derived from per capita water demand levels and are given in the table below.

Table 3-2 : Sewage per Capita Levels

	Baghdad (lpcd)	Municipality (lpcd)	Municipalities (lpcd)	Rural (lpcd)
Domestic Users	200	180	150	110
Industrial & Commercial.	25	20	15	0
Government	35	30	20	10
Infiltration	40	40	35	30
Total	300	270	220	150

3.2.1.1.4 Sewage Sources

Sewage sources will be calculated by multiplying the population of each category (Municipality, Municipalities, Rural) by the relevant per capita levels.

This calculation will be performed: (i) on the basis of the current population to assess current sewage sources, and (ii) on the basis of population forecasts for 2010 to assess 2010 requirements.

Current sewage source estimates may to some extent appear excessive, a fact attributable to the shortage of water due to the poor condition of the existing water supply system.

3.2.1.2 Coverage by Sewage Disposal Systems

3.2.1.2.1 Sewage Disposal Systems in Iraq

From the standpoint of human health, the hygienic disposal of sewage is essential. It is widely acknowledged that a lack of sanitation results in the spread of water borne diseases.

Sewage disposal in Iraq involves one of two forms of sanitation:

- Sewerage
- On-site sanitation

Sewerage

In dense urban areas, sewerage involving the treatment of the sewage prior to discharge to rivers is considered as the only form of sanitation conducive to proper hygiene. Before the war, GOI made very considerable efforts in this area, with particular emphasis on urban areas including Baghdad and other major cities.

At present, sewerage incorporating the treatment of sewage is limited to projects serving:

- 80% of the population of the Mayoralty of Baghdad.
- 9% of the urban population of other big cities in the Center South region.
- None of the population of the Northern Autonomous Region though sewers do exist in this region.

Sewerage is a public service which relies on public infrastructure and is managed by a public body.

On-site Sanitation

On-site sanitation is proposed as a method of disposing of domestic wastewater, including excreta, in areas where sewerage is neither technically nor economically feasible. In rural areas it is standard practice, whereas in urban areas it serves as a temporary solution to be replaced when possible by sewerage.

On-site sanitation includes a variety of methods:

- Collective on-site sanitation for small communities or individual on-site sanitary units at the household level.
- A wide range of technologies including pit latrine, pour-flush latrines, septic tanks, etc.

For presentational purposes two methods have been selected:

- Septic tanks
- Pit latrines

Septic tanks are in principle watertight to prevent the seepage of sewage into the surrounding environment. Pit latrines, on the other hand, have no concrete base so that the sewage permeates the soil. Pit latrines are accordingly confined to rural areas or areas where there is no risk of polluting the groundwater table.

On-site sanitation investment and operating costs are usually borne by the local inhabitants.

On-site sanitation facilities require regular emptying, the frequency of which depends on:

- Whether they cater for domestic water (used for bathing, cooking and washing), in addition to excreta.
- Whether there is any seepage from the system.

The emptying of on-site sanitation facilities requires purpose-built vehicles which should be operated by the public authorities. Due to the lack of public authority vehicles however, communities are forced to rely on privately-owned vehicles.

Unhygienic Sanitation

All situations that are not covered by either of the categories above (collection of sewage for treatment or on-site sanitation) fall into the category of unhygienic sanitation.

This covers a number of situations including:

- Communities served by sewers which are not connected to treatment systems
- Communities where sewage is disposed of in storm drains
- Communities with no form of sewage facility and practicing open land defecation

3.2.1.2.2 Coverage Indicators

Indicator Definition

The adequacy of sewage disposal systems can to a large extent be assessed by means of coverage indicators. In rural areas, coverage is always through on-site sanitation in the form of septic tanks or pit latrines. In Urban areas, coverage is either on-site or by sewers connected to a sewage treatment plant. The indicators used are as follows:

For the rural population:

- Septic-tank coverage, referring to the percentage of rural population served by septic tanks.
- Pit-latrine coverage, referring to the percentage of rural population served by pit latrines.
- Sanitation coverage, referring to the sum of septic tank coverage and pit latrine coverage.

For the urban population:

- Septic-tank coverage, referring to the percentage of urban population served by septic tanks.
- Pit-latrine coverage, referring to the percentage of urban population served by pit latrines.
- On-site sanitation coverage, referring to the sum of septic tank coverage and pit latrine coverage.
- Sewerage coverage, referring to the percentage of urban population served by a sewer network connected to a sewage treatment plant.
- Sanitation coverage, referring to the sum of on-site coverage and sewerage coverage.

Calculation

- GCWS and the Mayoralty of Baghdad

The survey undertaken by UNICEF in 1995 gives at the sub-district level the breakdown of the above-mentioned categories in terms of percentage and population.

Though the population has increased since that time, coverage levels remain substantially the same, and coverage percentages are accordingly applied to the current population.

- Northern Autonomous Region

In the absence of the database from the 1995 survey, the data has been taken from the survey carried out during the course of the study.

- Urban Areas

The percentage of coverage is derived from the breakdown of the population as arrived at from the responses to Questionnaire N° 5. Percentages have been applied to the available statistics on the urban populations. Where not available, the data has been completed by average data at the Governorate level.

- Rural Areas

The percentage of coverage is derived from Questionnaire N° 11 where the share of population said to have access to safe sanitation are assumed to have pit latrines. For each sub-district, the percentage has been applied to the available population statistics.

3.2.1.2.3 Coverage Results by Region

Table 3-3 : Sewered Population Connected to Treatment Systems [1]

Region	Urban Population	Population Served	Percentage
Mayoralty of Baghdad	4 753 379	3 802 703	80%
Centre South	9 387 381	924 394	10%
North	2 483 777	0	0%
Total	16 245 537	4 727 097	28.4%

Table 3-4: Urban Population Served by On-site Sanitation [2]

Region	Urban Population	Population Served by Pit Latrines	Population Served by Septic Tanks	Total Population served by On-site Sanitation	Percentage of Urban Population Served
Mayoralty of Baghdad	4 753 379	0	950 676	950 676	20%
Centre South	9 387 381	2 835 419	4 551 028	7 386 447	79%
North	2 483 777			1 633 521	66%
Total	16 624 537			9 970 644	60%

Table 3-5: Rural Population Served by On-site Sanitation [2]

Governorate	Rural Population	Population Served by Septic Tanks	Population Served by Pit Latrines	Total Population served by On-site Sanitation	Percentage of Rural Population Served
Mayoralty of Baghdad	15 694	0	15 694	15 694	100%
Center South	6 728 567	1 514 333	937 597	2 451 930	36%
North	1 020 706			390 283	38%
Total	7 764 967			2 857 907	37%

[1] Query IS 2

[2] Query IS 4

3.2.2 Public Sewerage Infrastructure

3.2.2.1 Sewage Treatment Plants

3.2.2.1.1 Treatment Standards

Standards applicable to treated effluent are defined by Government Act Regulation N°25, 1967. Parameters include:

• BOD5	less than 40 mg/l
• Suspended solids	less than 60 mg/l
• COD	less than 100 mg/l
• Nitrate	less than 50 mg/l
• Ammonium	no standard
• Phosphate	less than 3 mg/l

With regard to Nitrate, the figure may be understood as referring either to Nitrate (NO3) or to Nitrogen (N-NO3). 50 mg/l NO3 is equivalent to 11 mg/l N-NO3. Depending on the interpretation, the level of treatment required differs considerably.

Basically, sewage treatment plants are designed either for carbon pollution removal or for carbon and nitrogen removal.

Nitrogen removal is usually limited to developed countries where rivers are prone to eutrophication. This stage of treatment is far more costly in terms of plant sizing and power consumption. In view of the design of the existing sewage treatment plants, the Nitrate level shall be taken as 50 mg/l N-NO3, i.e. that for treatment limited to carbon removal.

3.2.2.1.2 Main Processes

With regard to the facilities provided, Iraqi sewage treatment plants can be divided into three main categories:

- Conventional Activated Sludge
  - Inlet works including screening and lift station
  - Grit removal system
  - Pre-aeration
  - Primary settling tanks
  - Aeration tanks and return sludge pumping station
  - Final sedimentation tanks
  - Sludge consolidation and digestion
  - Sludge drying beds

- Chlorination of final effluent

- Activated Sludge - Extended Aeration
  - Inlet works including screening and lift station
  - Grit removal system
  - Aeration tanks and return sludge pumping station
  - Final sedimentation tanks
  - Sludge drying beds
  - Chlorination
- Trickling Filters
  - Inlet works
  - Grit removal system
  - Primary sedimentation tanks
  - Pre-aeration and grease removal system
  - Trickling filters and return filter effluent pumping station
  - Sludge consolidation and digestion
  - Sludge drying beds
  - Chlorination of final effluent

Processes (i) "Conventional Activated Sludge" and (iii) "Trickling Filters" are suitable for large plants. Process (ii) "Activated Sludge – Extended Aeration" is used in smaller units.

These designs are well proven and well suited to their purpose. It should be noted that:

- The main advantage of trickling filters is the lower associated power consumption cost. Performance levels are however lower than those achieved with the activated sludge process.
- These processes are not designed to reduce phosphate levels. In the event that the sewage contains phosphate (a fact which is not known owing to the lack of analyses performed to date), the effluent fails to comply with standards.
- Primary settlers are provided for large-scale plants with the aim of reducing the size of aeration tanks and trickling filters as well as the power requirement. The sludges generated by primary settlers have a higher organic content and require sludge digestion, which is duly provided.
- Sludge dewatering is provided for by means of sludge drying beds, a suitable method in view of the hot, dry climate.

3.2.2.1.3 Sewage Characteristics

There are very few analyses available in Iraq regarding the quality of sewage. The only data made available originates from the Mayoralty of Baghdad and is presented below:

Table 3-6: Sewage Characteristics at the Inlet of Baghdad Sewage Treatment

	BOD5 * (mg/l)			COD ** (mg/l)			SS *** (mg/l)			P Tot *' (mg/l)		
	Max	*Average*	*Min*	*Max*	*Average*	*Min*	*Max*	*Average*	*Min*	*Max*	*Average*	*Min*
R0, 1 &2	492		114	1196		566	504		201			
R3	300		190				400		240			
Kerkh	200	150	100	600	200	100	400	300	200	30	15	10

All the systems operating in Iraq receive septic effluent, resulting in:

- Development of odors in the sewer system and treatment plants due to H_2S.
- Rapid deterioration of mechanical equipment.
- Development of sulfate-reducing bacteria which corrode ordinary concrete.
- Corrosion of reinforcement bars, which are uncovered.

The combination of high average temperature and flat land requiring a large number of pumping stations is a negative factor, which explains the tendency towards sewage septicity. To a large extent this is unavoidable and treatment plants should be designed accordingly.

3.2.2.1.4 Design Considerations

- Low Lift Pumps

Screw pumps are not protected against bulky, floating debris: the screws are dented and the drive units damaged.

- Screening

Most of the screens are out of order because:

- The equipment is not sufficiently robust.
- No measures are taken to address corrosion by H_2S.
- Access is either difficult or dangerous, preventing regular care of the equipment.
- Handling of the screenings is difficult.

- Grit Removal

Most of the plants are equipped with old-fashioned detritors, which are relatively inefficient: water melon stones only are retained, the volume of sand removed being extremely small in comparison.

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* Biochemical Oxygen Demand in 5 days

** Chemical oxygen Demand

*** Suspended Solids

*' Total Phosporus

Where longitudinal grit removal equipment is used, large amounts of sand can be found. In Rustamiyah, the volume of sand was so great that the resistance of the equipment was exceeded and the scraper assembly broke down shortly after commissioning.

Grit removal needs to be handled with care, with a requirement for sturdy equipment and sound design underpinned by a solid experience of the question.

- Digestion

All digestion plants are out of service and this for the following reasons:

- Obsolete design of gazometers and floating bells in the case of Rustamiyah Stages 1 and 2, and Kerkh, Stages 1, 2 and 3.
- Immersed mechanical mixing device which cannot be accessed for maintenance purposes in Rustamiyah, Stage 3.
- Lack of maintenance when gas sparging is used.
- Impaired operation of digestors owing to the presence of large particles due to ineffective grit removal.

- Sludge Drying

All mechanical dried sludge lifters equipping drying beds are out of order because they are not sufficiently robust to cope with the prevailing conditions.

- Quality of Equipment

The importance of sturdy, high quality equipment of proven design is to be stressed, since all sanitation equipment operate in extreme conditions (corrosive environment, out-of-doors operation and poor maintenance). Construction materials in particular must be judiciously chosen.

3.2.2.1.5 Civil Works Conditions

The quality of the concrete structures built before the war with Iran is generally good. Since the war and with the imposition of the embargo, the situation is very different owing to the shortage of cement (in particular the sulfate-resistant variety), of appropriate site equipment and of skilled labor. Quality of construction is poor, except where projects have been entrusted to foreign civil works contractors and closely supervised by experienced foreign consultants. Sewage treatment works in particular are subject to septicity of sewage.

3.2.2.1.6 General Condition

Public infrastructure has felt the full impact of the country's situation in recent years, with overall efficiency decreasing to reach in some cases an almost zero level of service.

This overall decrease in efficiency can be explained by a combination of factors, including:

- The lack of power to supply pumping stations and sewage treatment plants.
- The lack of spare parts to maintain facilities.
- The lack of vehicles and staff to clean sewer lines which, combined with the switching-off of pumping stations, has resulted in certain sewers becoming obstructed.

- The corrosion of concrete pipes and civil works resulting from the production of Hydrogen Sulfide in the sewer system.
- The lack of staff to operate the facilities.

The consequences of this situation are:

- The discharge to rivers of untreated sewage where existing sewage treatment plants and pumping stations are not operating efficiently.
- The depreciation of assets which will become more difficult to renovate with time.
- The risks to human health.

3.2.2.1.7 Indicators Related to Sewage Treatment Plants

Capacity

The adequacy of sewage treatment plant will be defined by:

- The implemented capacity (m^3/day).
- The ratio of available capacity to required capacity (%) expressed as implemented capacity (m^3/day) / urban sewage sources (m^3/day).

Efficiency (%)

UNICEF and Care International undertook a comprehensive survey of the efficiency of the existing sewage treatment facilities. The efficiency of the treatment facilities is based on the evaluation of the appropriateness and maintenance level of the following stages:

- Inlet works
- Primary (where any) and final settling
- Aeration tank or trickling filters
- Sludge consolidation and digestion (where any)
- Sludge drying beds
- Chlorination of final effluent

Each stage is given a weighting and broken down according to assessment criteria such as component appropriateness and level of maintenance.

The resulting project efficiency distinguishes between:

- The calculated project efficiency (%).
- The power-factored project efficiency (%). The project efficiency is reduced by assuming a power factor taking into account the level of availability of power supply or replacement by generators.

Survey data are not available for the Mayoralty of Baghdad.

3.2.2.2 Pumping Stations

3.2.2.2.1 Design and Condition

Three main types of pumping stations are found in Iraq:

- Submersible pumping stations
- Dry-well pumping stations
- Lift stations with screw pumps

The pumping stations generally suffer from three main problems:

- The lack of maintenance
- Corrosion due to sewage septicity
- Inadequate power supply

Recently, the situation has slightly improved with certain pumping stations affected by frequent power cuts being equipped with power generators and the replacement of defective pumps by imported equipment. The overall condition of pumping stations remains very poor however, particularly with regard to control panels and piping appliances. Very few pumping stations have screening devices which function correctly and pump lives are affected accordingly. While the electro-mechanical equipment was found to be in very poor condition, the condition of the civil works of the pumping stations visited was found to be acceptable.

Rehabilitation requirements are high, even where emergency rehabilitation has been provided by replacement of defective pumps and equipping with generators.

The analysis of data on the Center South region shows that pumping stations can be categorised according to:

- Small pumping stations, the number of which depends on local features, in particular land flatness and groundwater level.
- Main pumping stations whose number is independent of these factors.

3.2.2.2.2 Survey of Pumping Station Efficiency

UNICEF and Care International undertook a comprehensive survey of the efficiency of the existing sewage pumping stations. The efficiency of the treatment facilities is determined on the basis of the evaluation of the appropriateness and maintenance level of the following stages:

- Pump suitability
- Control panel
- Piping system
- Lifting appliances
- Regular maintenance

The resulting project efficiency is differentiated by:

- The calculated project efficiency (%).
- The power-factored project efficiency (%).The project efficiency is reduced by assuming a power factor taking into account the level of availability of power supply or replacement by generators.

In the Central South region, the results of the survey are used to assess rehabilitation needs. In the absence of data for The Mayoralty of Baghdad and the northern region, the results for the Center South region will be extrapolated.

3.2.2.3 Sewer Networks

3.2.2.3.1 Presentation

The term "sewer" applies to the separate or combined-system pipes through which the sewage flows.

In addition to sewers, there are stormwater drains which are not part of the sanitation infrastructure facilities since they are not intended to carry sewage. Existing stormwater pipe lengths will be presented herein however, where the relevant data is available. In many cases, there is no clear distinction between combined sewers and storm drains, since in the absence of sewers, communities dispose of their sewage via the stormwater network.

Much of the sewer network in Iraq was laid during the early eighties. Concrete sewers were subject to corrosion by Hydrogen Sulfide and preference is now given to PVC pipes for sewers of up to 400 mm in diameter and to GRP pipes for sewers of larger diameters.

Iraqi sewers are severely affected by silting and obstruction, which occur for the following reasons:

- Pumping station power cuts result in siltation of upstream pipes due to the sharp decrease in flow velocity.
- Lack of sanitation vehicles to carry out regular pipe cleaning.
- In some cases, the misuse of sewers is reported with pipes and drains used for the disposal of garbage.

With regard to network design:

- In Baghdad, the network laid between 1960 and 1980 is of the separate type.
- Since 1980, Baghdad has opted for a combined system.
- Projects within the Governorates are of the separate type.
- The nucleus networks of cities lacking comprehensive sewerage projects are in some cases of the combined type. In these cases, the distinction between combined and stormwater systems is unclear.

3.2.2.3.2 Indicators

The assessment by region makes use of questionnaire responses. These data remain limited since not all questionnaires have been returned.

Description

- Pipe length in ml, with breakdown by type: combined, separate, stormwater.
- Sewer length per population served (*ml/inhabitant*).
- Breakdown by material where available.

These indicators are presented below.

The length of sewer line per inhabitant served is a convenient indicator of quantity. It is particularly useful for the purposes of the planning tool. Given the dispersal of these data, they are difficult to exploit however and so ratios have been developed which are presented in a later chapter.

Efficiency

Assessing the efficiency of sewers is a useful step in determining rehabilitation needs. It is difficult however to define suitable indicators. As a tentative approach, the questionnaires include items on the condition of pipes and problems registered. From the response to these questions and from interviews with officials it can be deduced that:

- Concrete sewers are not suited to the country's climate. The use of concrete pipes should be strictly limited to storm sewers. Where this is not the case, rapid corrosion will occur resulting in pipe degradation. All concrete sewers should consequently be replaced.
- Where other materials are used (generally PVC and GRP) corrosion does not appear to be of concern. In these cases, the main problem is pipe obstruction. As opposed to the condition of the pipes, the problems involved are associated with i) the lack of regular pipe cleaning due to the lack of equipment and staff; ii) use of pipes to dispose of garbage; iii) pipe design - certain pipes being too small.

As a result, it is proposed that:

- All concrete sewers be replaced.
- 10% of other sewers be replaced to allow for pipe replacement and rehabilitation.

3.2.2.4 Sanitation Vehicles

The number of sanitation vehicles is limited. Those which do exist were acquired only recently under the oil-for-food program and are far from sufficient in number to ensure the proper cleaning of sewers. Sewer cleaning is a problematic issue in Iraq where: i) the general topography is flat; ii) sewerage projects rely on pumping stations which are frequently turned off due to lack of power and faulty equipment. Both factors combine to cause substantial levels of sand deposits in Iraqi sewers.

3.2.3 External Factors Impacting on Sewerage

Though sewerage and on-site sanitation are both seen as means to ensure safe sanitation, the two methods do not provide the same quality of service.

While sanitation needs appear to be best served by sewerage and treatment – where properly implemented and maintained - the quality of service provided by on-site sanitation is affected by the local situation.

Dependability indicators will reflect the impact of the local situation on sanitation, either by magnifying the consequences of inadequate sanitation or affecting the technical design of the project, in particular with regard to cost.

The groundwater level impacts the sanitation system by rendering on-site sanitation inefficient where the water table is high. The higher the water table, the greater the requirement for sewerage systems.

The indicator distinguishes three levels:

- Very high water level (0 to 2 m): the water table is near ground level so that septic tanks fill rapidly with infiltration water.
- High water table (2 to 5 m) : Although septic tanks are feasible, interactions will occur between the groundwater table and the sanitation system.
- Low water table (more than 5 m): the water table is deep and cannot affect the sanitation system.

The water table is:

- Very high throughout southern Iraq from Qadisiyah to Basra.
- High in Baghdad, where the table is approximately 3 m deep, except in those areas where the table is even higher due to the lack of sewerage.
- Low in Northern Iraq, i.e. in Ninevah and the Northern Autonomous Area.

River Water Quality

Water quality may be affected by unsatisfactory sanitation.

Some countries have developed monitoring programs to assess river water quality with regard to:

- Hydrological data: flows and, more specifically, low flows.
- Water uses: domestic, industrial, irrigation and recreational.
- Water quality: pollutant concentrations for a range of parameters including organic matter, nitrogen, phosphorous, suspended solids, toxicity and bacteriology.
- Impact of sewage on water quality: percentage of river pollution originating from sewage.

The available information on river water quality does not allow rivers to be classified according to their vulnerability to pollution. An indicator is proposed for a more detailed assessment however, since the impact on river water quality should be a crucial factor in formulating sanitation programs.

The proposed indicator is as follows:

- Normal level of vulnerability to pollution
- High vulnerability to pollution.

At this stage, all areas will be classified as highly vulnerable to pollution.

Urban Development

Urban development greatly magnifies the consequences of poor sanitation due to the large volume of sewage produced and the high concentration of the population which makes it vulnerable to the spread of disease.

Urban cities will be classified according to size. Urban city size is assessed by the Sub-district urban populations.

Table 3-7: Urban Categories

Category	Sub-district Urban Population
1	0 – 10 000
2	10 000 – 20 000
3	20 000 – 50 000
4	50 000 – 100 000
5	100 000 – 500 000
6	Above 500 000

Level of Rural Sedentarity

In rural areas, not all inhabitants live in flats or houses. Some live in more informal types of accommodation where sanitation is not necessarily an imperative - or sanitation requirements are simply different.

Census information at the Governorate level allows two categories of rural inhabitant to be distinguished:

- Category 1: Occupants of flats or houses
- Category 2: Occupants of other types of accommodation

3.2.4 Garbage Management

3.2.4.1 Introduction

In Iraqi cities, large amounts of garbage are left uncollected on the streets. The garbage sub-sector appears to be affected by the country's situation.

This presentation of the garbage sub-sector will address:

- The quantity of garbage produced by the population.

- Organisation of garbage handling and collection.
- Garbage disposal in landfill sites.

Garbage management is limited to urban areas and organized as follows:

- Mayoralty of Baghdad: Garbage management is under the responsibility of the Municipalities.
- Center South: At the Governorate level, responsibility for garbage management is shared between the Directorate for Municipality responsible for the Governorate capital, and the Directorate for Municipalities responsible for the other urban areas.
- Northern Autonomous Region: same case as for Center South.

The remit of the above-mentioned bodies is not limited to garbage management but also includes, for instance, street and road maintenance. The scope of the following assessment is strictly limited to garbage management however.

3.2.4.2 Garbage Production

Per capita urban domestic garbage production will be taken as 0.6 kg per day.

Generally-speaking, the production of garbage is dependent on a country's economic status. At the global level, garbage production is assumed to vary between 0.4 and 2 kg per capita per day. On the basis of information furnished during meetings with officials, garbage production in Iraq is assessed at between 0.5 and 0.75 kg per capita day. This figure concerns domestic garbage in urban areas which is subject to collection and treatment. Other garbage, like construction waste materials, will not be taken into account.

Garbage production cannot be assessed with any degree of precision. In the absence of weighing machines, the amount of garbage collected is deduced from truck capacity, a method which tends to magnify production levels. On the other hand, owing to the lack of equipment, not all garbage is collected, a fact which tends to shrink production levels compared with the true situation.

The figures mentioned by officials seem realistic considering the country's economic situation. We will therefore assume per capita production to be 0.6 kg per day. In no way does the analysis of database information allow us to arrive at a more precise figure.

Domestic per capita garbage production in European countries is evaluated at approximately 1 kg per capita day, including a large proportion of waste in the form of packaging, which is not a feature of garbage production in Iraq.

Per-capita garbage production is reported to have decreased since the beginning of the war owing to the economic situation. This tendency will no doubt reverse once the economy begins to recover further to the lifting of the sanctions.

It is likely that, within Iraq, per capita garbage production varies, particularly as a function of city size. The usual tendency is that in small urban areas, smaller levels of garbage are left out for collection than is the case in large urban centers. This fact will not be taken into consideration however owing to the lack of relevant data.

3.2.4.3 Garbage Handling and Collection

3.2.4.3.1 General

To a large extent, the issue of garbage handling and collection is a matter of logistics requiring the equipment and staff numbers to match the needs. It is these criteria which therefore provide the basis for the sub-sector assessment. At present both are inadequate.

Effective garbage management is not merely a question of having sufficient numbers of trucks however. It is also a matter of sound planning and management requiring collection systems which are tailored to the local situation, bringing into play factors such as urban typology and cultural practices.

3.2.4.3.2 Impact of Urban Setting on Garbage Management

With regards to garbage collection, the distinction should be made between:

- The size of cities
- The type of urban setting

Size of Sub-district

Generally, sub-districts are equipped with their own collection and disposal system including staff, vehicles and landfill disposal sites. Ninevah, for example, has as many landfills as urban sub-districts.

Small sub-districts produce lower levels of garbage and their needs are accordingly limited to small vehicles such as tractors.

Urban Setting

For main urban centers three types of urban setting be differentiated:

- Residential areas. Garbage presses are used to collect domestic garbage. Door-to-door collection is seen as the most efficient method where feasible.
- Dense city center areas. Many areas, including old downtown centers are characterized by a network of narrow streets which are not accessible to garbage collectors. Garbage collection in these areas tends to be tailored to the local situation. Among the technical means used are: tractors, shovels, dumping trucks, tippers and even hand carriages.
- Street and trade markets. Theses generate high quantity of garbage which is strewn on the ground and must be removed by street cleaners. In this case, the garbage is transported by presses or tractors.

3.2.4.3.3 Garbage Packaging

Packaging of garbage is a problematic issue in Iraq. The use of cheap plastic bags which were subsidized before the war, is today less frequent and large amounts of garbage are thrown out unwrapped. Collection of this loose garbage is consequently more time consuming and cleaning less efficient.

3.2.4.3.4 Removal of Garbage by Inhabitants

In areas where door-to-door collection is not provided, garbage is removed by the local inhabitants - in particular, women – and deposited in nearby wasteland areas, from where it is removed by garbage collectors or any other available means.

3.2.4.3.5 Organization of Garbage Collection

Technical Means

The main technical means found in Iraq are:

- Door-to-door collection by garbage press or tractor in the case of residential areas.
- On open wasteland and in the absence of buildings, streets or markets, any appropriate technical means depending on access: garbage press, tractor, shovel and tipper, dumping trucks or hand carriage.
- Containers provided for the disposal of garbage by inhabitants. When full, these containers must be removed by lorries equipped with cranes. To be effective this type of collection requires: (i) that containers be removed on a regular basis so that the service is reliable; (ii) that users be educated on the benefits of using the containers properly.

Frequency

Collection on a daily basis is seen as the most efficient way to remove garbage. However, due to the lack of equipment and staff, the actual frequency of garbage collection is often much lower. Though certain key locations are serviced daily, the majority are visited far less often or in some cases never.

In European countries, reducing the frequency of collection to once or twice a week is seen as a means of optimizing the cost of collection. This does not appear feasible in Iraq where the population is not in the habit of keeping garbage in the home.

Available Equipment

According to the database, the equipment available in Iraq comprises:

- Garbage presses of capacities ranging between 1 and 16 m3, the usual capacity being 8 m^3.
- Tractors of capacity ranging between 1 and 8 m^3, the usual capacity being 4 m^3.
- Dumping trucks of capacity ranging between 1 and 12 m^3, the usual capacity being 8 m^3.
- Tippers of capacity ranging between 1 and 16 m^3.
- Containers of capacity ranging between 2 and 16 m^3, the usual capacity being 8 m^3.

3.2.4.4 Garbage Disposal

Garbage is disposed of in landfills. Generally, each Sub-district has its own landfill the capacity of which depends on the urban population. Since the urban population in many sub-districts is small, there are a large number of very small landfills.

The quality of service provided by the landfill is usually assessed according to:

- Whether or not the landfill complies with regulatory standards.
- The residual capacity of the landfill in terms of the number of years of operation remaining before the landfill is filled to capacity.

3.2.4.4.1 Standards

Existing Standards

Standards exist with regard to landfill location and operation. These can be summarized as follows:

- Garbage areas should be located 10 to 15 km to the south of cities.
- Garbage should be compacted.
- After filling, landfills should be covered by layer of compacted soil.

As determined in meetings with officials in Baghdad, Mosul, Diwayiniay and Basra, and from a visit of landfills in Baghdad, very few disposal areas comply with the existing regulations. In Basra, a landfill site does exist at a distance of 30 km from the city but a closer landfill is also in use.

The lack of equipment (in particular, bulldozers) is seen as a major obstacle to the sound management of the sites.

To comply with standards landfill sites would also need to be located further away from cities than is the case at present. Such a measure would increase transport times between the city and the landfill area, reducing the time available for collection and hence the collection efficiency per truck.

Groundwater Protection

At the global level, landfills are increasingly required to be risk-free in terms of groundwater pollution, a tendency fuelled by the increasingly stringent regulations in this area. Such a requirement involves the implementation of measures such as protection against seepage by use of watertight soils, construction of linings, draining and treatment of seepage and collection and combustion of gases.

The protection of groundwater is not considered of importance in Iraq, where much of the drinking water comes from surface water.

Where complied with, the existing standards allow limited protection of the water table by:

- Locating landfills at least 15 km away from cities to prevent pollution of groundwater near urban areas;
- Covering landfills after operation by imported fill, so that garbage is protected against rainwater and there is no resultant seepage into the groundwater table.

The question should be posed however as to whether the existing standards are sufficiently stringent. Guidelines on this matter are presented below.

3.2.4.4.2 Landfill Capacity

The data available do not allow the residual capacity of the existing landfills to be determined with any degree of precision. Where available, the residual capacity is reported to be limited to just a few years.

The only landfills which are thought to have at least 5 more years of operating capacity are in Ninevah, Kerbala Center and Amara Center.

3.2.4.5 Sector Performance Indicators

3.2.4.5.1 The sector performance is based upon a comparison of the available equipment with theoretical figures.

The performance of the garbage sub-sector can be assessed in one of two ways:

- By comparing the quantity of garbage collected to a theoretical value calculated from the urban population, the hypothetical production rate of 600 g per capita per day and the average density assessed at 0.3 kg/m^3.
- By comparing the available equipment to theoretical values.

The dispersed nature of the available data makes the first of these two methods impracticable.

The following assessment relies therefore on a comparison of the available equipment with theoretical figures.

The theoretical figures are derived using the planning tool developed for the purpose of assessing the development plan. This tool is presented further on. The theoretical figures which are used to assess the existing situation are based upon the 2000 population while the development plan draws on population forecasts for the year 2010.

Basically, the collection profile from which the theoretical figures have been derived is based upon the following assumptions:

- Small centers producing less than 2.5 tons of garbage per day rely on tractors.
- Medium-sized sub-districts rely on garbage presses for collection of 90% of garbage production and on tractors for 10% of production.
- Large centers producing more than 50 tons per day rely on three types of collection: garbage presses for 80% of the garbage produced, containers for 10% of garbage production and, for the remaining 10%, specific means suitable for collection in dense areas.

3.2.4.5.2 Staff

Staff requirements are based upon the number of garbage collection vehicles and the number of staff required per vehicle type:

- 3 people per garbage press
- 2 people per tractor
- 1 per shovel
- 1 per tipper

- 1 per dumping truck
- 2 per lorry

Based upon these assumptions, the staff required to collect garbage represent around 1 in 1 300 inhabitants, or 1 person per 800 kg garbage per day, which means a low level of efficiency. The far lower ratio of 1 person per 500 inhabitants was proposed during meetings with officials.

It should be pointed out that:

- The number of staff required depends on the means of collection used. The larger the number of dense areas requiring specific means of collection, the higher the staff requirement. The split (80%/10%/10%) that we have proposed as a medium-term objective may today appear optimistic.
- The number of staff required also depends on the amount of garbage packaged. Where staff have to gather loose garbage, efficiency is lower than expected.
- A third factor influencing staff requirements is staff motivation. A policy of hiring staff daily may have a negative impact in this respect.

The staff in charge of solid waste management are also responsible for street cleaning, since in the local context, both activities are closely related. It is thought that the permanent staff for both activities represent nearly 20 to 25% of the total staff of each local Directorate. In addition to permanent staff, these activities require the hiring of daily labor, whose number may triple that of the permanent staff assigned to collection and cleaning. Including hired staff, the staff dedicated to garbage management can account for a large proportion of the total staff employed in Governorate capital cities.

As a result, the current levels of staff dedicated to garbage management are not known with any degree of precision and cannot be considered as a performance indicator.

3.2.4.5.3 Garbage Collection Performance Indicator

The indicator proposed to assess the current level of service is defined as:

Value of recent equipment including equipment on hold (USD) / value of equipment needed to meet requirements.

3.3 Assessment of Sanitation in the Mayoralty of Baghdad

3.3.1 Sewage Sources

Table 3-8 : Sewage Sources within the Mayoralty of Baghdad [3]

Governorate	Urban		Rural	
	Urban Population 2000	*Urban Sewage Sources (m^3/day)*	*Rural Population 2000*	*Rural Sewage Source (m^3/day)*
Mayoralty of Baghdad	4 753 379	1 426 013	15 694	2 354

3.3.2 Existing Sewage Disposal System

3.3.2.1 Coverage

Table 3-9: Existing Sewage Disposal Coverage in Rural Mayoralty of Baghdad [4]

Governorate	Septic tanks coverage (%)	Pit Latrine coverage (%)	Sanitation coverage (%)
Mayoralty of Baghdad	100%	0	100

Table 3-10: Existing Sewage Disposal Coverage in Urban Areas – Mayoralty of Baghdad [5]

Governorate	On-site Sanitation Coverage			Sewerage Coverage	Sanitation Coverage
	Septic Tanks (%)	*Pit Latrines (%)*	*Total (%)*	(%)	(%)
Mayoralty of Baghdad	20	0	20	80	100

The non-sewered population relies in principle on septic tanks. It is doubtful whether, in the case of Baghdad, such a means of sanitation can be considered as safe. In the unsewered areas, the water table is gradually rising due to wastewater stagnation. This phenomenon was observed during a visit to the Al-Khansa area (Seventh of July District) and is partly attributable to the fact that the population in these areas cannot afford regular emptying of the septic tanks as required from a health and environmental standpoint.

[3] Query IS 8

[4] Query IS 10

[5] QuerY IS 9

3.3.2.2 External Constraints

- Groundwater Table

  The groundwater table in Baghdad can be classified as high. On average it is around 3 meters, except where sewage infiltration in the absence of sewers raises the water table to around soil level.

- Urban Development

3.3.3 Public Infrastructure

3.3.3.1 Background

Until 1963 Baghdad had no major form of sewerage system. Virtually all waste was disposed of by septic tanks, or as in the case of certain industrial effluents discharged untreated into the river. Following completion of the east trunk sewer in 1963, various east bank districts between the army canal and the River Tigris were equipped with foul sewers. In addition to the area served by the east trunk sewer, much of the city center of Rusafa was provided with proper sewerage through connection to the Shutait surface water drainage system. The Shutait outfall and the East trunk sewer feed the Rustamiyah treatment works, which were completed in 1963 and extended in 1966, 1982 and 1984.

Sewerage was introduced to the West bank following the completion of the west trunk sewer. Flows from the west trunk sewer discharge into the Kerkh sewage treatment works commissioned in 1982 and extended in 1985.

A sewerage development plan was formulated in the early eighties, since at that time the sewered population represented still only 24% of the total population. The existing sewer system is the result of the extensive sewerage development efforts deployed between 1982 and 1985.

3.3.3.2 Sewage Treatment Plants

Table 3-11: Existing Sewage Treatment Plants - Mayoralty of Baghdad [6]

Governorate	Project	Design Capacity m^3/day	Process
Mayoralty of Baghdad	Rustamiyah 0 &1	79 000	Conventional
Mayoralty of Baghdad	Rustamiyah 2	90 000	Conventional
Mayoralty of Baghdad	Rustamiyah 3	300 000	Conventional
Mayoralty of Baghdad	Kerkh	205 000	Conventional
Mayoralty of Baghdad	**Sub total**	**674 000**	

[6] Query IS 11

Table 3-12: Sewage Treatment Plants –

Ratio of Available Capacity to Required Capacity – Mayoralty of Baghdad [7]

Mayoralty of Baghdad

Governorate	Sewage Treatment Plant Capacity (m^3/day)	Urban Sewage (m^3/day)	Ratio of Available Capacity to Required Capacity (%)
Mayoralty of Baghdad	789 200	1 426 013	55

In the absence of the efficiency survey undertaken by UNICEF in Baghdad, the following efficiency table is proposed based upon visits paid to the site in the course of the study.

Table 3-13 : Sewage Treatment Plant Efficiency – Mayoralty of Baghdad

Project	Inlet Works		Pre Aeration Grease Removal	Primary and Final Settling	Aeration Tanks	Digestion	Sludge Drying Beds	Chlorination	Project Efficiency
	Stage Weighting 20 %	*Stage Weighting 10 %*	*Stage Weighting 5 %*	*Stage Weighting 15 %*	*Stage Weighting 25 %*	*Stage Weighting 10 %*	*Stage Weighting 10 %*	*Stage Weighting 5 %*	
R 0&1	70 %	25 %	50 %	25 %	50 %	5 %	20 %	5 %	41 %
R2	70 %	25 %	50 %	25 %	50 %	5 %	20 %	5 %	41 %
R3	30 %	5 %	40 %	5 %	70 %	5 %	20 %	5 %	33 %
Kerkh	30 %	5 %	20 %	5 %	20 %	5 %	10 %	5 %	17 %

3.3.3.3 Pumping Stations

Located in an alluvial plain, the Baghdad area is very flat. The mean gradient from North to South is about 1 in 5000. The sewerage system thus relies on 139 pumping stations comprising:

- Submersible pumping stations
- Vertical pumping stations

The major lift stations are:

- Habibiah
- Doura
- Ghazaly
- Hindiya

[7] Query IS 13

Table 3-14: Number of Pumping Stations per 100 000 Inhabitants - Mayoralty of Baghdad

Governorate	Number of Pumping Stations	Population Served	Number of Pumping Stations per 100 000 Inhabitants
Mayoralty of Baghdad	139	3 802 703	3.66

In the absence of any survey to this effect, it is proposed to assign a 50 % project efficiency level to all pumping stations in the Mayoralty of Baghdad. This figure is the average PS efficiency within GCWS.

Table 3-15: Sewage Pumps Financed by the MOU Program

Governorate	Sewage Pumps Financed by the MOU Program Phases 1 to 7 USD
Mayoralty of Baghdad	8 371 534

The financing of pumps through MOU programs has allowed to begin the rehabilitation of pumping stations. However, this rehabilitation usually remains limited to replacing out of order pumps.

3.3.3.4 Sewer Lines

3.3.3.4.1 Current Situation

Table 3-16: Sewer Network Description - Mayoralty of Baghdad [8]

Governorate	Sewer System Length			Stormwater System Length	Total Pipe Length
	Separate *km*	*Combined* *km*	*Total Sewers* *km*	km	km
Mayoralty of Baghdad	1 407 524	2 636 513	4 044 037	51 268 273	55 312 310

[8] Query IS 15

Table 3-17: Sewer System Length per Capita - Mayoralty of Baghdad [9]

Governorate	Sewer System Length m	Population Served Inhabitants	Sewer Length per Capita m per Capita
Mayoralty of Baghdad	4 044 037	3 802 703	1.06

Background

Two main periods can be distinguished in the history of the Baghdad sewer system: before and after 1980.

The sewers laid between 1963 and 1980 are of the separate type. The dominant material is concrete. These concrete sewers are affected by high levels of corrosion resulting in the reduction of the life time of the pipes.

Following a decision made at that time, the sewers laid since 1980 differ in that:

- Corrosion-resistant materials like PVC and GRP have been used.
- Sewer system design shifted towards the use of the combined type rather than the separate systems of the past.

The allowance made for storm water was however limited for reasons of cost. It was considered acceptable to limit the design flow to four times the average foul flow. On this basis, computer analysis showed that the system could accept the entire run-off from a two-year return period storm event.

A high proportion of the sewers are in poor condition

The sewers laid before 1980 have been affected by severe corrosion due to Hydrogen Sulfide production. A detailed survey should confirm that all pre-1980 sewers require replacement.

In the Saddam City district, the poor construction of sewers has resulted in the presence of sand deposits in the system, particularly at the bottom of manholes and at pipe junctions. This situation is at its most severe in the northern part of the C line.

Certain areas are affected by flooding during storm events

In storm periods, the Saddam City district - one of the denser areas of Baghdad – is affected by surface flooding comprising a mixture of stormwater and sewage. Although the system was initially designed as combined, its storage capacity is insufficient. This problem is partly explained by the accumulation of sand and silt in the system, since the remaining pipe volume does not allow for the storage of stormwater. According to the operator, sand infiltration also affects the effectiveness of sewer cleaning.

The question also arises as to whether the storage capacity of the system is sufficient to meet sewerage requirements. This is particularly the case with regard to the East trunk sewer, although 3 m in diameter. There are tentative plans to lay a new trunk sewer to increase the capacity, which will require a comprehensive hydraulic study of possible alternatives.

[9] Query IS 16

Sewer Cleaning

As reported in meetings with operators, the accumulation of silt and sand in the system varies within the city. Sedimentation was reported to be acceptable in the Seventh of July district, while emerging as a major issue in the Saddam City district.

Two main problems are observed. Firstly, jetting machines are limited in number and cleaning is performed manually in many cases. Secondly the number of staff available for cleaning is not sufficient.

In the Saddam City district, operating capacity is limited to four jetting machines, one manhole emptier, one tractor and 130 staff, for an area which serves approximately two million inhabitants and contains as much as 500 km of sewers with 100 000 connections.

3.3.3.4.2 Rehabilitation Requirements

Rehabilitation and replacement requirements are assessed as:

- 100 % of the separate network
- 10 % of the combined network

Table 3-18: Sewer Network Rehabilitation Requirement - Mayoralty of Baghdad

Governorate	Total Sewer System Length ml	Rehabilitation Requirement (%)
Mayoralty of Baghdad	4 044 037	41

3.3.3.5 Vehicles Allocated to Governorates

Table 3-19: Sanitation Vehicles Allocated to Governorates- Mayoralty of Baghdad

Governorate	Sanitation Vehicles Allocated to Governorates MOU Phases 1 to 7 US $
Mayoralty of Baghdad	5 270 919

3.3.4 Staff

The sector is split between BSA and the Municipalities.

Within BSA, the total number of positions is 597, of which only 197 are filled.

The number of staff allocated to sewerage in the Municipalities is not known.

3.3.5 Garbage

3.3.5.1 Theoretical Requirements

Table 3-20: Garbage Sector Theoretical Requirements – Mayoralty of Baghdad

Governorate	Garbage Production Ton/day	Garbage Presses (8 m³)	Tractors (4 m³)	Dumpers	Shovels	Tippers	Lorries	Containers	Staff
Mayoralty of Baghdad	2 852	907	121	62	62	119	119	289	3 444

The above figures are based on country-wide assumptions, so that the local situation may not be reflected with precision, particularly in terms of the breakdown between the different means of collection. The table does however give an idea of the task force necessary to meet the requirements.

Per capita ratios can be defined by dividing the requirements by the urban population of the Mayoralty of Baghdad (4 753 379):

- Total collection-vehicle requirements: 1 per 3 400 inhabitants.
- Garbage press requirements: 1 per 5 240 inhabitants.
- Staff requirements: 1 per 1 400 inhabitants.

3.3.5.2 Comparison with Existing Capacity

3.3.5.2.1 Visit to Municipalities

Saddam City

Saddam City is a densely-populated area of Baghdad with approximately 2 millions inhabitants.

The vehicles effectively in operation are below requirement levels, at:

- 50 garbage presses (1 per 40 000 inhabitants)
- 8 shovels
- 70 containers with 16 m3-capacity
- 70 containers with 1 m3-capacity

Staffing is also inadequate with only drivers on a permanent basis and operators hired on a daily basis. This results in poor levels of staff motivation whose efficiency is limited. The two main reasons for staff shortages are (i) the low wage levels, (ii) the cultural stigma associated with working in the garbage sector. It appears that prior to the war, garbage collection was largely performed by foreign workers. Since the massive departure of these, the industry has been unable to recruit Iraqis willing to replace them, particularly in Baghdad.

7th of July District

The population in this area stands at approximately 800 000. In 1999 only 20 vehicles were available. With the arrival of 50 new trucks, this number has risen to 70. The number of garbage presses is only 1 per 11 400.

The district is also equipped with 100 containers of 16 m^3-capacity and 100 containers of 1 m^3-capacity.

3.3.5.2.2 Investment under the MOU Program

New equipment has been ordered under Phases 5 and 6 of the MOU Program.

Table 3-21: Investment under the MOU Program – Mayoralty of Baghdad

Mayoralty of Baghdad	Population	Value in USD	Number of Garbage Collectors	Number of Inhabitants per Vehicle
Phase 5		9 604 744	150	
Phase 6		28 305 800	500	
Total	4 753 379	37 910 544	650	7 312

Only a small part of this equipment has effectively been delivered and distributed to the Municipalities. The situation will improve however with the arrival of the rest of the equipment.

3.3.5.3 Garbage Collection Performance Indicator

Table 3-22: Garbage collection performance indicator – Mayoralty of Baghdad

	Value in USD Million of Current Fleet of Recent Vehicles (Including Vehicles on Hold)	Value of Vehicles Required to Meet Present Needs (USD million)	Garbage Service Level (%)
Mayoralty of Baghdad	38	151	25

3.4 Center South Region

3.4.1 Sewage Sources

Table 3-23: Sewage Sources within GCWS [10]

Governorate	Urban		Rural	
	Urban Population 2000 (Inhabitant)	*Urban Sewage Sources (m^3/day)*	*Rural Population 2000 (Inhabitant)*	*Rural Sewage Sources (m^3/day)*
Anbar	578 700	136 039	512 686	76 902
Babil	577 754	140 301	632 775	94 916
Baghdad	485 023	106 705	608 887	91 333
Basrah	1 331 889	328 276	347 713	52 156
Salaheldin	435 103	99 271	533 349	80 002
Ta'meem	594 147	155 879	239 437	35 916
Thiqar	759 794	183 792	521 479	78 222
Wasit	464 022	113 121	403 089	60 463

3.4.2 Existing Sewage Disposal System

Table 3-24: Existing Sewage Disposal Coverage in Rural Areas – GCWS [11]

Governorate	Septic Tank Coverage (%)	Pit Latrine Coverage (%)	Sanitation Coverage (%)
Anbar	43	47	90
Babil	10	75	85
Basrah	12	9	22
Diala	0	0	0
Kerbala	50	28	78
Missan	100	0	100
Muthanna	10	0	10
Najaf	0	16	16
Ninevah	0	0	0
Qadisiyah	76	10	86
Salaheldin	0	0	0
Ta'meem	0	0	0
Thiqar	0	0	0
Wasit	100	0	100

[10] Query IS 8

[11] Query IS 10

Table 3-25: Existing Sewage Disposal Coverage in Urban Areas – GCWS [12]

Governorate	On-site Sanitation Coverage			Sewerage Coverage (%)	Sanitation Coverage (%)
	Septic Tanks (%)	*Pit Latrines (%)*	*Total (%)*		
Anbar	29	65	94	4	98
Babil	10	72	82	5	87
Baghdad	18	49	66	0	66
Basrah	43	22	65	22	87
Diala	16	84	100	0	100
Kerbala	11	44	55	33	88
Missan	15	38	53	13	66
Muthanna	59	14	73	0	73
Najaf	0	80	80	20	100
Qadisiyah	52	31	83	12	95
Salaheldin	0	87	87	13	100
Ta'meem	68	14	81	4	86
Thiqar	74	11	85	15	100
Wasit	41	34	76	0	76

Table 3-26: Groundwater Table per Governorate - GCWS

Governorate	Groundwater Table Level	Source of Data
Anbar	Deep	Assumed
Babil	Very high	Assumed
Baghdad	High	Visit
Basrah	Very high	Visit
Diala	Deep	Assumed
Kerbala	Deep	Form 9
Missan	High	Assumed
Muthana	High	Assumed
Najaf	High	Assumed
Ninevah	Deep	Visit
Qadisiyah	Very high	Form 9 / visit
Salahuddin	Deep	Assumed
Ta'mem	Deep	Assumed
Thiqar	Very high	Assumed
Wasit	High	Assumed

[12] Query IS 9

Table 3-27: Rural Sedentarity Level [13]

Governorate	Sedentarity Level
Anbar	0.96
Babil	0.62
Baghdad	0.93
Basrah	0.72
Diala	0.76
Kerbala	0.97
Missan	0.30
Muthana	0.83
Najaf	0.96
Ninevah	0.72
Qadisiyah	0.60
Salaheldin	1.00
Ta'mem	0.36
Thiqar	0.49
Wasit	0.59

The sedentarity level fluctuates within the Governorates. The need for proper sanitation varies accordingly.

3.4.3 Public Infrastructure

3.4.3.1 Sewage Treatment Plants

3.4.3.1.1 Existing Projects

The sewage treatment plants operated by GCWS are presented in the following table:

[13] Query IS 18

Table 3-28: Existing Sewage Treatment Plants -GCWS

Governorate	Project	Design Capacity m³/day	Project Efficiency %	Powered Factor Efficiency %	Process
Anbar	Cement factory	2 000	5	5	
Anbar	Ubaidi	10 000	5	0	Extended aeration
Anbar	Ana	4 000	5	0	Extended aeration
Babil	Central Hilla	12 000	54	33	Extended aeration
Baghdad	Residential buildings	7 000	7	7	Extended aeration
Baghdad	Al Iskan Al Sina'ee	11 000	5	5	Extended aeration
Basrah	Central Basrah	35 200	44	44	Extended aeration
Kerbala	Central Kerbala	116 000	36	17	Extended aeration
Missan	Amara	30 000	13	7	Trickling filters
Najaf	Central Najaf	43 000	40	20	Trickling filters
Qadisiyah	Central Diwaniyah	12 000	39	13	Extended aeration
Salahedin	Al Faris	67 680	28	28	Extended aeration
Salahedin	Central Tikrit	20 160	55	14	Extended aeration
Thiqar	Central Nasiriyah	17 000	5	4	Trickling filters
Thiqar	Al Isqar	1 000 to	9	8	Trickling filters
Thiqar	Al Isqar al Sina'ai	1 400	20	13	Extended aeration
Thiqar	Residential buildings	1 000	10	9	Extended aeration
Total capacity		**389 440**			

3.4.3.1.2 Ratios of Available Capacity to Required Capacity

The following table gives, for each Governorate, total sewage treatment plant capacity and sewage production in urban areas.

Table 3-29: Sewage Treatment Plant / Level of Service –GCWS [14]

Governorate	Sewage Treatment Plant Capacity (m³/day)	Urban Sewage Sources (m³/day)	Ratio of Available Capacity to Required Capacity (%)
Anbar	16 000	136 039	11.8
Babil	12 000	140 301	8.6
Baghdad	18 000	106 705	16.9
Basrah	35 200	328 276	10.7
Diala	0	120 153	0
Kerbala	116 000	110 537	104.9
Missan	30 000	117 642	25.5
Muthanna	0	54 556	0
Najaf	43 000	161 856	26.6
Ninevah	0	370 728	0
Qadisiyah	12 000	117 642	25.5
Salaheldin	0	99 271	0
Ta'meem	0	155 876	0
Thiqar	19 400	183 792	10.6
Wasit	0	113 121	0
Total GCWS	**283 600**	**2 209 388**	**20.9**

3.4.3.2 Pumping Stations

3.4.3.2.1 Installed Capacity

Breakdown by Size of Pumping Station

The number of pumping stations per inhabitant is an indicator which fluctuates depending upon the local context, especially topography and groundwater table.

The local context usually impacts more on the number of small pumping stations. Therefore it has been proposed to split the pumping stations between long and small.

The distinction between Large Pumping Stations and Small Pumping Stations is made on the basis of pumping capacity. Pumping stations of 4 000 m3/day capacity and above have been defined as Main Pumping Stations.

Table 3-30: Breakdown by Size of Pumping Station

Pumping Station Capacity	Pumping Station Capacity	Number of Stations	Average Capacity m³/day
Main Pumping Stations	> 4 000 m³/day	39	20 389
Small Pumping Stations	< 4 000 m³/day	105	1 718

Breakdown by Type of Governorate

With regard to the number of pumping stations versus population served, three types of Governorate are distinguished:

[14] Query IS 13

- Governorates with a high number of pumping stations per capita.
- Governorates with a lower number of pumping station per capita.
- Governorates for which this analysis is not relevant (figures negligible).

The figures for the two first categories, given in the following table, show that the number of pumping stations per inhabitant served varies by region. In the Governorates where land slope is limited and water tables high, there is a large number of small pumping station per capita. On the other hand, no clear pattern emerges with respect to the Main Pumping Stations, since the larger per capita number is offset by a lower average capacity.

Table 3-31: Small Pumping Station - GCWS

Governorate	Number of Units	Average Capacity (m³/day)	Number of Pumping Stations per 100 000 Inhabitants Sewered
Anbar	5	2 500	23.2
Babil	10	1 320	37.9
Baghdad	1	2 000	
Basrah	56	1 882	18.9
Diala			
Kerbala			
Missan	1	3 000	1.7
Muthanna			
Najaf	2	2 000	1.6
Ninevah	5	132	ns
Qadisiyah	13	1 938	23.0
Salaheldin	2	1 800	3.6
Ta'meem	2	1 500	7.9
Thiqar	7	943	6.0
Wasit	1	1 200	

Table 3-32: Large Pumping Stations - GCWS

Governorate	Number of Units	Average Capacity (m^3/day)	Number of Pumping Stations per 100 000 Inhabitant Sewered
Anbar			
Babil	1	6 000	3.8
Baghdad	2	4 000	
Basrah	23	13 678	7.8
Diala			
Kerbala	3	72 000	2.2
Missan	1	57 600	1.7
Muthanna			
Najaf	3	7 000	2.4
Ninevah			
Qadisiyah			
Salaheldin	2	39 980	3.6
Ta'meem			
Thiqar	2	16 000	1.7
Wasit	1	10 000	

Table 3-33: Breakdown of Number of Pumping Station per Capita by Type of Governorate

Type of Governorate	Name of Governorate	Total Population Served	Main Pumping Stations			Small Pumping Stations		
			Number	*Average Capacity m^3/day*	*Number per 100 000 Inhabitant served*	*Number*	*Average Capacity m^3/day*	*Number per 100 000 Inhabitants Served*
High number of PS per capita	Anbar, Babil, Basrah, Qadisiyah	401 232	25	14 824	6.2	84	1 861	20.9
Lower number of PS per capita	Missan, Salaheldin, Thiqar, Kerbala, Ta'meem	397 293	8	48 195	2.0	12	1 350	3

3.4.3.2.2 Efficiency

Average pumping station efficiency was put at 50% by UNICEF and CARE, this figure being unaffected by project size:

- Main pumping stations: 50.73% efficiency
- Small pumping stations: 50.61 % efficiency

Efficiency varies according to the type of pumping station:

- Dry-well pumping station: 27.42%
- Lift pumping station: 29.41%
- Submersible pumping station: 54.51%

Pumping station efficiency also varies within the region, ranging between 26% at Anbar and 77% at Missan. In Basra, which accounts for a large share of the total number of pumping stations, efficiency is 57%.

3.4.3.2.3 Efficiency by Stage

The pumps themselves appear more efficient than other pumping station equipment, particularly pipe systems and lifting appliances. This would suggest that while it makes sense to limit emergency rehabilitation to the replacement of defective pumps, a long-term pumping station rehabilitation policy should take into account the facilities as a whole.

Table 3-34: Pumping Stations Efficiency by Stage

	Pump Suitability	Control Panel	Piping System	Lifting Appliances	Regular Maintenance	Project Efficiency	Power-Factored Project Efficiency
Main PS	58.04	48.55	33.77	40.49	54.94	50.73	36.44
Small PS	59.24	40.68	38.77	39.2	54.52	50.61	34.38

3.4.3.2.4 Sewage Pump Replacement under the MOU Program

Investment budgets allocated to pump replacement under the first Phase of the MOU program are presented below by Governorate.

Table 3-35: MOU Program Budget Allocation for Pumping Stations – GCWS (US$)

Governorate	Value of Sewage Pumps Distributed to Governorates under Oil for Food Program Phases 1 to 7
Anbar	1 643 640
Babil	45 571
Baghdad	42 064
Basrah	1 113 493
Diala	38 990
Kerbala	71 917
Missan	830 243
Muthanna	104 059
Najaf	81 825
Ninevah	72 214
Qadisiyah	75 829
Salaheldin	59 703
Ta'mem	45 835
Thiqar	107 199
Wasit	151 852
Total	**4 484 434**

The financing of pumps through MOU programs has allowed to begin rehabilitation of existing pumping stations. However, the table efficiency by stage shows that future full rehabilitation remains necessary.

3.4.3.2.5 Comments

Pumping stations are an important feature of Iraq's sewerage systems owing to topographic and climatic characteristics.

- The flatness of the country renders pumping stations an essential part of any design scheme.
- The high average temperature has a negative impact since it favors the development of Hydrogen Sulfide. This phenomenon is exacerbated by the large number of pumping stations.

Hydrogen sulfide results in:

- Odor problems
- Corrosion of concrete structures
- Corrosion of electrical equipment
- Influent septicity

In these circumstances it is particularly important that pumping stations operate efficiently. Unfortunately, due to the lack of staff and spare parts and above all the lack of power, many pumping stations have a global efficiency well below requirements.

3.4.3.3 Sewers

Table 3-36: Sewer and Stormwater Network Lengths – GCWS [15]

Governorate	Sewer Network Length			Stormwater Network Length	Total System Length	Population Served	Sewer Network Length per Capita
	Separate	*Combined*	*Total sewers*				
	km	*km*	*km*	km	km		m/capita
Anbar			0		0		
Babil		120.0	120.0	50.4	170.4	26.3911	4.5
Baghdad			0.0		0.0		
Basrah	565.3	147.0	712.3	108.0	820.3	296 708	2.4
Diala			0,0	4.2	4.2		
Kerbala		223.0	223.0	634.0	857.0	139 326	1.6
Missan	40.0		40.0		40.0	60 581	0.7
Muthana			0,0		0,0		
Najaf		162.0	162.0		162.0	123 406	1.3
Ninevah			0,0		0,0		
Qadisiyah	0.5	161.2	161.8	188.2	349.9	56 581	2.9
Salaheldin			0,0		0,0		
Ta'meem	50.0	150.0	200.0	100.0	300.0	25 166	7.9

Table 3-37: Pipe Breakdown by Material –GCWS [16]

Governorate	Breakdown Availability	Concrete	PVC	Asbestos Cement	Clay	Ductile	Other
	%[17]	(%)	(%)	(%)	(%)	(%)	(%)
Babil	59	10	90				
Basrah	88	2	75	1			
Kerbala	100	74	23	3			
Missan	125	50	50				
Najaf	100	9	85				6

[15] Query IS 15 and IS 16

[16] Query IS 20

[17] Breakdown availability means the percentage of sewer network length for which the breakdown per material is available.

Table 3-38: Pipe Breakdown by Age -GCWS [18]

Governorate	Breakdown Availability (%)	Less than 10 years	More than 10 years
Anbar			
Babil	59	100	
Baghdad			
Basrah	88	29	71
Diala	0		
Kerbala	100	100	
Missan	125	100	
Muthanna			
Najaf	100	100	

Table 3-39: Pipe Breakdown by Condition -GCWS [19]

Governorate	Breakdown Availability (%)	Good Condition (%)	Poor Condition (%)	Unknown (%)
Anbar				
Babil	59			100.0
Baghdad				
Basrah	88	21.4		78.6
Diala	0			
Kerbala	100	62.6		37.4
Missan	125	68.0	26.0	6.0
Muthanna				
Najaf	100	84.6		15.4

Although the data available remains limited, the main conclusions that can be drawn from the above tables are :

- The sewer length per capita fluctuates within the governorates. This may result of the inadequacy between sewer length and population served. Also, some storm drains may be included in the calculation. Usual figures in countries like Iraq can be expected between one and two meter sewer line per capita. We suggest 1.4 m per capita to develop the planning tool.

- The only project comprising a large number of concrete pipes is that of Missan, with 25 km of concrete pipes of more than 10 years in age, 52% of which are in poor condition.

- The network laid prior to 1975 is of the combined type. Since then, the policy has been to build a separate network using PVC and GRP pipes, a decision which seems to have produced an overall improvement in the condition of the system given the fact that the older concrete pipes are affected by corrosion. In the early eighties, large projects such as Basra were constructed by foreign contractors. Drawings for these projects are reportedly to be found at GCWS headquarters.

[18] Query IS 21

[19] Query IS 19

The problems reported are related more to obstruction and silting of sewers than to poor condition. However, there are no in-pipe CCTV surveys available to support the fact that pipe condition is generally good.

A tentative assessment of pipe condition would put this at 90%, meaning that 10% of the existing pipes should be replaced.

3.4.3.4 Vehicles

To ensure the satisfactory operation of the existing networks, the system require a fleet of cleaning vehicles, including:

- Jetting machines and drain cleaners for cleaning of existing sewers.
- Cesspit emptiers to ensure the regular cleaning of septic tanks.

The existing vehicles are superseded and cannot meet service requirements. The Governorates have been allocated new equipment however under the last Phase of the MOU.

The following table gives Vehicle Investment Budgets per Governorate:

Table 3-40: Oil-for-Food Budget Allocated to Sanitation Vehicles (US$)

Governorate	Total Value of Cesspit, Jetting and Drain Cleaning Vehicles Allocated to the Governorates under the Oil for Food Program, Phases 1 to 7
Anbar	1 319 187
Babil	1 044 946
Baghdad	1 344 595
Basrah	1 153 357
Diala	863 962
Kerbala	1 161 151
Missan	1 044 946
Muthanna	512 516
Najaf	1 069 351
Ninevah	827 451
Qadisiyah	863 571
Salaheldin	1 123 551
Ta'meem	640 866
Thiqar	140 400
Wasit	991 682

This table shows the present value of investment already made. This value will be deduced of future requirements.

3.4.3.5 Staffing

Table 3-41: Comparison Between Occupied and Vacant Positions

	Sewage Authority														
	Administrators			Managers & Engineers			Operators			Technicians			Unskilled Laborers		
	Occupied	Vacant	Total	Occupied	Vacant	Total	Occupied	Vacant	Total	Occupied	Vacant	Total	Occupied	Vacant	Total
Maqar SA	17	80	97	19	47	66	6	17	23	5	40	45	4	15	19
Anbar	10	94	104	6	18	24	26	123	149	7	75	82	5	86	91
Babil	32	39	'71	9	11	20	31	33	64	3	17	20	52	60	112
Baghdad	8	51	59	4	12	16	16	59	75	6	36	42	5	36	41
Basraqh	38	55	93	15	5	20	73	65	138	19	20	39	96	134	230
Diala	30	42	72	9	13	22	13	42	55	6	9	15	6	64	70
Kerbala	24	30	54	4	15	19	35	60	95	7	14	21	19	56	75
Missan	49	85	134	5	21	26	75	57	132	15	35	50	133	186	319
Muthana	7	30	37	4	8	12	26	71	97	2	16	18	5	60	65
Najaf	21	28	49	7	11	18	20	22	42	5	6	11	21	77	98
Ninevah	25	85	110	15	18	33	22	101	123	4	70	74	10	162	172
Qadisia	14	17	31	8	6	14	27	32	59	8	13	21	16	67	83
Salaheiden	13	41	54	5	15	20	22	55	77	4	26	30	23	52	75
Tamem	6	18	24	3	9	12	14	29	43	2	10	12	2	55	57
Thiqar	26	29	55	8	9	17	71	85	156	12	9	21	48	80	128
Wasit	19	58	77	6	19	25	46	39	85	9	35	44	39	79	118
Grand Total	339	782	1121	127	237	364	523	890	1413	114	431	545	484	1269	1753

Whatever category of staff, the number of vacant position is higher than the number of filled. This is due to a set of reasons including low wages, lack of motivation and lack of qualified staff. Increasing the number of staff dedicated to the sector is a must before any development.

3.4.4 Garbage Management

3.4.4.1 Theoretical Requirements

Table 3-42: Garbage Sector Theoretical Requirements - GCWS

Region	Garbage Production Ton/day	Garbage presses (8 m^3)	Tractors (4 m^3)	Dumpers	Shovels	Tippers	Lorries	Containers	Staff
Centre South	5 632	1 707	556	85	85	156	156	373	6 871

Per capita ratios can be determined by dividing vehicle requirements by the urban population of the region (9 387 381):

- Total collection-vehicle requirements: 1 per 3 750 inhabitants
- Garbage press requirements: 1 per 5 500 inhabitants
- Staff requirements: 1 per 1 350 inhabitants

3.4.4.2 Comparison with Existing Capacity

The number of garbage collection vehicles is so limited that only a small proportion of the garbage produced can be collected.

The questionnaires elicit details of the fleet of vehicles available within the sub districts. The questionnaires that have been returned provide data with respect to 3 million urban inhabitants, i.e. 34% of the urban population. For these 3 million inhabitants, the total number of vehicles is no more than 309 of which only 139 garbage presses. Only 60% of this number are in operation, representing only one vehicle per 16 000 inhabitants and one garbage press per 40 000 inhabitants.

It should also be stressed that the vehicles in operation are aging. Almost all are more than twenty years old, with none less than ten years in age. Replacement has begun recently, but on the basis of the questionnaire responses, the number of new vehicles is only 14 to date.

In these circumstances it is clear that:

- The total capacity of the vehicles in operation is far less than the amount of garbage produced so that the service fails to meet the requirements.
- The current fleet of vehicles cannot be considered as viable for the long term, since almost all are superseded and at the limit of their possible life, whatever the maintenance provided.

A total of 150 garbage collectors have been ordered under the previous MOU phases, but only some of these have been delivered or distributed.

The staff in charge of solid waste management also perform street cleaning, since in the local context, both activities are closely related. It is thought that the permanent staff for both activities combined represents nearly 20 to 25% of the total staff employed by the local Directorates. In addition to the permanent staff, three times as many operatives may be hired on a daily basis. As a result, current staff numbers dedicated to garbage management are not known with any degree of precision.

3.4.4.3 Garbage Collection Performance Indicator

Table 3-43: Garbage Collection Performance Indicator Center South

	Value of Existing Fleet of Recent Vehicles (Including Vehicles on Hold) (USD million)	Value of Vehicles Required to Meet Present Needs (USD million)	Garbage Service Level (%)
Center South	7.6	336	2

3.5 Autonomous Region of Northern Iraq

3.5.1 Sewage Sources

Table 3-44: Sewage Sources Within Region of Northern Iraq

Governorate	Urban		Rural	
	Urban Population 2000 (Inhabitant)	*Urban Sewage Sources (m^3/day)*	*Rural Population 2000 (Inhabitant)*	*Rural Sewage Sources (m^3/day)*
Dohuk	398 150	96 370	211 380	31 707
Erbil	878 786	225 508	346 133	51 920
Sulaymaniyah	1 206 841	301 033	463 193	69 479

3.5.2 Existing Sewage Disposal System

3.5.2.1 Coverage

Table 3-45: Existing Sewage Disposal Coverage in Rural Areas [70]

Governorate	Septic Tank Coverage (%)	Pit Latrine Coverage (%)	Sanitation Coverage (%)
Dohuk	0	100	100
Erbil	0	33	33
Sulaymanyiah	0	46	46

Table 3-46: Existing Sewage Disposal Coverage in Urban Areas [71]

Governorate	On-site Sanitation Coverage			Sewerage Coverage (%)	Sanitation Coverage (%)
	Septic Tanks (%)	*Pit Latrines (%)*	*Total (%)*		
Dohuk	100	0	100	0	100
Erbil	51	0	51	0	51
Sulaymaniyah	8	57	65	0	65

[70] Query IS 10

[71] Query IS 9

3.5.2.2 External Constraints

The groundwater table in the northern autonomous area is very deep.

Sedentarity level: information not available.

3.5.3 Public Infrastructure

3.5.3.1 Sewage Treatment Plants

No sewage treatment plants are reported in the Northern Autonomous Region.

3.5.3.2 Pumping Stations

There are very few pumping stations in the Northern Autonomous Region. Those that exist are not currently in operation

Table 3-47: Pumping Stations -Northern Autonomous Region

Governorate	Number of Projects with Pumping Stations	Number of Pumping Stations
Dohuk	0	0
Erbil	2	8
Sulaymaniyah	0	0

3.5.3.3 Sewers

Table 3-48 : Sewer and Stormwater System Length -Northern Autonomous Region

Governorate	Sewer System Length			Stormwater System Length	Total Pipe Length
	Separate km	*Combined* km	*Total* km	km	km
Dohuk	60.3		60.3		60.3
Erbil	2.5	50.9	53.4	112.4	165.7
Sulaymaniyah	124.8	27.9	152.7	1.2	153.9

Table 3-49: Breakdown by Pipe Material -Northern Autonomous Region [22]

Governorate	Breakdown Availability %[23]	Concrete (%)	PVC (%)	Asbestos cement (%)	Clay (%)	Ductile (%)	Other (%)
Dohuk	98	87		13			
Erbil	83	78					223
Sulaymaniyah	240	93	4				2

Table 3-50: Breakdown by Pipe Age - Northern Autonomous Region

Governorate	Breakdown Availability (%)	Less than 10 years	More than 10 years
Dohuk	98	56	44
Erbil	83	13	87
Sulaymaniyah	240	28	72

Table 3-51: Pipe Breakdown by Condition -Northern Autonomous Region [24]

Governorate	Breakdown Availability (%)	Good Condition (%)	Poor Condition (%)	Unknown (%)
Dohuk	98	54.6	30.7	14.7
Erbil	83	18.7	80.5	0.7
Sulaymanyiah	240	6.5	77.8	15.7

[22] Query IS 20

[23] Breakdown availability means the percentage of sewer system length for which the breakdown by material is available.

[24] Query IS 19

Table 3-52: Percentage of Concrete Pipe more than 10 Years out of Pipes in Poor Condition – Northern Autonomous Region [25]

Governorate	Pipes in Poor Condition (km)	Percentage of Which are Concrete Pipes of More than 10 Years in Age
Dohuk	18.9	56
Erbil	111	88
Sulaymaniyah	287.5	76

Table 3-53: Northern Autonomous Region [26]

Governorate	Concrete Pipes of More than 10 Years in Age (km)	Percentage of Which are Poor-condition Pipes
Dohuk	18.2	54
Erbil	101	97
Sulaymaniyah	244	90

In the northern Governorates, the sewerage systems consist of numerous small networks which are not connected to any sewage treatment plant.

In the Governorates of Erbil and Sulaymaniyah, most of the sewer system is of the combined type, and accounts for a large share of the concrete pipes reported to be in poor condition. The distinction between combined and stormwater networks is unclear, given that household sewage is in many cases discharged into the stormwater network. When envisaging future sewerage projects, careful thought should be given to the question of completely rebuilding the network and abandoning the limited existing systems.

In Dohuk, the network is reported to be of the separate type and for the most part, less than 10 years old. The pipes, which are in concrete, appear to be in poor condition.

Many questionnaire respondents mention:

- Frequent pipe obstruction
- Burst pipes (particularly in the case of concrete pipes)
- Corrosion of concrete pipes

Network design is also commented on:

- In some cases, pipes are reported to be too small in size.

[25] Query IS 22

[26] Query IS 23

- The limited number of manholes prevents proper cleaning of pipes.

3.5.3.4 Garbage Management

Table 3-54: Garbage Sector Theoretical Requirements – Northern Autonomous Region

Region	Garbage Production Ton/day	Garbage Presses (8 m³)	Tractors (4 m³)	Dumpers	Shovels	Tippers	Lorries	Containers	Staff
Northern Autonomous Region	1 490	452	171	22	22	42	42	99	1 868

Per capita ratios can be defined by dividing vehicle requirements by the urban population of the region (2 483 191):

- Total collection vehicle requirement: 1 per 3 307 inhabitants
- Garbage press requirement: 1 per 5 500 inhabitants
- Staff requirement: 1 per 1 330 inhabitants

The following table gives numbers of vehicle types entered into the database. The figures concern approximately 98% of the urban population and can be considered as close to total numbers.

Table 3-55: Garbage Sector Available Equipment – Northern Autonomous Region

	Garbage presses	Tractors	Shovels	Dumping trucks	Tippers	Total
Existing	112	114	2	67	6	301
In Operation[27]	70	77	1	46	5	199
Recent (Less than 10 Years)	26	23	0	23	3	75

The staff allocated to garbage collection numbers 2 065 or 1 per 1 200 inhabitants.

In the Northern Autonomous Region of Iraq, garbage collection is hindered by the lack of equipment.

[27] The number of trucks in operation has been assessed by means of a percentage. This percentage is a global value at the sub-district level - as entered into the data base - and may not reflect the breakdown by type of vehicle precisely.

Table 3-56: Garbage Collection Performance Indicators – Northern Autonomous Region

	Value of Existing Recent Vehicles (Including Vehicles on Hold) (USD Million)	Value of Vehicles Required to Meet Present Needs (USD Million)	Garbage Service Level (%)
Northern Autonomous Region	6.1	77.6	8

Strategic Planning Framework

SAFEGE
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4. Strategic Planning Framework

4.1 Introduction

The aim of this section is to present the proposed Guidelines for the preparation of the relevant Development Plans up to the year 2010, including physical (investment program) and non-physical (institutional, managerial, etc...) aspects. As stated in the TOR, "The outcome of this study targets to propose national technical references for setting national plans and defining national standards for the WES sector till year 2010".

The situation prevailing in the water and sanitation sectors is described in the first three chapters of this report. The relevant data have been organized in an interactive database, which allows the production of synthetic performance assessment indicators.

The sector development options are examined in the following chapters with the focus on 2010 performance targets represented by the expected levels of the performance indicators by 2010 as a result of the GOI action plan. The costs of an ideal and a minimum development option will be determined as requested by the TOR.

This chapter contains a brief description and assessment of sector policies, development strategies and planning framework as established by the Government agencies. The assessment provides the basis for the identification of sector development objectives and prioritization criteria, designed to facilitate coordination of the action plans of the operating agencies.

The resulting planning indicators are established as an instrument to monitor the effectiveness of the action plans. The planning indicators are based on the above mentioned assessment indicators with the aim of evaluating the results of the development plans against relevant benchmarks.

4.2 Sector Development Objectives and Strategies

4.2.1 Background[1]

In the preparation of the future development plans for the water supply subsector, various hypotheses must be envisaged. Two alternative planning scenarios have therefore been developed corresponding to 2 boundary options:

- An " ideal option " corresponding to the satisfaction of all quantitative and qualitative objectives by the year 2010 (based on the Master Plans prepared in the mid 80s).
- A " minimum option " compatible with the present budget plus possible funds allocated under the " oil for food programme ".

Further to the findings of the sector assessment phase, attention was drawn to the following aspects, which have resulted in the review of the boundary options:

- Sector development trends are not at present affected by a lack of financial resources for capital investment. Even in the context of the sanctions, the Oil-for-Food program provides sufficient funding to cover the capital expenditure in the WES sector. Under the 6-month Phase VIII of the Oil-for-Food program sector expenditure amounted to nearly US$ 500 million, corresponding to US$ 20 per inhabitant, which represents a significant level of investment.

- The OFFP procurement framework generates excessive delays in the supply of goods and service, which complicates the planning tasks. The lack of long-term sector planning affects the feasibility of implementing effective development programs.

- The lack of a "cash component", or local resources in general, is a further constraint affecting the feasibility and sustainability of the development programs.

4.2.2 Sector Policies and Strategic Goals

The overall objectives of the Water and Sanitation Sector in Iraq are:

- To provide potable water to the population in sufficient quantity.

- To dispose, hygienically, of all types of (solid and liquid) waste.

The main sector development objective defined by the GOI is to provide the Iraqi population with universal access to potable water. This objective can be broken down into 2 components:

- Coverage of water supply facilities should tend towards 100%.

- The provision of potable water by public utilities should meet household needs in accordance with an agreed standard per capita level. The impact of shortages should be distributed evenly among all users.

It should be noted that water quality is not at present a criterion for selecting investment projects and is considered to result from inefficient operation and maintenance of water systems. Compliance with national water quality standards *is* however a criterion for assessing performance and high priority should be therefore be given to projects aiming to achieve such compliance.

Water supply and wastewater sector development objectives will determined according to water demand.

Water needs are evaluated according to a standard demand pattern, which was established by the WES working group in coordination with the BWA and GEWS.

Table 4-1. Strategic Water Supply Goals for Different Categories of User, in Liters per Capita per Day (lpcd)

Categories of User	Baghdad	Municipality	Municipalities	Rural Area
Domestic Users	330	300	250	180
Industrial & Commercial Users	40	30	20	
Government	55	50	40	10

An Adequacy Line will be established indicating the minimum level of demand to be satisfied during seasonal shortages:

- 150 lpcd in urban areas
- 80 lpcd in rural areas[1]

In the event that the average supply is inferior to the above minimum demand levels, the priority will be to allocate water evenly among users to ensure the same level of supply for all.

Both the "ideal" and "minimum" options would be designed to achieve the same levels of coverage and to meet water quality standards as soon as possible. The availability of water in terms of the quantities of water effectively made available at the household connection level would constitute a measure of the scope of the action plan or planning scenario.

4.3 Sector Planning Framework

4.3.1 Institutional Structure for Sector Management

Sector management is the responsibility of three regional authorities: i) the Ministry of the Interior, with the GEWS managing the water services in the 15 Governorates of the Centre South region of Iraq and the municipal authorities operating the garbage management facilities; ii) the Mayoralty of Baghdad, which is responsible for the provision of services in 9 municipalities of the urban area of Baghdad and; iii) the Government of the 3 Northern Governorates forming the ARNI. These are composed of local governments developing their own sector policies independently from Baghdad GOI, and with reference to 2 separate sub-sectors: urban areas and rural areas.

In the 15 Governorates of the center/south region, the public utilities are operated by a Directorate of Water Supply (DWS) and a Directorate of Sewerage. The DWS collects WES revenue from connected users in accordance with national tariff levels. The Directorate is entitled to retain this revenue to cover operating costs and maintenance expenditure though 10% of the total income is transferred to GEWS head office.

The GEWS head office is responsible for planning and general management. As mentioned above, head office expenditure is covered by a percentage of WES revenue. Under GOI policy, the GEWS is a public self-financed corporation in charge of operating and maintaining the existing facilities, including the replacement of obsolete equipment. In exercising this function, the GEWS implements sector development action plans and public investment programs approved by the GOI.

In the Mayoralty of Baghdad, BWA has a similar role with regard to the head works, primary and secondary networks, and storage and boosting facilities; the 9 municipalities are assigned to perform the operation and maintenance of the tertiary pipe networks under BWA technical coordination, as well as customer management operations including the installation and maintenance of service connections. Billing and revenue collection are performed by BWA.

The GOI elaborates sector policies, establishes the applicable tariff settings and levels, and provides financial resources for funding capital investment in foreign and local currency. Foreign-currency financing is provided by transfers from the oil sector; this funding is currently channeled through the Oil-For-Food programs under 6-month phase agreements between the GOI and the UN administration. Upon lifting of sanctions, these transfers will be channeled through the Planning Commission as a subsidy fund operated under the supervision of the Department of Finance.

[1] This is valid in Centre South Iraq. In ARNI the adequacy line is evaluated by 50 lpcd in rural areas

Under the MOU of OFFP's Phase VII, the sum of USD 604.09 million earmarked for the WES sector, was allocated to the various sector management units as follows: 22% for the Mayoralty of Baghdad, 51.3% for the other center/south Governorates and 26.7% for the Northern Autonomous Region.

The Planning Commission establishes the ceiling for local-currency subsidies for WES development projects implemented by the GEWS, the Mayoralty of Baghdad and the Northern Region. The criteria governing the allocation of the national budget for WES development are unspecified; it should be noted that no budgetary funding has been dedicated to WES sector activities in the 3 Northern Governorates of ARNI. The WES budget is at present limited, owing to the situation of the Iraqi economy in the context of the sanctions. Once the sanctions have been lifted, the attendant expansion of the Iraqi economy may generate greater tax revenues that could boost WES financing. The ideal scenario works on the assumption that there would be no restrictions on the funding of the local component of WES capital expenditure where this is feasible and sustainable.

At the sector management unit level, the development projects would be ranked according to their cost-effectiveness. In Baghdad, BWA and BSA are responsible for structuring comprehensive investment programmes designed to improve service performance within the urban area of the capital. This task consists in providing treated water at acceptable pressures and operating adequate sewage disposal facilities. The municipalities are responsible for developing the tertiary network and connections to the new housing, as well as the operation and maintenance of the sewage pumping facilities. The latter programs are related to the urban development framework; BWA and BSA are expected to assist municipal utilities by providing pipes, equipment and spare parts and the municipalities execute and finance the connection works with the income derived from the newly connected households.

GEWS action plans are coordinated by the planning department of the corporation, which establishes performance targets and develops criteria for sharing the available funds approved by the GOI between the 15 regional directorates according to WES performance levels. The GOI policy, which provides for a uniform tariff level, aims to achieve similar performance levels all over the country. Funding for investment is therefore allocated on the basis of the gap between the performance levels of individual Governorates and the average performance level of the 15 Governorates as a whole.

Within each Governorate, the WES investment programs will consist of a series of development projects. Under the guidance of the GEWS, these projects would be ranked according to the cost-effectiveness criteria in terms of increasing coverage of water and sanitation services and increasing the availability of potable water for the population. At the same time due consideration would be given to reconciling future operating expenditure with expected operating revenues.

Table 4-2. Institutional Framework for Sector Planning Activities

Institutions	Functions
GOI Cabinet	Formulating and coordinating WATSAN Sector policies. Formulating public sector policies on financial management. Arranging bilateral agreements for the importation of foreign equipment by local private suppliers at a subsidized exchange rate. Arranging 6-month funding programs by MOU with UN under OFFP.
Ministry of Finance	Provides local cash subsidies to finance public investment and part of O&M costs borne by institutional operators.
Planning Commission	Prepares and coordinates public investment budget (local cash component). Will coordinate cross-sector subsidies in foreign currency upon lifting of sanctions.
Mayoralty of Baghdad Deputy Minister for Technical Aspects	Operation of the WATSAN sector in the 9 municipalities of the urban area of Baghdad.
Mayoralty of Baghdad Deputy Minister of BWSA	Elaborating water supply investment programs within the global budgets established by the GOI Cabinet (tariff levels, use of foreign currency subsidies) and the Planning Commission (local currency cash component). Executing investment programs covering water production facilities, transmission lines, booster stations, secondary distribution network (Φ>= 250 mm), sewage pumping stations and sewer network. Coordinating and providing mechanical equipment and technical assistance for the execution of investment programs for the tertiary distribution network and sewerage facilities.
GCWS Planning Department	Coordinating the investment budget of the 15 WS Directorates of the center/south region, in coordination with the Planning Commission and the GOI. Establishing performance targets for Directorate operations. Providing technical assistance to Directorates for planning activities.
WS Directorates	Identifying investment projects and ranking them under the guidance of the GEWS Planning Department.
Ministry of Municipalities and Tourism (Erbil & Dohuk, and Sulaymaniyah)	Planning WATSAN investment programs for urban areas within the budget allocated to the Northern Autonomous region.
Ministry of Reconstruction & Development (Erbil & Dohuk)	Planning WATSAN investment programs for rural areas.
Ministry of Works & Reconstruction (Sulaymaniyah)	Planning WATSAN investment programs for rural areas.

The GOI establishes the amount of investment allocated to WES sector development in both foreign and local currencies, according to oil revenues and GOI fiscal revenues respectively.

The Planning Commission determines the state and oil revenue-financed subsidies which can be made available for financing WES capital expenditure. This financing capacity is determined by the boundary conditions, which are likely to be independent of WES performance, depending instead on the oil market and on the structure and the productivity of the national economy.

The GOI determines the share of the WES investment budget to be allocated to the Mayoralty of Baghdad, GEWS and Northern Autonomous Region respectively. The exact policy in this respect is unknown - as mentioned previously, ARNI has received no budgetary allocation for the last 10-years. In the future, GOI policies purport to secure similar levels of service throughout the country, in which case, budgetary policies would be determined on the basis of population forecasts and country-wide service performance levels and targets. Budgetary allocations to the directorates should accordingly take into account the service performance levels and operating efficiencies at the local level as compared to the national average.

4.3.2 Sector Budgetary Policies

4.3.2.1 General Overview

The structuring of the sector budgets is the main instrument for implementing the sector development policies. The sector budget links public expenditure to the strategic development objectives established by the Government. The institutions responsible for developing sector policies in Iraq are the sector authorities identified in Table 4-3. Political Authorities & Management Units below:

Table 4-3. Political Authorities & Management Units

	Sector Administrative Structure			
Sub sectors	*Baghdad City*	*Center/South*	*Autonomous Gov. of Erbil & Dohuk*	*Autonomous Gov. of Sulaymaniyah*
Sector Authorities (Policy Makers)	Mayoralty of Baghdad	Ministry of Interior	MMT & MRD	MMT & MWR
Management Units : Water Supply	BWA[2]	GCWS	MMT & MRD	MMT & MWR
Sewerage	BSA			
Solid Waste	Deputy Mayor of Municipalities	General Directorate of Municipalities	MMT	MMT

It is at this level that the sector development strategies are defined, generating the action plans to be executed by the subsector and/or regional management units figuring in Table 4-3. Political Authorities & Management Units, and implemented by local operating units. The management units coordinate the execution of the local action plans and oversee the operating activities.

[2] BWA and BSA have overall responsibility for sector planning and management. The municipalities are involved in the operation and maintenance of the tertiary distribution networks of the water supply and sewerage systems, however, these entities act as executing agencies under the guidance and with the managerial support of the BWA and BSA. The associated institutional boundaries may require extensive revision in order to reconcile decentralisation objectives with efficient management.

4.3.2.2 Investment Budget Structuring

The budgetary allocations to the institutional operators can be determined according to a capital investment rate (CIR in US$ per capita), relating the budgetary allocations for public expenditure in the WATSAN sector to the total population.

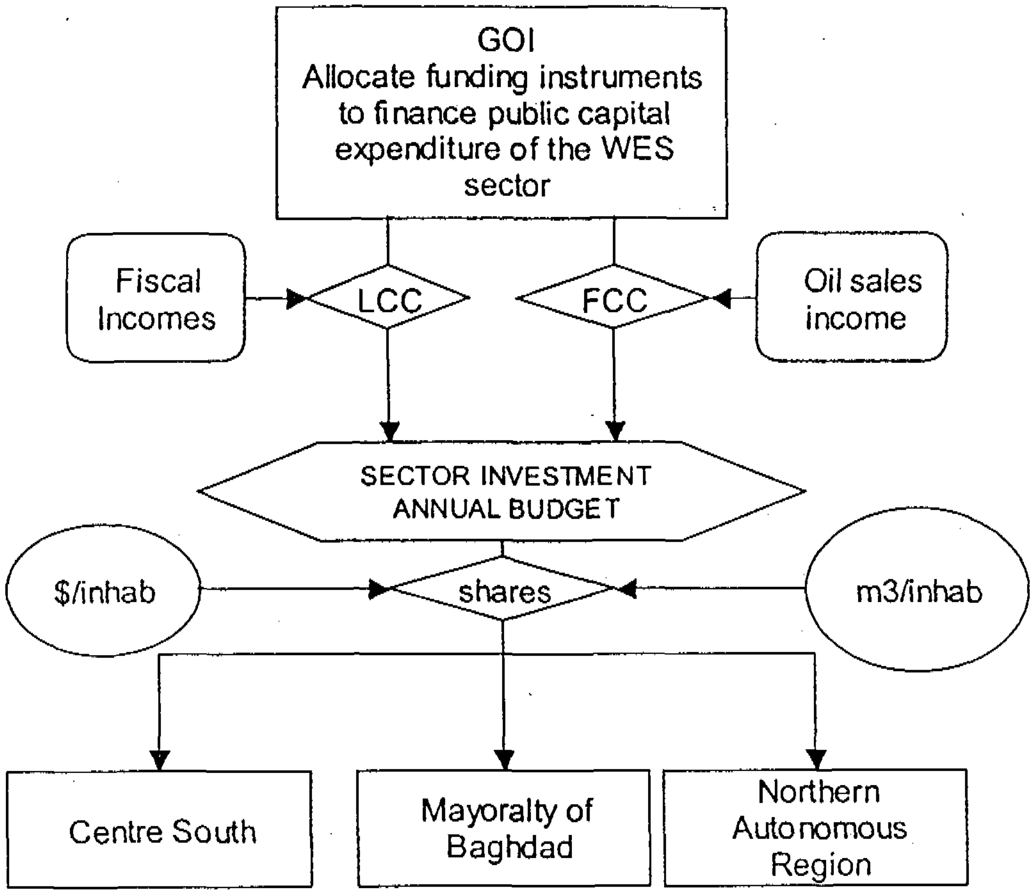

Chart 4-1. Budget Planning Framework

Capital expenditure, serviced by subsidies and GOI budgetary allocations, is targeted at:

- New works designed to increase coverage and/or the level of service, or
- Other expenditure to compensate for the depreciation of existing assets
  - The rehabilitation works designed to boost the installed capacities which have declined due to lack of maintenance.
  - The renewal works to replace existing equipment at the end of their technical life.
  - Regular supplies of spare parts to allow proper maintenance and repair of the operating facilities.

4.3.2.3 General Criteria Governing Budgetary Allocations

The effectiveness of this subsidy can be evaluated by a regional Production Capacity Rate[3], which expresses the global level of availability of water (RPR).

PCR = Installed Production Capacity/Total Population

The lower the PCR, the higher the CIR requirement to increase the availability of water to address domestic needs.

Such a criterion could be used as a yardstick for determining the allocation of funds for the sector among the three institutional operators (Management Centres): the GEWS, Mayoralty of Baghdad and Autonomous Northern Region (Erbil, Dohuk and Sulaymaniyah). The budget will ultimately be apportioned by the GOI after taking into consideration various other aspects that are unrelated to sector operation.

The allocation of funds to the institutional operators could be determined by:

Capex(IO) = CIR * total population * PRC(IO) *EC(IO)

where

- EC is a policy based weighting coefficient (the initial default value of which could reflect the 2001 budgetary allocations), and
- PRC is a weighting parameter designed with a view to targeting investment at the regions that need more. This concept of "needing more" should reflect the sector development policies. PRC measures the gap between the current performance level and the performance targets established by the Government; it may also include an incentive for improving the efficiency of the regional management units operating the public utilities.

4.3.3 Planning Parameters

Sector performance and operating efficiency can be evaluated by the relevant indicators[4] as mentioned in the sector assessment sections:

- **The Service Coverage (WSC)**, which expresses the percentage of population receiving sufficient potable water from public networks to satisfy their needs.
- **The Rate of Supply (WSR)**, which expresses, in liters per capita per day (lpcd), the average quantity of potable water supplied to all categories of service connections with regard to the served population.
- **The Shortage Rate (SHR),** which indicates the proportion of served population receiving an inadequate quantity of water (deemed insufficient to address their needs).
- **The Sewer Coverage Indicator,** which expresses the collection and disposal of wastewater in urban areas through a sewerage system connected to a wastewater treatment plant.
- **The On-Site Urban Area Coverage,** which reflects the disposal of domestic wastewater through individual septic facilities in urban areas.
- **The On-Site Rural Area Coverage,** which expresses the disposal of domestic wastewater through individual septic facilities in rural areas.

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[3] In Chapter 2, this indicator is broken down in urban and rural capacity rates referring to urban and rural shares of water projects

[4] See Chapter 2

- **The Garbage Collection Capacity**, which expresses the level of domestic solid waste management service in number of trucks per 1 000 inhabitants.

The population needs are determined by the GOI (Planning Commission) according to:

- The CSO population forecasts.
- The existing and long-term forecast service level targets.
- Macroeconomic indicators (tax revenues, public expenditure budget per sector).
- Urban development policy.

The **effectiveness** of public expenditure can be evaluated by comparing the reduction of the gap between the existing situation and the long-term performance targets with the budget allocated to the associated investment programs and subsidies. The EC and PRC parameters allow the effectiveness criteria to remain consistent with GOI policies in respect of economic development and the management of public utilities.

The budget for public expenditure covers:

- Local currency provided by tax revenues.
- Foreign currency provided by the Central Bank at subsidized exchange rates under bilateral agreements between the GOI and certain supplier countries (the current rate for water and sanitation sector supplies from the countries concerned was set at ID 100 per US dollar in the applicable agreements).
- Foreign currency provided by export activities (primarily oil sales); under the sanctions, the use of foreign currency incomes is regulated under SCR 986 by the Oil-for-Food programme (OFFP) six-month budgets.

The *efficiency* of the individual Directorates in developing the public utilities is taken into account in quarterly budget adjustments related to subsidized public investment programs, which aim to secure the allocation of the total amount of annual capital expenditure budgeted by the GOI to the different authorities. This is particularly applicable to those Directorates under GEWS authority.

In the foregoing sector assessment sections, various other efficiency indicators are mentioned; *such as* the **Project Efficiency indicators** developed by UNICEF, which are particularly useful in evaluating rehabilitation needs or the impact of inefficient power supply. **UFW** management is an effective means of improving continuity of supply and water quality; the water utilities, assisted by the UNICEF WES team developed criteria to estimate likely UFW levels in each sub-district of the center/south region; in the Mayoralty of Baghdad, the available data allow the volume of water billed to be estimated at 38% of the total production of treated water, while physical losses are currently evaluated at 50%. Since an accurate estimate of UFW is crucial for evaluating management efficiency, flow metering must be considerably improved during the implementation of the emergency action plans.

Human resources development is crucial to improving the sustainability of investment programs; **productivity** gains are generally considered to be a factor leading to increased investment levels.

Other financial indicators such as the **Operating Ratio** and the **Collection/Billing** rate should be used by the public authority to evaluate the feasibility and sustainability of the action plans proposed by the operating Directorates. In the present study, the lack of available data precludes the establishment of relevant benchmarks.

4.3.4 Population Forecast

Population forecasts are the main factor influencing sector planning for the long term. The development plans, which are discussed in Chapters 5 and 6, are based on population forecast assumptions for the urban populations (UP) and rural populations (RP) of each sub-district over the 10-year period from 2000 to 2010.

Population growth rates (PGR) were evaluated for each Governorate. Urban and rural PGR are assumed to be identical within each sub-district of a given Governorate. PGR(Gov)[5] estimates are based on available CSO census data.

Table 4-4. Population forecast

Governorate	Urban Population Growth Rate	Urban Population by 2010	Rural Population by 2010
Anbar	3,03%	780 142	691 145
Babil	2,05%	708 078	775 510
Baghdad	2,99%	651 158	796 278
Basrah	4,05%	1 981 071	517 192
Diala	2,43%	641 117	868 968
Dohuk	1,38%	456 440	242 326
Erbil	3,92%	1 290 882	508 448
Kerbala	3,14%	576 680	294 504
Mayoralty of Baghdad	2,99%	6 381 543	21 070
Missan	2,76%	611 505	310 702
Muthanna	3,24%	298 351	350 101
Najaf	3,36%	879 529	356 368
Ninevah	3,41%	2 027 676	1 250 464
Qadisiyah	3,16%	639 814	529 367
Salaheldin	3,37%	605 973	742 807
Sulaymanyiah	3,47%	1 706 573	558 930
Ta'meem	2,39%	752 453	303 232
Thiqar	2,85%	1 006 207	690 602
Total/Average	3,10%	637 704	553 964
Wasit	3,23%	22 632 896	10 362 078

4.4 UFW Reduction Action Planning

4.4.1 Introduction

Water loss in water supply and distribution systems is a critical problem facing many water operators. At the global level, losses as high as 35 % or 40% are not uncommon. In Iraq, the situation is exacerbated by the country's political and economic situation. Visits within Iraq have shown that the scale of the problem is such that no water supply development plan can be effective without efforts to dramatically reduce losses.

[5]. Table Governorates of the database

The impact of the phenomenon is both technical and financial. Without control of losses, the production capacity required to meet the needs is greater - and in some cases requirements may never be fully satisfied, irrespective of the production capacity. From a financial standpoint, the attainment of a given set of objectives determines the financial viability of a water project, particularly where billing of water is considered as a means of recouping operating costs.

4.4.2 Losses

4.4.2.1 General

Losses in a water network correspond to the difference between the quantity of water entering the network and the identified (metered or estimated, billed or unbilled) quantities of water consumed.

The losses can be divided into two categories:

- Physical losses (leaks, overflows, etc.), i.e. the amount of water produced but not consumed.
- Non-physical or commercial losses (due to fraud, under-metering, etc.): these represent the water produced and consumed but neither billed nor accounted for.

In general, the only relevant data at the disposal of the operator are the quantities produced (where reliable macro-metering of sources exists) and/or the quantities metered. In Iraq however, even macro-metering data are limited and it is almost impossible to evaluate water losses with any degree of precision. Estimating the ratio of physical losses to non-physical losses is also difficult.

4.4.2.2 Loss Components in a Water Distribution System

For the purposes of defining and analyzing "loss" in a water supply and distribution system, a formula can be applied based on the following components.

4.4.2.2.1 Physical Losses

- Visible leaks reported to the water company by customers or the general public.
- Visible leaks not reported by the public.
- Invisible leaks, discernible with leak detection equipment.
- Invisible and non-discernible leaks (not detectable by standard leak detection equipment).
- Leaks (infiltration) from tanks or other structures.
- Tank overflows.

4.4.2.2.2 Non-physical Losses

Consumers not on Billing Records

- Illegal individual connections
- Collective illegal connections.

Consumers Billed through Metering

- Under-billing due to damaged meters.
- Under-metering caused by unsuitability, age or over-dimensioning of meter.
- Fraud (by-passes, double connections, magnets, unsealed meters, etc.).
- Illegal consumption by consumers disconnected for non-payment.

Consumers Billed on a Lump-sum Basis (without Meters)

- Over-consumption with respect to the lump sum effectively billed.

Others

- Inaccuracy of source metering.
- Identified but unbilled consumption: tank cleaning, network cleaning, fire consumption, staff consumption; public distribution points etc. Whether this consumption is incorporated as a loss will depend on the Non Revenue Water (NRW) or Unaccounted For Water (UFW) considered.
- Anomalies and discrepancies may result from the type of billing and/or customer management procedures implemented.
- Computer-based fraud, where access rights are not fool-proof.

4.4.2.3 Need for an Action Plan

4.4.2.3.1 Overview of the Existing Situation

The above list shows that the overall loss can be attributed to both physical and human factors: in all cases the level of the overall loss reflects the efficiency of the utility, including aspects such as network management, management of meter stocks, customer management and personnel management.

The reasons for water losses in Iraq have been described in the assessment part of the report and can be summarized as follows:

- Many of the water mains are aging, subject to corrosion and need to be replaced.
- Very few macro-meters are available.
- Metering of users is rare and seldom used as a basis for billing of water.
- The technical management of the network is characterized more by emergency procedures than by programmed interventions.
- Water production is insufficient.

Although necessary, the replacement of aging pipes cannot be considered as the sole means of controlling water losses. Additional measures are necessary since not all losses are attributable to (aging) burst pipes - with experience showing that leakage problems are often due to innumerable small leaks on service connections.

4.4.2.3.2 Proposed Action Plan

Any loss reduction program should focus on:

- Optimization, in terms of the cost effectiveness of the work carried out.
- Monitoring, before, during and after actions to reduce losses.
- Sustainability, so that improvements are durable.

A phased implementation policy is therefore proposed with the aim of strengthening the technical capability prior to extending the plan to the rest of the country.

The first phase would involve the setting up of pilot areas - possibly three in number, comprising one district of the Mayoralty of Baghdad, one Governorate capital city and one city in the northern autonomous region of Iraq.

Subsequently, drawing on the experience gained from the operation of these pilot areas, an action plan shall be implemented at national level.

4.4.3 Proposed Approach for the Pilot Areas

4.4.3.1 General Organization

The implementation of the pilot area program will be governed by a specific procedure involving the setting up of teams dedicated to UFW reduction.

These teams will comprise a number of units each with a specific function. The different units will be complementary and the program will be based on their combined output.

The functional units would be as follows:

- Hydraulic Unit
- GIS Unit
- MIS Unit
- Leak Detection Unit
- Consumer Survey Unit
- Pipe Repair Unit.

4.4.3.2 Hydraulic Unit

The Hydraulic Unit will be responsible for implementing a computer-based hydraulic model of the water supply and distribution system. Following calibration, the model will allow the assessment of network flows and pressures and provide a thorough understanding of the hydraulic conditions in the pilot area system. It will also be used to define waste metering districts and the optimal size of bulk meters.

The hydraulic model is built using GIS network topology (pipes, nodes, etc.) as well as billing data where available.

The unit is composed of:

- Hydraulic engineers to run the model.
- Technicians and operatives to set up meters for calibrating the model.

The unit will be furnished with the following equipment:

- A hydraulic modeling software system.
- A computer.
- Measuring equipment: portable ultrasonic flow-meters, data loggers with pressure gauges, software to program and process measurement data.
- A vehicle.

Output will consist of:

- Field data (pressure and flow measurements, district and waste district metering data).
- Network analysis reports (identification of leakage, optimization of water distribution).

4.4.3.3 G.I.S. Unit

The main function of the GIS Unit is to produce maps from data furnished by an accurate and up-to-date database of the network and of customers.

The material means required are:

- Computers equipped with GIS software.
- Digitizing tables or scanning devices.
- Plotters.
- For field survey purposes: a vehicle and metal detector to locate buried valves and metal pipes; a stetophone with amplifier to sound the valves; and a true meter to check the pipe length.

Output will consist of accurate and up-to-date maps of the network and of customers. Two kinds of maps are printed for each area: (i) water network against base map: roads, plot limits, pipes, valves, fire hydrants; (ii) customers against base map: roads, plot limits with meter (plot number), large customers.

4.4.3.4 M.I.S. Unit

The role of the MIS Unit is:

- To collect the operational data and billing data to be incorporated in the MIS database (input data).
- To produce from this data, weekly, monthly, quarterly and annual MIS reports.
- To analyze the results of these reports together with the Hydraulic Unit and UFW team manager.

The MIS system will share the computer resources of the GIS Unit.

Output consists of thematic maps featuring operational, billing data and indicators for:

- A given period (week, month, quarter, financial year).
- A given geographical entity (Area, District, pressure zone).

4.4.3.5 Leak Detection Unit

The main task of the unit is to monitor UFW and implement actions in co-ordination with Network Repair Unit.

The unit will be equipped with:

- District meters and waste district meters,
- Leak detection equipment: acoustic leak detectors, acoustic correlators, stetophones with electronic amplifier, truemeters and metal detectors.

Output consists of:

- Reports on tests and routine leak detection surveys.
- Reports on reactive leak detection interventions (for example repair of burst pipes reported by customers or operating staff).
- Reports on the renewal, operation and maintenance of revenue meters.
- Data on district metering to be included in the MIS database.

4.4.3.6 Customer Unit

The role of the Customer Unit will depend on whether the function of the UFW includes the reduction of non-physical losses, in addition to leakage control. It will also depend on whether the global strategy includes the provision of individual meters to all customers and the setting up of a customer management system.

The Customer Unit will be responsible for some or all of the above tasks, depending on the case.

4.4.3.6.1 Actions in Test Zones

Actions in small test zones (i.e. areas of around 5000 inhabitants, *within* the pilot area):

- Inventory of customers and identification of illegal connections.
- Survey of household consumption.
- Installation of a flow meter at the inlet of the zone.
- Detection and repair of network leaks.
- Repair of service connections and rising pipes in apartment blocks; advice to consumers on reduction of losses in apartments.
- Installation of meters.

- Creation of a reception center for customers in the zone.
- Monitoring of big consumers.

Expected results:

On completion of these measures, which will be implemented throughout the duration of the program, billing and receiving levels should be significantly improved. These improvements will however be dependent on the effective implementation of a sound production and distribution strategy with the emphasis on continuity of service, control of water pressure and the actions performed by the technical services, particularly in the test zone. Such a procedure is an effective means of defining realistic objectives for application on a wider scale. It will also allow more accurate evaluation of individual water consumption.

4.4.3.6.2 Surveys of Large Consumers

Surveys of large consumers will be performed with the aim of identifying wastage and procuring and installing water meters for industrial, commercial and administrative entities, places of worship and public distribution points.

4.4.3.6.3 Rehabilitation of Service Connections

A comprehensive survey of service connections must be carried out prior to the preparation of a repair/replacement program for those meters which have not been properly maintained since their installation or more recent meters which have not been correctly installed.

4.4.3.6.4 Systematic Metering

Ideally, each customer should be metered individually so that billing is based upon actual water consumption.

4.4.3.6.5 Customer Management

To maximize efficiency, the commercial department must be provided with the means to:

- Manage customer contracts
- Install and maintain connections
- Install and maintain meters
- Read the meters correctly
- Take charge of billing operations
- Take charge of receiving payments
- Handle customer relations.

To optimize operation, the commercial department would ideally be equipped with its own data-processing system for customer management. This system would include:

- A data-processing system for all tasks performed by the commercial department and a customer management software package to handle all customer-related activities (contracts, meter reading, billing and receiving, outstanding payments, meters, etc.).

- An interface with the accounting system.
- An interface with the GIS.

4.4.3.7 Pipe Repair Unit

Although the responsibility of the operator or contracted out to a third party, pipe repair involves close cooperation with the UFW team with regard to the following aspects:

- Definition of the works to be carried out
- Up-dating of the GIS system
- Monitoring of repair operations.

4.4.3.8 Schedule

The suggested period for the implementation of the program at pilot-area level is approximately three years, with phasing of the program as follows:

Year 1: Setting up of the UFW Unit:

- Software implementation
- Input of mapping data
- Preliminary hydraulic analysis
- Implementation of macro metering
- Staff training.

Years 2 and 3: Operation of the system and first results.

4.4.4 Progressive Implementation at the Country-wide Level

4.4.4.1 Objective

The objective of the national UFW-reduction plan is to reduce leakage to approximately 15%. This objective is ambitious in the current circumstances and requires very considerable efforts to be deployed.

4.4.4.2 Content at the Local Level

Each area subject to UFW reduction will require a two-stage approach.

4.4.4.2.1 First Stage: Priority Actions and Setting up of Network Evaluation Tools (Duration: 2 years)

- Setting up of the UFW Unit, including means to better evaluate the water network. The UFW Units will be organized – and possibly adjusted - according to the results of the pilot-area programs.
- Replacement of as many of the oldest pipes as technically and financially feasible.

- Installation of bulk meters.
- Repair/replacement of source meters.
- Survey of large consumers.

4.4.4.2.2 Second Stage: Rehabilitation Strategy (Duration: 3 years Minimum)

Actions to be implemented in the distribution sectors according to priorities defined in the previous stages:

- Rehabilitation/replacement of pipes subject to leaks
- Rehabilitation of service mains and connections
- Rehabilitation of defective valves
- Installation of meters at the consumer level
- Implementation of leakage detection on routine basis.

4.4.4.3 Schedule

- Year 1 to 3:
  - Implementation of UFW Units in pilot areas
  - Validation of the methodology prior to country-wide application
  - Training of staff.
- Year 3: Definition of Country-wide Program

The program shall include the creation of a national observatory for water loss control. This observatory would notably be responsible for:

- Validation of local methodology and means
- Staff training
- Implementation of a national MIS to monitor local results against budget allowances.

- Years 4 to 10

  At the local level, it is proposed to implement the action plans progressively over a six years period.

4.5 Sewage Disposal Standards

4.5.1 Master Planning / Design Horizon

A master plan should be carried out prior to implementing any sewerage scheme. The master plan should rely on reasonably acceptable urban development forecasts. Assumption of sewage flows at different design horizons are required at the sewage catchment area level:

- Short term flow, according to the present population and water consumption, in order to check the minimum velocity in sewers.
- Medium term flow (10 years) for sewage treatment plants and main trunk sewer sizing.
- Long term flow (30 years) for pipe sizing.

4.5.2 Sewerage Network

4.5.2.1 Alternative Types of Sewerage Networks

The first decision required before starting the design of any future sewerage system concerns the type of systems. That is, shall the systems be 'combined' or 'separate' or 'partially separate'?

- A 'combined' sewerage system accepts and conveys both sewage and stormwater. As they take stormwater, the sewers need to be relatively very large.
- A 'separate' sewerage system accepts all industrial, commercial, institutional and household wastewaters, including sullage, but it does not accept any stormwater.

4.5.2.1.1 'Combined' Sewerage Systems

Although a combined system offers the advantage of having a single system for both sewage and stormwater, it is usually the most expensive system.

One reason is that the use of cheaper open channel drains for carrying foul wastewaters is not acceptable, and combined systems therefore need to use buried pipes. Stormwater flows are often many times greater than the normal dry weather sewage flow, although the rainy season in Iraq lasts only for a limited period.

In the Mayoralty of Baghdad, the result of the study by Haisse and Partners (1981) was that designing the network for design flow equal to 4 times the dry weather flow resulted in a combined network. Thanks to limited storm frequency, this combined network is supposed to protect against street flooding with a two year time return frequency

4.5.2.1.2 'Separate' Sewerage Systems

The separate system is the cheapest, as it requires smaller diameter trunk sewers. However, it can only properly function if there is also an efficient parallel stormwater drainage system.

Where sewerage systems are designed as separate systems, with the foul sewage flows theoretically kept separate from any stormwater, there are often many connections from roadside drains or properties into the sewerage system..

In Iraq, it can be accepted that:

- Within the Mayoralty of Baghdad, given the size of the city, street drains are not a satisfactory means of disposing of rainwater, so that the decision of having a combined system is a good economical compromise.
- In the other towns of the country, including the Governorate capital, the laying of separate systems is seen as preferable. However, much care should be paid to forbidding storm water connection to the sewer network, especially through property connections.

- Other compromises may be decided upon at the local level as a result of the sewerage master plan. A local factor that may influence the decision is the existence of a reasonably good nucleus of a sewer network which is usable as part of the new sewerage scheme.

4.5.2.2 Materials

Wastewater pipes in the following materials are used over the world:

- Precast concrete (PC) pipes
- Vitrified clay, or stoneware (SgW), pipes
- Plastic (uPVC) pipes
- Asbestos cement (AC) pipes
- Steel pipes
- Cast iron (CI) and ductile iron (DI) pipes
- High density polyethylene (HDPE) pipes
- Glass fibre reinforced plastic (GRP) pipes
- Pitch fibre (PF) pipes.

The major issues that have to be faced by pipes in Iraq are:

- The high temperature and presence of sulphides
- The saline ground water in which much of the pipes will be laid, especially in the South.

It results that attention should be paid to selecting a corrosion resistant material such as uPVC or GRP, as is the pattern over the Middle-East area. Providing manholes with an inner lining is also recommended.

uPVC is an inert material, and is suitable for carrying many corrosive effluents and for laying in aggressive ground conditions. However, the pipes are susceptible to poor workmanship, when longitudinal warping, cross-sectional distortion and cracking have been experienced. Many of these factors are exacerbated by the thin walled sewer pipes, and it is recommended that, if uPVC pipes are to be used for sewers, then pressure pipes are used rather than sewer class pipes. It is also recommended that very careful attention is given during installation to pipe stacking, handling, trench bedding and backfilling procedures.

Glass Reinforced Plastic pipes are used extensively in the Middle East, where sulfide corrosion of concrete pipes has proved to be a major problem. They require skilled handling and laying techniques.

Ductile Iron pipes are too expensive for normal gravity sewers, but could be used for shallow lengths of sewers, elevated sewers, and for rising mains.

Care should also be given to the laying of pipes in order to guarantee as little water infiltration

as possible. It is good practice too that new pipes be subject to specific tests with regards to water infiltration before commissioning.

4.5.2.3 Protection against Corrosion by Hydrogen Sulfide

Hydrogen sulfide has long been recognized as a source of corrosion in concrete sewers, particularly with high ambient temperatures and long retention time.

The gas is produced anaerobically in the sewage or in the slimes on the sewer walls either by the hydrolysis of proteins containing sulfur or by the direct reduction of sulfates. Aerobic bacteria on the sewer walls above the sewage level oxidize the hydrogen sulfide gas to sulfuric acid. The acid then attacks the concrete by a highly complex reaction, the end result of which is a rapid deterioration of the concrete into a paste.

The time of onset of the attack depends upon many variables, including sewage strength and sulfate content, dissolved oxygen concentration, ambient temperature and velocity of flow. Temperature is particularly important and the incidence of sewer corrosion is far greater in warm climates than in temperate areas.

The precautionary measures that can be taken against hydrogen sulfide attack fall into two main categories:

- Designing a sewerage system and conditioning its environment to prevent the onset of septicity.
- Constructing the sewer from, or protecting it with, corrosion resistant materials.

Higher velocities, which are a function of the steepness of the sewer gradient, reduce the possibilities of sedimentation, increase the oxygen absorption into the stream, increase the rate of oxygen transfer to the slime layer, and shorten the time that the sewage spends in travel, all of which reduce the risk of hydrogen sulfide production. Thus, care taken in the proper design of sewers will help to prevent the risk of pipe corrosion.

For a sewerage system involving pumping, as it is generally the case in Iraq, hydrogen sulfide generation can be minimised by various design means, such as sizing sumps for short retention periods, arranging automatic pump operation for all ranges of flow, and the use of minimum pumping main capacities to induce high velocities.

Having taken such design precautions, conditioning the sewer environment is the next consideration. Options are:

- Induced ventilation
- Neutralisation by lime addition
- Chlorination.

All of these methods require specialised equipment with its attendant operational and maintenance costs. None of these methods is considered appropriate for use in Iraq.

It is considered that a well-designed and constructed system of sewers is the best way of preventing corrosion from occurring.

4.5.2.4 Sewage Pumping Stations and Pumping Mains

4.5.2.4.1 Sewage Pumping Stations

General

When a sewerage system is being designed the aim should be to avoid sewage pumping stations wherever possible. This is because the pumps and associated equipment automatically form a weak point in the system and increase hydrogen sulfide generation. However given the flatness of much of Iraqi land it is not possible to avoid pumping stations. Projects have been considered in middle-east countries to limit the number of pumping stations by constructing very deep trunk sewers. However, such solutions require to be carefully scrutinized from an economical point of view. In any case, they do not appear as realistic before the lifting of the embargo.

Sewage pumping is always a management problem. Sewage pumping results in the environmental impacts of noise and odor, and there are always environmental risks associated with failure of the pumping station. Also the station creates an environmental nuisance because of the need of vehicular access for repairs, maintenance and sludge removal.

Recommendations

- For simplicity of maintenance, it is recommended that all sewage pumping stations should be of the dry well/wet well type. The electrically driven pumps should be unchokeable and wear-resisting types, capable of passing solids up to 100 mm spheres, and should operate close to their points of maximum efficiency. Standby pump units should be provided at all pumping stations.

- Controls and electrical equipment should be enclosed in weatherproof structures. Sewage pumping stations should be capable of automatic operation with manual override facilities, and should be provided with suitable protection, indicators and alarms. They should not require full-time attendance.

- The vulnerability to power failure, and the potential impact of consequent flooding, should be considered for each pumping station. When there is any doubt as to the reliability of the electricity supply, standby power diesel generators should be provided, to cater for a minimum of 1.5 x average dry weather flow.

- It is recommended that a safety overflow, leading to a ditch or preferably to a river, should be provided at all sewage pumping stations regardless of whether or not they have standby power diesel generators. These emergency overflows should be designed to ensure the minimum of adverse environmental impact if ever they operate.

- All pumping station wet wells need to be ventilated to avoid a build-up of hydrogen sulfide.

4.5.2.4.2 Pumping Mains

The recommendations are the following:

- Pumping mains should be designed with a minimum velocity of 0.9 m/s to avoid sedimentation. The maximum velocity should be determined from an economic comparison between pipeline and energy costs for different diameters of pipe.

- The minimum diameter for pumping mains should be 150 mm to minimise the chances of blockages. Anchor blocks are required at all changes in direction of the pumping main.

- Where high points in the pumping main are absolutely unavoidable, sewage type air relief valves, including an isolating valve to aid maintenance, should be provided.

- Washouts, leading to a ditch or preferably to a river, should be provided at all low points.

- Manholes and other chambers into which pumping mains discharge should be well-ventilated to avoid a build-up of hydrogen sulfide, the release of which is commonly caused by turbulence.

4.5.2.5 Property Connections

Practices and regulations regarding property connections should be issued as a building code. They should include as follows:

- As far as possible, all property connections should be made at sewer manholes.

- For any property connection the prior approval should be obtained of the official department in charge of Sewerage as to its design and the materials to be used.

- The property owner should be required to submit detailed plans indicating: (i) invert levels of the proposed connection together with relevant ground levels; (ii) the location and dimensions of both the property inspection chamber, located usually at the property boundary, from which the connection is to come and the sewer manhole into which the connection is to be made, together with details of how the connection is to be made, (iii) the method of passing the drain through the manhole wall, (iv) any drop-pipe requirements if the connection is made above the sewer invert, and (v) details of any reconstruction of the manhole benching together with all reinstatement details of the manhole walls.

- All work is required to be carried out by a licensed plumber and the official department in charge of sewerage are responsible for checking the plans and supervising all the work from the sewerage system to the property inspection chamber.

- It should be made clear that any deviations from the Building Code would have to be rectified at the property owner's expense before permission is given for him to use his property connection.

- It is recommended that before any property is considered for connection to a sewer, a complete plan of the building and compound plus details of all proposed or existing plumbing and drainage arrangements is submitted to and approved by the official department in charge of sewerage. Details of the materials to be used and the ancillaries (inspection chambers, ventilating pipes, etc.) should be listed in an annex included with the plan.

- It is recommended that a 'drop-lead' is required if there is a drop of more than about 0.75 m between the invert of the lateral property sewer and the invert of the main sewer, and if there is a 'drop-lead' the manhole benching should be modified accordingly. The drop-lead should preferably be outside the manhole, and there must always be a 'rodding eye' at the top of the drop-lead level with the incoming property drain.

- The rule that washing and kitchen water must be discharged only into the sewer should be strictly observed. The washing and kitchen water down-pipe and any other drains should each connect to the property drains via a trapped gully. There should be no other types of traps/water seals on the property drains.

- Inspection chambers should be properly built and have air tight covers. Inspection chambers are required at the boundary of each property and at all changes of direction of the property drains, at all junctions and at all changes of gradient, which should only take place at inspection chambers.

4.5.2.6 Existing Sewer Rehabilitation / CCTV Survey

Given the high temperature climate of Iraq, it is likely that much of the concrete or asbestos cement sewers should be replaced.

For other materials, it is desirable that a pipe condition survey be assessed. A good way to assess pipe condition is to carry out CCTV surveys by using a small camera pulled through the pipes allowing their inner condition to be inspected. Usually, this is done first at sampling level to assess which areas are most subject to bad pipe conditions. In those areas where pipes have proved to be in bad condition, surveys should be carried out systematically so that all bad condition pipes can be identified and their replacement scheduled.

The main objectives of the CCTV survey is to examine internally the existing sewers for condition, including:

- Corrosion of pipes and manholes
- Defective joints
- Settlement
- Infiltration/exfiltration
- Intrusion of roots
- The presence of grease and other potentially sewer-blocking substances which are not removed by normal sewer cleaning.

4.5.3 Sewage Treatment

4.5.3.1 Introduction

The issues to be addressed by the GOI for new sewage treatment plants are as follows:

- Effluent standards: selecting existing or modifying treated effluent standards.
- Effluent disposal: discharge to river or re-use of treated water.
- Sewage treatment plant insertion as part of sewerage scheme: centralized or compact plants.
- Sludge treatment and disposal.

4.5.3.2 Effluent Standards

Effluent standards are usually defined depending on:

- The possible impact of treated effluent on the environment.
- The likely re-use of water if any.

When treated water is disposed to rivers, standards usually differentiate:

- Carbon removal
- Nitrogen removal
- Phosphorous removal.

The first level consists of removing carbon. Whatever the process, the objective is to get the BOD down to a level which limits the oxygen requirement of the treated sewage flowing in rivers, so that it does not pollute the river. This can be achieved by different processes such as trickling filters or activated sludge.

The second possible level deals with Nitrogen removal. Two successive processes are required:

- Nitrification: the ammonia is transformed into nitrates.
- Nitrogen removal: removal of nitrate which is turned into gas and disposed to the air.

Nitrogen and phosphorous are factors which favor eutrophication of water. Eutrophication means the increase of algae development in rivers, with consequent destabilisation of the river environment.

Nitrification usually requires longer retention times since the biological process of transforming ammonia begins only after carbon removal has been completed. Therefore nitrogen removal requires bigger volumes of tanks, including anoxic areas, where in absence of aeration, oxygen is taken from nitrate to feed specialised bacteria. The consequence is an increase in both investment and operating costs.

Phosphorous removal usually requires adding chemicals to the water to get phosphates settled.

In European countries, the decision whether or not to remove nitrogen and phosphorous has been taken on a case by case basis, by geographical hydrological catchment areas, following extensive river quality monitoring and assessment of the respective share of agriculture and sewage in river quality.

As far the data we have gathered is relevant, it does not seem that the problem of river eutrophication due to nitrogen and phosphorous require strengthening the standards.

Therefore, it is proposed to stick to standards of treatment aimed at carbon removal only.

4.5.3.3 Re-Use of Water

Where water scarcity is of concern, the re-use of treated sewage becomes an objective. Among possible uses are:

- Agricultural re-use
- Urban landscaping and beautification
- Various industrial re-use.

Industrial re-use usually requires expensive tertiary treatment to match the specific needs of industries. Also, the quality of water required depends on the type of industry concerned so that industrial re-use can never be seen as a national policy. Instead it can be an opportunistic policy.

Re-use of water for agriculture is certainly a track to consider in Iraq. There are international guidelines defining the standards to achieve prior to re-using treated sewage water in agriculture.

Among the more widely known are:

- US EPA standards
- WHO guidelines.

US EPA standards are considerably more stringent than WHO ones with regards to the level of treatment required.

Basically, these standards:

- Differentiate between the type of re-use: without constraint or limited to plants to be eaten cooked.
- Strictly prohibit the presence of helminth eggs, especially nematodes.
- Limit the bacteriological content of treated effluent.

The issue of nematodes is to be addressed specifically. The presence of nematodes in sewage is a consequence of alimentation patterns and public health condition. Classical processes are said to be able to reduce nematodes by say 90%. Where the quantity of nematodes in the sewage is significant the only means to comply with the standards is to provide tertiary treatment, either sand filtration or final lagoons. In the absence of any information on the possible presence of nematodes in the sewage, the need for such tertiary treatment cannot be decided upon.

4.5.3.4 Process / Plants Location

4.5.3.4.1 General

The study of any sewerage scheme involves selecting the best combination process/ sewage treatment site location. This issue includes several aspects:

- (1)Building the plant inside or close to the urbanized area, or (2) shifting the plant far away from the city.
- (1)Building one centralized plant whatever the city size, or (2) limiting the maximum size by selecting several plants instead of one.

The criteria that are usually scrutinized prior to deciding are as follows:

- Environmental constraints, and especially sensitivity to bad smells.
- Urban development forecasts: With urban growth, many plants originally designed as remote from the city center have turned out to be surrounded by new human settlements.

4.5.3.4.2 Compact Sewage Units As A Temporary Solution In Iraq

In the specific situation of Iraq, selecting compact units is seen in many cases as the only workable solution since it allows the length of trunk sewers of large diameter to be reduced. The laying of large diameter sewers is seen as difficult to carry out within the Iraqi context.

The solution would be:

- Laying of collection networks by local governmental construction contractors.

- Until the lifting of the embargo, purchasing of compact sewage treatment plant units, with limited requirements in terms of civil works.

However, there are some disadvantages that need to be carefully scrutinized prior to selecting compact units.

- The management of sludge is made much more complicated since (1) the number of sludge production sites increases with the number of sewage treatment plants, (2) the concept of compact units is neither in favor of digestion nor of sludge drying beds. Several solutions exist including that of laying a network of small pipes to transport liquid sludge produced by several sewage plants to only one sludge treatment plant where digesting sludge is feasible.
- In absence of odor control and treatment, which is relatively high tech and expensive, locating the compact units close to urban areas may result in high environmental nuisances to the near by dwellers.
- Operating several plants is more difficult than managing only one plant.
- Classical compact sewage treatment plants have limited expected duration life.

Therefore, unless specific long term solutions are selected, compact unit sewage treatment plants should be seen as temporary solutions only.

4.5.3.4.3 Long Term Possible Solution for Compact Sewage Treatment Plants

Where decentralized compact units are seen as a long term solution, international design would recommend environmentally friendly solutions. A good solution which has been implemented in cities like Paris, includes:

- Chemically enhanced primary settling
- Bio-filtration

Thanks to very limited foot prints, these plants are easily protected against odor nuisances to the neighboring environment by full coverage of treatment units. The polluted air inside the plant is extracted and treated before disposal to external air.

The advantage of this solution is that:

- It limits the laying of transfer pipes and pumping stations to remote areas.
- It is fully environmentally friendly.

The disadvantages are that:

- It requires a good level of expertise of civil contractors since civil works are rather complicated.
- Its operation requires chemicals: (1) for primary settlings, (2) for air treatment.

With regards to sludge disposal, it is worth considering centralizing sludge treatment to remote areas. This issue can be addressed in different ways:

- Pumping of liquid sludge through small diameter pipes to the sludge treatment site.
- Transport of liquid sludge by trucks. This option is feasible for small plants only.
- Transport of liquid sludge by boat to the sludge treatment site.

- Sludge dewatering by centrifuges and transport by trucks of dewatered sludge.

In the present situation of Iraq, phasing the implementation could be considered. The first step of treatment, namely chemically enhanced primary treatment allows a treatment yield around 70% as far as BOD_5 is concerned to be reached. Although not fully guaranteeing compliance with the standards, it could be seen as a very efficient temporary solution.

4.5.3.5 Centralized Sewage Plants

Where sewage treatment plants are built in sites remote from urban areas, where environmental nuisances are not that big, the solutions which are favored in Iraq are quite appropriate.

They include:

- Extended aeration, without primary settling. From a financial point of view, this is the best solution for small plants only.
- Conventional treatment, that is primary settling, activated sludge and clarifiers. Sludge treatment usually involves sludge digestion That is the best solution from an economical point of view as far as large plants are necessary.
- Trickling filters. The efficiency of trickling filters could be improved by replacing stones by plastic medium. However, it would increase investment costs.

Given the climate of Iraq, lagoons are also a means of treatment which may appear suited to the country. The advantage of lagoons is that operating costs remain very low with limited maintenance. Lagoons are usually seen as fitted for limited capacity plants since they require extensive surfaces. It should however be pointed out that best practices require protecting the groundwater table against pollution by seepage of water. This means that a geological study should confirm that the soil is watertight. Otherwise technical means to make the soil watertight are available including bentonite improved soil or sheet lining. Also, lagoon design requires attention to be paid to regular desludging. This can be achieved by providing the first lagoon with a hardened bottom on which bulldozer can enter after draining for sludge removal.

4.5.3.6 Effluent Septicity

4.5.3.6.1 General

All the systems operating in Iraq receive septic effluent, resulting in:

- Development of bad odorous in the sewer network and the treatment plants, due to H_2S.
- Rapid deterioration of mechanical equipment.
- Development of sulfate reducing bacteria which corrode ordinary concrete.
- Reinforcement bars are exposed and subject to corrosion.

The combination of high average temperature and flat land requiring many pumping stations constitutes a negative factor which explains the tendency towards sewage becoming septic. To a large extent, this cannot be avoided, so sewage treatment plants should be designed accordingly.

4.5.3.6.2 Chemical Analyses

Chemical analyses should be carried out on samples of existing effluent so that the contents of sulfate and hydrogen sulfide can be assessed.

4.5.3.6.3 Sulfide Treatment

The minimum step for sulfide treatment is to provide the pre-treatment with sewage pre-aeration. Where it is not sufficient for guarantying the treatment, it is possible to provide specific sulfide treatment stage. However it increases investment and operating costs by the adding of chemicals.

4.5.3.6.4 Sulfate Resistant Concrete

The best quality of sulfate resistant concrete should be used for all sewage treatment plants in Iraq.

4.5.3.7 Sludge Treatment and Disposal

Sludge treatment comprises the following steps:

- Sludge thickening, increasing the sludge dry solids content from approximately 1% to 5%
- Sludge stabilization
- Sludge dewatering
- Sludge disposal.

Sludge thickening is necessary whatever the following steps. It is achieved through sludge thickeners.

Sludge stabilization through digestion or adding of lime is necessary when processes result in high sludge organic matter content. It is usually said that primary settling involves further sludge digestion. Sludge digestion is also interesting prior to further sludge agriculture reuse. However to be efficient, digesters require high technological design and excellent maintenance.

Sludge dewatering. Necessary for final reduction of the water content.

Sludge disposal: Basically three ways of disposal are available: (1) land filling to disposal areas, (2) agriculture reuse, (3) incineration. (reminder incineration is not seen as interesting in Iraq.

Considering the specific climate of Iraq, where rain is not frequent, and temperatures often very high, sludge-drying beds are seen as the best option for the country, prior to either landfilling or agriculture re-use.

Where sewage treatment plants are built in remote areas, it is logical to have sludge drying beds inside the sewage treatment sites.

Where sewage treatment plants are built inside urban areas, which would be the case with compact unit treatment plants, the best option may be to have sludge transported to the sludge drying beds. This issue can be addressed by different ways:

- Pumping of liquid sludge through small diameter pipes to the sludge treatment site.
- Transport of liquid sludge by trucks. This option is feasible for small plants only.

- Transport of liquid sludge by boat to the sludge treatment site.

- Sludge dewatering by centrifuges up to around 20% water content and transport by trucks of dewatered sludge for further drying

4.5.3.8 Existing Plants Rehabilitation

All existing infrastructures are eligible for rehabilitation, renovation and eventual extension except:

- When the civil structures are in bad condition to a point which makes it counter productive to repair.

- If the demand has so much increased that it is cheaper to construct a new extension and destroy the existing plant than to rehabilitate it and construct a smaller new plant.

- In all cases, when the raw water is so much different in volume and quality that a new process must be implemented.

All sites eligible must be studied in order not only to rehabilitate the existing structures and equipment but also to correct the design deficiencies, improve the robustness and the flexibility of the whole related schemes. Designs and equipment must be selected for long lasting service; These considerations shall be taken into consideration when assessing the tenders so that the most cost efficient proposal be selected rather than the lowest in tender price: " cheap and dirty" proposals must not be selected any more. It is recognized that civil works construction is difficult at the present time which in itself is a strong reason to favor rehabilitation of existing sites. It is believed however, that civil works mending is possible. Construction of small civil works structures might be more difficult.

Though the following technical recommendations include addition of civil works structures, which poses an obvious problem presently, the design of the rehabilitation works should take into consideration future construction of the said structural civil works and specific means to mitigate the effect of delayed construction.

4.6 Guidelines for Garbage Collection and Disposal

4.6.1 Collection

4.6.1.1 Introduction

To improve garbage collection in Iraq the means must be provided to cater for daily garbage production. The initial aim of any garbage collection action plan is therefore to provide the sector with the adequate technical and human resources.

To meet national objectives however, - i.e. that all urban domestic garbage is collected and disposed of in a hygienic fashion – a further imperative is that the collection systems adopted are suited to the types of urban area concerned.

After summarizing the different forms of collection found in Iraq and constituting the background against which the sub sector development plan has been formulated, this section goes on to propose guidelines for medium term improvements of garbage collection.

4.6.1.2 Characteristics of Garbage Collection in Iraq

Garbage collection in Iraq cannot rely solely on door-to-door collection by garbage presses. Several types of collection are required according to the characteristics of the urban area concerned.

For the purposes of costing the development plan, a range of garbage collection systems has been proposed depending on the size of the urban area concerned. These consist in a combination of four types of collection means, as shown in the following table.

Production of Garbage by the Sub-District Urban Population	Means of Collection
Garbage production is less than 2.5 tons per day	Collecting equipment is limited to tractors with carriages of 1.6 ton capacity (Type 1).
Garbage production is between 2.5 and 50 tons per day	Collecting equipment comprises: ♦ Garbage presses (8 m^3) for 90% of the garbage production (Type 2) ♦ Tractors and hand carriages for 10% of production (Type 1)
Garbage production exceeds 50 tons per day	Collecting Equipment Comprises: ♦ Garbage presses (8 m3) for 80% of garbage production (Type 2) ♦ Containers removed by lorries equipped with crane for 10% of garbage production (Type 4) ♦ Fleet for dense areas (10% of production) comprising tractors, tippers, shovels and dumping trucks (Type 3)

The percentage breakdown by means of collection presented in the above table may appear optimistic in the present situation. However, the development plan assumes that the share of garbage collected at door-to-door level by garbage press will increase over time.

At the local level, the split between the different collection types should be determined on the basis of the characteristics of the urban area concerned. Significant factors which affect the means implemented:

- The density of construction and the width of the streets
- Whether or not pavements exist
- Involvement of residents in the garbage collection process.

4.6.1.3 Proposed Improvements

4.6.1.3.1 Garbage Development Plan at the Governorate Level

Each Governorate should produce a garbage collection development plan defining which means of collection are to be used in which type of area and how this situation should evolve over the next ten years.

The typology thus formulated would then serve as a basis for determining precise requirements in terms of equipment and staff.

4.6.1.3.2 Improving the Packaging of Garbage

The previous practice of supplying users with cheap plastic bags should be reinstated. Other means of garbage packaging could also be used such as tin boxes.

4.6.1.3.3 Optimizing the Collection System

From a short-term point-of-view, improving efficiency means catering for daily garbage production.

In the medium term, improving collection should also involve augmenting the quantity of garbage handled by worker or by vehicle.

The different ways to achieve this objective include:

- Increasing the proportion of garbage collected by garbage presses. Since this factor is influenced by urban typology, such an objective can only be achieved in conjunction with the modernisation and revival of urban areas - and in particular the rehabilitation of hazardous areas and the reconstruction of pavements.
- Increasing the daily number of collection rounds per vehicle. The number of rounds made is dependent on four factors: (i) garbage packaging, since the greater the proportion of garbage packaged, the shorter the collection time; (ii) staff motivation ; (iii) collection round management. In Europe efficiency has in many cases been improved through the reorganization of collection rounds. Accomplishing this in Iraq requires studies at the local level to determine the type and number of vehicles to be allocated to the different areas of the city; (iv) reducing times of transport of garbage to disposal areas. In many big European cities, efficiency has been improved by separating the collection and transport stages. This requires the construction of a transfer bay where garbage presses discharge to large-capacity trucks, the latter being the sole means of transport to the garbage disposal area. This solution is particularly apt where the disposal area is located a long way from the city center.
- Reducing the frequency of collection. This requires storage of garbage in the home until collection day.
- These measures may appear unrealistic at present. For the short term, a primary aim would be to restore public confidence in the ability of the authorities to ensure a reliable collection service. Optimising the collection system to cut costs can only be envisaged once this initial objective has been achieved.

4.6.1.3.4 Public Awareness Campaigns

Once the collection system has been defined at the local level, it is essential to involve the local community in the collection process. In Iraq streets are often cleaned by local residents - particularly women - garbage disposed of in nearby wasteland areas. Where containers are provided, these are not always used. There is a need to encourage communities to consider garbage management as a partnership with the competent authority in order to iron out inconsistencies between public and private actions. To this end a public awareness campaign should be organized. This can only be effective however once confidence in the public body has been restored.

4.6.2 Disposal

4.6.2.1 Introduction

The present section outlines the garbage management and disposal means which can be envisaged as an alternative for Iraq.

The following deals principally with domestic garbage. It should be stressed however that the waste to be disposed of is not limited to domestic garbage. A national plan should be extended to cover all types of waste, including:

- Domestic garbage
- Commercial and industrial waste
- Construction and civil works waste
- Sludge produced by sewage treatment plants
- Sludge discharged from septic tanks.

Commercial and industrial waste is generally assimilated to domestic garbage, provided that the material concerned is comparable in quality and has no adverse environmental affects. Normally this requirement is guaranteed through specific standards and regulations, and checked by the relevant public authorities.

Construction wastes generally present no health or environmental risk and are disposed of with domestic garbage or to more economic landfill sites requiring less stringent environmental provisions.

Possible garbage management and disposal means implemented in other countries include:

- Incineration. This method will not be considered as feasible for implementation in Iraq. Although increasingly used in other countries, it is by far the most expensive method of treatment. The recent tendency to add high-technology smoke treatments to incineration due to a growing awareness of the environmental impact of untreated combustion gases, precludes the use of incineration in Iraq, at least in the short term.
- Composting figures as a promising way to address the issue of garbage disposal. Although, in the case of Iraq, it is not considered as the most feasible means for the short term, the implementation of composting sites on a pilot level may prove to be of interest.
- Landfilling is the preferred option for a national policy, provided that landfills are progressively upgraded from open dumps to sanitary landfills.

4.6.2.2 Existing Disposal Methods

Standards governing the location and operation of landfill sites do exist in Iraq. These can be summarized as follows:

- Garbage areas should be located 10 to 15 km to the south of cities.
- Garbage should be compacted.
- After filling, landfills should be covered by a layer of compacted soil.

4.6.2.3 Guidelines for Landfill Sites

4.6.2.3.1 Summary of International Practices

This section summarizes international approaches to solid waste landfill management. [*]

Best practices ensure the mitigation of possible environmental nuisances through the implementation of adequate design and operation strategies.

Environmental Impact of Landfills

Adverse environmental affects of landfills include:

- Nuisances such as odor, dust, vermin and birds, which can be mitigated by compacting the waste and the application of daily soil cover.
- Leachate, which results in pollution of the groundwater table. Leachate will continue to be generated even after the landfill is closed.
- Landfill gas which contains approximately 50% methane, which, when released into the atmosphere, can contribute 2 to 4% of the total global release of greenhouse gases. Simple and often inexpensive measures including flaring or gas recovery for energy purposes can provide a possible source of income and significantly reduce the environmental effects of methane gas.

Landfill Classification

The sanitary landfill differs from the open dump in a number of ways.

- Open dumps are the primitive stage of landfill development and remain a default approach to municipal waste treatment.
- Operated dumps record incoming waste and include limited compaction by bulldozer and compactor.
- Engineered landfills embody further attempts to minimise environmental impacts.
- Sanitary landfills incorporate a full set of measures to control gas and collect and treat leachate, apply a daily soil cover and implement plans for closure and aftercare long after waste has ceased coming to the site.

The sanitary landfill requires attention to all technical aspects of landfill development, including siting, design, operation, and long-term environmental impact.

In principle, practices include:

- Recording incoming waste by implementing a weighting system.
- Limiting access to authorised waste. Special provisions are made for hazardous waste, which is not normally allowed to enter the domestic waste landfill.
- Selecting a site where the impact on the environment is limited.

[*] Observations of Solid Waste Landfills in Developing Countries. Lars Mikkel Johannessen with Gabriela Boyer / The World Bank 1999.

- Defining daily operation: organising the tipping front, determining the thickness of the layer in which waste is compacted and the amount of daily soil cover applied.
- Planning of leachate management and control strategies. A number of techniques exist depending on the country - and in particular climatic factors.
- Collecting and treating gases.

4.6.2.3.2 Recommendations for Developing Landfill Management in Iraq

Recording Incoming Waste

- All landfills: record of number of incoming trucks.
- Large landfills: implementation of a weighting system.
- Restricting income of hazardous waste.

Siting

The site should be selected after comparison of possible alternative sites. Criteria for selecting the best site include geological setting, distance from urban areas and dominant winds.

Daily Operation

- Application of a thin layer of sand (relaxed approach)
- Restricted access to waste pickers.
- Compacting of waste by bulldozer (small landfills) or compactor (large landfills).

Leachate Management

Given the dry climate of Iraq, it is likely that the environmental impact of leachate will be less significant than that in wet countries. For Iraq, the recommended method is the controlled containment release approach which allows leachate to enter the environment in such a way that it should have no serious impact. This technique requires particular emphasis on proper siting of the landfill, environmental considerations and monitoring. It is normally adopted in arid and semi-arid countries, and is the most economic and environmentally sustainable approach for low or medium income countries. Where test monitoring showed this method to be suitable, a containment strategy could be developed, including laying of PE sheets , leachate collection and treatment by aerated ponds.

Gas

- All landfills: gas collection.
- Big landfills: gas collection and flaring.

Yearly Operation

Each year, a single 3-metre deep cell of one-year storage capacity will be built. The construction works require at least a shovel, a bulldozer and a dumping truck. Part of the excavated earth is piled around the pit to form a bund and the rest is stored close-by. The construction works should be terminated before the rainy season.

After one year of operation, the cell is closed. The excavated earth is removed from the storage area and used to cover the cell.

4.6.2.4 Composting

Compost is the result of a bio-chemical reaction between waste and a suitable bulking product. Bulking products are generally derived from plants, small pieces of wood and in some cases, palm trees.

The process itself consists of two stages:

- Composting: mixing and aeration of sludge and bulking product (fresh compost).
- Maturation: four months' storage is required to arrest the chemical reaction.

The composting site would contain the following items:

- Raw garbage storage area
- Bulking product storage
- Bulking product crushing unit
- Mixing unit
- Covered storage area
- Equipment to turn the windrows
- Maturation area with limited permeability sloping gently down to a collection area for treatment of seepage water.

Compost is a valuable agricultural product which acts as a fertilizer thanks to its organic matter content. However, many composting operations implemented around the world have been unsuccessful. In these cases, potential crop-growing or afforestation areas have virtually been transformed into wastelands, owing to the accumulation of non-degradable waste such as plastic bags and metal objects.

As a result, composting should not be adopted without thorough sorting of waste to eliminate undesirable objects.

The re-use of compost for agricultural or similar purposes (afforestation, soil improvement) is possibly a viable alternative for the long term which needs careful scrutiny before selection. Investigations should be undertaken to determine whether: (i) there is effectively a need from an agricultural point of view (although this seems very likely at present), (ii) sorting to eliminate plastic and metals is feasible (in view of the staff requirement), (3) co–composting of sludge and garbage is feasible.

Composting of septic tank discharge sludges is possibly a safe alternative to the disposal of those waste constituents which are difficult to eliminate. Experience shows that co-composting of garbage and septic tank sludge in a ratio of 80% / 20%, is feasible.

The implementation of a small-scale pilot study is proposed, comprising:

- Sorting of garbage to eliminate unacceptable waste.
- Co-composting of domestic garbage and septic tank sludge.

- Reuse for agricultural purposes.
- Monitoring.

Developing Water Supply Sub-Sector Performance

SAFEGE
Consulting Engineers

CONTENTS

TABLES

5. Developing Water Supply Sub-Sector Performance

5.1 Introduction

In this chapter, we develop water sector investment plans corresponding to the two boundary scenarios. The "ideal scenario" aims to meet the GOI service performance targets by achieving the 3 strategic phases of the GOI Action Plan. In the "minimum scenario" the water authorities achieve Phase I only and maintain the present coverage rates over the planning period by completing the UFW reduction programme and expanding production capacities with the aim of delivering the supply target rates to the covered population.

5.2 Development Strategies

5.2.1 Background of Sector Objectives and Strategy

The overall objective of the Water Sub-Sector in Iraq is to provide potable water to the population in sufficient quantity.

Securing open access to potable water for all the population in Iraq is the main sector development objective of the GOI. This objective comprises 2 aspects:

- Water supply facilities should tend towards 100% coverage.
- The availability of potable water from public utilities should meet household needs according to an agreed standard per capita level. The impact of shortages should be distributed evenly among all users.

The GOI's strategy, aiming to increase the supply of potable water to the population, can be outlined as follows:

- Stage I: To rehabilitate the existing systems with the aim of enhancing efficiency and improving performance as well as quality.
- Stage II: Fill in the gaps so that universal accessibility of service can be achieved and the "underserved" and the "unserved" are covered.
- Stage III: Increase the level of service in line with the normal growth of the population.

5.2.2 Rehabilitation Investment Programmes

Rehabilitation programmes aim to increase the efficiency of existing facilities to an Efficiency Target to be defined for the various categories of assets. These are:

- A Project Efficiency (PE) was defined by UNICEF to evaluate the efficiency of production facilities (water treatment plants, wells, compact units) and boosting stations. It consists of a combination of efficiency parameters, which are related to relevant technical components; the weighted sum of the components' efficiency evaluates the effective production capacity of the production unit as a percentage of the Design Installed Capacity[1] (DC), corresponding to an average operation of 20h a day[2].

- Power Factored Efficiency (PFE), which evaluates the actual Production Capacity (PC) as a percentage of design capacity after considering the average of hours operating with the main power supply and the average of hours operating with an emergency generator, related to a standard 20 hours of operation per day.

The Production Capacity represents the production, which is available at the head of transmission lines and distribution systems.

The distribution facilities may need rehabilitation and upgrading to meet the targeted network efficiency targets. The main parameters, which are used to evaluate network efficiencies are:

- The Unaccounted-for-Water (UFW%) evaluates the efficiency of distribution facilities to bring treated water to the users. This parameter evaluates the physical losses including leakage, pilferage, and free service.

- The Commercial Losses Indicator. This indicator is not currently evaluated due to lack of reliable data; it comprises 3 main components:

  - Metering efficiency which evaluates the efficiency of the operator to measure the quantity of service supplied.

  - Customer management efficiency which evaluates the efficiency of the operator to bill the services provided.

  - Collection efficiency evaluating the ability of the DWS to collect the revenue resulting from the billing activity on time: % of bad debts and pending accounts.

Water quality control monitors the efficiency of treatment and distribution facilities to supply potable water according to the applicable quality standard.

5.2.3 Schedule for Expansion Work

Phase II of the GOI strategy refers to increasing service coverage and reducing the water shortage indicator (SII) by preventing situations where the Water Supply Rates (WSR) would be less than the WSAL. The corresponding emergency programmes will aim to ensure that the WSAL is reaching all the served population.

Phase III will aim to reduce the SII shortage indicator.

These 3 phases indicate the priority given by the Cabinet to a preferred action plan over other alternative action plans. However, the overall schedule for the sector will allow overlapping actions to be undertaken combining the 3 phases, with the aim of achieving the service performance goals within a 10-year action plan.

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1 In the database, the Uinstalledcap and Rinstalledcap refer to urban and rural shares of the installed capacity corresponding to 20 hours of operation in m^3/d. WTPinstalled cap indicates the installed capacity of a DWTP, WTCUInstalled refers to the installed capacity of compact units, wellInstalledcap, referring to the installed capacity of wells.

2 Except for the Bafag compact units, evaluated for an average operation of 10h a day.

5.3 Water Demand

5.3.1 Water Supply Demand[3]

Standard Water demand (SWD) of water supply services is the water supply target rate defined by the GOI for 2010. The SWD, corresponding to a seasonal peak flow, is given in Table 5-1.

From the population database and SD table, we calculate the water demand (WD) in 2000 and in 2010 as follows:

$$\{WD_i\} = \{SP_i\,(M,U/R) * SWD_k(M,U/R)/1000\} * (1+PGR\,(Gov))^n$$

- WD is the water demand estimated in m^3/d
- i: sub-district
- PGR(Gov) is the estimated population growth rate corresponding to a Governorate
- SP_i (M,U/R) is the served population in sub-district I, in year 2000, broken down with respect to urban and rural areas; "M" refers to sub-districts, which may be capitals of the Governorates or not. The population forecast is shown in table 4.4.
- SWD is the standard water demand of the k categories of users, corresponding to the served population (rural, or urban in a municipality and municipalities); the water needs are evaluated according to a standard demand pattern, which was established by the WES working group in co-ordination with BWA and GCWS.

Table 5-1. Standard Water Demand (SWD) for Different Categories of User, in litres per capita per day (lpcd)

Categories Of Users	Baghdad	Municipality	Municipalities	Rural Area
Domestic Users	330	300	250	180
Industrial & Commercial Users	40	30	20	
Government	55	50	40	10
UFW	75	70	50	35
Total	500	450	360	225

A water supply Adequacy Line was established by the Water Authorities including non-domestic uses and excluding UFW:

- 150 lpcd in urban areas
- 80 lpcd in rural areas of Centre South Iraq
- 50 lpcd in rural areas of ARNI.

In the event that the average supply is inferior to the above minimum demand levels, the priority will be to allocate distribution evenly among users to ensure the same level of supply for all.

[3] Database, Query IP2

The SH indicators defined in Chapter 2 evaluate the served population, which is receiving water supply from public utilities under the WASI.

Free supply and supplies by public wells and public standpipes are considered as UFW as long as such supply sources do not provide an adequate service level according to the Adequacy Line Criteria. The availability of water in terms of the quantities of water effectively made available via household connections constitutes an indicator of the efficiency of the local operators in achieving the UFW reduction targets.

5.3.1.1 Required Production Capacity

The Required Production Capacity (RPC) is the effective production capacity (PC), which will be required to meet the Water Standard Demand (WSD), after compensating the efficiency levels of the UFW of the networks' operation; it can be evaluated for each sub-district "i" by the expression:

$$RPC_i = WD_i / (1 - UFW_i\ \%)$$

Table 5-3. Required Production Capacity in 2000 in m³/d

Governorates	URPC	RRPC	RPC
Anbar	311 376	110 417	421 793
Babil	269 702	95 255	364 958
Baghdad	223 825	50 312	274 137
Basrah	540 021	49 479	589 500
Diala	203 347	134 616	337 964
Dohuk	202 544	54 328	256 872
Erbil	471 642	87 748	559 390
Kerbala	200 633	26 028	226 662
Mayoralty of Baghdad	3 366 977	4 970	3 371 947
Missan	202 903	8 646	211 549
Muthanna	99 212	28 702	127 914
Najaf	328 474	38 226	366 700
Ninevah	604 921	71 123	676 043
Qadisiyah	278 511	110 845	389 355
Salaheldin	180 960	67 477	248 436
Sulaymaniyah	519 633	116 725	636 359
Ta'meem	246 725	29 266	275 992
Thiqar	484 878	35 102	519 980
Wasit	253 254	68 264	321 518

The Required Installed Production Capacity (RIPC) is the production capacity which is required in the current year to address the Standard Water Demand, taking into account the actual efficiency levels of the production units working 20 hours per day:

$$RIPC = RPC/PFE$$

Where PFE is the actual Power Factored Efficiency of Production Units in the current year, which is evaluated as defined by the UNICEF Efficiency survey in Year 2000.

Since both of these parameters vary over the planning period as a result of the action plans, the planning requirement will be established according to the targeted standards in 2010:

$$RIPC = WDi(2010) / (1 - UFWi\%(2010))/PFE(2010)$$

Where UFW%(2010) and PFE(2010) are respectively the UFW and PFE efficiency targets envisaged by year 2010. The Water Authorities expect to achieve the following UFW targets by 2010:

Table 5-5. GOI UFW targets for 2010 and current average levels in 2000

UFW Targets	Baghdad	Municipality	Municipalities	Rural area
UFW 2010	15%	16%	14%	16%
UFW 2000	50%	35%	35%	45%

The required increase of water production capacity (ΔIPC) over the 10-year Action Plan will be evaluated by:

$$\Delta IPC = RIPC(2010) - IPC(2000)$$

The existing installed production capacity is the design capacity of existing production units (IPC): Water treatment plants (WTP), Compact Units (CU) and wells. The current Production Capacity of Treated Water is calculated from the UNICEF Efficiency survey:

$$PC = \Sigma\, IPC_k * PFE_k$$

Where k refers to a specific production unit

The Production Rate (PR) was defined as an indicator of the level of equipment (referring to the extension of existing infrastructure) integrating the service coverage (WSC) and the availability of water (WSR) within a global indicator:

$$PR = IPC/\text{Total population}$$

PR is an indicator (expressed in m^3/d/inhabitant), which may be used to allocate the GOI Capex subsidies (Chapter 2) to the Water Authorities.

5.3.1.2 Management Efficiency Parameters

Rehabilitating the production capacity should aim to restore 100% of the design capacity; the powered factor efficiency will be targeted according to the current design capacity of the auxiliary generators. Depending on the assessment of existing facilities, the rehabilitation may consist in replacing the facility; in this case, the new facility will be established according to the estimated required production capacity for 2010. Therefore, the first step will consist in selecting the facilities which are to be replaced with a view to evaluating production capacity after normal rehabilitation work.

UFW improvement will aim to:

- Increase availability of water by reducing leakage and improving pressure and flow management.
- Improve O&M performance by increasing revenue generation.

The corresponding targets consist of a Leakage target rate (which would include pilferage and other physical losses), based on corporate (or institutional) goals.

The Leakage Reduction Performance rate (LRPR) is defined at Directorate level as the gap between the existing situation evaluated by UNICEF and the water authorities at sub-district level and the UFW national targets.

$$LRPR = UFW/UFW\ target$$

The existing efficiency of the DWS and BWA to bill and collect revenues that correspond to the service provided is unknown. It is estimated at 76% in the Mayoralty of Baghdad, and it is deemed to be lower in the Governorates operated by GCWS. It seems to be easy to achieve a high standard of efficiency.

Regarding water quality, the rehabilitation of treatment facilities and the minimum improvement of the availability of water through leakage reduction programmes and improving pressure and flow management should allow for full compliance with the quality standards of the minimum scenario.

5.3.2 Budget Policies

5.3.2.1 General Policy

For the water supply sub-sector, a global performance indicator will be expressed by :

$$GPI = a\ WSC/WSC_{target} + b\ WSR/WSR_{target} + c\ UFW/UFW_{target}$$

- a, b, c are weighting coefficients, established by the Planning Commission with the aim of reflecting the GOI sector policies.

It is proposed to incorporate the reference to UFW situations in the Global Performance Indicator as an incentive to reduce losses. This is to reflect the GOI policies aiming to improve the efficiency of public service operations.

5.3.2.2 Budget Allocations by the GCWS

The GCWS is responsible for distributing funding resources amongst the 15 Governorates of the Centre-South Region. The Governorates' shares of subsidised public capital expenditure will be based on their comparative needs to reach the average performance levels, as reflected by the corresponding performance indicators:

- Coverage indicators
- Water availability & shortage indicators
- Productivity indicators.

The allowed (or targeted) capex share could be expressed as follows:

$$Dcapex = ACR*TDP*CC*CSL*CP*AF$$

Where:

- Dcapex: is the gross subsidy allocation of a specific Governorate.
- ACR : Average Capex Rate obtained by averaging the Capex(IO) allocation of the institutional operator with respect to the total population.
- TDP : is the total population of the directorate (r the corresponding operational unit).

- CC : is a coefficient of coverage, which is higher when the service coverage in the Governorate is less than the targeted average of the Institutional Operator.
- CSL : is a coefficient of service level, which is higher when the service level indicator of the directorate is less than the targeted average.
- CP : is a productivity coefficient, which is higher when the productivity in the Governorate is higher than the average; this will aim to provide incentives to improving efficiencies.
- AF : is an adjustment factor used to balance the sum of capex with the total Capex(IO) allocated by the GOI.

Securing adequate access to potable water for all the population in Iraq is the main sector development objective of the GOI. This objective can be broken down into 2 components:

- Water supply facilities should tend towards 100%coverage.
- The availability of potable water from public utilities should meet household needs according to an agreed standard per capita level. The impact of shortages should be distributed evenly among all users.

5.4 Structure of the Planning Tool

5.4.1 Overview of the Planning Procedure

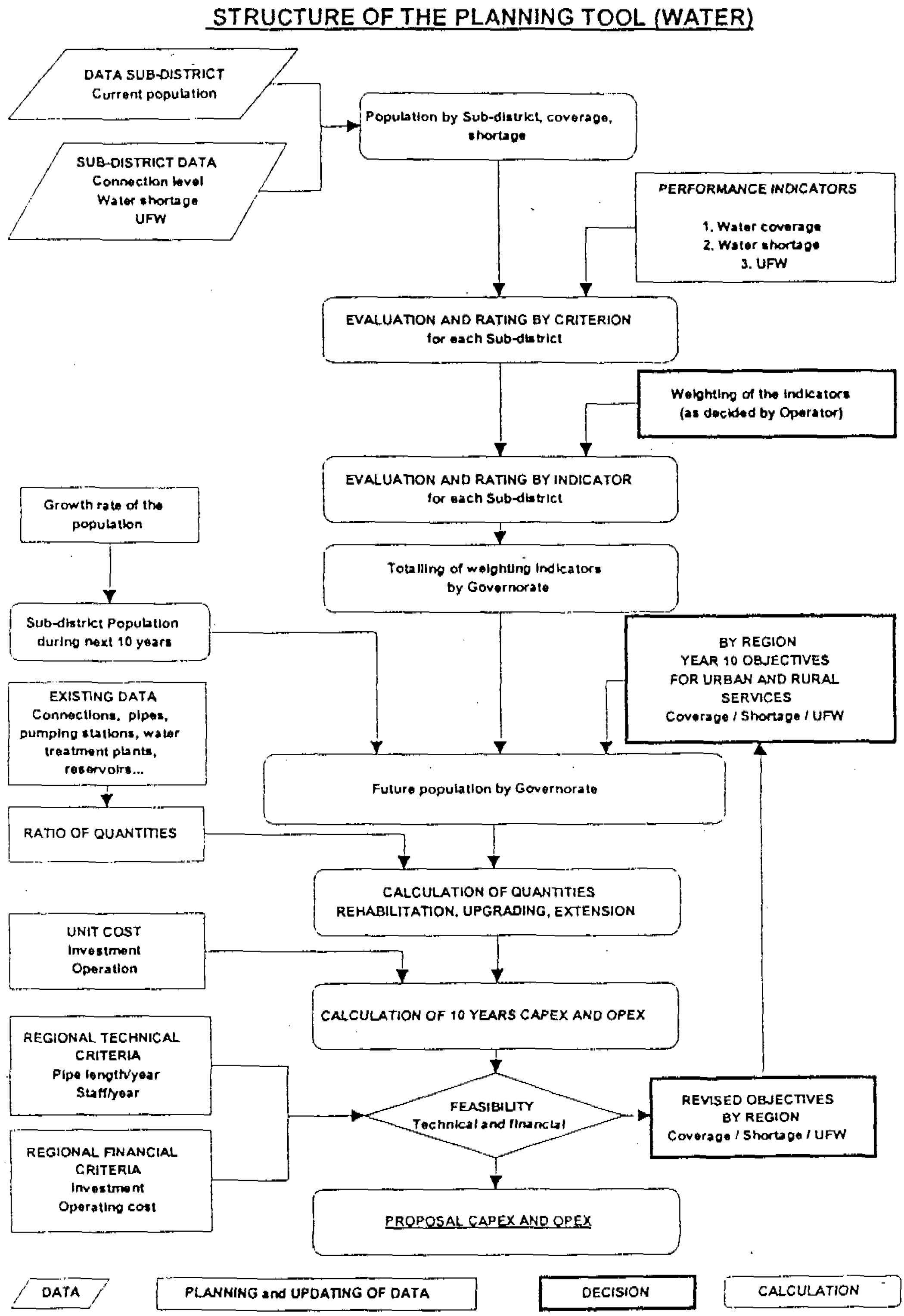


Chart 5-1: Structure of the Planning Tool (Water)

The data used in the capital investment and operating expenditure planning tool is extracted from the database, which was updated and completed in the course of the project.

The main data used is:

- Estimated sub-district urban (UP00) and rural (RP00) populations for the year 2000.
- Forecasted urban (UP10) and rural (RP10) populations for the year 2010.
- Level of coverage of water supply service in 2000 (WSC00).
- Evaluation of Unaccounted-for-Water.
- Installed and Effective Capacity of water supply facilities (treatment, pumping and storage facilities).
- Length and condition of water networks.

5.4.3 Estimates of Required Quantities of Work

5.4.3.1 General

The aim of the quantities evaluation is to determine the requirements in terms of investment and operating expenditure for the coming years.

With regard to investment costs, quantities will be evaluated in terms of:

- The rehabilitation work needed to improve the water supply service.
- The new projects to be implemented to remedy current service deficiencies and extend the supply system.

With regard to operating costs, the aim is to evaluate quantities in terms of the main items of expenditure related to the operation of the water supply system.

5.4.3.2 Capital Expenditure

5.4.3.2.1 Rehabilitation Requirements

Production Facilities And Boosting Stations

The aim of the rehabilitation of the intake works, treatment and pumping facilities is to ensure consumer demand is satisfied.

Rehabilitation requirements are evaluated on the basis of the following parameters:

- Forecast water demand by Year 2010.
- Targeted UFW levels.
- Current Effective Production Capacity of the existing projects as indicated by the database.
- Installed capacity of the existing water projects as indicated by the database.

The need to rehabilitate water project facilities is evaluated at **sub-district level** by evaluating the gap between the Effective Production Capacity (PC) and the Installed Production Capacity (IPC), where the RPC is higher than the Effective PC. At this stage, special attention should be paid to power supply availability in establishing rehabilitation programmes; the PFE/PE factor may be an efficient instrument for ranking rehabilitation projects and evaluating the needs of additional power generation devices during Phase I.

The costs of rehabilitation work in water projects are estimated by taking into consideration the recent experience of rehabilitation projects, which were undertaken by the Water Authorities with funding assistance from UNICEF ^.

The Database is used to evaluate rehabilitation needs expressed in m^3/d of increased production[4] per sub-district, which accurately results from the efficiency survey. ARNI' projects are deemed to have been rehabilitated during the achieved Phase I under OFFP.

In the present study, it is assumed that the GOI will give higher priority to power supply improvement; consequently, the proposed investment programme does not include programmes for increased power generation.

Where the 2010 requirements do not exceed 90% of the existing Installed Capacity, the Required Production Capacity can be achieve in Phase I by rehabilitating the existing facilities.

Where the requirements exceed 90% of the Installed Capacity, the facilities will require extension work in Phases II and III.

Reservoirs

Storage facilities comprise both reservoirs integrated to treatment facilities and balancing reservoirs in the networks.

Given that the condition of these facilities is unknown, the rehabilitation needs are evaluated as a percentage of the value of the existing reservoirs. On the basis of the information available, reservoir rehabilitation requirements are evaluated at 50% to provide 100% of the existing storage capacity in water projects and distribution networks.

Where the capacity of storage facilities is less than 12 hours the Required Production Capacity of Year 2010 extension work would be undertaken in phases II and III.

Distribution Systems

The rehabilitation of the existing distribution system is designed to fulfil three objectives: (i) reduce UFW losses; (ii) improve distribution system pressures; and (iii) improve the quality of the water distributed by eliminating the risk of contamination during depressurization of the networks.

The data available includes network lengths and diameters and pipe materials and age.

Pipes requiring replacement are those which are considered as "very old" or/and constructed in inappropriate material. In the present case this means pipes that are more than 35 years old and manufactured in asbestos.

- Lr = Length of piping >= 35 years + Length of piping in asbestos
- Dr = Avg. pipe diameter >= 35 years + Average diameter of asbestos pipes

[4] Query IP2

- Lr = Length of piping to be replaced
- Dr = Average diameter of pipes to be replaced.

Pipes requiring rehabilitation are those which are evaluated as "old", i.e. between 20 and 35 years old. Generally, a satisfactory pipe rehabilitation programme will result in the replacement of 30% of all old pipes. This value of 30% is given as a default value, to be adjusted if necessary by the operating DWS according to their own knowledge of the pipe network.

- Lh = 20 years <= pipes < 35 years * Rehabilitation factor
- Dh = 20 years <= pipes < 35 years
- Lh = Length of piping to be rehabilitated
- Dh = Average diameter of pipes to be rehabilitated.

Service Connections

The rehabilitation of service connections will be carried out in conjunction with pipe rehabilitation, within extensive UFW reduction programmes to be undertaken by the DWS, with the aim of meeting the ambitious UFW targets established by the GOI. We have seen that the achievement of UFW reduction programmes will have considerable impact on the improvement of the availability of water, which is expected to meet the above mentioned Standard Water Demand rates by 2010.

For budget evaluation purposes, the number of connections to be rehabilitated is evaluated on the basis of the present ratio of network length per service connection, while adding 25% to include non-domestic users.

Table 5-7: Assumed Average Pipe Ratio

Governorates	Ratio (m/Connect.)
Anbar	14,7
Babil	8,5
Baghdad	30,6
Basrah	19,5
Diala	14,1
Dohuk	7,6
Erbil	5,8
Kerbala	10,9
Mayoralty of Baghdad	20,4
Missan	11,5
Muthanna	18,2
Najaf	19,1
Ninevah	45,5
Qadisiyah	11,3
Salaheldin	19,9
Sulaymaniyah	5,4
Ta'meem	8,2
Thiqar	7,9
Wasit	7,1

Customer Meters

At present there are no meters on service connections, except in Baghdad, where most of them need replacement. No rehabilitation is therefore envisaged but replacement or installation of new facilities, which would be performed in Phase I and II, with the aim of supporting UFW reduction programmes.

5.4.3.2.2 Upgrading and Extension Requirements

Treatment Facilities and Intake Works

The requirements in terms of upgrading and extension of the water treatment facilities and source works are evaluated according to estimated water demand up to year 10.

The type of facilities to be built (conventional treatment plants/and or compact units and/or wells) need to be adapted to local constraints in each Governorate.

Reservoirs

Concerning storage for the treatment and distribution facilities, requirements are expressed as a percentage of water demand.

Distribution network storage capacities should satisfy the following requirements:

- Regulation of production of treated water
- Pump regulation
- Regulation of variations in flow demand
- Continuity of service in the case of treatment facility stoppages (in the case of daily servicing of filters, power cuts, etc.).

To meet these needs, the total storage capacity requirement was estimated according to usual standards as the average demand for a period of 24 hours.

Assuming that the users are generally equipped with a reservoir with a capacity estimated from 12 to 24 hours' demand, the required storage capacity at treatment plants and pumping stations was estimated as 12 hours of average installed production capacity.

These estimates are the basic data for the calculation of extension requirements.

Pumping Stations

Upgrading and extension requirements with regard to pumping stations are evaluated on the basis of the capacities available following the rehabilitation of the existing facilities; and the future requirements associated with the increase in the production of treated water.

Year 2010 requirements are expressed in kWh assuming an average delivery pressure equivalent to 60 m head of water.

Distribution Network

The requirements for upgrading and extending distribution networks are calculated as follows:

The number of service connections (SC) to domestic users is estimated by:

$$DSC = SP/CR$$

- DSC is the number of service connections to domestic users. The Non Domestic Service Connections (NDSC) are estimated as 25% of the DSC.
- SP is the served population.
- CR is the above mentioned average connection rate.

The length of pipe network extensions is estimated by:

Lc = (DSC_2010 – DSC_2000)*LC

- DSC is the number of domestic service connections in year 2000 and 2010.
- Lc is length of the required network extensions in m.
- LC is the density of the network in metres per connection.

The average diameter of network extension pipes is estimated by the expression:

Dc = f(WD2010-WD2000)

- Dc is the average diameter required for extensions, and is a function of water demand.
- WD2000 is the water demand in year 0
- WD2010 is the water demand by year 10

The replacement and rehabilitation of pipe networks should take into consideration the demand of the target year. These operations provide the opportunity to size the pipe networks correctly and in conformity with target year demand. The method of calculating the average diameter of the segments of network subject to replacement or rehabilitation is given below:

L2010*D2010 = Lrh*Drh + Lc*Dc + Lu*Du
Drh = (L2010*D2010 – Lu*Du – Lc*Dc) / Lrh
Lrh = Lr + Lh
L2010 = L2000 + Lc
D10 = f(WD2010)
Lu = L2000 – Lrh

- L2000 is the present network length.
- L2010 is the network length by year 10.
- D2010 is the average pipe diameter by year 10.
- Lrh is the length of network subject to replacement and rehabilitation.
- Lu is the length of network that remains unchanged.
- Du is the average diameter of the unchanged length of network.

Service Connections

The number of non-domestic users is calculated as 25% of domestic users.

Customer Meters

All users (domestic and major consumers) will be equipped with a meter by year 10.

Production and District Meters

Production and district meters should be installed in Phase I to obtain a better understanding of the water supply system operation and to improve operation accordingly, including control of unaccounted-for-water.

Quantity requirements are evaluated on average as follows:

- 1 production meter at the outlet of each treatment facility.
- 1 distribution network meter for each distribution sector. A distribution sector corresponds to a sub-reservoir serving an urban population of 20 000, or a rural population of 10 000.

Vehicles

The need for vehicles for normal operation and maintenance of the public utilities is expressed as a typical ratio, based on the experience of consultants in other countries.

Table 5-8: Planning Assumption for Estimate of Vehicles

Vehicles	Unit	No. Vehicles
Service vehicles	No./Employee	0.1
Trucks	No./KM of pipes	0.01

5.4.3.3 Operating Requirements

5.4.3.3.1 Staff

Staff requirements are evaluated on the basis of the following ratios, which reflect the usual staffing profile in well-operated facilities:

Table 5-9: Planning Assumption of Staffing Requirements

Type of Activity		Nb. Empl.	Unit
Operation	WTP	10	Nb./site
	CU	8	Nb./site
	Wells	4	Nb./site
	Storage	4	Nb./site
	Boosting	4	Nb./site
Maintenance	Network	0.02	Nb./km
Leak Detection		0.01	Nb./km
Customer service		0.0005	Nb./connect.
Admin		2%	% of Total

Nota: An higher ratio has been assigned for the city of Baghdad, representing an average of 80 employees per site.

5.4.3.3.2 Power

Power costs are determined according to the lift requirement:

- 10 m for raw water intake works located upstream from treatment plants
- 60 m for booster stations delivering water to distribution networks.

5.4.3.3.3 Treatment Chemicals

Chemicals requirements are evaluated on the basis of the following needs:

- Aluminium Sulfate: 30 ppm
- Chloride: 3 to 4 ppm.

5.4.3.4 Unit Costs

5.4.3.4.1 Rehabilitation Of Production Facilities

This includes treatment plants and boosting stations. An average rehabilitation cost function was developed, which relates the capital investment in foreign currency to the m³/d of gained production capacity. The cash component of these projects is assumed to be limited to acquisition and contract management, works supervision and commissioning.

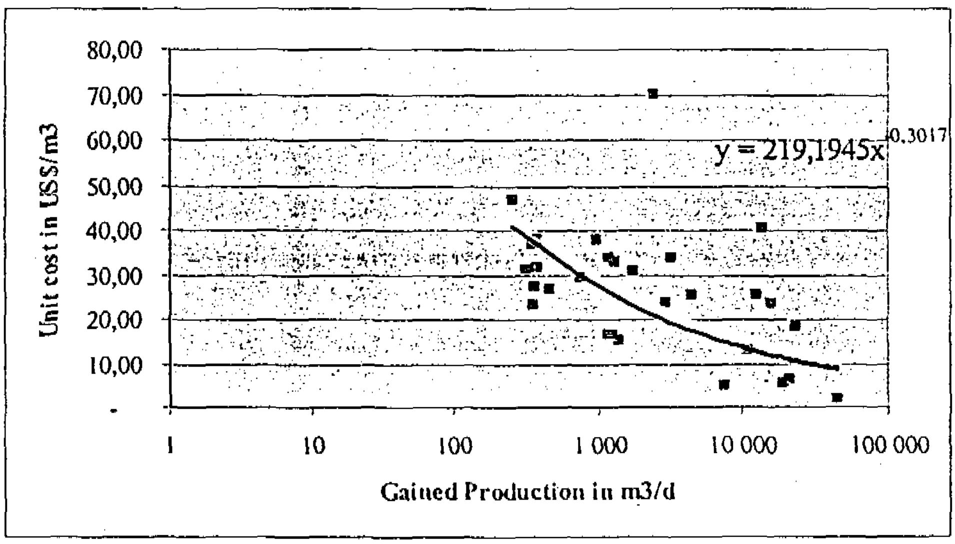


Chart 5-1. Cost estimates for rehabilitation works

Other rehabilitation costs were estimated as a percentage of the cost of new facilities:

Wells	Curr/m³	100%
Generators	Curr/kwh	50%
Storage	Curr/m³	50%
Boosting facilities	Curr/kwh	50%

Leakage detection facilities will be required. The corresponding capital cost was estimated by considering the equipment required for a technical team of 3 employees covering 300 km of pipes. The average cost of the corresponding equipment is estimated at $60 000. The local cash related expenditure is estimated as 10% of foreign expenditure.

UFW Reduction US$/km 200 +10% of local expenses in ID

5.4.3.4.2 Capital Expenditure for New Facilities

Treatment Facilities and Intake Works

The cost of new production facilities was estimated on the basis of usual average international unit prices. It is broken down into 2 components:

(FPU) Unit price for imported goods and services in US$

(LPU): Local Unit Price for expenditure in ID (Centre South Iraq and Mayoralty of Baghdad) and NID (ARNI).

- Conventional treatment plants:

$$FPU\ (US\$ per\ m^3/d) = 315.6 - 19.4\ Ln(RIPC)$$

$$LPU\ (MID\ per\ m^3/d) = 94{,}683 - 5{,}826\ Ln(RIPC)$$

Where IPC is the Installed Required Production Capacity in m^3/d

- Compact Units:

$$FPU = \$100\ per\ m^3/d$$

$$LPU = 30\ millions\ ID\ per\ unit$$

- Wells:

$$PU = (\$70 + 0{,}03\ MID)\ per\ m^3/d$$

Distribution Facilities

Table 5-10: Cost Estimates Parameters

Upgrading & Extension	Unit	Foreign Unit Cost ($)	Local Unit Cost (MID)	Af	Bf	Al	Bl
Storage	Curr/m³	Af*ln(R)+Bf	Al*ln(R)+Bl	-1,47	16,25	-0,01	0.16
Boosting facilities	Curr/kw	Af*ln(P)+Bf	Al*ln(P)+Bl	95,649	227	0,0478	0,1135
Pipes	Curr/m	Af*ln(DN)+Bf	Al*ln(DN)+Bl	0,27	4,90	20,40	296,00

- R is the required storage capacity in m^3
- P is the estimated required boosting capacity installed in kilowatts.

Service Connections

Table 5-11: Unit Costs for Connections Facilities

Upgrading & Extension	Unit	Foreign Unit Cost ($)	Local Unit Cost (MID)
Service Connections	Curr/Unit	150	0.033
Production Meters	Curr/Meter	4 000	0.800
Block Meters	Curr/Meter	2 000	0.400
Domestic Meters	Curr/Meter	20	0.004
Non-Domestic Meters	Curr/Meter	40	0.008
Large-Customer Meters	Curr/Meter	100	0.020

Vehicles

Table 5-12: Unit Costs for Vehicles

Upgrading & Extension	Unit	Foreign Unit Cost ($)
Service Vehicles	Curr/Unit	20 000
Works Trucks	Curr/Unit	50 000

Local costs are estimated by assuming 10% must be added for procurement services.

5.4.3.4.3 Unit Operating Costs

Staff 201 800 ID/Empl/Year

Salaries are expected to be re-evaluated over the period with an increase of 5% per annum

Power 8 ID/kWh

Chemicals

CHEMICALS AISO4	ID/kg	240	Or	0.075	US$/kg
CHEMICALS Cl2	ID/kg	45	Or	75	US$/kg

Miscellaneous

This item includes operating materials, tools, minor spare parts for routine servicing, overheads, etc. and is estimated at 30 % of total staff costs.

5.5 Development Planning Options

5.5.1 Introduction

In the section below, the 2 basic scenarios are discussed. The Planning Indicators are evaluated in order to establish action-planning priorities in each Governorate. The detailed evaluation of quantities and cost estimates of Capital expenditure and Operating costs for 2010 are attached in the Appendix to this report.

As a conclusion, we compare the 2 options; the impact of the leakage management programme is evaluated by comparing the results obtained for the 2 basic options with a third option.

The third option aims to achieve the ideal service level targets while adopting a less aggressive leakage reduction programme; with no leakage detection activities.

5.5.2 Ideal Scenario

The Ideal Option consists in achieving the GOI objectives for 2010:

- Coverage of 100% urban population and 90% rural population.
- Delivering the targeted rates of supply.
- Achieving an 90% efficiency rate for the production facilities .
- Achieving an efficiency rate for the distribution networks as scheduled by the Water Authorities in 2010 (about 15%).

The initial situation is evaluated with respect to these targets by evaluating the planning indicators:

- Coverage: WSC/WSC target
- Supply rate: WSR/WSD
- Efficiency: (1-UFW)/(1-UFW target).

Table 5-13. Evaluation of Planning Parameters for the Ideal Option

Governorates	Coverage			Shortage			Efficiency		
	Year 2000	*2010 Target*	*Ratio*	*LPCD*	*Required*	*Ratio*	*%*	*Required*	*Ratio*
Anbar	95%	76%	207	532	39%	47%	15%	62%	95%
Babil	95%	71%	232	447	52%	34%	15%	78%	95%
Baghdad	94%	57%	635	466	100%	40%	15%	70%	94%
Basrah	98%	75%	311	478	65%	28%	15%	84%	98%
Diala	94%	80%	147	379	39%	31%	15%	81%	94%
Dohuk	97%	92%	89	474	19%	35%	15%	76%	97%
Erbil	97%	92%	123	509	24%	35%	15%	76%	97%
Kerbala	97%	74%	232	494	47%	32%	14%	80%	97%
Mayoralty of Baghdad	100%	100%	372	707	53%	50%	13%	57%	100%
Missan	97%	63%	204	495	41%	30%	10%	78%	97%
Muthanna	95%	66%	203	437	47%	31%	16%	82%	95%
Najaf	97%	80%	305	531	57%	43%	16%	67%	97%
Ninevah	96%	72%	298	416	72%	20%	16%	94%	96%
Qadisiyah	95%	85%	154	559	28%	45%	16%	65%	95%
Salaheldin	94%	63%	212	431	49%	37%	15%	74%	94%
Sulaymaniyah	97%	78%	49	500	10%	35%	15%	76%	97%
Ta'meem	97%	80%	448	425	100%	22%	16%	93%	97%
Thiqar	96%	67%	95	634	15%	50%	15%	59%	96%
Wasit	95%	76%	146	514	29%	40%	15%	71%	95%

The 3 charts below show how the public investment budget can be structured according to the strategy adopted by the GOI with respect to service performance development.

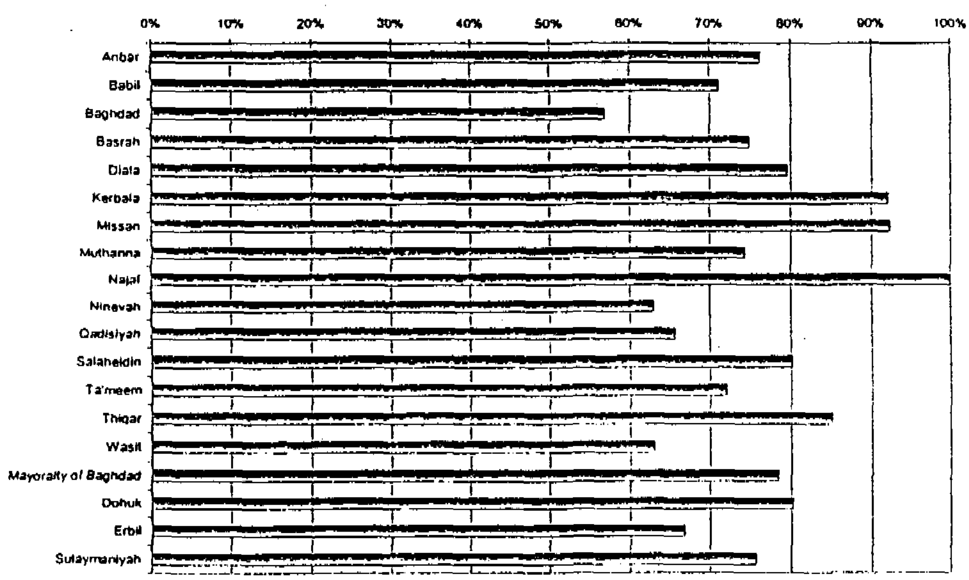


Chart 5-2. Coverage Planning Parameter for the Ideal Option

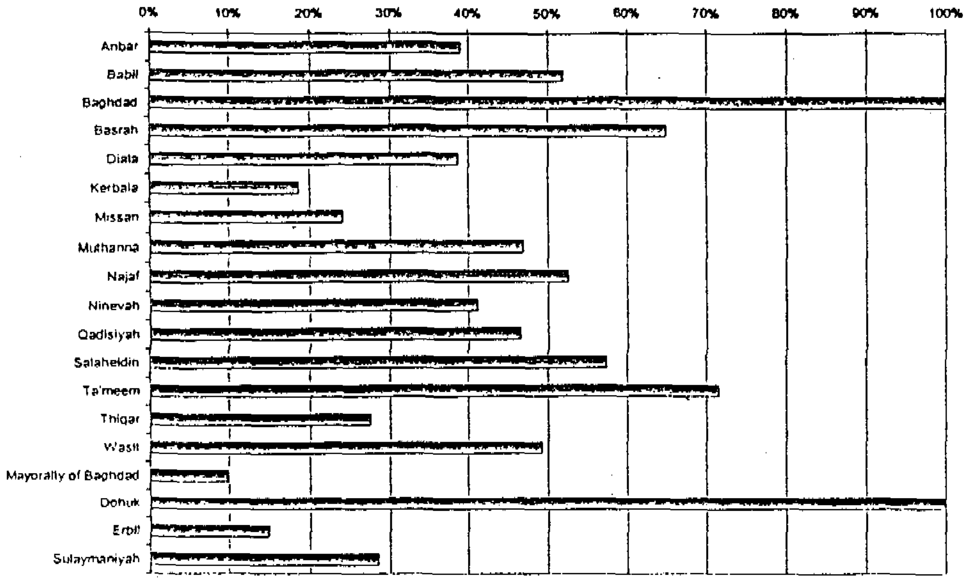


Chart 5-3. Water Supply Rate Planning Criteria for the Ideal Option

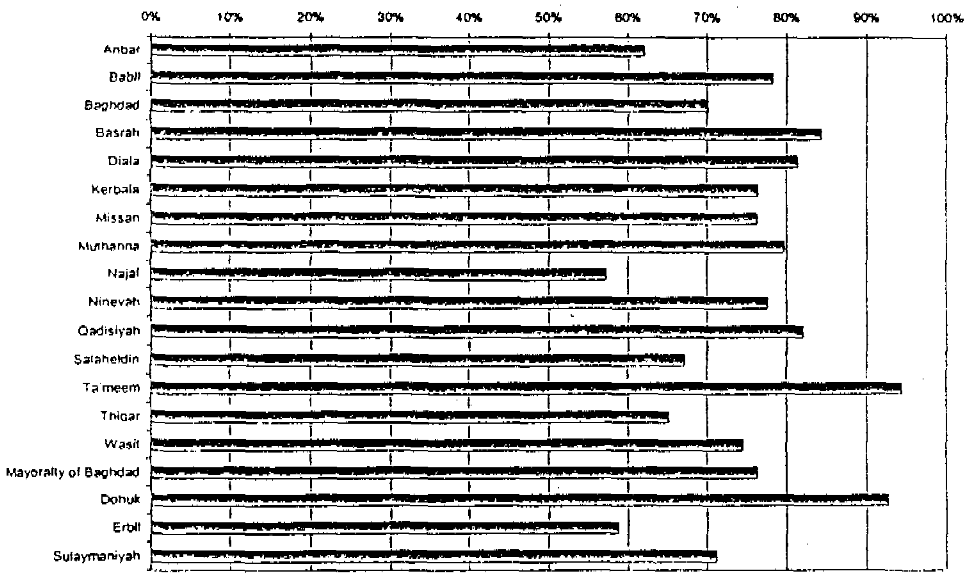


Chart 5-4. Efficiency Indicator for the Ideal Option

A Global Planning Performance Indicator was evaluated by weighting the above indicators in order to reflect GOI strategy: first rehabilitating the capacity of existing facilities, which would include an aggressive leakage reduction programme, then expanding coverage and finally improving the service level to meet the standard by 2010.

We expressed this strategy by evaluating the following Global Planning Indicator:

$$WGPI = 50\%\ Efficiency + 30\%\ Coverage + 20\%\ Supply\ Rate$$

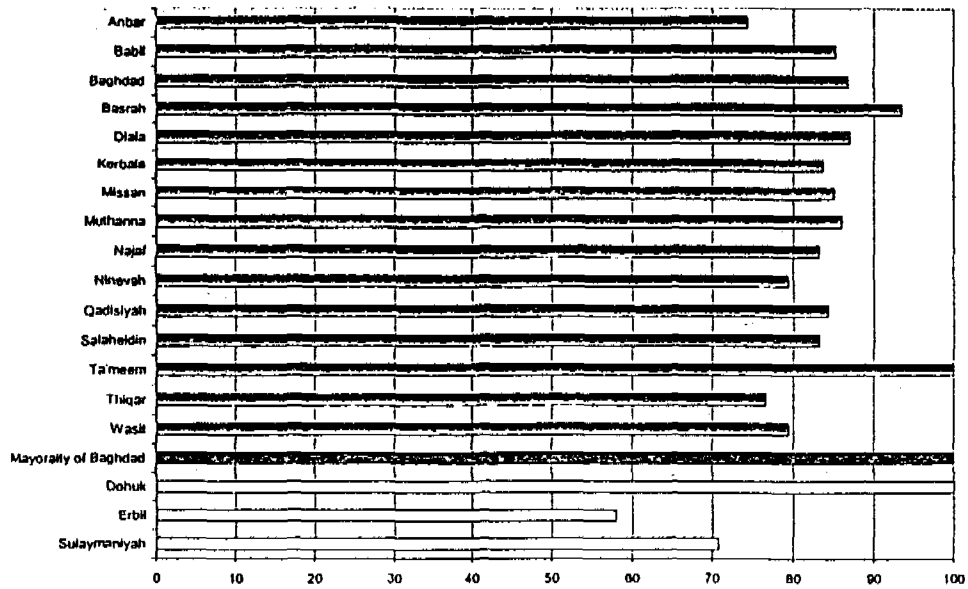


Chart 5-5 Global Planning Indicator Evaluation for the Ideal Option

Table 5-15. 10-year Capital Expenditure for the Ideal Option

		Foreign (M$)	Local (MID)	Total (M$)	% of Total
REHABILITATION					
	WTP	32	19 283	42	1%
	CU	18	11 025	24	0%
	Wells	4	8 238	8	0%
	Storage	2	1 783	3	0%
	Boosting	2	2 143	3	0%
	PIPES	1 157	555 713	1 435	22%
	Connections	114	25 275	126	2%
	Meters	0	0	0	0%
	Vehicles	0	0	0	0%
	UFW reduction	6	1 400		
	Sub-Total	1 329	623 461	1 641	26%
UPGRADING & EXTENSION					
	WTP	221	66 276	254	4%
	CU	250	36 270	268	4%
	Wells	0	0	0	0%
	Storage	12	120 181	72	1%
	Boosting	80	28 333	94	1%
	Pipes	3 574	78 300	3 613	56%
	Connections	208	46 121	231	4%
	Meters	124	27 554	138	2%
	Vehicles	95	21 140	106	2%
	UFW reduction	5	1 017		
	Sub-Total	4 563	424 177	4 775	74%
MISCELLANOUS					
Total Capex		5 892	1 047 638	6 416	642
Total Capex Per Year		589	104 764	642	
	Capex/Capita			200	$/inh.

The O&M costs are summarised in the table below:

Table 5-17. Estimated 2010 O&M budget for the Ideal Option in Current Currency

OPERATION		Imported goods & services (million US$)	Local (MID)	Total (M$)	% of Total
	Electricity	-	17 182.69	8.591	13%
	Chemicals	23.49	-	23.485	37%
	Salaries	-	8 893.49	4.447	7%
	Miscellaneous and Sundry	0.00	454.09	0.227	
	Sub-Total	23.49	26 530.27	36.751	57%
MAINTENANCE		-	-		
	Local Supply & Services	-	3 862.50	1.931	3%
	Imported Goods and Services	25.49	-	25.489	40%
	Sub-Total	25.49	3 863	27.421	43%
MISCELLANOUS					
Total Opex		48.97	30 393	64.171	
	Opex/M3	0.01	6.3	0.013	$/m^3 produced

5.5.3 Minimum Scenario

The "Minimum" Option consists in achieving a set of minimum targets, which are listed below:

- To maintain the current rates of coverage until 2010
- To achieve 90% efficiency in production by rehabilitating the existing facilities
- To deliver the GOI rates of supply in 2010 to the population served by public utilities
- To achieve 25% UFW, which represents a 40% reduction with respect to the existing situation; with no leakage detection campaigns.

The initial situation is evaluated with respect to these targets by evaluating the following planning indicators:

- Coverage: WSC/WSC target,
- Supply rate: WSR/WSD
- Efficiency: (1-UFW)/(1-UFW target)

Table 5-19. Evaluation of Planning Parameters for the Minimum Option

Governorates	Coverage (%)			Shortage			UFW		
	Year 2000	*2010 Target*	*Ratio*	*LPCD*	*Required*	*Ratio*	*%*	*Required*	*Ratio*
Anbar	73%	73%	100%	207	532	39%	47%	23%	69%
Babil	67%	67%	100%	232	447	52%	34%	25%	88%
Baghdad	54%	54%	100%	635	466	100%	40%	25%	80%
Basrah	73%	73%	100%	311	478	65%	28%	25%	95%
Diala	75%	75%	100%	147	379	39%	31%	25%	92%
Dohuk	89%	89%	100%	89	474	19%	35%	25%	86%
Erbil	90%	90%	100%	123	509	24%	35%	24%	85%
Kerbala	72%	72%	100%	232	494	47%	32%	24%	90%
Mayoralty of Baghdad	100%	100%	100%	372	707	53%	50%	13%	57%
Missan	61%	61%	100%	204	495	41%	30%	10%	78%
Muthanna	62%	62%	100%	203	437	47%	31%	25%	92%
Najaf	78%	78%	100%	305	531	57%	43%	25%	76%
Ninevah	69%	69%	100%	298	416	72%	20%	25%	100%
Qadisiyah	81%	81%	100%	154	559	28%	45%	25%	73%
Salaheldin	60%	60%	100%	212	431	49%	37%	25%	84%
Sulaymaniyah	76%	76%	100%	49	500	10%	35%	24%	85%
Ta'meem	78%	78%	100%	448	425	100%	22%	25%	100%
Thiqar	64%	64%	100%	95	634	15%	50%	25%	66%
Wasit	72%	72%	100%	146	514	29%	40%	25%	80%

The 3 charts below show how the public investment budget can be structured according to the strategy adopted by the GOI with respect to service performance development.

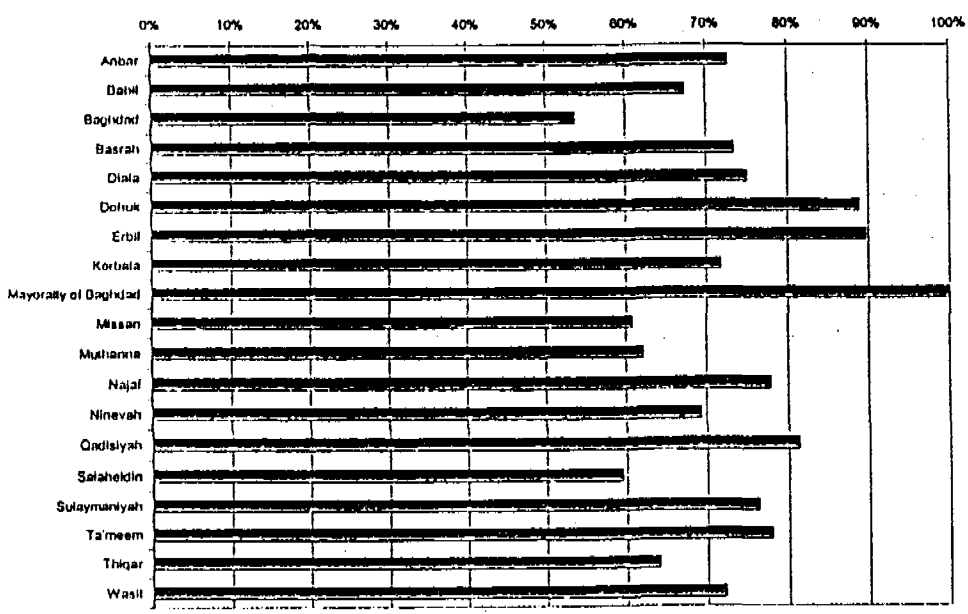


Chart 5-6. Coverage Level over the 10-year Planning Period for the Minimum Option

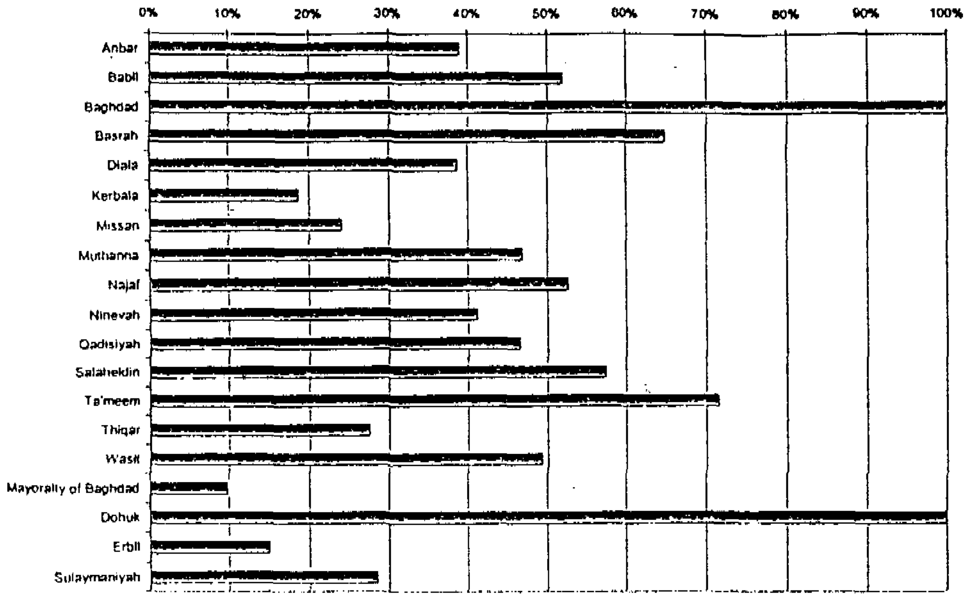


Chart 5-7. Water Supply Rate Planning Indicator for the Minimum Option

This objective is the same as for the Ideal Option.

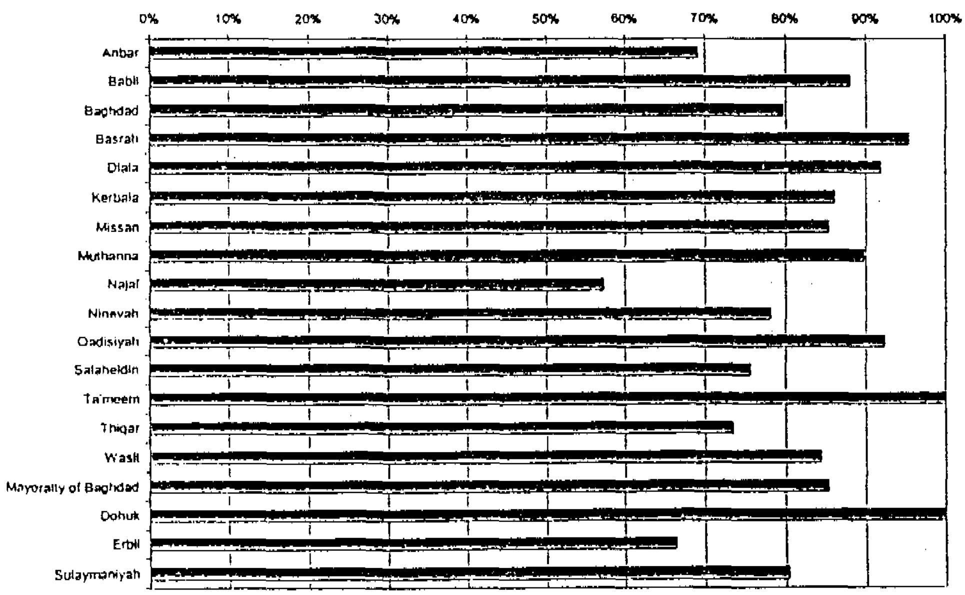


Chart 5-8. Efficiency Indicator for the Minimum Option

The Global Planning Performance Indicator was evaluated by weighting the above indicators in order to reflect GOI strategy: first rehabilitating the capacity of existing facilities, which would include an aggressive leakage reduction programme, then expanding coverage and finally improving the service level to meet the standard by 2010.

We expressed this strategy by evaluating the following Global Planning Indicator:

WGPI= 50% Efficiency + 30% Coverage + 20% Supply Rate

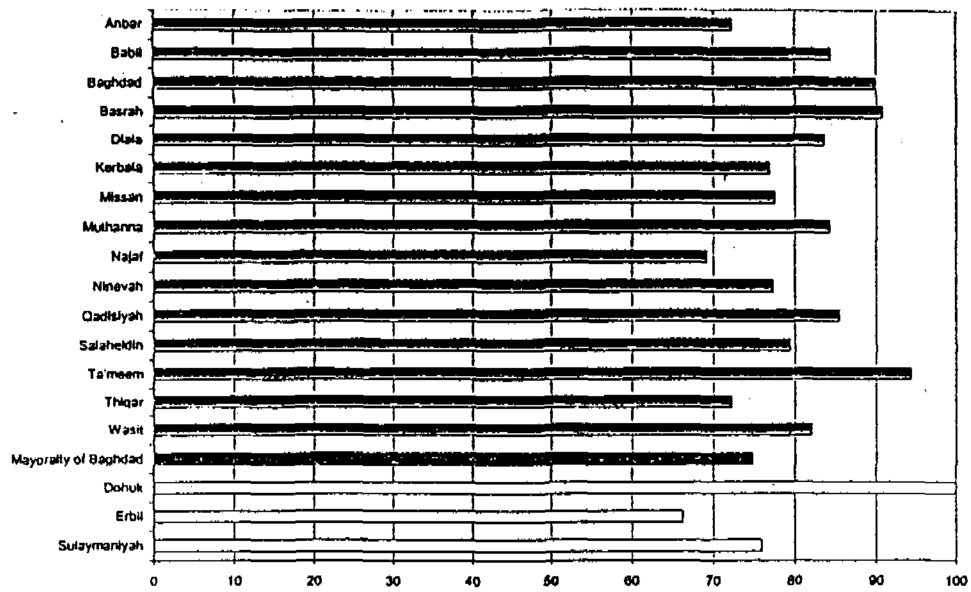


Chart 5-9 Global Planning Indicator Evaluation for the Minimum Option

The local action plans will aim to achieve GPI = 100 in 2010. Dohuk will not require major efforts except for Phase III; Najaf, Anbar and Erbil DWS should focus on developing UFW reduction programmes. Leakage from the distribution networks is expected to be reduced by replacing old pipes, rehabilitating connections and managing metering records. This programme does not include systematic leakage detection campaigns. Improvement in supply rates will rely on increasing production capacities.

The costs of a national action plan according to the Minimum Option were estimated as indicated in the following summary tables.

Table 5-21. 10-year Capital Expenditure for the Ideal Option

		Foreign (M$)	Local (MID)	Total (M$)	% of OF Total
REHABILITATION					
	WTP	32	19 283	42	1%
	CU	18	11 025	24	0%
	Wells	4	8 238	8	0%
	Storage	2	1 783	3	0%
	Boosting	2	2 143	3	0%
	Pipes	1 055	474 421	1 293	23%
	Connections	114	25 275	126	2%
	Merters	0	0	0	0%
	Vehicles	0	0	0	0%
	UFW reduction	0	0		
	Sub-Total	1 228	542 169	1 499	27%
UPGRADING & EXTENSION					
	WTP	218	65 263	250	4%
	CU	172	36 270	190	3%
	Wells	0	0	0	0%
	Storage	11	113 686	68	1%
	Boosting	72	25 592	85	2%
	Pipes	3 175	39 078	3 195	57%
	Connections	99	22 108	111	2%
	Meters	97	21 593	108	2%
	Vehicles	82	18 141	91	2%
	UFW reduction	0	0		
	Sub-Total	3 927	341 731	4 098	73%
MISCELLANOUS					
Total Capex		5 155	883 900	5 597	560
Total Capex Per Year		589	515	88 390	560
	Capex/Capita			219	$/inh.

The capital cost per capita is 10% higher than in the Ideal Option. The O&M costs are summarised in the table below:

Table 5-23. Estimated 2010 O&M budget for the Ideal Option in Current Currency

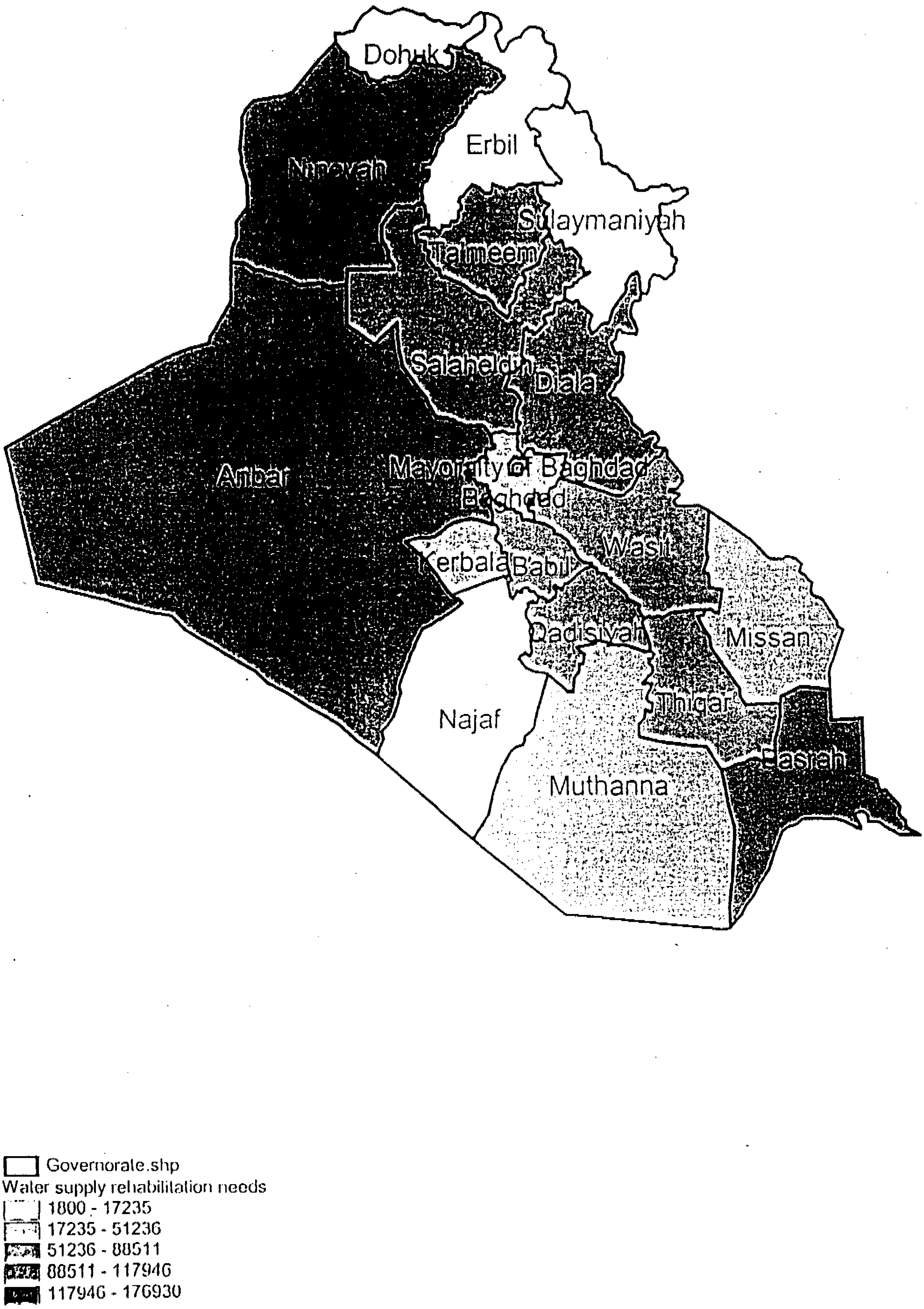
OPERATION		Imported Goods & Services (million US$)	Local (MID)	Total (M$)	% of Total
	Electricity		5 250	2,63	14%
	Chemicals	6		6,15	32%
	Salaries		713	0,36	2%
	Miscellaneous and Sundry	0,0	38	0,02	0%
	Sub-Total	6	6 002	9,15	48%
MAINTENANCE		-	-		
	Local Supply & Services		1 032	0,52	3%
	Imported Goods and Services	9,4		9,39	49%
	Sub-Total	9	1 032	10	52%
MISCELLANOUS					
Total Opex		16	7 034	19,059	
	Opex/M3	0,012	5,6	0,015	$/m³ produced

The OPEX average cost of water supplied is 10% higher to account for inefficient operations.

CHARTS

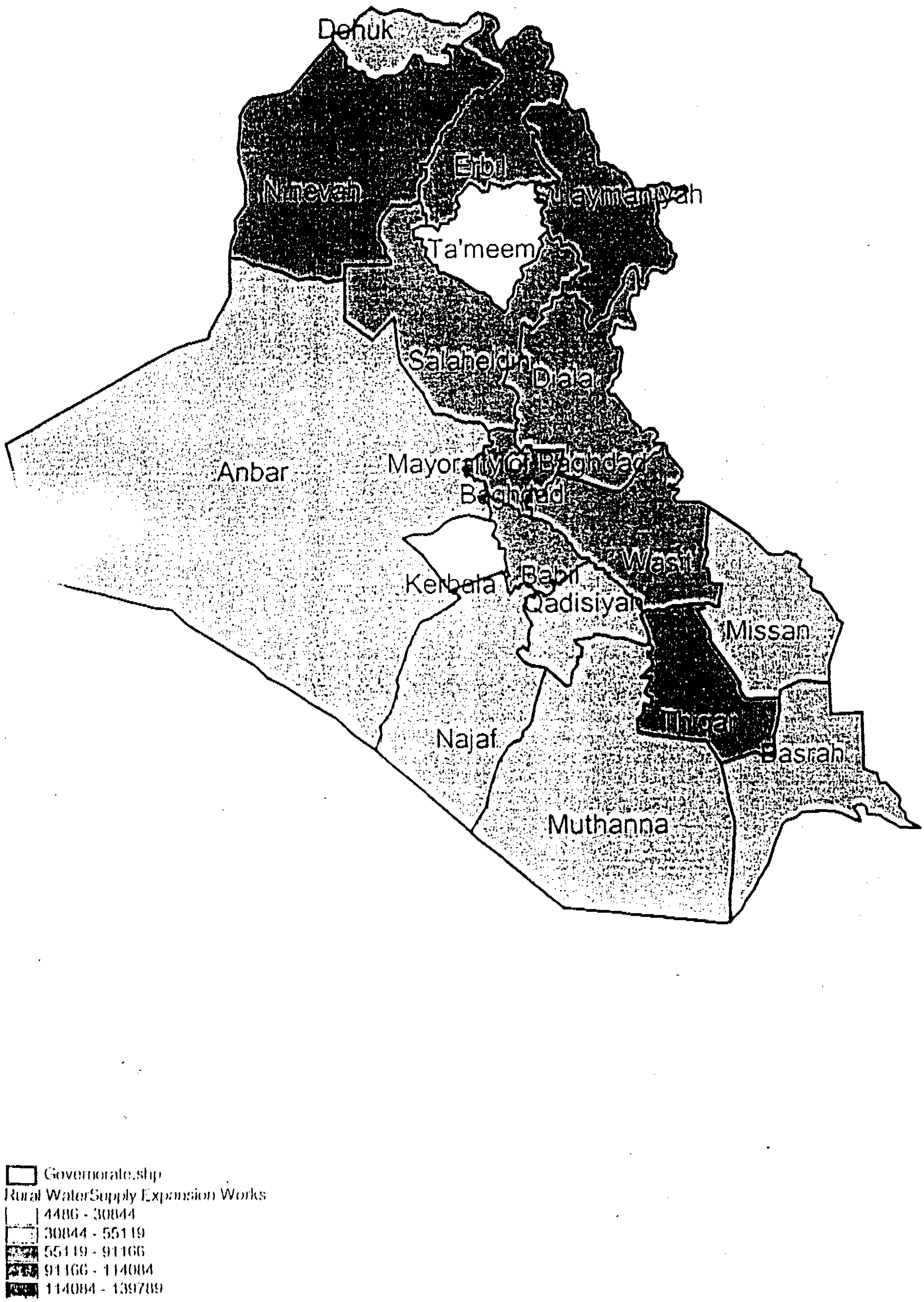
MAPS

Map 5.1: Water Supply Rehabilitation Needs in m³/d gained



Ma 5.2: Required Increase of Installed Production Capacity in Urban Areas (Ideal Option m³/d)

Map 5.3: Required Increase of Installed Production Capacity in Rural Areas (Ideal Option m³/d)



18

Development of the Sanitation Sub-Sector

for Sewerage and Garbage

SAFEGE
Consulting Engineers

CONTENTS

TABLES

CHARTS

6. Development of the Sanitation Sub-sector for Sewerage and Garbage

6.1 General

The planning tool described in this section is designed to determine the priorities for the water and sanitation sub-sectors.

Based on the analysis of the present situation (performance indicators) and the objectives in terms of the level and quality of the different services, the tool will be used to evaluate: quantitative requirements in terms of facilities; operating requirements; and capital and operation expenditures to be engaged over the next ten years.

Once obtained, this data will be used to formulate an ideal solution and the feasibility of this ideal solution with respect to the technical and financial constraints. An optimum solution will then be determined taking into account the feasibility criteria.

The use of the tool involves the implementation of the following procedures:

- Rating and evaluation of Districts and Governorates based on database data and performance indicators.
- Weighting of the criteria with a view to ranking the Districts and Governorates according to the performance indicators.
- Identification of ideal objectives for each region for the year n + 10.
- Calculation of quantities in terms of rehabilitation, extension, reinforcement and operation.
- Cost evaluation of the ideal solution: CAPEX and OPEX.
- Comparison of the evaluation results with regional technical and financial criteria.
- Revision of the objectives with a view to defining the optimum solution and the associated CAPEX and OPEX.

6.2 Structure of the Sanitation Tool

6.2.1 Structure of the Sanitation Planning Tool for the Sewerage Sector

6.2.1.1 Main Stages in the Implementation of the Tool

The following schematic presents the main steps involved in the implementation of the planning tool for the evaluation of sewerage investment requirements and operation costs.

STRUCTURE OF THE PLANNING TOOL (SEWERAGE)

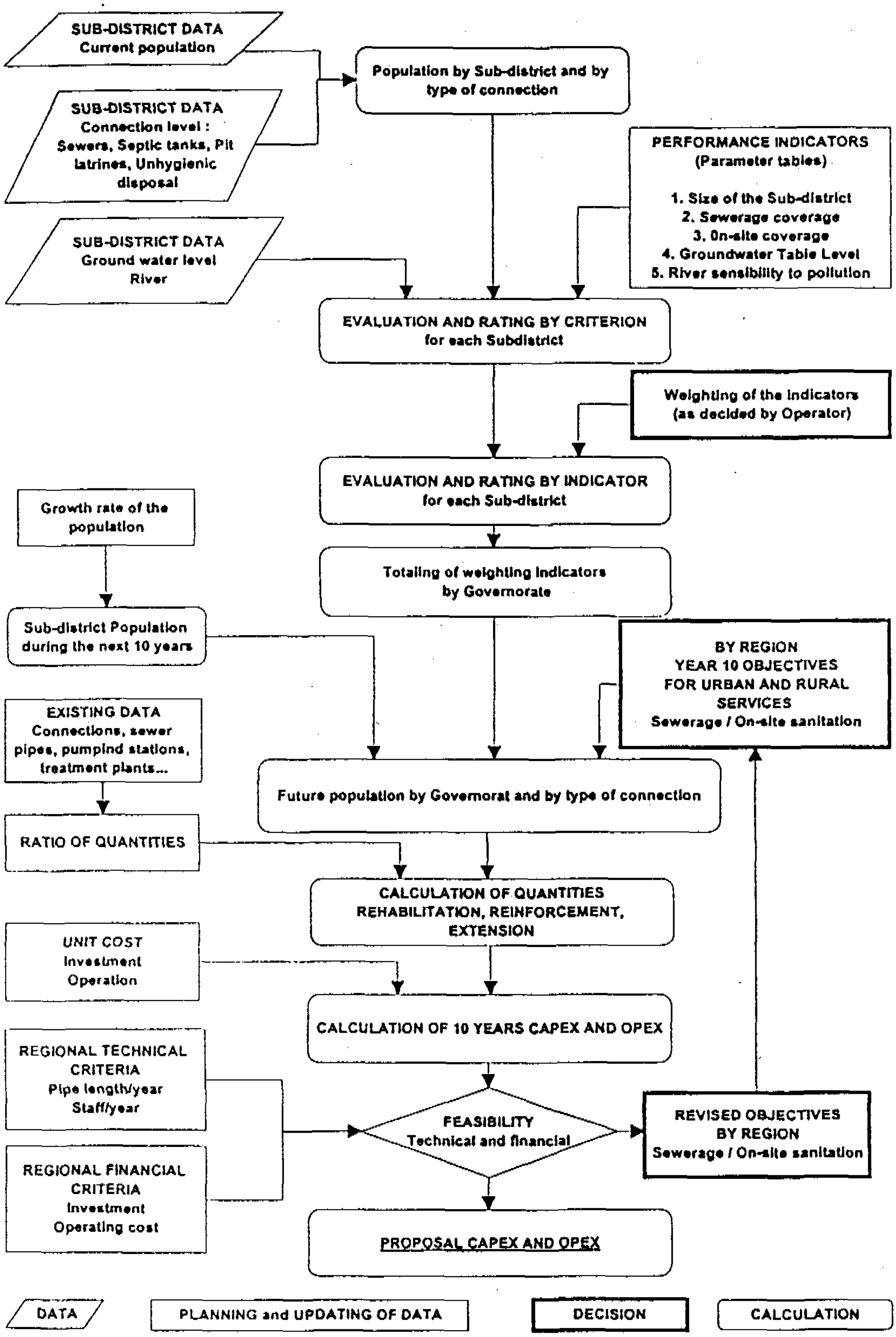


Chart 6-1: Framework of the Planning Tool

6.2.1.2 Data used by the Sewage Planning Tool

The data underpinning the sanitation planning tool is as follows:

- Sub-district urban and rural populations as assessed for the year 2000.
- Sub-district urban and rural population forecasts for the year 2010.
- Present sanitation coverage: urban coverage by sewerage, urban coverage by on-site sanitation, rural coverage by on-site sanitation.
- Environmental data concerning the groundwater table level and river vulnerability.
- Description of existing sewerage system (quantities).
- Condition of the existing sewerage system (efficiency).

6.2.1.3 Guidelines for Prioritisation / Sewage Performance Indicators

6.2.1.3.1 General

In the present section, guidelines are proposed for prioritising projects at Governorate level within the different regions, together with proposals for performance indicators and weighting of indicators.

The first part of this section outlines the general methodology, while the proposed rating and weighting systems are presented in the section "Development of the Sanitation Sub-sector".

Performance indicators include:

- Adequacy indicators: coverage and level of service.
- Dependability indicators. These indicators are primarily related to the external factors that have an impact on defining or prioritising sector development.
- Efficiency indicators. These describe the condition of existing infrastructure and are used to assess rehabilitation requirements. They are not used for prioritisation purposes, since rehabilitation *is* the GOI priority.

6.2.1.3.2 Sewerage Performance Indicators

The tool incorporates the following indicators:

- Sub-district size
- Sewerage coverage in urban area
- On-site sanitation coverage in urban areas
- On-site sanitation in rural areas
- Groundwater table
- River vulnerability.

At the sub-district level, indicators are expressed by a rating system of 0 or 1. A rating of 0 indicates low priority while 1 indicates high priority.

The different indicators are calculated according to the tables described in Section**.

6.2.1.3.3 Sewage Indicator Weighting

The indicator ratings for each sub district are then adjusted by allocating a specific weighting to each indicator. These weightings will differ according to whether they apply to urban or rural areas.

The weighting matrix can be adjusted to better evaluate the sensitivity of the final rating to the weighting given to each indicator.

6.2.1.3.4 Ranking of Governorates by Order of Priority

The ratings given to each sub-district of a given Governorate are then totaled to rank the Governorates of a given region by order of priority.

It is these totals by Governorate that will provide the basis for the adjustment of equipment objectives and the definition of the quantities of work to be carried out.

6.2.1.4 Assessment of Quantities

Unless otherwise specified, the same set of unit parameters is used for each Governorate (default value).

6.2.1.4.1 Investment

Rehabilitation Requirements

- Sewer Lines

  The proportion of existing sewers that require rehabilitation is defined as a percentage of the total sewer system length. The associated data is given in the chapter on assessment.

- Pumping Stations

  The rehabilitation requirement is deduced from the pumping station efficiency. For instance, the rehabilitation cost for a pumping station whose efficiency is assessed as 40% will be equal to 60% of the investment cost for a pumping station of the same capacity.

- Sewage Treatment Plants

  Same mechanism as for pumping stations.

Extension Requirements

- General

  The decision whether to build compact treatment plants or alternatively, larger, more central sewage treatment plants has an impact on the sewerage programme in terms of quantities and cost.

  As long as the embargo remains in place, the construction of large trunk sewers of diameters greater than 1500 mm is not feasible. A more realistic solution is to favour compact sewage treatment plants over major transmission structures (pumping stations and large trunk sewers).

The planning tool is established on the basis of this assumption. However, since this decision may be open to question, the planning tool allows for any modification of the approach.

The distinction is accordingly made between:

- Sewer networks and pumping stations located downstream of compact installations.
- Transmission systems which are presently assessed as 0.
- Sewage treatment plants, which at this stage are considered as compact installations.

- Sewer Lines

For each Governorate, the requirement will be expressed as sewer system length per inhabitant served.

The term "sewer lines" includes the (small-diameter) collecting system and the trunk sewers up to the catchment outlet but does not encompass house connections. It is assumed that the average Governorate population served is 100 000 and for Baghdad, a population of 500 000.

The figures incorporated in the tool ~~as an initial estimate~~ are as follows:

Table 6-1: Sewer Length per Capita

Governorate	Sewer Length per Capita (Meters per Inhabitant)
Mayoralty of Baghdad	1.06
Others	1.40

- Pumping Stations

The number of pumping stations per 100 000 inhabitants depends on the level of the groundwater table and on the gradient of the land.

At this stage, the pumping stations are differentiated according to:

- Very high water table (as in Basra)
- High water table (Baghdad)
- Low water table (Mosul).

Table 6-2: Number of Pumping Stations

Water Table Level	Number of Main Pumping Stations per 100 000 Inhabitants 20 000 m³/day	Number of Small Pumping Stations per 100 000 Inhabitants 1 700 m³/day
VHWT	4	22
HWT	2	6
LWT	1	0

Power consumption is calculated assuming a Total Manometric Head (TMH) of 7m.

- Connections

Table 6-3: Number of Connections per Capita

Governorate	Population Sewered	Number of Inhabitants per Sewer Connection	Number of Sewer Connections
	Target (%) of Total urban population	Assessed by the number of inhabitants per water connection	Population sewered x number of sewer connections

- Septic Tanks

Outside local authority remit. To be borne by users.

- Vehicles

Table 6-4: Number of Vehicles

Governorate	Number of Vacuum and Jetting Machines	Special Vehicles	Auxiliary Vehicles	Cesspit Emptiers
	1 per 50 km sewer line	1 per 100 km sewer line	1 per 10 staff	1 per 10 000 inhabitants to be served by on-site sanitation

- Sewage Treatment Plants

Table 6-5: Number of Sewage Treatment Plants

Governorate	Sewage Treatment Plants	Power Consumption
	Compact units Unit capacity 50 000 PE (PE = population equivalent)	0.06 kWh/day/inhabitant capacity

6.2.1.4.2 Operating Requirements

Table 6-6: Staff Requirement

Governorate	Administration (Studies)	Sewer Cleaning	Jetting Machines, Vacuum and Cesspit Emptiers	Special Vehicles	Pumping Stations	Sewage Plants
	20	6 per 100 km sewer line	3 per vehicle	6 per vehicle	4 per pumping station	10 per 50 000 PE

Power for pumping stations and sewage treatment plants is taken into account.

6.2.1.5 Cost Evaluation

6.2.1.5.1 General

The cost evaluation is based upon:

- The above-mentioned quantities
- Unit costs.

Investment and operating costs are calculated for year 10. The results are given as yearly average costs at Regional and Governorate levels.

6.2.1.5.2 Unit Costs

Investment Costs

- Sewers

Table 6-7: Sewer Unit Investment Costs

Governorate	Local Unit Price	Foreign Unit Cost
Mayoralty of Baghdad	ID 56 657 per m	USD 65.8 per m
GCWS Very High Water T	ID 21 786 per m	USD 26.8 per m
GCWS High WT	ID 16 935 per m	USD 26.78 per m
GCWS Low WT	ID 12 078 per m	USD 20.03 per m
Northern Region	ID 2 700 per m	USD 20.3 per m

- Pumping Stations

Table 6-8: Pumping Station Unit Investment Costs

Region	Small Pumping Station 1 700 m^3/day		Main Pumping Station 20 000 m^3/day	
	Local Cost	*Foreign Cost USD*	*Local Cost*	*Foreign Cost USD*
Mayoralty of Baghdad	ID 21 500 000	40 000	ID 138 000 000	150 000
GCWS	ID 21 500 000	40 000	ID 138 000 000	150 000
Northern Region	NID 239 000	40 000	NID 1 530 000	150 000

- House Connection

Table 6-9: House Connection Investment Costs

Governorates	House Connection Costs
Mayoralty of Baghdad	ID 200 000
GCWS	ID 100 000
Northern Region	NID 1 100

- Septic Tanks Investment Costs are not assessed
- Sewage Treatment Plants

Table 6-10: Sewage Treatment Plants Investment Costs

Governorate	Capacity	Local Cost	Foreign Cost USD/PE
Mayoralty of Baghdad	50 000 PE	ID 10 000 / PE	USD 50 /PE
GCWS	50 000 PE	ID 5 000 ID/PE	USD 50 /PE
Northern region	50 000 PE	NID 100/ PE	USD 50 /PE

PE is the population equivalent.

- Vehicle

Table 6-11: Vehicle Investment Costs

Jetting Machine USD	Vacuum and Cesspit Emptiers USD	Special Vehicle USD	Auxiliary Vehicle USD
250 000	250 000	60 000	20 000

Operating Costs

- Staff

Salaries and other personnel remuneration are estimated at ID 258 000 /capita/year (average figure within GCWS)

The same figure is used for The Mayoralty of Baghdad and the Northern autonomous region (taking into account the exchange rate).

- Power

20 ID/kWh

- Vehicle Operating Costs

Table 6-12: Vehicle Operating Costs

	Jetting Machines	Vacuum and Cesspit Emptiers	Special Vehicles	Auxiliary Vehicles
Local ID /NID	100 000/11 000	100 000/11 000	40 000/4 400	20 000/22 000

- Overheads and Miscellaneous (Consumables)

  Assessed as 30% of staff salaries & wages.

6.2.2 Structure of the Sanitation Planning tool for Garbage Collection

6.2.2.1 Steps Involved in Implementation of the Tool

The following schematic presents the main steps involved in the implementation of the planning tool for the evaluation of investment and operation costs for garbage management.

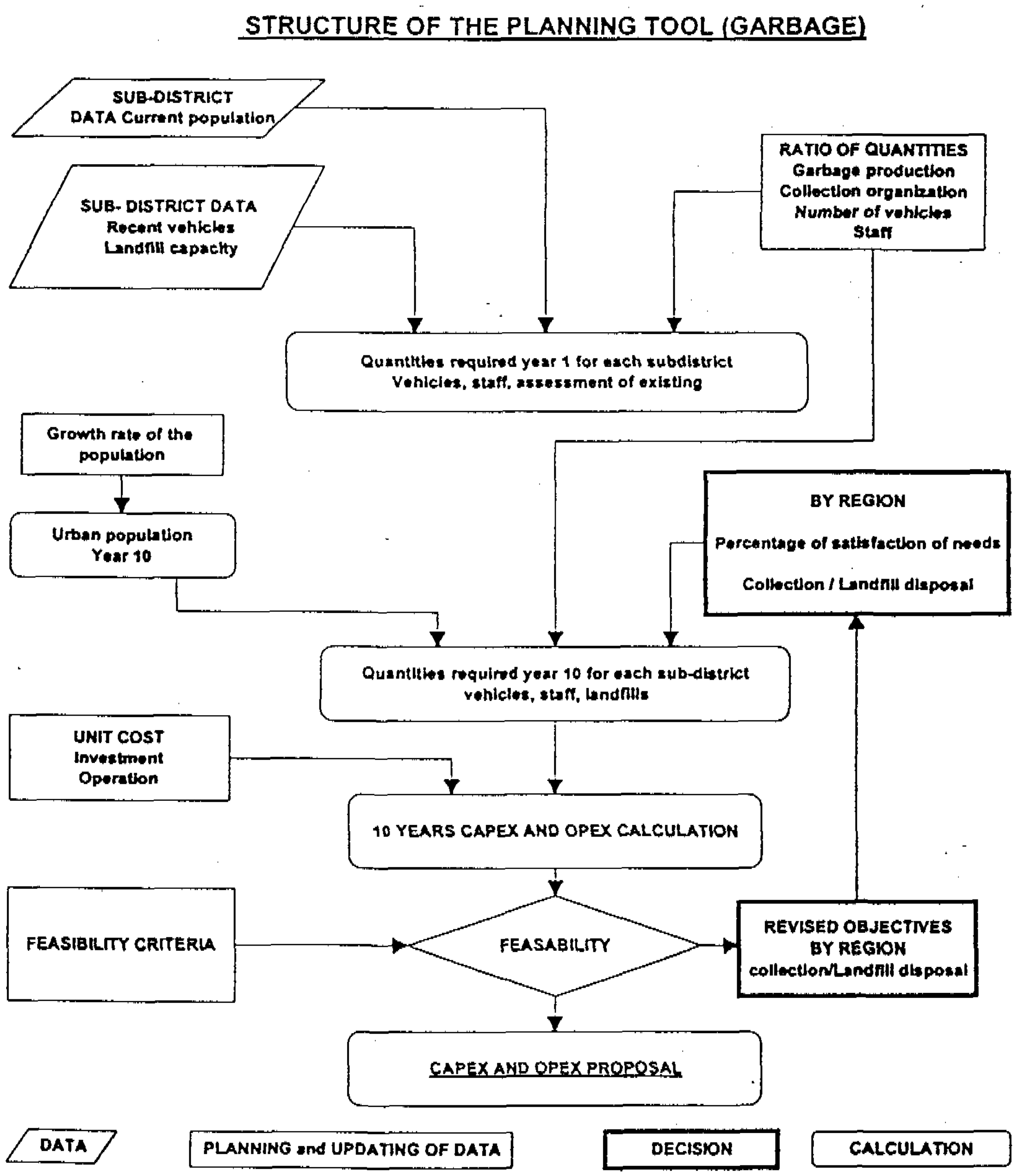


Chart 6-2: Framework of the Garbage Planning Tool

6.2.2.2 Data Incorporated in the Garbage Management Planning Tool

The data incorporated in the garbage management planning tool is as follows:

- Urban Population as assessed for the year 2000, per sub-district.
- Urban populations forecasts for the year 2010, per sub district.
- Classification of sub-district according to size of urban population.
- Existing equipment (quantities).
- Governorate investment budgets as per MOU programme.

6.2.2.3 Guidelines for Prioritisation

6.2.2.3.1 General

In this section guidelines are proposed for prioritising projects at Governorate level within the different regions, together with proposals for performance indicators and weighting of indicators.

The first part of this section outlines the general methodology, while the proposed rating and weighting systems are presented in the section "Development of the Sanitation Sub-sector".

Performance indicators include:

- Adequacy indicators such as coverage and level of service.
- Dependability indicators. These indicators are primarily related to the external factors that have an impact on defining or prioritising sector development.
- Efficiency indicators. These describe the condition of the existing infrastructure and are used to assess rehabilitation requirements. They are not used for prioritisation purposes however, since rehabilitation *is* the main priority.

6.2.2.3.2 Garbage Management Performance Indicators

The tool incorporates the following indicators:

- Sub-district size (urban population).
- Ratio of existing equipment to theoretical equipment.

Existing and theoretical equipment is assessed in USD (as new value).

At the sub-district level, indicators are expressed by a rating system of 0 or 1. A rating of 0 indicates low priority while 1 indicates high priority.

6.2.2.3.3 Weighting of Garbage Management Indicators

Once the indicator ratings for each sub district are obtained, these are weighted, assigning a specific weight to each indicator.

The weighting matrix can be adjusted to better evaluate the sensitivity of the final rating to the weight given to each indicator.

6.2.2.3.4 Classification of Governorates by Order of Priority

The indicator ratings for each sub-district of a given Governorate are then totaled to rank the Governorates of a given region by order of priority.

It is these totals by Governorate that will provide the basis for the adjustment of equipment objectives and the definition of the quantities of work to be carried out.

6.2.2.4 Quantities Assessment

6.2.2.4.1 Garbage Collection

Typology

Garbage collection is organised on the basis of the size and nature of the urban area served. The tool works on the assumption that the different types of collection can be separated into 4 categories, Types 1 to 4, which are given below:

Table 6-13: Garbage Collection Typology

Production of Garbage by the Sub-district Urban Population	Means of Collection
Garbage production is less than 2.5 tons per day	The collection equipment is limited to tractors with carriages of 1.6 ton capacity (Type 1)
Garbage production is between 2.5 and 50 tons per day	The collecting equipment comprises: ♦ Garbage presses (8 m^3) for 90% of garbage production (Type 2) ♦ Tractors and hand carriages for 10% of production (Type 1)
Garbage production is more than 50 tons per day	The collection equipment comprises: ♦ Garbage presses (8 m^3) for 80% of garbage production (Type 2) ♦ Containers removed by lorries equipped with crane for 10% of garbage production (Type 4) ♦ Fleet for dense areas (10% of production) comprising: tractors, tippers, shovels and dumping trucks (Type 3)

Unit Capacities by Means of Collection

- Type 1: 1 tractor handles 1.66 tons per day
- Type 2: 1 garbage press 8 m^3 handles 2.5 tons/day
- Type 3: 1 fleet comprising 2 tractors, 1 shovel, 1 dumping truck and 1 tipper handles 5 tons per day
- Type 4: 2 lorries and 5 containers of 4 m^3 handle 5 tons per day.

Staffing

- Type 1: 2 people
- Type 2 3 people
- Type 3: 7 people
- Type 4: 4 people

6.2.2.4.2 Landfill Areas

Number of Landfills

Each sub-district is in principle equipped with one landfill with a 10-year storage capacity. Sub-districts producing more than 200 tons of garbage per day are equipped with one landfill per 200 tons produced.

Equipment

The landfills are equipped as follows:

- Landfills receiving less than 50 tons per day: 1 bulldozer.
- Landfills receiving more than 50 tons per day: 1 bulldozer, 1 shovel, and 1 compactor.

Staff

For each landfill:

- Less than 50 tons per day: 1 person.
- More than 50 tons per day: 3 people.

6.2.2.5 Cost Evaluation

6.2.2.5.1 General

The cost evaluation is based upon:

- The above-mentioned quantities
- Unit costs.

Investment and operating costs are calculated for year 10. The results are given as average annual costs at the Regional and Governorate levels.

6.2.2.5.2 Unit Costs

Investment Costs

- Vehicles

Table 6-14: Garbage Investment Unit Costs

Garbage Presses USD	Tractors USD	Dumping Trucks USD	Shovels USD	Tippers USD	Lorries USD	Containers USD	Bulldozers USD	Compactors USD
150 000	40 000	50 000	25 000	50 000	50 000	10 000	30 000	30 000

Operating Costs

- Staff

  ID 258 000 / capita / year

- Power

  ID 0.1 / kWh

- Vehicle Operating Costs

Table 6-15: Vehicle Operating Costs

	Garbage Presses USD/year	Tractors USD/year	Dumping Trucks USD/year	Shovels USD/year	Tippers USD/year	Lorries USD/year	Containers USD/year	Bulldozers USD/year	Compactors USD/year
Local ID[1]	100 000	40 000	40 000	40 000	40 000	40 000		40 000	40 000
Foreign USD	10 000	4 000	4 000	4 000	4 000	4 000		4 000	4 000

6.3 Development of the Tool for the Sanitation Sub-sector

6.3.1 Sector Development Objectives and Strategies

The GOI's primary aim with regard to the Sanitation sub-sector is to ensure the hygienic disposal of all solid and liquid waste.

To meet this objective, three subsequent stages of works are required:

- Stage 1: Rehabilitation of the existing system to enhance efficiency and improve performance and quality.
- Stage 2: Achievement of universal coverage.
- Stage 3: Increased level of service in line with population growth.

The strategic approach for planning sanitation sector development is outlined below.

With regard to sanitation, the fulfillment of these objectives will result in the treatment of the polluting effluents -particularly in densely populated areas where there is a greater risk to human health - and the sanitary disposal of solid waste and the remaining effluent.

Increasing coverage to match "universal needs" would involve:

[1] Local costs in ID are subject to the currency exchange rate used in the Northern Autonomous Region.

- Expanding (after rehabilitation of the existing facilities) collecting systems connected to treatment facilities (or more generally, to a hygienic system of disposal) and developing adequate disposal facilities.
- Providing operating services for individual sanitation systems, while ensuring hygienic disposal of the associated sludge.
- Collection and disposal of solid waste (in urban areas).

The development strategy for the sanitation sub-sector must be formulated on the basis of:

- The evaluation of the current situation.
- The infrastructure investment program outlined for the ideal option and an estimate of the associated costs. The planning tool is designed to address this issue, as described above.
- The definition of a minimum option. Rather than defining a minimum option involving a combination of factors that are not known with any degree of precision and are subject to rapid change, the methodology consists in proposing criteria for prioritisation. The limits to sector development are set by the financial and technical constraints.

6.3.2 Development of Global Performance Indicator

6.3.2.1 General

The current status of the sanitation sub-sector is described in Chapter 3 «Sanitation ». The assessment is made on the basis of the data available and the information furnished by the competent authorities.

Unlike the drinking-water sector, knowledge of the sanitation sub-sector is scant. Potentially useful data for evaluating the sector often lacks precision and/or is incomplete. It is accordingly recommended the database be consolidated in the coming years, giving particular importance to the consistency and uniformity of the data acquisition process across the different regions of Iraq.

The current situation is presented as follows:

- Governorate coverage by sewerage in urban areas and by on-site sanitation in urban and rural areas.
- Aspects related to garbage.
- Notation of performance indicators.
- Weighting of performance indicators.

6.3.2.2 Existing Levels of Service

6.3.2.2.1 Current Sewerage Coverage Levels

The current situation with respect to sewerage is summarised by the following histograms:

- Coverage by sewer networks
- Coverage by on-site sanitation.

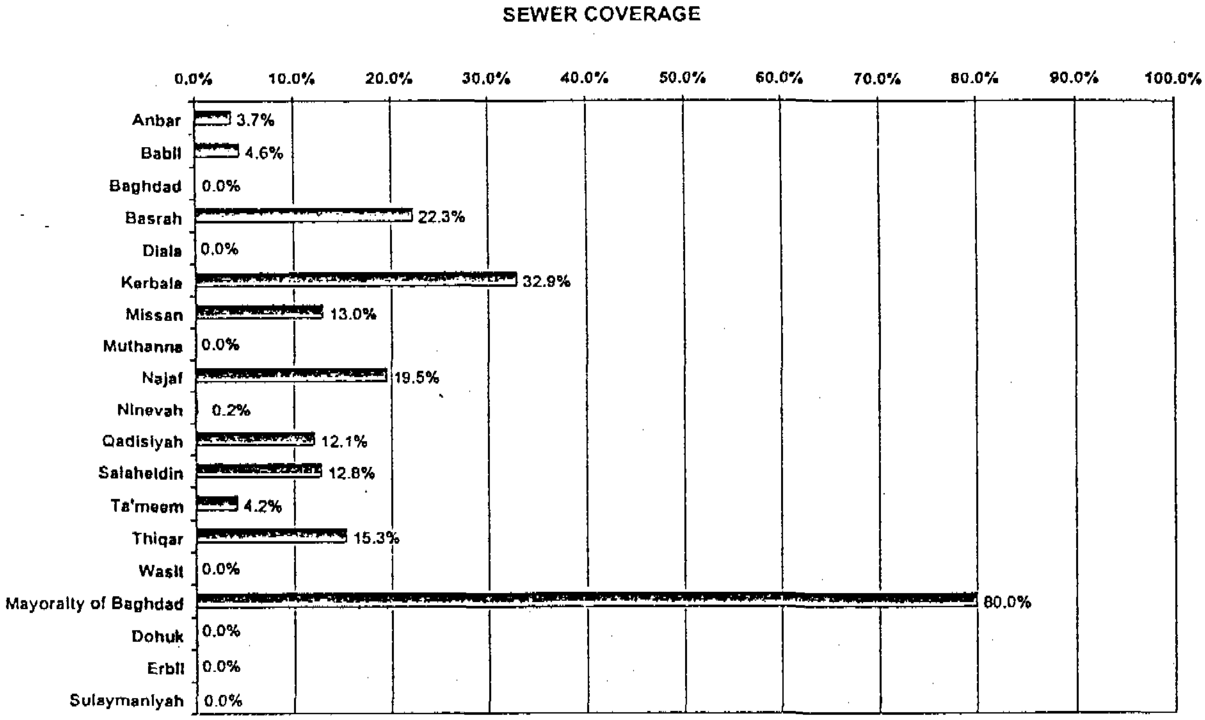


Chart 6-3: Existing Urban Sewerage Coverage

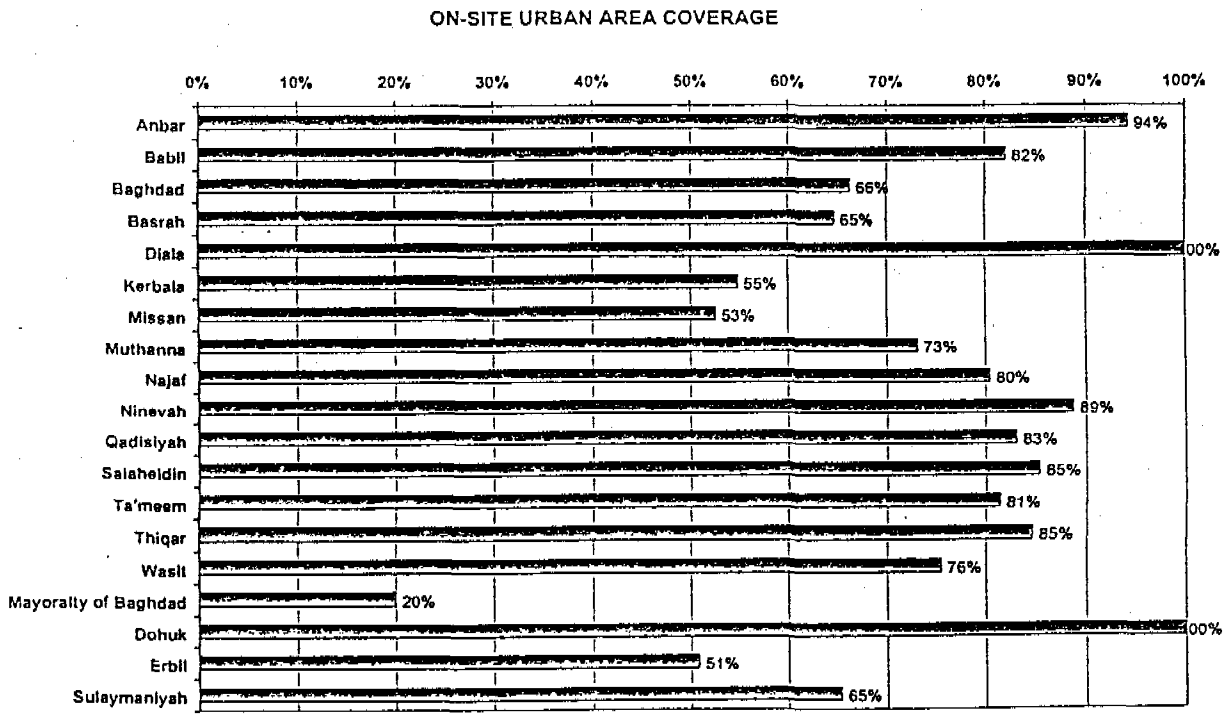


Chart 6-4: Existing On-Site Urban Area Coverage

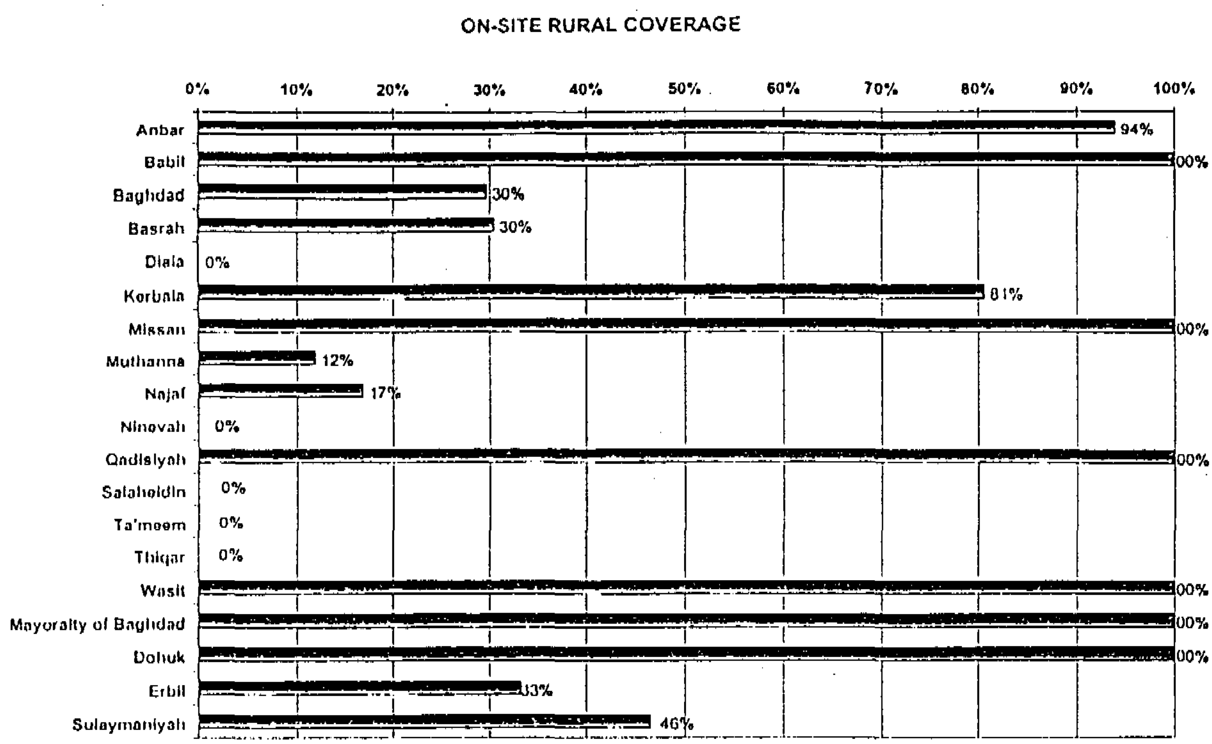


Chart 6-5: Existing On-Site Rural Coverage

6.3.2.2.2 Aspects Related to Garbage

With regard to garbage collection, the level of service is assessed by comparing the existing fleet of equipment with theoretical needs. The indicator can be expressed as the as-new value of the existing fleet (USD) divided by the value of the theoretical fleet (USD).

At present, owing to the lack of equipment there is a failure to ensure a satisfactory level of service, which is reflected by the accumulation of garbage all over the city.

The notion of service coverage - i.e. whether or not one is served by garbage collection - does not appear relevant. The failure to meet the needs is due to a combination of restricted geographical coverage, insufficient frequency of collection and inadequate cleaning. Given that none of these factors are directly measurable, the performance of the sector has been assessed by comparing the existing fleets of equipment (recent vehicles, including budgets on hold under previous MOU phases) with theoretical requirements.

The comparison, as presented above, shows the requirements of the sector are far from satisfied.

Table 6-16: Garbage Collection Level of Service

Region	Governorate	Garbage Collection Indicator
Centre South	Anbar	3
	Babil	2
	Baghdad	2
	Basrah	2
	Diala	2
	Kerbala	5
	Missan	2
	Muthanna	5
	Najaf	2
	Ninevah	3
	Qadisiyah	3
	Salaheldin	3
	Ta' meen	1
	Thiqar	2
	Wasit	2
Mayoralty of Baghdad	Mayoralty of Baghdad	25
North	Dohuk	6
	Erbil	9
	Sulaymaniyah	7

6.3.2.3 Performance Ratings

The following two tables give performance indicator ratings for urban and rural areas.

For each area the ratings take into account the weightings by sub-district (rating by sub-district and weighting by the number of sub-districts of the Governorate).

The highest rating that can be given to any Governorate is 100. A rating for each Governorate is thus obtained that reflects the priority of the Governorate with respect to the indicator considered. The higher the rating, the greater the priority given to the Governorate with respect to the criterion concerned.

Table 6-17: Sewerage Performance Ratings for Urban Areas

Region	Governorate	Sub-district Size	Groundwater Level	River Vulnerability	Sewerage Coverage	One-site Sanitation Coverage
Centre South	Anbar	67	100	100	88	5
	Babil	66	100	100	99	27
	Baghdad	100	100	100	100	53
	Basrah	97	100	100	90	33
	Diala	52	100	100	100	0
	Kerbala	78	100	100	93	37
	Missan	49	100	100	98	48
	Muthanna	54	100	100	100	25
	Najaf	63	100	100	97	0
	Ninevah	50	100	100	99	40
	Qadisiyah	48	100	100	99	9
	Salaheldin	73	100	100	87	0
	Ta' meem	47	100	100	99	100
	Thiqar	62	100	100	98	0
	Wasit	65	100	100	100	45
Mayoralty of Baghdad	Mayoralty of Baghdad	100	100	100	100	100
North	Dohuk	69	0	100	100	0
	Erbil	96	0	100	100	5
	Sulaymaniyah	100	0	100	100	100

N-B: In the absence of reliable data, all rivers have been classified as "highly vulnerable" to pollution inputs.

Table 6-18: Sewerage Performance Ratings for Rural Areas

Region	Governorate	Sub dist. Size	Ground Water Level	On-Site Sanitation Coverage
Centre South	Anbar	60	100	34
	Babil	87	100	15
	Baghdad	100	100	74
	Basrah	73	100	74
	Diala	83	100	100
	Kerbala	95	100	31
	Missan	33	100	0
	Muthanna	80	100	91
	Najaf	93	100	80
	Ninevah	75	100	100
	Qadisiyah	79	100	14
	Salaheldin	93	100	100
	Ta' meem	50	100	100
	Thiqar	66	100	100
	Wasit	69	100	0
Mayoralty of Baghdad	Mayoralty of Baghdad	100	100	100
North	Dohuk	54	0	100
	Erbil	100	0	100
	Sulaymaniyah	72	0	100

Table 6-19: Garbage Collection Performance Ratings

Region	Governorate	Sub dist. Size	Garbage Level of Service
Centre South	Anbar	67	59
	Babil	66	40
	Baghdad	100	42
	Basrah	97	38
	Diala	52	40
	Kerbala	78	94
	Missan	49	36
	Muthanna	54	100
	Najaf	63	30
	Ninevah	50	50
	Qadisiyah	48	53
	Salaheldin	73	55
	Ta' meem	47	29
	Thiqar	62	41
	Wasit	65	50
Mayoralty of Baghdad	Mayoralty of Baghdad	100	100
North	Dohuk	69	50
	Erbil	96	100
	Sulaymaniyah	100	79

6.3.2.4 Weighting of Performance Indicators

The various performance indicators are then weighted at the level of each Governorate. The resulting rating is a weighted average of the ratings for each indicator.

For urban areas we propose to retain the following weighting coefficients:

Table 6-20: Weighting Coefficients for Urban Areas

Performance Indicators	Coefficient
Subdistrict Size	4
Groundwater Count Level	1
River Vulnerability	1
Sewerage Coverage	4
On-Site Coverage	1

For rural areas we propose to retain the following coefficients:

Table 6-21: Weighting Coefficients for Rural Areas

Performance Indicators	Coefficient
Sub-district Size	1
Groundwater Count Level	4
River Vulnerability	0
Sewerage Coverage	0
On-site Coverage	4

For the garbage component, we propose to retain the following coefficients:

Table 6-22: Weighting Coefficients for Garbage Collection

Performance Indicators	Coefficient
Sub-district Size	1
Garbage Level of Service	4

For each region, the Governorates are classified by order of priority in terms of equipment needs: the higher the overall rating, the greater the priority of the Governorate in the region considered.

Table 6-23: Ranking of the Governorates by Region: Urban Areas

Region	Governorate	Overall Rating	Ranking
Centre South	Anbar	72	15
	Babil	89	4
	Baghdad	100	1
	Basrah	98	2
	Diala	75	13
	Kerbala	92	3
	Missan	79	12
	Muthanna	79	11
	Najaf	79	10
	Ninevah	73	14
	Qadisiyah	79	9
	Salaheldin	80	8
	Ta' meem	83	7
	Thiqar	84	6
	Wasit	85	5
Mayoralty of Baghdad	Mayoralty of Baghdad	100	
North	Dohuk	78	3
	Erbil	89	2
	Sulaymaniyah	100	1

Table 6-24: Ranking of Governorates by Region: Rural Areas

Region	Governorate	Overall Rating	Ranking
Centre South	Anbar	67	11
	Babil	61	12
	Baghdad	89	8
	Basrah	86	9
	Diala	99	2
	Kerbala	69	10
	Missan	49	15
	Muthanna	95	6
	Najaf	91	7
	Ninevah	98	3
	Qadisiyah	60	13
	Salaheldin	100	1
	Ta' meem	95	5
	Thiqar	97	4
	Wasit	52	14
Mayoralty of Baghdad	Mayoralty of Baghdad	100	
North	Dohuk	37	3
	Erbil	100	1
	Sulaymaniyah	82	2

Table 6-25: Ranking of Governorates by Region: Garbage Sector

Region	Governorate	Total Indicator	Ranking
Centre South	Anbar	66	3
	Babil	50	10
	Baghdad	59	5
	Basrah	54	9
	Diala	46	12
	Kerbala	100	2
	Missan	43	13
	Muthanna	100	1
	Najaf	41	14
	Ninevah	55	8
	Qadisiyah	57	7
	Salaheldin	65	4
	Ta' meem	36	15
	Thiqar	49	11
	Wasit	58	6
Mayoralty of Baghdad	Mayoralty of Baghdad	100	-
North	Dohuk	62	3
	Erbil	100	1
	Sulaymaniyah	84	2

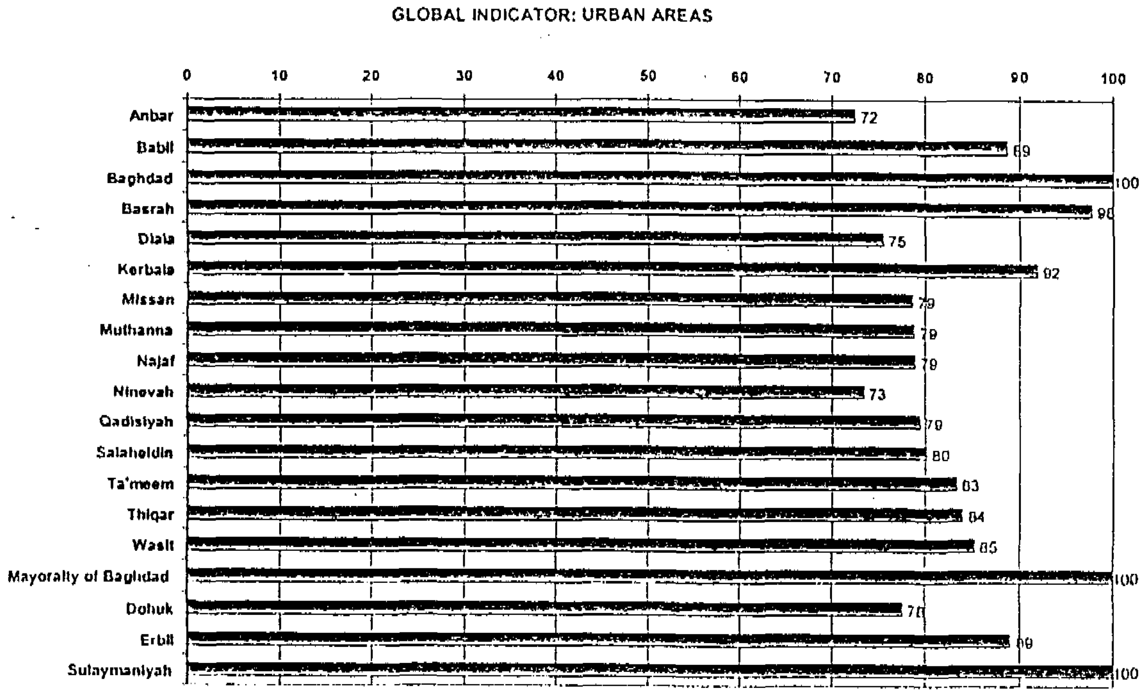


Chart 6-6: Global Indicator : Urban Areas

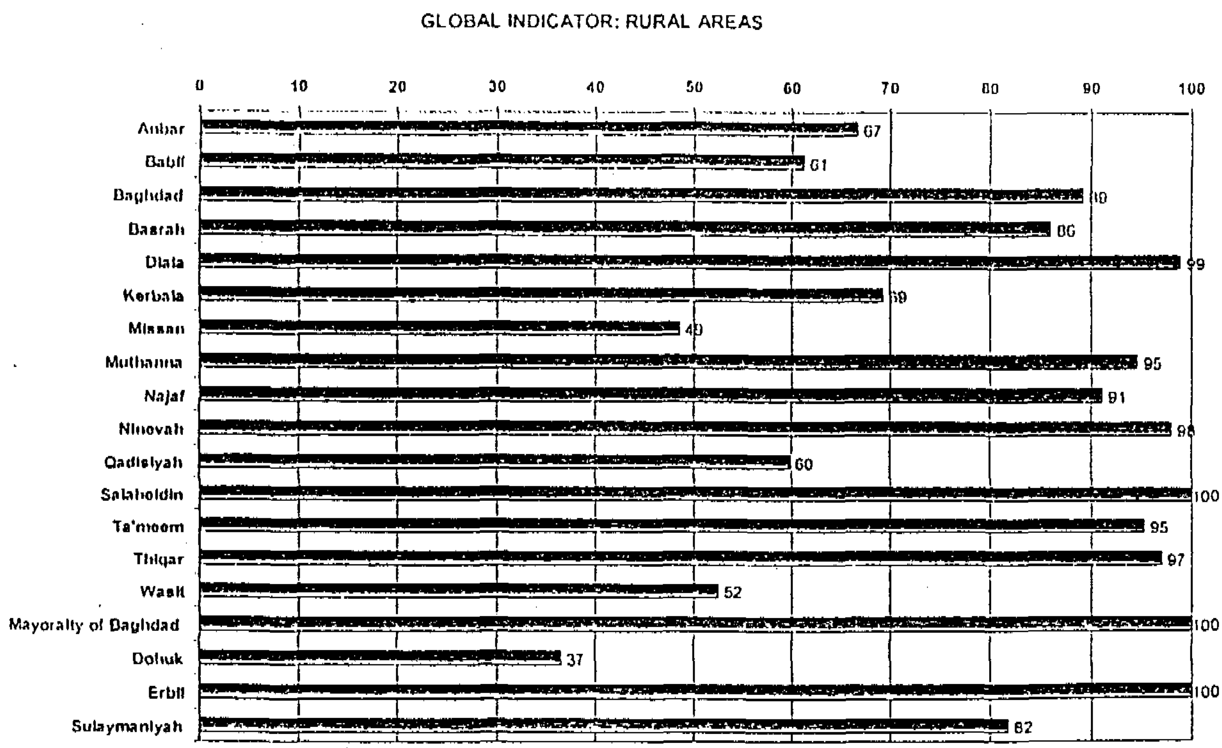


Chart 6-7: Global Indicator : Rural Areas

6.3.3 Planning of Investment and Operating Expenditure for the Sewage Sub-sector

6.3.3.1 Policy Guidelines for the Improvement of the Iraqi Sewage Sub-sector

This section presents the methods of calculation and recommendations relating to the planning of investment and operating expenditure for the three major regions of Iraq: Mayoralty of Baghdad, Centre South and North.

6.3.3.1.1 Guidelines

An analysis of the current situation allows the cumulative sewerage and garbage collection needs to be defined for each Governorate and region in the current situation. The additional expenditure needed to ensure service coverage for the target year 10 can also be calculated by extrapolating from the ratios and quantities defined above.

At present, the level of investment to be allocated to each of the three regions over the next 10 years is unknown with investment levels known only for the current year.

The decision-makers and technicians are thus confronted with a number of choices, which require a more global understanding of the sanitation sub-sector and the answer to three fundamental questions:

- Which projects are to be implemented as priority projects in year 1?
- What levels of improvement will be achieved in 10 years time if the level of investment for year 1 is maintained over the next 10 years?
- Assuming that year 1 levels of investment are maintained, does the technical capability exist to keep apace of the associated service requirements?

To answer these questions, we have defined:

- Indicators and an overall rating for each Governorate, which prioritise actions to be implemented in each region.
- A database that provides a better understanding of the current situation and the rehabilitation requirements for the existing works.
- A method of evaluating quantities and costs which allows requirements to be evaluated in terms of improvements and extensions, as well as the operating costs for a given level of service coverage.

6.3.3.1.2 Recommended Step

In the absence of any knowledge of the investments to be allocated to the sewage sub-sector over the next 10 years, the following approach is proposed:

- Use of year 1 investment levels to extrapolate investment levels for the ensuing 10-year period while assuming that the year 1 level can be maintained over this period.
- Calculation of the service coverage which can be achieved by region if year 1 investment levels are effectively maintained over the 10 year period.
- Calculation of quantities of work and operating resources to be implemented annually.

- Calculations of trends in operating costs over the ten 10-year period.
- Verification of technical and financial feasibility.

Investments

The investment costs concern three main categories of work:

- Rehabilitation
- Reinforcements
- Extensions of the sewerage service.

Rehabilitation relates to all repair work to existing facilities whose efficiency is lower than 100% and which, as a result of these insufficiencies, fail to fulfil their function correctly.

Reinforcements correspond to urgent extensions of the existing works to ensure the satisfaction of current needs.

Extensions relate to all works intended to supply new inhabitants and thus to extend sewerage coverage.

Operation

For a given level of investment, the associated level of coverage can be calculated and hence the associated quantities and operating costs.

Feasibility Criteria

The technical and financial feasibility criteria are primarily:

Technical capabilities:

- Local capacity of sewer pipes (m/year).
- Average technical resources and capacities of Iraqi companies with regard to sewer construction (m per annum and per region).
- Potential for recruiting skilled operating staff.

Financial capacities:

- Comparison between the resources available (from invoicing) and the operating costs calculated for the target level of coverage.

6.3.3.1.3 Objectives (Ideal Scenario)

Investment and operating costs which are presented below are based on the following sector development objectives.

- Urban area : 100% of the urban population is connected to sewer and treatment at year 10.
- Rural area : 100% of sedentar rural population relies on on-site sanitation at year 10.

6.3.3.2 Investments (Ideal Scenario)

The costs given in the various tables are in ID and USD year-2001 values. The costs in ID for the northern region of Iraq are calculated assuming an exchange rate of NID 9 for ID 1.

6.3.3.2.1 Rehabilitation of the Sewage Sub-sector

The value of rehabilitation work is calculated on the basis of the efficiency of the work and the current level of coverage.

The following table presents evaluations of the investment costs necessary for the rehabilitation of facilities in urban areas.

Table 6-26: Rehabilitation in Urban Areas

Region	Unit	Sewer Connections	Sewers	Pumping Stations	Wastewater Treatment Plants	Total
Mayoralty of Baghdad	ID 10^6	9 506.8	83 334.3	1 139.3	7 892.0	101 872.4
Centre South	ID 10^6	1 155.5	1 589.3	3 279.6	3 967.1	9 991.5
North	ID 10^6	0.0	0.0	1.3	18.6	19.9
Mayoralty of Baghdad	USD 10^6	0.0	96.8	1.4	39.5	137.6
Centre South	USD 10^6	0.0	2.0	3.9	39.7	45.5
North	USD 10^6	0.0	0.0	0.1	8.4	8.5

For the rural areas equipped with on-site sanitation, no rehabilitation is envisaged.

The expenditure engaged by the Iraqi administration in the past year is to be deducted from future rehabilitation needs.

Table 6-27: Budgets Allocated

Region	Unit	Sanitation Vehicles	Sewage Pumps	Total
Mayoralty of Baghdad	USD 10^6	5.3	8.4	13.6
Centre South	USD 10^6	14.1	4.5	18.6
North	USD 10^6	0.0	0.0	0.0

It is instructive to calculate for each region the average rehabilitation costs per family. These costs are as follows:

Table 6-28: Average Rehabilitation Costs per Family in Urban Areas

Region	Existing Connections	Rehabilitation ID/connection	Rehabilitation USD/connection
Mayoralty of Baghdad	475 338	214 316	289
Centre South	115 549	86 470	394
North	Data not available		

N-B: One connection or one septic tank = one family

6.3.3.3 Reinforcement of the Sewage Sub-sector (Ideal Scenario)

The assessment of requirements in terms of reinforcements to the sewerage system in urban and rural areas is presented in the following tables:

Table 6-29: Reinforcements in Urban Areas

Region	Unit	Wastewater Treatment Plants	Auxiliary Vehicles	Special Vehicles	Jetting Machines	Cesspit Emptiers	TOTAL
Mayoralty of Baghdad	ID 10^6	30 135.0	0.0	0.0	0.0	0.0	30 135.0
Centre South	ID 10^6	2 094.5	0.0	0.0	0.0	0.0	2 094.5
North	ID 10^6	0.0	0.0	0.0	0.0	0.0	0.0
Mayoralty of Baghdad	USD 10^6	150.7	4.7	2.2	9.0	23.8	190.2
Centre South	USD 10^6	20.9	5.9	0.4	1.7	184.5	213.3
North	USD 10^6	0.0	1.1	0.0	0.0	40.8	41.9

Table 6-30: Average Reinforcement Costs per Family in Urban Areas

Region	Existing Connections	Reinforcement ID/Connection	Reinforcement USD/Connection
Mayoralty of Baghdad	475 338	63 397	400
Centre South	115 549	18 126	1 846
North	Data not available		

Table 6-31: Reinforcements in Rural Areas

Region	Unit	Cesspit Emptiers	TOTAL
Mayoralty of Baghdad	ID 10^6	0.0	0.0
Centre South	ID 10^6	0.0	0.0
North	ID 10^6	0.0	0.0
Mayoralty of Baghdad	USD 10^6	0.3	0.3
Centre South	USD 10^6	46.9	46.9
North	USD 10^6	9.8	9.8

Table 6-32: Average Reinforcement Costs per Family in Rural Areas

Region	Existing Cesspits and Pit Latrines	Reinforcement ID/Cesspit	Reinforcement USD/Cesspit
Mayoralty of Baghdad	1 131	0	250
Centre South	170 323	0	275
North	Data not available		250

6.3.3.3.1 Extension of the Sewage Sub-sector (Ideal scenario)

Current service coverage in rural and urban areas has been estimated as follows, based on data from the database.

Table 6-33: Current Levels of Service by Area

Region	Urban Areas Sewer Connection Level	Rural Areas One-site Connection Level
Mayoralty of Baghdad	80.0%	100.0%
Centre South	9.8%	37.9%
North	Data not available	Data not available

The calculations that follow are performed assuming a 100% connection level in both urban and rural areas. To determine the capital costs of the extensions for the target year 10, it is thus necessary to divide the total amounts by (100% - χ%) and to multiply the result by (target % - χ%) where χ corresponds to the values in the above table.

The estimated investments necessary for the extension of the sewage sub-sector in urban and rural areas are given in the following tables.

Table 6-34: Extension in Urban Areas

Region	Unit	Sewer connection	Sewer	Small pumping station	Hand pumping station	Wastewater treatment plant	Auxiliary vehicle	Special vehicle	Jetting machine	TOTAL
Mayoralty of Baghdad	10^6 ID	64 481.0	137 860.5	28 387.9	14 237.4	25 792.4	0.0	0.0	0.0	270 759.
Center South	10^6 ID	149 570.7	184 755.0	0.0	16 384.2	59 363.1	0.0	0.0	0.0	410 073.
North	10^6 ID	37 417.0	661.6	181.0	211.3	382.8	0.0	0.0	0.0	38 853.
Mayoralty of Baghdad	10^6 USD	0.0	160.1	52.8	15.5	129.0	12.3	1.5	6.1	377.
Center South	10^6 USD	0.0	227.3	0.0	17.8	593.6	2.8	5.1	21.2	867.
North	10^6 USD	0.0	50.0	30.3	20.7	172.2	8.5	1.5	6.2	289.

Table 6-35: Average Extension Costs per Family in Urban Areas

Region	Number of New Connections	Extension ID/connection	Extension USD/connection
Mayoralty of Baghdad	322 405	839 810	1 170
Centre South	1 495 707	310 130	643
North	430 616	89 440	548

Table 6-36: Extensions in Rural Areas

Region	Unit	Cesspit Emptiers	Total
Mayoralty of Baghdad	ID 10^6	0.0	0.0
Centre South	ID 10^6	0.0	0.0
North	ID 10^6	0.0	0.0
Mayoralty of Baghdad	USD 10^6	0.1	0.1
Centre South	USD 10^6	120.2	120.2
North	USD 10^6	15.5	15.5

Table 6-37: Average Extension Costs per Family in Rural Areas

Region	Number of New Cesspits and Pit Latrines	Extension	Extension
		ID/Cesspit	*USD/Cesspit*
Mayoralty of Baghdad	388	0	250
Centre South	443 280	0	271
North	101 063	0	250

6.3.3.3.2 Improvement of the Garbage Service

The following investments are necessary to expand the number of vehicles and equipment in line with the needs of the 2010 population.

Table 6-38: Improvement of Garbage Service

Region	Unit	Collection Equipment	Landfill Equipment	Total
Mayoralty of Baghdad	USD 10^6	153	10	163
Centre South	USD 10^6	441	11	451
North	USD 10^6	99	2	101

Table 6-39: Average Costs per Urban Inhabitant

Region	USD / Inhabitant
Mayoralty of Baghdad	35
Centre South	26
North	30

6.3.3.4 Operating Costs

Year 1 and Year 10 operating costs at are presented in the following tables.

Table 6-40: Operating Costs in Urban Areas

Region	Total Operating Costs *Year 1* ID 10^6/annum	Number of Connections *Year 1*	Operating Costs per Connection *Year 1* ID/connection	Total Operating Costs *Year 10* ID 10^6/annum	Number of Connections *Year 10*	Operating Costs per Connection *Year 10* ID/connection
Mayoralty of Baghdad	3 205.9	475 338	6 744	7 402.2	797 743	9 279
Centre South	1 622.7	115 549	14 044	11 229.9	1 611 256	6 970
North	1.8	Data not available		21.8	430 616	51

Table 6-41: Operating Costs in Rural Areas

Region	Total Operating Costs	Number of Cesspit and Pit latrines	Operating Costs per Cesspit	Total Operating Costs	Number of Cesspit and Pit latrines	Operating Costs per Cesspit
	Year 1	*Year 1*	*Year 1*	*Year 10*	*Year 10*	*Year 10*
	10^6 ID/year		ID/Cesspit	10^6 ID/year		ID/Cesspit
Mayoralty of Baghdad	1.3	1 131	1 106	1.7	1 519	1 106
Centre South	207.4	170 323	1 218	739.4	613 603	1 205
North	0.0	Data not available		1.0	101 063	10

Table 6-42: Operating Costs for Garbage Management in Urban Areas

Region	Total Operating Costs	Operating cost per Inhabitant	Total Operating Costs	Operating Costs per Inhabitant
	Year 10	*Year 10*	*Year 10*	*Year 10*
	USD 10^6 /annum	USD/inhabitant	ID 10^6/annum	ID/inhabitant
Mayoralty of Baghdad	15	2.4	1 358	213
Centre South	30	2.4	2 786	216
North	8	2.4	8	2.5

6.3.4 Example of Application

Current sewerage coverage is 80% in the urban area of the Mayoralty of Baghdad.

6.3.4.1 Ideal Scenario

Contrary to the ideal scenario presented in the above paragraph, we assume here an ideal scenario of 95% sewerage coverage only instead of 100%. It is for example purpose only since we know that the objective of the Mayoralty of Baghdad is to reach 100% sewer coverage. The point is to show, from a methodological point of view that in some governorates after master plans have been carried out, the 10 years ideal objectives of 100% may appear excessive. The methodology must therefore allow a lower objective to be selected.

If, for the target year 10, an ideal scenario is determined consisting of a coverage level of 95%, all rehabilitation and reinforcement work must be completed and the sewer system extended to a further 15% of the population.

The investment costs for rehabilitation and reinforcement are defined above.

Given that the values of the extensions calculated above correspond to a 20% coverage of the current "unserviced" population (100% - 80%), the investment costs for extending coverage to 95 % of the population are estimated on the basis of the amounts defined above multiplied by 15 % / 20 %.

Table 6-43: Ideal Scenario: Investments

Investments	Total ID 10^6	Total USD 10^6
Rehabilitation	101 872	138
Reinforcement	30 135	190
Extension	239 264	335
TOTAL	372 272	663

For the ideal scenario, the annual average value of the investments would thus be ID 37 000 million and USD 66 million.

At this stage of the evaluation, it is recommended that the work be phased as follows:

Table 6-44: Phasing of Work for the Ideal Scenario

	Year	1	2	3	4	5	6	7	9	10
Rehabilitation	ID									
	USD									
Reinforcement	ID									
	USD									
Extension	ID									
	USD									

Under this proposal:

- The rehabilitation component would be completed in the next 2 to 3 years.
- The reinforcement component would begin in year 3 and be completed by year 5.
- The extension component would be completed in years 5 to 10.

Per annum operating costs which are currently ID 3 200 million would rise to ID 7 068 million by year 10 and the average cost per family would increase from ID 6 744 in year 1 to ID 9 326 in year 10.

6.3.4.2 Optimum Scenario

The optimum scenario consists in using the available budget for the Mayoralty of Baghdad region as effectively as possible.

Objectives are defined for the next 10 years on the basis of the sanitation sector budget after allocation between water, sewerage and garbage.

For example, for a budget of ID 20 000 million and USD 40 million, the budgets for the next 10 years would be ID 200 000 million and USD 400 million respectively.

Table 6-45: Optimum Scenario: Investments

Investments	Total ID 10^6	Total USD 10^6
Rehabilitation	101 872	138
Reinforcement	30 135	190
Extension	67 993	72
TOTAL	200 000	400

Given that each percentage extension of service coverage corresponds to an investment budget of ID 12 000 million and USD 17 million, coverage could be increased by 4% reaching 84% by year 10. The limiting factor being the budget in USD, the surplus in ID is approximately ID 20 000 million and could be to assigned to the water and/or garbage sectors.

This amount could be used to subsidise the operating cost if the price of drinking water allows operating costs to be covered.

Guidelines for Water Quality Control

SAFEGE
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Appendix 1 *Raw and Treated Water Quality Data Collected by GEWS*
Appendix 2 *GEWS – Analysis and Sampling Forms*

7. Guidelines for Water Quality Control

7.1 Introduction

The objective of this study is to assess the water quality control and surveillance system under water suppliers and health/environment bodies in Iraq.

To do so, the consultant considered:

- The situation of the water supply in Iraq (sources in use, drinking water production, distribution).
- The water quality in Iraq, both for the sources and the drinking water produced and distributed.
- The institutional, organizational and regulation aspects of the water quality surveillance (Department for Environment Protection and Development) and control (water suppliers).
- The implementation of the water quality control by Directorates of Water and the implementation of water quality surveillance by the Ministry of Health (staff, equipment, transport, methodology).

The assessment was made based upon:

- The data collected by UNICEF and SAFEGE regarding water supply and water quality.
- A three week visit to the various entities involved in the Water Quality Control and Surveillance (water suppliers, Ministry of Health). Visits were made at national level (headquarters in Baghdad) as well as at Governorate (Ninevah, Basra, Qadisiyah and Erbil), district and sub district level.
- Finally, an action plan was proposed, defining recommendations and specifications to improve the water quality control carried out by Water Suppliers in Iraq.

7.2 Water Quality

7.2.1 Sources

7.2.1.1 Sources in Use

The main source used for producing drinking water in Iraq is surface water, coming from the Euphrates and Tigris rivers, and their tributaries.

Surface water accounts for 98% of the total production in the Central and Southern governorates (see Table 7-1). Groundwater is scarcely used and represents only 2% of the water produced. Wells and springs are sometimes used as a secondary resource, in addition to the surface water.

Wells and springs are mainly found in small rural projects, in the governorates of Ninevah, Salaheldin and Ta'meem, situated on the large central limestone plateau.

The use of groundwater and wells is much more developed in the mountainous three northern governorates. For example, 500 deep wells are in operation in the governorate of Erbil. The deep wells approximately account for 50% of the production of Erbil City.

The groundwater is not used in the southern governorates, as a result of high salinity. This region is a flat lowland alluvial plain, with many lakes and marshes.

The Table 7-1 presents the water sources in use for each governorate.

The Euphrates and the Tigris are the two main rivers of Iraq. The two rivers rise in the mountains of eastern Turkey. The Euphrates flows through Syria to Iraq before emptying into the Arabic Gulf. The Tigris flows to Iraq and joins with the Euphrates in Iraq before reaching the Arabic Gulf via the Shatt-al Arab. The Tigris receives part of its water in Iraq. The Euphrates hardly receives any water in Iraq.

The Euphrates and its tributaries supply the governorates of (from upstream to downstream) Anbar, Kerbala, Babil, Qadisiyah, Najaf, Muthanna and Thiqar.

The Tigris and its tributaries supply the governorates of (from upstream to downstream) Dohuk, Ninevah, Erbil, Sulaymaniyah, Ta'meem, Salaheldin, Diala, Baghdad, Wasit and Missan.

The governorate of Basrah gets most of its water from Nasiriya (Thiqar governorate).

The total fresh water withdrawal in Iraq is between 45 to 50 billion m^3 per year, divided between:

- Domestic use 5%
- Industrial use 8%
- Agricultural use 87%

Extensive irrigation schemes have been developed in Iraq. The main projects are in Ta'meem and southern governorates.

Table 7-1: Sources in Use in Iraq (as % of production) – Year 1999 (UNICEF-SAFEGE data)

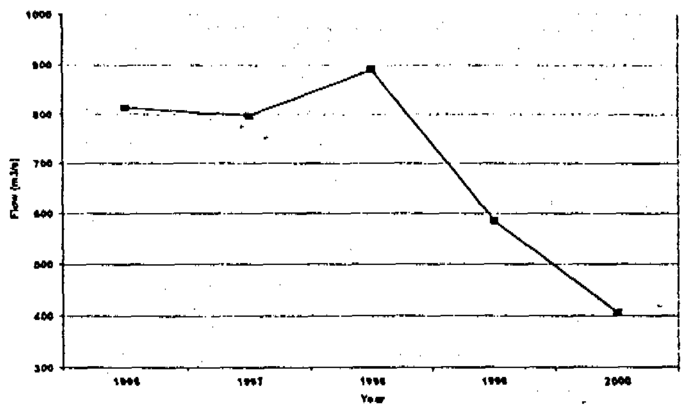
Governorate	%Well&Springs	%Surface Water
Dohuk	-	-
Sulaymaniyah	-	-
Erbil	-	-
Muthanna	1%	99%
Thiqar	0%	100%
Qadisiyah	0%	100%
Wasit	0%	100%
Baghdad	0%	100%
Missan	0%	100%
Kerbala	0%	100%
Babil	0%	100%
Diala	0%	100%
Salaheldin	7%	93%
Najaf	0%	100%
Anbar	1%	99%
Ta'meem	3%	97%
Basrah	0%	100%
Ninevah	5%	95%
Mayoralty of Baghdad	0%	100%
TOTAL[1]	2%	98%

The country has been undergoing dry conditions the past two years (1999 and 2000). To this adds the implementation of major dams in Turkey. As a result the average flows are lower. The Tigris's average flow at Sarai Baghdad site was 890 m^3/s in 1998, 584 m^3/s in 1999 and 405 m^3/s in 2000 (seeFigure 7-1).

A striking feature is that water resource management is already under stress due to shortage of water. For instance, some water treatment plants are supplied from irrigation channels. The management of irrigation induces big variations of flow and thus of raw water quality (turbidity), due to rationing systems. In this context the optimum management of treatment plants is very difficult. The global water management will be discussed under the water quality control and surveillance chapter.

[1] the results does not include the three Northern Governorates. The proportion of groundwater/springs is much higher in these governorates, in the range of 50% for Arbil City.

Figure 7-1: Average Tigris River's Flow – Sarai Baghdad Site



7.2.1.2 Quality

7.2.1.2.1 Data Collected

The consultant and UNICEF collected the following data:

- Raw water physical and chemical parameters collected by GEWS for all Central and South governorates except Basrah and Qadisiyah.
- Raw water physical and chemical data collected by Baghdad Water Authority.
- Physical and chemical parameters collected by DOH in Erbil governorate on two samples.
- The report issued by the Environment Protection Center issued in 1992 and entitled "pollution of running water in Iraq".

The aim of this chapter is not to carry out a full diagnosis of the source's water quality, but to point out its main features in order to define the context of water quality control and surveillance activities.

7.2.1.2.2 Data Analysis

Central and South Governorates (Except Baghdad)

The compiled results (minimum, maximum and average from 1995 to 2000) are presented in Appendix I for each governorate.

The quality of the rivers varies significantly from North to South of Iraq. The Total Dissolved Solids periodically exceeds WHO standards (1500 mg/l) in the governorates of Missan, Thiqar and Anbar.

Figures 10-2 & 10-3 present the average conductivity and TDS in each governorate, as measured by GEWS in year 2000. These two maps point out a significant difference of salinity between the governorates North and South of Baghdad.

Figure 7-4 shows the evolution of conductivity and TDS from 1996 to 2000 in the Missan governorate.

The situation is of much concern in the Southern governorates since the salinity of water is likely to increase as the quantity of water decreases. This phenomenon can be already noticed when analyzing the data collected by GEWS from 1996 to 2000 (see Figure 10-4). The extensive use of irrigation combined with high water tables in the South certainly contributes to raise salinity levels. Alternative treatments such as Reverse Osmosis are under study in some places (Amara for example).

Though salinity is within the WHO standard (based on health and taste considerations) in most governorates, it is too high for optimum operation of distribution networks (early clogging of pipes and equipment).

No data is available regarding other parameters such as nitrates, nitrites, ammonium, iron, manganese, copper, heavy metals, organic constituents and pesticides (see water quality control). The report "pollution of running water in Iraq" dated 1992 identifies the main sources of pollution (agricultural effluents, sewage discharges, industries). Very few data are available to quantify the impact of these sources of pollution on the Euphrates and Tigris rivers (quality and quantity of effluents, river flow data).

The groundwater is reported to be too saline for drinking water production in the Southern governorates. It is however used in the governorates, north of Baghdad such as Ninevah, Salaheldin and Ta'meem.

Northern Governorates (Dohuk, Erbil and Sulaymaniyah)

Wells and springs are used in rural places, with a simple disinfection treatment. A coagulation-sedimentation-filtration–disinfection process is used to treat the water abstracted from rivers in urban centers (example Erbil city).

The water quality of both surface and ground water is reported (WHO, DWS) to be suitable for drinking water production using these treatments. The analyses recently carried out by WHO indeed indicate that both surface water and groundwater have low salinity. There is however no data at the time of this assessment concerning organic constituents, pesticides and heavy metals.

It was reported (WHO, DWS) that high concentrations of nitrates (above 50 mg/l) are sometimes found in water sources. 5 wells are contaminated in Erbil City, presumably by human waste (septic tanks, cemetery) in the immediate perimeter of the wells (no protection perimeter implemented).

Baghdad

The Baghdad Water Authority is operating 7 treatment plants, from Northern Baghdad (Khark) to Southern Baghdad (Doura). The range of data collected for each DWTP (1 month) is not enough to assess the evolution of Tigris water quality through Baghdad.

Besides, not enough data could be collected to make an assessment of the pollution caused by the effluents discharged in Tigris through Baghdad (number of industries, effluents' discharge and type, pollution load, Tigris flow data...).

However the comparison of the raw water analysis done by GCWS upstream and downstream of Baghdad, respectively at Al-Rashidia and at Al-Mada'n, allows us to point out a significant increase of conductivity. This is illustrated by Figure 10-5.

The analyses carried out by BWA in 1999 and 2000 indicate that concentrations of heavy metals are within the WHO guidelines.

The compiled data collected by BWA is summarized in the table below (average for the treatment plants of Baghdad).

Table 7-2: Water Analysis Results – Baghdad Water Authority - 1st Semester 2000

Analysis	Raw Water			Treated Water		
	Min	Max	Ave	Min	Max	Ave
Color	0/5	0/5	0/5	0/5	0/5	0/5
Temperature C	7	32	20	8	34	20
Turbidity N.T.U	11	140	25	0.2	26.5	3.9
pH	7.4	8.3	8	7.1	8	7.7
Alkalinity as $CaCO_3$ mg/l	118	171	146	114	162	141
Total Hardness as $CaCO_3$ mg/l	211	592	367	210	588	372
Calcium as Ca mg/l	53	159	94	52	155	97
Magnesium as Mg mg/l	18	57	34	18	57	34
Chloride as Cl mg/l	39	179	94	39	173	93
Conductivity microS/cm	540	1980	950	520	1710	935
Aluminum as Al mg/l	Nil	0.16	0.01	Nil	0.20	0.08
Total Dissolved Solids mg/l	350	1194	693	350	1062	680
Suspended Solids mg/l	15	172	51			
Iron as Fe mg/l	0.1	4.6	0.77	0.01	0.88	0.134
Sulfate as SO4 mg/l	90	445	266	90	440	263
Fluoride as F mg/l	0.07	0.30	0.15	0.04	0.5	0.14
Ammonia as NH3 mg/l	< 0.01	0.36	0.08	< 0.01	0.08	0.01
Nitrite as NO2 mg/l	0.001	0.03	0.006	< 0.001	0.002	0.001
Silica as SiO2 mg/l	2.0	70	5.9	2	70	5.3
Nitrate as NO3 mg/l	< 1	< 1	< 1	< 1	< 1	< 1
PO4	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Manganese as Mn mg/l	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Cadmium As Cd mg/l	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Lead as Pb mg/l	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007
Copper as Cu mg/l	0.15	0.28				
Zinc as Zn mg/l	0.07	0.14				
Chromium as Cr mg/l	< 0.005	0.028	0.013	< 0.005	0.026	0.011
Mercury as Hg mg/l	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Figure 7-2: Average Conductivity (microS/cm) for Year 2000 (Data Collected by GEWS)

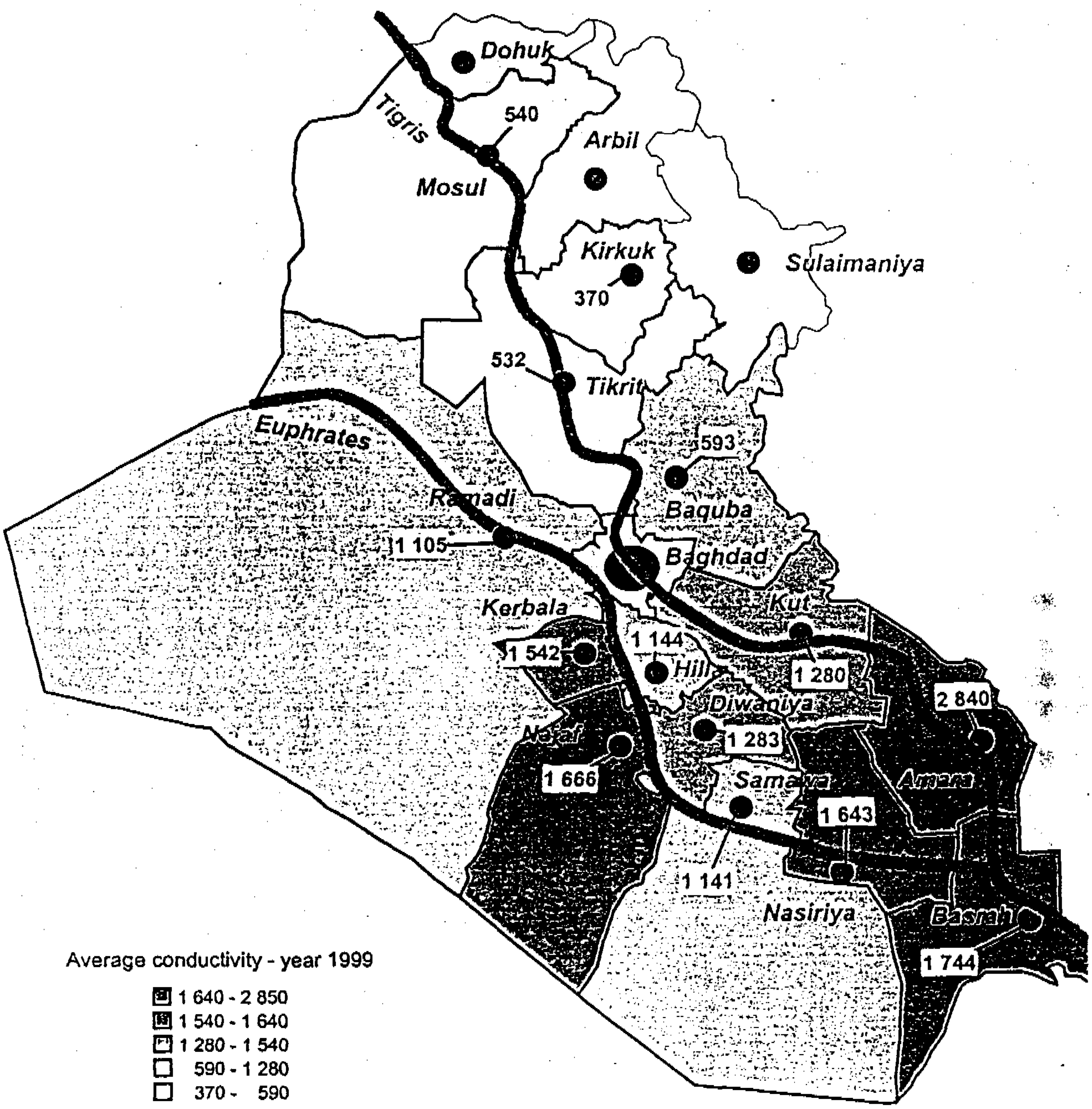
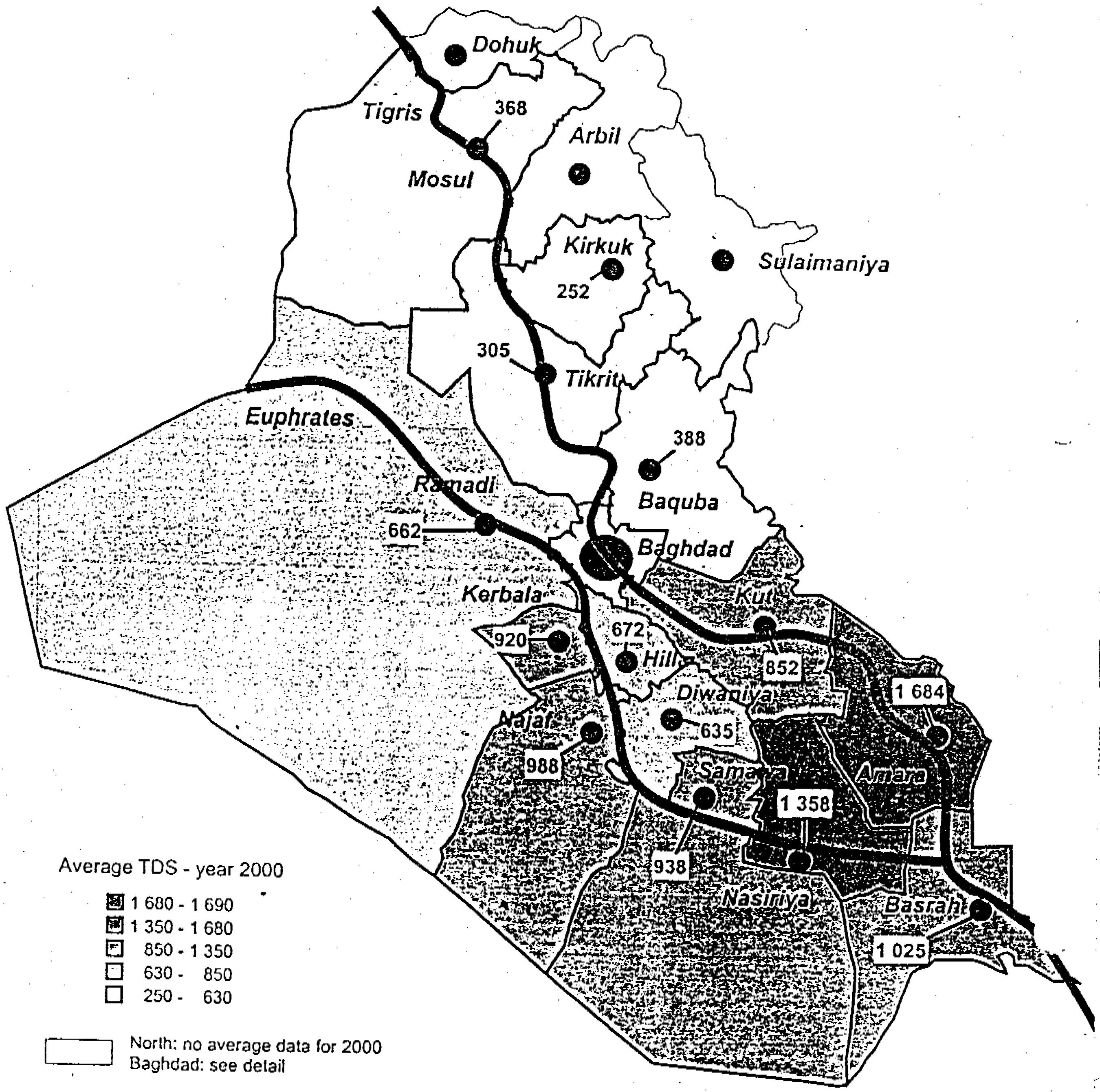


Figure 7-3: Average TDS (mg/l) for Year 2000 (Data Collected by GEWS)



Appendix

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MINISTRY OF INTERIOR

GENERAL CORPORATION FOR WATER & SEWERAGE

Telphone : 4441555 (Labratory ext. I3I) Baghdad

BACTERIOLOGICAL WATER ANALYSIS

Sender :

Name Of Collector :

Nature Of Sample :

Source Of Samplè :

Datè Of Sampling : / / Time :

Datè Of Analysis : / / Time :

Rèsidual Chlorine mg/I :

RESULTS :

Total Coliform	: 37 C:	/I00ml
E. Coli	: 44 C:	/I00ml
Plate Cdunt	: 37 C:	/Iml

Water Bacteriolgically ☐ Good ☐ Bad

Date Of Report

Name and Signature Of Biologist :

MINISTRY OF INTERIOR
GENERAL ESTABLISHMENT FOR WATER & SEWERAGE
Telphone : 4441555 (Labratory ext. 131) Baghdad

Sender :
Date Of Sampling
Date Of Analysis :

CHEMIICAL WATER ANALYSIS

Characteristicn in mg/L unless otherwise stated	Nature Of Sample						Maximum permlsslble levle
Turbidity NTU							10
PH							6.5-85
Electrical Conductivity Umhos/Cm. 25 Co							2000
Total Alkalinity (asCaCO3)							125-200
Ph Pnthan. Alkalinity (asCaCO3)							
Total Hardness (asCaCO3)							500
Calcium (asCa)							200
Magnesium (asMg)							150
Chloride (asCl)							600
Sulphate (asSO4)							400
Sodium (asNa1)							200
Potassium (asK)							
Fluoride (asF)							1.0
Total Iron (asFe)							0.3
Aluminium (asAI)							0.2
Total Dissolved Solids							1500
Total Suspended Solids							

Remarks:

Date Of Report:
Name & Signature Of Chemist:

[1] Appendix

Distribution plan for phase VIII

Executive Summary, 25 July, 2000.

The conditions of potable water and sanitation systems remain critical throughout Iraq. Rehabilitation requirements are estimated over US $ 604.09 million, in addition US$ 300 million to complete the unfinished project to serve 1.8 million inhabitants. The garbage collection had been neglected due to the shortage of funds and the sector needs US$ 100 million to purchase spare parts and new equipment. However, due to limited funds, the Plan allocates US$ 604.09 million, of which US$ 133 million for Baghdad serving about 6 million people in the city and its surrounding districts. US$ 471.09 million to be provided for the rehabilitation of water and sanitation facilities in the remaining governorates, including US$ 161.09 million for the rehabilitation of water and sanitation facilities in the three northern governorates. Deterioration in this sector continues as referred to in the UN Secretary-General's report of 8 June 2000 (S/2000/573). The report pointed out that the situation requires greater attention in this sector, which has a serious impact on public health, environment and population, especially children, women and the elderly. Equipment will be imported to rehabilitate potable water and sanitation facilities in Baghdad and other governorates.

- dDP VIII

Sector/Activity	Allocations in US$m (countrywide)	Allocations for Dihouk, Erbil, Suleimaniyeh (US$m)
SECTOR		
Food ** Food supporting supplies of equipment/ spare parts for food supply, goods transportation/trucks/ standardization and quality control labs.	1,266.00 518.42	183.32 1.42
Medicines and medical supplies	548.00	50.00
Water and Sanitation	604.09	161.09 (26.7%)
Electricity	752.38	134.38
Agriculture Irrigation	431.63 373.50	216.63
Primary , Secondary Education Higher Education	227.09 161.89	67.59 41.89
Settlement Rehabilitation	202.35	202.35
Mine Related Activities	36.89	36.89
Nutrition	16.08	16.08
Health Rehabilitation	147.66	147.66
Transport and Communications / Rehabilitation of Railway Network	488.50	8.00

Housing	757.00	
SUB TOTAL	6,531.48	1,267.30
Oil	600.00	/
GRAND TOTAL	7,131.48	1,267.30 (17.8%)

* The estimated allocations by sector constitute indicative figures to give an order of magnitude of intended use of resources. The actual amounts will depend on market prices at the time of procurement.
** The daily food ration will provide 2472kcal and 60.20 g of protein, 64.90 g of fat, 439.40mg of calcium, and 9.80g of iron.
*** The inclusion of milk and weaning food for infants fill an important nutritional need by adding 2 boxes of baby milk and 2 boxes of baby food and 1 kilo of milk for adult per capita

PLAN OF EQUIPMENT PURCHASE FOR

WATER AND SANITATION SECTOR

40. Deterioration in this sector has manifested itself seriously in the decrease in quantities of potable water and in inadequate sanitation for the population, both of which have contributed to sharp increase in the incidence of water –borne diseases in the whole country . With the drastic deterioration in this sector during the past Nine years, a survey recently undertaken by UNICEF revealed that the water coverage has gone down to an average of 41 % in all rural areas. On the other hand, the per capita share of water has gone down to 218 liters / day in Baghdad, 138 liters / day in other urban areas and 91 liters / day in served rural areas . This deterioration is related to the acute need for new plants the poor functioning of most of the existing water treatment plants, lack of spare parts and equipment , the poor status of the water distribution network, and electrical power cuts of up to 10 hours per day. Water quality results, reported by MOH and WHO, have shown a high contamination percentage of water samples. On the other hand and while the turbidity of water reaching the population should not exceed 1 National Turbidity Unit (NTU) as set by Iraqi standards, more than 70 % of the water currently served is of a turbidity exceeding 10 NTU.

41. Despite the identification of the deteriorated situation of the sector of potable water and sanitation by the reports of UN agencies and the report of the UN Secretary- General of 18 May 1999 (S/1999/573), which clarified the actual situation of the projects and the minimum requires needs for maintaining their operation , deterioration continues, due to the limited sums allocated for this sector in the previous distribution plants, the delay in the arrival of supplies , mainly due to complicated process for S.C. approval as well as the nature of these supplies which require no less than six months for their manufacture and shipment.

Sector Objective and Strategies :

The overall objectives of the Water and Sanitation Sector in Iraq are :
1. To provide sufficient quantity of potable water to the population.
2. Dispose, hygienically, of all kinds of waste (solid and liquid).
To meet the above objectives three subsequent planning stages are to be followed :

Stage I: Rehabilitate the existing system to enhance efficiency and improved performance as well as quality . The estimated cost of this phase is US$ 700 million.

Stage II : Fill in the gap to reach universal accessibility of service where by the underserved and the unserved will be covered .

Stage III : Increase the level of service to meet the normal growth of the population.

The purchase strategy followed in preparing the three subsequent distribution plans of SCR.

42. The production of potable water in 14 governorates is 1200 million cubic meter / year. The design capacity of Baghdad is 850 million cubic meter / year. As the requirements determined in the previous distribution plans, have not arrived in Iraq yet, the current estimated capacity of these facilities is 30 % less than their design capacity. The water system in center / south Iraq is composed of 218 water treatment plant, 1191 compact water unit, 51 boosting station and thousands of kilometers of water supply pipes. In the north the system is composed of 21 water treatment plants, 640 bore-holes and 140 various other systems. However, most of these water supply systems are working at less than 30 % efficiency. Breaks and leaks of the water network are decreasing water pressure, water quality and per capita share as a result.

43. In sanitation, the situation is even worse. None of the 13 sewage treatment plants in the country is functioning properly, and raw sewage is disposed directly into rivers and causing contamination.

The sewage collection , and rainfall collection systems which are composed of 250 vertical sewage pumping stations and more than 1.000 sewage submersible pumping station are all malfunctioning and in desperate shape , because of the deteriorating status of the network , and the lack of pumps, spares and other supplies and mainly due to disability to construct new treatment plants and net work to face the population growth Other areas where septic tanks and cesspools are utilized for sewage disposal are also facing enormous problems due to the high water table and the breakdown of the fleet of cesspool emptiers.

Flooded septic tanks are flooding residential areas and causing contamination.

44. The current situation necessitates much attention to this sector , due to its negative effects on public health , environment and citizens, particularly children and women . This requires the allocation of US$ 604.09 million in the plan to meet the urgent humanitarian needs in this sector according to the details contained in annexes 1 and 2 / water and sanitation , US$ 133 million to Baghdad and US$ 310 million to the districts surrounding Baghdad and other 14 governorates, and US$ 161.09 million will be allocated to the three northern governorates.

45. The spare parts and equipment required for this sector are described in annexes 1-8 / water and sanitation.

The proposed DP has some changes in the purchase policy. Priority continues to be given to the purchase of water purification chemicals and some of the specific urgent required supplies in specific water treatment plants not only for Baghdad Municipality but also to the General Establishment for water and Sewerage.

There will be a focus on improving water services to under-served or unserved rural population by the purchase of 400 compact water treatment plants.
More attention is being given to sanitation by the purchase of sewage pumps, cesspool emptiers, sewers jetting units, sewers cleaning equipment and garbage collectors.
As a second priority, focus will be given to the purchase of supplies to water treatment plants (pumps, circuit breakers, starters, and motors) and also supplies for incomplete water treatment plant meant to serve unsaved population and whose civil works are 60-90% completed.
Also, focus will be given to the purchase of some ductile and UPVC pipes for the water supply network. There will also be focus on water quality control through the purchase of required supplies. The water tankers, which are included in DP-VI, should be used to face needs incurred by the current drought situation.
On a third priority basis, water tankers to provide services to unserved areas and some support vehicles (trailers and loaders) will be purchased.

An amount of up to US$ 161.09 million is allocated to the three northern governorates for the water and sanitation sector, where again the prevailing situation is very similar to that pertaining throughout Iraq.

The pattern of deterioration has not yet been arrested. The adverse effects on public health and the environment and especially on women and children continue to be very much in evidence.

In urban areas the apparent ready access to water and sanitation systems tends to conceal the fact that the quality of potable water is highly variable and very dependent on a reliable and continuous electricity supply. The latter ensures that pressures remain sufficient to avoid drawing polluted water back into the main supply pipes. In addition many of the pumps are well beyond their useful working life, with the result that the supply of water o households is by no means guaranteed even where systems are nominally in place. For rural areas, recent surveys indicate that water supply coverage is under 50%, rather less than had originally been thought.

access to sanitary latrines is much less at only 16%.

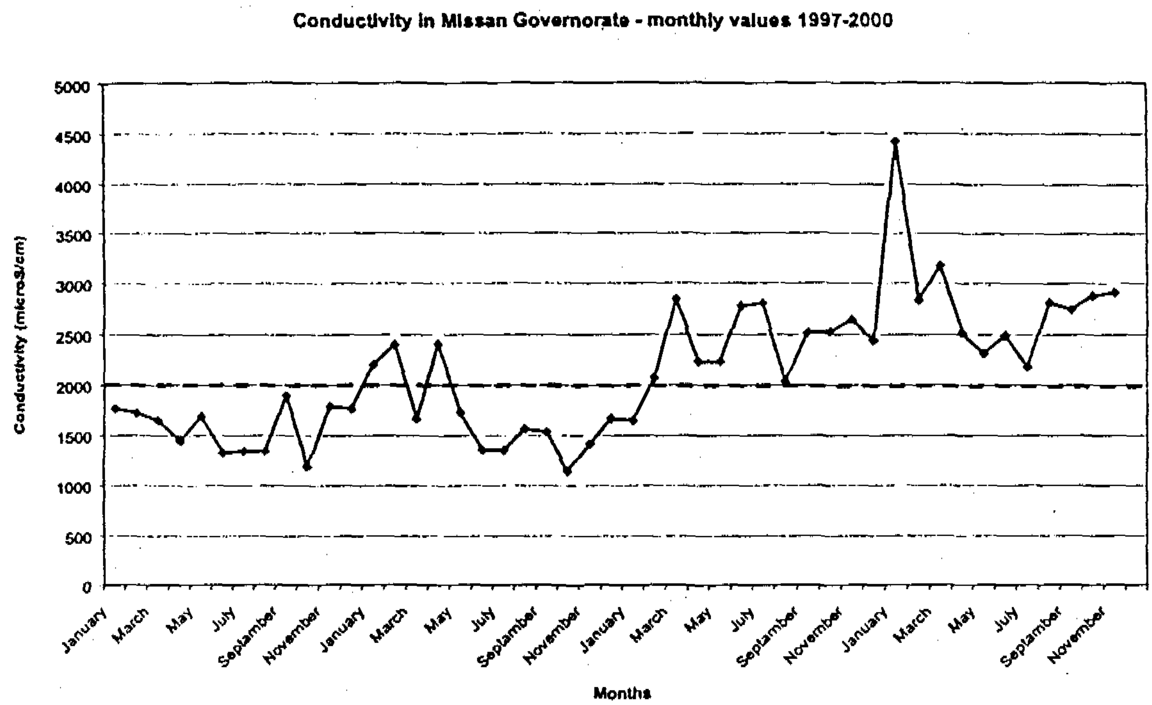
A particular problem in this sector is the widespread deterioration of the vehicle sanitation fleet, which is used for regular removal of both liquid and solid wastes. The much-reduced capacity of this fleet is compromising both the health and environmental situations, which will become even worse over the coming summer unless corrective action is taken before then.

Computers that are ordered as part of DP-VI should be used to computerize the management of supplies in the major warehouses in order to alleviate some of the present bottlenecks in the process of distribution of supplies in the Water and Sanitation sector.

The acquisition of more vehicles and repair of the existing fleet is therefore identified as a top priority, to which the sum of US$ 5 million will be allocated. The next priority will be for rural water and sanitation for an amount of US$ 4 million, and thereafter US$ 10 million for urban sanitation and finally US$ 11 million for urban water supply.

46. In accordance with paragraph 40 of the MOU, the Government of Iraq shall provide the Programme with detailed information about the delivery of supplies and equipment to their locations in order to facilitate the monitoring of their use and to make sure of this. The Programme will conduct the tasks provided for in paragraph 8 of annex-1 of the MOU.

Figure 7-4: Evolution of Conductivity and TDS since 1997 in Missan Governorate



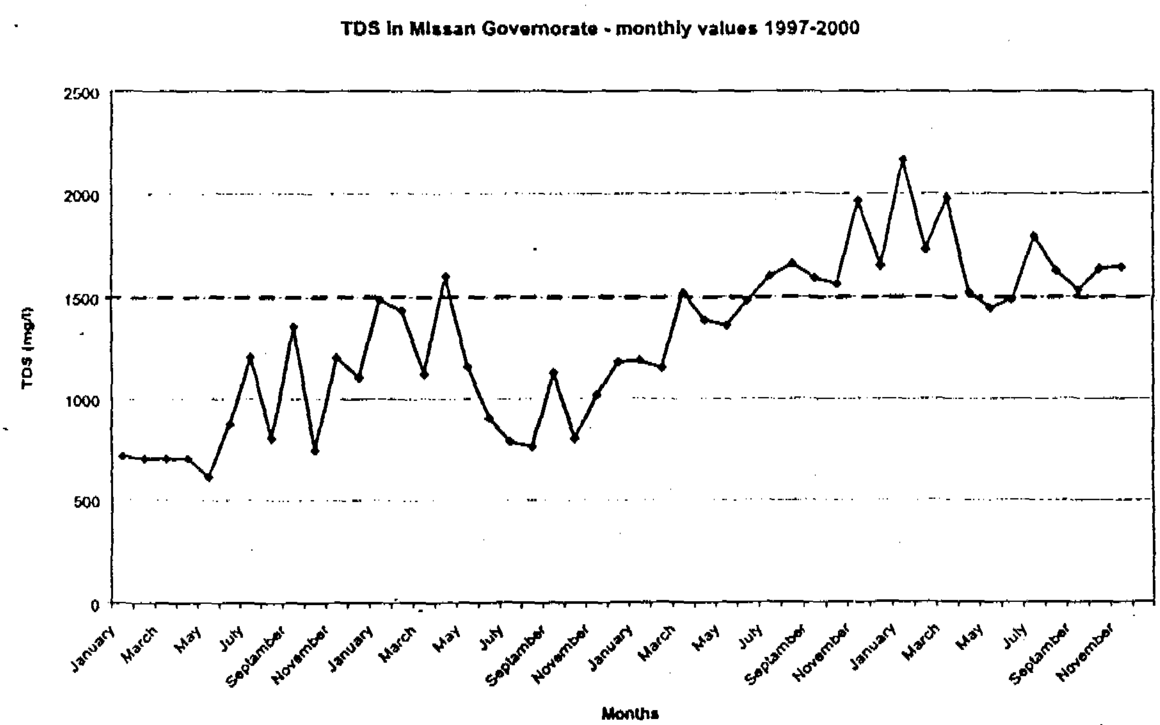


Figure 7-5: Conductivity of Raw Water North and South of Baghdad (Year 1995 to 2000)

7.2.2 Treated Water

7.2.2.1 General

The total drinking water average production was in 1999 around 3,880,496 m^3 per day.

Three types of production are found in Iraq:

- Production through drinking water treatment plants (DWTP), using a sedimentation/filtration/disinfection process. These plants account approximately for 80% of the total production. They are used mainly in major urban centers (capital and districts).

- Production through the use of water treatment Compact Units. The capacity of these units is much lower as they are mainly used in rural areas or in addition to DWTPs. The Compact Units account for approximately 18% of the total production.

- Production through the use of wells and springs. The wells account only for 2% of the water produced.

The water production quality is currently affected by a number of factors:

- As discussed, the water resources have degraded in quantity and quality these past years. Shortage of raw water was reported to stop production in Qadisiyah governorate. "The competition" with other water use such as irrigation is sensitive in Southern governorates.

- The current operation of production units is not satisfactory because of lack of means and staff. The DWTP are run directly by the Water Supplier (GCWS, BWA). Only a fraction (around 30%) of the Compact Units are run by the directorates of water. The rest is managed by the communities. This results in significant differences in the operation of the production units. The Compact Units use high technology and therefore require tight operation The involvement of communities doesn't seem effective unless under tight supervision of the water supplier. The use of springs and wells is more adapted to community management since it requires simple disinfection treatment. (However even such simple operation causes problems in the Northern Governorate and require permanent training and supervision of communities). The quality of groundwater is not adequate for simple disinfection treatment.

- The aluminum sulfate and chlorine is not always supplied in adequate quantities, even under MOU. The locally made alum is of poor quality.

- The production units are affected by the unreliability of the power supply (this has deteriorated during the embargo).

- The sand filters were reported to be ineffective in some DWTPs (lack of maintenance) by the Baghdad Water Authority.

7.2.2.2 Treated Water Quality

The adequacy of treatment depends on the ability to decrease turbidity under 5 NTU. This limit dictates the efficiency of the disinfecting process.

The field visits indicated that the treatment unit operators have difficulties to respect this guideline for the following reasons:

- Turbidity in raw water is varying a lot.
- Quality of alum is not adequate.
- Sand filters are inefficient.
- Means of monitoring turbidity are insufficient (see water quality control).
- Lack of staff to monitor and operate closely the treatment plants.

The results of BWA illustrate the fact that turbidity of treated water sometimes exceeds the guidelines (see maximum turbidity after treatment in Table 7-2).

Regarding chlorination, most production units are equipped with chlorinators. The residual chlorine is monitored in most DWTP. However, operators of smaller projects (compact units, wells) lack staff and means to measure chlorine (see water quality control). In response to the poor condition of the distribution systems the operators maintain high chlorine residual concentrations (frequently above 2 mg/l).

Besides, unreliable supply of chlorine and poor maintenance of chlorinators affect the efficiency of the disinfecting process.

7.2.3 Distributed Water

The bacteriological data collected by the Ministry of Health and GCWS in each governorate (except Northern governorates) in 1999 is summarized in Table 7-3.

The following remarks can be made:

- The MOH data indicates big differences in numbers of contaminated samples between rural (see "failed limits") and urban (see "failed center") areas in most governorates.
- The MOH data indicates big differences between governorates: the % of contaminated samples varies from 0.4% in Qadisiyah to 21.5% in Thiqar.

The lack of means and staff have badly affected the maintenance of the distribution networks in the past decade. The network is reported to be leaking. Besides the network capacity doesn't reach the increased demand. The elevated tanks are bypassed, water is boosted directly in the network.

This results in low pressures, illegal unsafe connections which increase the risk of contamination from sewage, especially where there is a shallow water table (Baghdad, southern governorates).

The power cuts increase as well the risk of contamination in the distribution network.

The levels of residual chlorine are set very high to limit the risk of contamination. A residual chlorine of 0.5mg/l is targeted in most governorates. These values may anyway not be effective when turbidity is above 5 NTU.

All this is worst in rural areas where operation and maintenance by communities is not effective.

Table 7-3: % Failed Samples for Each Governorate In 1999 – Comparison of MOH and GCWS Data

	Ministry of Health				GCWS	
	No. of Samples	Failed center %	Failed limits %	Total failed %	No of samples	Failed %
Ninevah	5991	1.6	6.7	2.7	2671	0.2
Ta'meen	4330	2.1	11.3	4.7	2320	7.5
Salahedin	3831	5.3	8.7	7.8		
Anbar	4358	4.7	13.2	8.4		
Diala	3940	2.5	3.2	3.1	2339	0.8
Baghdad	7326	7.9	7.4	7.8	1338	1.8
Wasit	3534	8.3	9.5	9.0	532	8.3
Missan	4617	3.2	3.8	3.5	2406	2.1
Babil	4850	4.9	11.4	8.0	1015	6.6
Qadissiya	3661	0.0	0.9	0.4	1501	3.8
Kerbala	4303	8.6	8.6	8.6	1127	0.2
Najaf	6949	1.5	5.1	4.4	1142	2.2
Muthanna	2561	0.3	1.0	0.7	1244	1.2
Thiqar	5059	10.6	25.9	21.5	1350	2.2
Basrah	6156	5.8	20.2	11.3	2301	3.2

7.3 Water Quality Control and Surveillance

7.3.1 General

Two entities are involved in the surveillance and control of drinking water quality:

- Water suppliers (GCWS for Central and South, DWS for Northern governorates and BWA for Baghdad).
- Ministry of Health/Center for Environment Protection.

The **water suppliers** are responsible for producing and distributing drinking water according to water quality Iraqi standards. They carry out a **control of the quality** of the raw water they abstract, treat and distribute.

The Ministry of Health/Center for Environment Protection is a **surveillance body** in charge of checking that the water distributed by water suppliers is within Iraqi Standards guidelines. Besides, this body is also in charge of monitoring the global quality of Iraqi water sources including the pollution from effluents (industrial, agricultural, sewage).

The Ministry of Irrigation has a major role in the management of the water resources. More specifically, it controls the allocation of water to irrigation and to drinking water production. This management has a direct impact on the quantity and quality of the raw water available for drinking water production.

The system is presented on Figure 7-7

The standards of drinking water quality are specified by Iraqi Standards 417 (1974). The guideline values are derived from WHO specifications (1971). The Iraqi standards also include guidelines concerning water sampling. Both water suppliers and the Ministry of Health/Center for Environment Protection use this guideline to carry out, respectively, the water quality control and the water quality surveillance. A summary of these guidelines is presented in Table 7-4 .

Figure 7-6: Water Quality control and Surveillance, Actors and Responsibilities

Table 7-4: Iraqi Quality Standards Applied in Iraq for The Main Physical and Chemical Parameters

Parameter	Guideline
Turbidity NTU	10
Color	
T	
pH	6.5-8.5
TDS	1500mg/l
Electrical Conductivity	2 000 µS/cm
Total Alkalinity (as CaCO3)	125-200 mg/l
Total Hardness (as CaCO3)	500 mg/l
Calcium	200mg/l
Magnesium	150mg/l
Chloride	600mg/l
Sulfate	400mg/l
Sodium	200mg/l
Fluoride	1mg/l
Iron	0.3mg/l

7.3.2 Centre for Environment Protection

7.3.2.1 General Organization

The water quality surveillance used to be carried out by the Ministry of Health. A separate entity, the Center for Environment Protection and development, was created in 1997 under the same ministry to carry out water quality surveillance.

The Center for Environment Protection is carrying out two different types of surveillance:

- Surveillance of sources' water quality and pollution
- Surveillance of drinking water quality

Besides water quality surveillance, the MOH has authority over concerned parties to make sure that regulations are followed (protection perimeters of production units, quality of effluents).

Prior to 1997 the surveillance of water quality and pollution was centralised in Baghdad. The central lab in Baghdad is equipped to carry out full physical, chemical and bacteriological analysis.

- The surveillance of drinking water quality (residual chlorine and bacteriology) was done in the central lab of each governorate. These labs were also used for other activities of the Health Authorities (food, health).

- After 1997 separate environmental labs started to be established in each governorate to carry out both drinking water quality and source quality surveillance. This plan is still under implementation.

7.3.2.2 Source's Water Quality Surveillance

The central authorities (Ministry of Health) produced in 1992 a global assessment study of river water quality untitled "Pollution of running water in Iraq". This report identified the main sources of pollution and their causes and presented corrective measures to be implemented.

The main sources of pollution identified were:

- *Agricultural drainage waters* - The drainage effluents are considered as the main source of salts. The implementation of a large drain, "the Leader's River" is proposed to reduce by two the amount of salts drained into the Tigris and Euphrates rivers.

- *Industrial effluents* - Many industries did not have treatment facilities at the time of the report. Many treatment units were ineffective because of lack of maintenance.

- *Domestic effluents* - Few cities are equipped with waste water treatment plants. A number of treatment plants were not functioning because of lack of maintenance.

Though sources of pollution were identified and listed, their impact was not precisely quantified because of "limited test methods and observation". The river quality surveillance was indeed limited to concentrations of salts in the Tigris, Euphrates and Shat Al Arab at various monitoring sites. Part of the recommendations made in the report thus stressed the need of reinforcing the capacities of Environment Protection Centers at governorate level (staff, training, transport, laboratories) in order to have a better monitoring of both river quality and pollution.

The development of environmental labs started in 1997. However, the site visits and discussions indicated that the development of environmental laboratories is not complete and is facing the following problems:

- After separation of health and environmental centers, the staff mainly remained within health activities. There is a lack of staff in environmental centers. Environmental Center's staff is mainly found in the central laboratories, there is hardly any staff at district or sub-district level. The context of the embargo adds to the shortage of staff.

- The river quality and pollution analysis were so far carried out by the central Health laboratory in Baghdad. The creation of environmental laboratories at governorate level requires the purchase of a lot of new equipment to carry out physical and chemical analysis. The pollution analysis (heavy metals, pesticides, fertilizers) uses high technology (atomic absorption, gas and liquid chromatography). The establishment of these labs must involve adequate training. In the context of embargo, it is very difficult to implement such a program. From the three governorates the consultant visited, only one was being equipped for river quality and pollution surveillance (Qadisiyah).

7.3.2.3 Distributed Water Quality Surveillance

7.3.2.3.1 Distributed Water Quality Surveillance - Guideline

In each governorate, Environmental labs follow the Iraqi guideline which defines the number and frequency of samples to be taken based on the total population served in each governorate.

The Iraqi guidelines are summarized in Table 7-5 below. The WHO guidelines and the guidelines applied in France are indicated for comparison.

Table 7-5: Iraqi Guidelines for Water Sampling (Bacteriological Analysis)

Population	WHO Guidelines (1)	Guidelines Applied in France (2)	Iraqi Guidelines 417
Up to 20 000	1 sample per month per 5 000 population	1 sample per month per 5 000 population	1 sample per month per 5 000 population
From 20 000 to 50 000	1 sample per month per 5 000 population	1 sample per month per 5 000 population	1 sample biweekly per 5 000 population
From 50 000 to 100 000	1 sample per month per 5 000 population	1 sample per month per 5 000 population	1 sample every 4 days per 5 000 population
100 000 and above	1 sample per month per 10 000 population plus 10 additional samples	1 sample per month per 5 000 population	1 sample every day per 5 000 population

(1): WHO "guidelines for drinking-water quality volume 3 – 1997"

(2) Décret 89-3 3rd January 1989 regulation concerning water for domestic use

The table indicates that the sampling frequencies in the Iraqi guidelines are much higher than the WHO and French guidelines. The comparison of the guidelines with the number of samples actually taken by Health Authorities is presented in the next paragraph.

7.3.2.3.2 Distributed Water Quality Surveillance – Statistics

Table 7-6 presents the comparison of the number of samples taken by MOH with the WHO and French guidelines.

Table 7-6: comparison of MOH sampling activity with WHO and French guidelines

directorate	Total samples taken by MOH in 1999		WHO		France	
	Urban	Rural	Urban	Rural	Urban	Rural
Ninevah	4 688	1 299	1 693	1 942	3 146	1 942
Ta'meen	3 095	1 235	785	535	1 330	535
Salahedin	924	2 907	607	1 195	974	1 195
Anbar	2 469	1 889	769	1 150	1 298	1 150
Diala	828	3 112	695	1 560	1 150	1 560
Baghdad	***6 111***	1 215	5 918	1 385	***11 597***	1 385
Wasit	1 300	2 234	624	876	1 008	876
Missan	2 779	2 240	634	521	1 027	521
Babil	2 586	2 264	799	1 486	1 358	1 486
Qadissiya	2 084	1 577	631	845	1 022	845
Kerbala	2 785	1 518	592	482	943	482
Najaf	1 309	5 640	809	557	1 378	557
Muthanna	1 098	1 463	356	554	473	554
Thiqar	***1 430***	3 521	964	1 157	***1 687***	1 157
Basrah	3 784	2 372	1 613	778	2 986	778

The comparison indicates that the number of samples taken by MOH is always above the numbers defined by WHO guidelines. The number of samples is slightly insufficient according to French guidelines in two governorates: Baghdad and Thiqar.

To conclude, the frequency of sampling done by health authorities is within WHO and French guidelines.

7.3.2.3.3 Distributed Water Quality Surveillance - Organization

The analysis is done in the central lab. The sampling is done at primary health center level by the staff in charge of Environment Protection. The sample is then given to the central laboratory of the governorate for analysis.

No detailed data is available at this stage to assess precisely the effectiveness of the coverage and the quality of the sampling done. However, the following remarks can be made based on the visits and discussions:.

- Coverage of Environmental Centers:

  There is a total of 140 Primary Health Centers in Iraq. These centers thus ensure a good coverage of both urban and rural areas. The effectiveness of this presence is however affected by:

- The lack of staff dedicated to water quality surveillance at primary health center level.
- The lack of transportation to bring samples from primary health centers to central environmental labs. Lack of transportation also deteriorates the supervision of the sampling by the central lab, the quality of the samples (delay, no iceboxes to keep samples), the training of staff...

- Central Laboratories:

  Only the staff of the Environmental Laboratory in Qadisiyah governorate could be met during the consultant's visit to Iraq. The staff met was qualified (chemical and microbiologist engineers).

  The visit of the lab in Diwaniya pointed out a lack of equipment for bacteriological analysis. The environmental lab staff is currently using the equipment of the health lab to store samples (fridge) and to sterilize sampling bottles (autoclave). The lab also lacks media for culture growth and basic glassware (sampling bottles, test tubes...).

  As mentioned, the means of transport are far too little: in Qadisiyah for example, there is one car for all the environmental lab's activities (central laboratory plus primary centers).

  The staff also mentioned the lack of a computer to follow up the activity of the lab and to analyze the data.

7.3.2.4 Conclusions

The 1992 report and the current establishment of environmental laboratories indicate that the surveillance of Iraq's water resources quality is under development today. However, this development is facing difficulties due to the current context. As a result, it is not in operation in most governorates and still remains under the central authority in Baghdad. The surveillance of source's water quality is then mainly carried out by Water Suppliers.

The surveillance of distributed water quality is much more developed than the surveillance of source's water quality. Despite the current difficulties due to embargo, the frequencies of sampling are within WHO guidelines. It benefits from the good coverage of Primary Health Centers and the presence of qualified staff at Central Laboratories level. However, the quality (accuracy, coverage) of the surveillance is affected by the lack of trained staff at Primary Health Centers level, the lack of transportation, the lack of lab equipment and consumables.

7.3.3 Water Suppliers

7.3.3.1 General

The responsibility of supplying drinking water in Iraq is divided between three authorities:

- The Baghdad Water Authority, in charge of supplying water to Baghdad Mayoralty.
- The General Establishment of Water Suppliers (GEWS), in charge of supplying drinking water in each Central and South Governorates.
- The Directorates of Water and Sewerage, in charge of supplying drinking water in the three Northern governorates.

Each of these authorities is responsible for controlling the quality of the water they abstract, treat and distribute to consumers.

The organization of the water quality control under each authority is presented hereafter.

7.3.3.2 Baghdad Water Authority

7.3.3.2.1 Organization

The Baghdad Water Authority has the responsibility of producing and supplying water. The municipalities of Baghdad have the responsibility of running the distribution networks. However, the monitoring of the quality of the water distributed is entirely under the Baghdad Water Authority's responsibility.

The monitoring consists in:

- Carrying out sampling and physical and chemical analysis of the raw and treated water on a daily basis.
- Carrying out sampling and bacteriological analysis of water in distribution network, reservoirs and boosting stations, according to Iraqi guidelines.

Figure 7-8 hereafter describes the organisation of the water quality control:

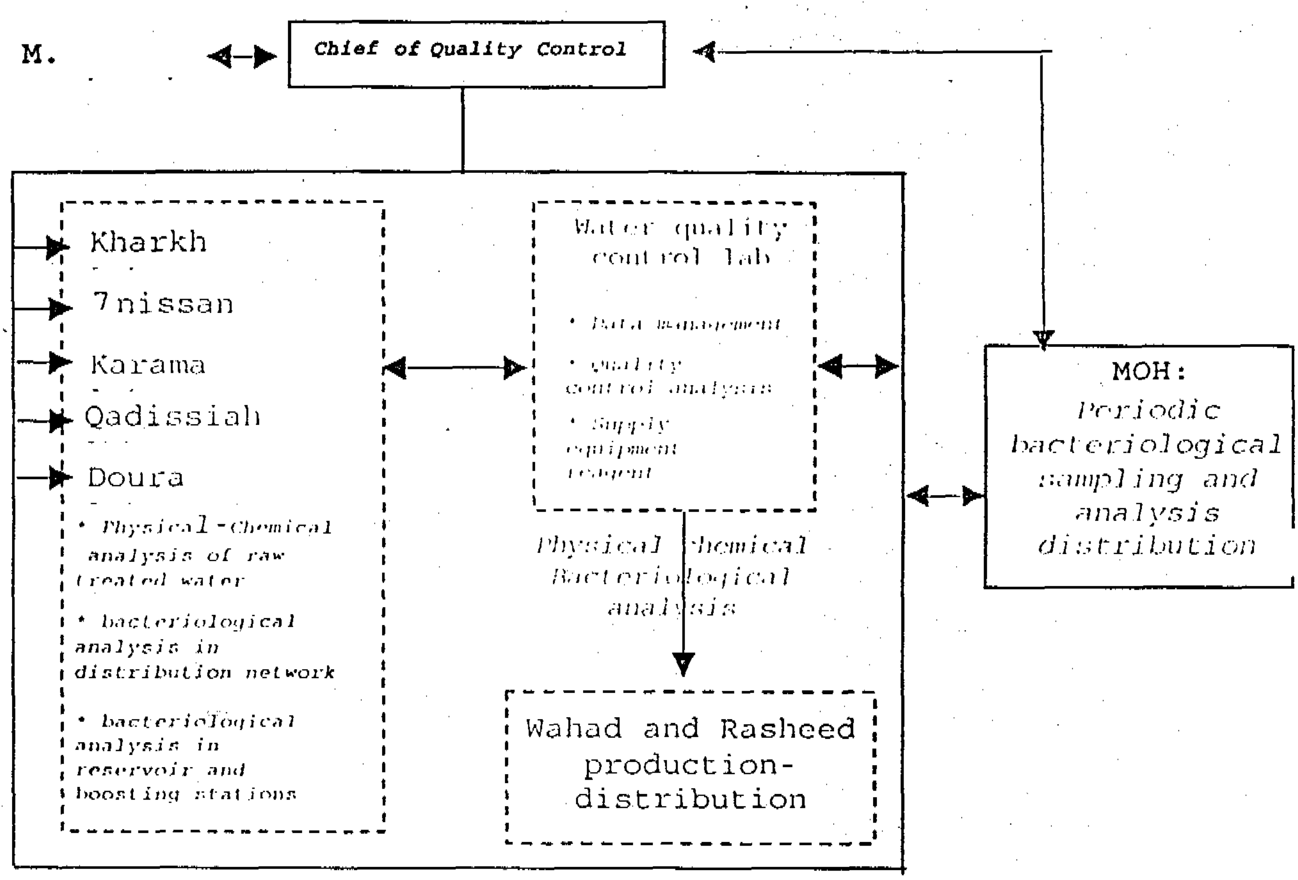
There are seven Water Treatment Plants in Baghdad, located from North (Kharkh) to South (Rasheed) of Baghdad City. The control of water quality (both production and distribution, physical, chemical and bacteriological analysis) is carried out directly by five of these treatment plants which are equipped with laboratories and which have their own means (staff, laboratory equipment, transportation). These five plants are Kharkh, 7 Nissan, Karama, Qadisiyah and Doura. Each plant has its own zone of control (which includes distribution system, reservoirs, booster stations and compact units).

In addition, BWA runs an independent Water Quality Control laboratory based in 7 Nissan Treatment Plant. The responsibilities of this lab are:

- To carry out the water quality control (production and distribution) for the 2 treatment plants of Wahad and Rasheed.. These 2 treatment plants are not equipped with their own laboratory.
- To carry out regular additional sampling (monthly) to check the result of analysis carried out by the five laboratories.
- To gather and analyze the data collected by each laboratory.
- To organize supply of laboratory equipment and reagents.
- To supervise laboratory staff and provide training.

A chief of Quality Control Department is supervising the five Water Treatment Plant laboratories and the water quality control laboratory. In addition to supervision and management, the chief of Quality Control liaises with other entities such as the Ministry of Health, Ministry of Irrigation, GEWS...

Figure 7-7: Water Quality Control under Baghdad Water Authority



7.3.3.2.2 Water Quality Control

Control of Raw and Treated Water Quality

Each laboratory is carrying out a daily routine control of the raw and treated water quality. The daily control concerns general parameters such as pH, turbidity, temperature, and conductivity. The other parameters (alkalinity, hardness, calcium, magnesium, chloride, aluminum, TDS, SS, iron, sulfate, fluoride; ammonia, nitrite, silica, nitrate, phosphate, manganese, cadmium, lead, copper, zinc, chromium, mercury) are usually measured on a weekly basis.

The laboratories don't have at the moment the means to analyze organic constituents, pesticides, and fertilizers.

Some parameters are analyzed several times a day (pH, turbidity). The monitoring is however not continuous. The need for continuous monitoring to detect incidental pollution of the raw water will be discussed in the recommendations (chapter 7.4)

Monitoring of Distributed Water Quality

Each laboratory is carrying bacteriological analysis of distributed water quality in its operational zone. The samples are taken in the reservoirs and in the boosting stations. Samples are also taken in the distribution network at various points, including ends of distribution network. Residual chlorine is measured on site. The target value of residual chlorine is 0.5mg/l.

The main weaknesses identified by the consultant are:

- Lack of means (see below).
- The monitoring does not include continuous measurement of residual chlorine in distribution reservoirs and in the network. Such action would allow BWA to monitor more efficiently the distributed water quality.
- The monitoring seems to be not enough targeted to improve network operation and maintenance. The reason is that water quality control staff lacks counterparts in the operational divisions of treatment, supply and distribution.

Means for Water Quality Control

The Water Quality Control Department is facing difficulties due to a lack of means in the context of the embargo.

The following points were highlighted by the Water Quality Control Department:

- There is not enough qualified staff to carry out sampling and analysis.
- There is lack of transportation means to collect samples.
- The equipment of the lab is outdated and insufficient.
- Consumables such as media for culture growth are missing.
- There are no computerized tools for water quality data processing and analysis.

Water Quality Control Data Management

Each laboratory keep the results of its analysis in a book with precise description of location and time. The laboratories transmit regularly the results to the Water Quality Control Laboratory. The staff of the Water Quality Control laboratory is then in charge of processing the data collected in each water treatment plant. A report is issued each semester summarizing the values of each parameters (average, minimum and maximum) for the seven water treatment plants. This report also presents for comparison the results of the monitoring carried out by the Water Quality Control laboratory.

The Water Quality Control Laboratory stressed out the need for a computer in order to capture the results of water analysis and to process them more efficiently: statistics, follow-up of parameters in time. Computerization reduces the time needed for data analysis and thus increases the efficiency of action to take to improve water quality (adjustment of treatment, network operation and maintenance).

Co-Ordination with Other Entities

Center for Environment Protection

The activity of the Water Quality Control Department is co-ordinated with the activity of the Center for Environment Protection:

- The Center for Environment Protection informs (through weekly reports) the Water Quality Control Department of the results of bacteriological analysis.
- When contamination is found, the two entities do a common sampling and analysis to confirm the problem. The cause of the problem is then identified and corrective actions taken.

This co-operation is formalized as a "joint Committee".

The co-operation between the two entities extends sometimes to common training sessions. In some governorates (Qadisiyah for example) the two entities closely co-operate (sharing of laboratory means, transport).

Ministry of Irrigation

The Water Quality Control Department co-ordinates with the Ministry of Irrigation on the management of the drain situated upstream of Baghdad. The management of the drain has indeed consequences on the salinity and turbidity of the Tigris River.

7.3.3.2.3 Conclusions

To conclude, the visits and discussions indicated that:

- The BWA Water Quality Control Department possesses **a good existing organization.** The five water treatment plants laboratories provide good monitoring of the raw water quality from upstream to downstream of Baghdad. The water quality control laboratory provides supervision and expertise to the other laboratories.
- The staff working in the Water Quality Control Department is qualified and motivated. Despite the lack of means the department still manages to provide BWA with a monitoring of the water quality.
- However, the Water Quality Control Department is facing difficulties due to a lack of means: shortage of staff, laboratory equipment, transportation, computers. This lack of means certainly affects the quality and quantity of the monitoring.
- The actions of the Water Quality Control Department do not seem to be well integrated to the operation of the Baghdad water production, supply and distribution system. The main reason is the lack of counterparts in the operational divisions (also affected by the lack of staff and means).

The main recommendations (see Chapter 7.4 for details) would be:

- To rehabilitate the current system by upgrading the laboratories' equipment and providing the minimum transportation means required.
- To introduce computer for data management.
- To extent the range of parameters to organic constituents.
- To provide the corresponding training to the laboratory staff.
- To study the security of the raw water (protection perimeters, risks of pollution...) and to adapt the raw water quality control.

7.3.3.3 General Corporation of Water

7.3.3.3.1 Organization

The General Corporation of Water is in charge of monitoring the water quality in the Central and South governorates.

The organization is indicated on Figure 7-8

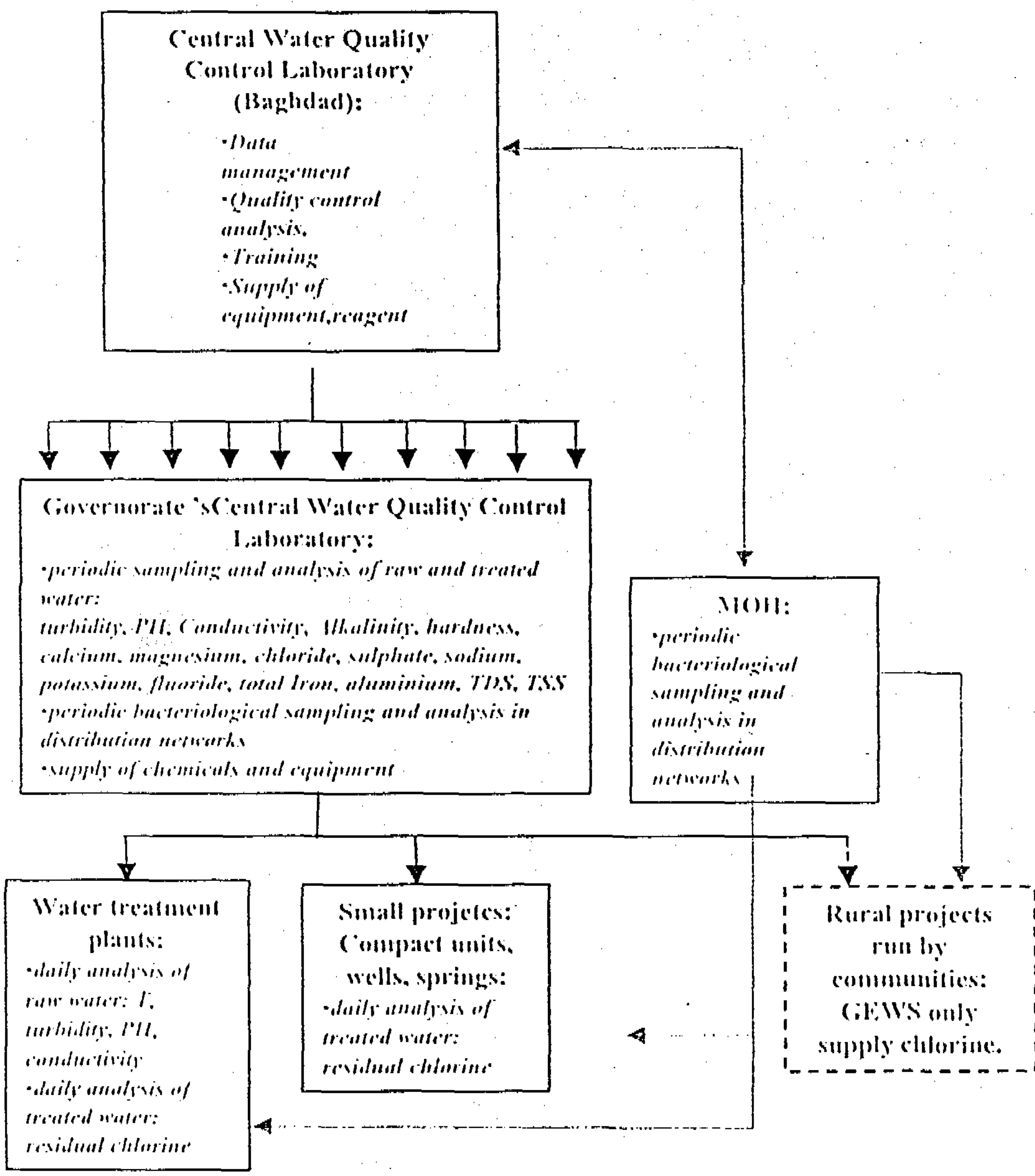
Each governorate possesses a central laboratory, located in one of the main water treatment plant of the governorate. This laboratory is in charge of supervising the water quality control of all the projects run in the governorate by the Corporation of Water. It consists in:

- Supplying projects with chemicals (chlorine, alum...).
- Carrying out periodic raw, treated and distributed water sampling and analysis in each project.
- In addition, the daily analysis (pH, turbidity, residual chlorine after treatment, temperature) is carried out directly by the operators of the projects when they are equipped with laboratories. It concerns the major water treatment plants. The rest of the projects simply operate the chlorination process and check the residual chlorine after treatment.
- A significant number of rural projects are run by the communities. In that case the MOH is the only monitor of the distributed water quality.

The whole quality control organization is supervised by the Central Water Quality Control Laboratory in Baghdad. This laboratory is charge of:

- Following up and assessing the water quality control of the directorates' central laboratories.
- Supplying laboratories' equipment and chemicals.
- Providing training to the staff in the directorates.
- Collecting and processing the water analysis results.

Figure 7-8: GEWS Water Quality Control Organization



7.3.3.3.2 Water Quality Control

Control of Raw and Treated Water Quality

Each project equipped with a laboratory is carrying a daily routine control of the raw and treated water quality. The daily testing concerns general parameters such as pH, turbidity, temperature, residual chlorine, and conductivity.

The other parameters (conductivity, alkalinity, hardness, calcium, magnesium, chloride, sulfate, sodium, potassium, fluoride, iron, aluminum, TDS and TSS) are usually measured on a weekly, biweekly or monthly basis, depending on the means of each governorate's central laboratory.

The laboratories don't have at the moment the means to analyze organic constituents, pesticides, and fertilizers.

Some parameters are analyzed several times a day (pH, turbidity). The monitoring is however not continuous. The need for continuous monitoring to detect incidental pollution of the raw water will be discussed in the recommendations (chapter 7.4).

Control of Distributed Water Quality

Each Governorate's Central laboratory is carrying out bacteriological analysis of distributed water quality in the projects under GEWS's responsibility. The samples are taken in the reservoirs and in the boosting stations. Samples are also taken in the distribution network at various points, including ends of distribution networks. Residual chlorine is measured on site. The target value of residual chlorine is 0.5mg/l.

The main weaknesses identified by the consultant are:

- Lack of means (see below).
- The testing does not include continuous measurement of residual chlorine in distribution reservoirs and in the network. Such action would allow GEWS to monitor more efficiently the distributed water quality.
- The monitoring seems to be not enough targeted to improving network operation and maintenance. The reason is that water quality control staff lacks counterparts in the operational divisions of treatment, supply and distribution.

Means for Water Quality Control

The Water Quality Control laboratories are facing difficulties due to a lack of means in the context of the embargo.

The following points were highlighted by the Water Quality Control staff met during the visit to laboratories in the governorates of Ninevah, Baghdad, Qadisiyah and Basra:

- There is not enough qualified staff to carry out sampling and analysis.
- There is lack of transportation means to collect samples.
- The equipment of the labs is outdated and insufficient.
- Consumables such as media for culture growth are missing.
- There are no computerized tools for water quality data processing and analysis.

The Central Water Quality Control department in Baghdad has listed all the laboratories in operation in each governorate,, indicating the number of staff and the overall condition of the laboratory. This list is presented in Table 7-7 below.

Table 7-7: List of Laboratories in Each Governorate (GEWS Central Quality Control Lab in Baghdad)

Governorate	Laboratories	Lab. Condition	Staff	
			BSc	Technician
Ninevah	Central lab/new left bank	working	7	2
	Project lab/old left bank	working		
	Central lab/united right bank	working		
Kirkuk	Central lab in directorate	working	2	2
	water project lab	not working		
Salahedin	central lab/water project Tikret	not working	1	
Anbar	Central lab in Ramadi	not working	1	
Dialah	Central lab/water project Baquba	working	1	3
Baghdad	Central lab in directorate	working	2	2
	Meda'n water project lab	working		1
	QaQa project lab	working	1	
	Rashidiyah project lab	working		1
Karbala	Central lab in directorate	working	1	2
Babil	Central lab in directorate	working	5	3
Najif	central lab	working	3	1
Qadissia	Central lab in directorate	working	3	
	Deghara lab	not working		
	Shamiyah project lab	working		1
	Al-Hamza Project lab	working		1
Wasit	central lab	working	3	
Al Mithana	central lab	working		2
Thi qar	Central lab in directorate	working		5
	Qalat Suker water project lab	working		2
Missan	central lab	working		8
Basrah	Central lab/al Baradhia	working	4	6

Table 7-7 indicates:

- There are 25 laboratories covering the 15 governorates under GEWS's responsibility. Four of these laboratories are not in operation.

- There is no central laboratory in operation in the two governorates of Anbar and Salaheldin.
- There is an average of 2 graduate staff (BSc) and 2 technicians in each central laboratory.
- There are 9 project laboratories in operation in addition to the 13 central laboratories in operation. There is an average of one staff in the project laboratories.

These figures clearly illustrate the lack of laboratories and staff available for water quality control in the GEWS:

- Not enough staff in the central laboratories.
- Not enough project laboratories to control water quality in the water treatment plants. There are only 9 project laboratories for a total of 221 water treatment plants in Iraq (UNICEF survey).

Recommendations are made in Chapter 7.4 regarding staff and equipment, based on discussions with central laboratory managers in Baghdad, Ninevah, Qadisiyah and Basra.

Water Quality Control Data Management

Each central laboratory keeps the results of its analyses in a book with precise description of location and time. The laboratories transmit monthly the results to the central Water Quality Control Laboratory in Baghdad where the analysis of each governorate are kept in books. The head of the Central Water Quality Control laboratory in Baghdad then processes the data collected in each water treatment plant (statistics).

Each central water quality control laboratory stressed the need for a computer in order to capture the results of water analyses and to process them more efficiently: statistics, monitoring of parameters in time. Computerization reduces the time needed for data analysis and thus increases the efficiency of actions taken to improve water quality (adjustment of treatment, network operation and maintenance). Computerization would also improve the transmission of results between governorate's central laboratories and the central laboratory in Baghdad.

Co-Ordination with Other Entities

Center for Environment Protection

The activity of the Water Quality Control Department is co-ordinated with the activity of the Center for Environment Protection in each governorate:

- The Center for Environment Protection informs (through weekly reports) the Water Quality Control Department of the results of bacteriological analysis.
- When contamination is found, the two entities do a common sampling and analysis to confirm the problem. The cause of the problem is then identified and corrective actions taken.

This co-operation is formalized as a "Joint Committee" in each governorate.

7.3.3.3.3 Conclusions

To conclude, the visits and discussions indicated that:

- The existing GEWS Water Quality Control system as presented in Figure 7-8 a good framework on which to rehabilitate an efficient water quality control.
- The existing staff working in the Water Quality Control laboratories is qualified and motivated. Despite the lack of means the department still manages to provide GEWS with a follow-up of the water quality.
- However, the Water Quality Control system's efficiency is limited because of a lack of means:
  - Lack of staff, equipment and transportation in the central laboratories.
  - Lack of secondary laboratories in the water treatment plants to carry out routine analysis: pH, turbidity, conductivity, temperature, dissolved oxygen and residual chlorine.
- The actions of the Water Quality Control Department do not seem to be well integrated to the operation of the production, supply and distribution system. The main reason is the lack of counterparts in the operational divisions (also affected by the lack of staff and means).

The main recommendations (see chapter 4 for details) would be:

- To rehabilitate the current system by:
  - Upgrading the central laboratories' equipment and providing the minimum transportation means required.
  - Developing project laboratories in the major projects (Water treatment plants) to carry out routine water quality control (pH, turbidity, temperature, conductivity, dissolved oxygen and residual chlorine).
- To introduce computers for data management.
- To extend the range of parameters to organic constituents.
- To provide the corresponding training to the laboratory staff.
- To study the security of the raw water (protection perimeters, risks of pollution...) and to adapt the raw water quality control.

7.3.3.4 Northern Governorate

The organization of the water quality control in each of the three governorates is very similar to the one in each of the Central and Southern governorates.

The situation however differs in the means provided to the laboratories.

The laboratories in the three northern governorates are benefiting from a program implemented by the WHO and UNICEF in the three governorates.

- The central laboratory in Erbil has been upgraded and supplied with new equipment:
  - Turbidity meter, pH meter, conductivity meter, Dissolved Oxygen meter, flame photometer, spectrophotometer for physical and chemical analyses.
  - Steriliser, incubator, media, fridge and freezer for bacteriological analysis.
  - Computer for data capture and analysis.
- 3 vehicles are available for sampling.
- Incentives are given to the staff working in the laboratories. 13 staff (8 BSc , 2 diploma and 3 assistants) are working in the central laboratory in Erbil.

Despite the means, the water quality control system lacks counterparts in the operational divisions to carry out corrective actions in treatment and in distribution operation and maintenance.

7.4 Conclusions and Recommendations

7.4.1 Conclusions

- There is in Iraq an **existing structure for both water quality surveillance** (Center for Environment Protection and Development) **and water quality control** (water suppliers).
- As presented in the previous chapters, **both Centers for Environment Protection and water suppliers are lacking means (laboratories, equipment and transportation) and staff** to carry out fully the water quality control under their responsibility. This lack of means affects the coverage and frequency of the quality control. It certainly also affects the quality of the sampling and analysis.
- Despite difficulties, each entity is currently carrying out water quality control. The water quality control actions of Centers for Environment Protection and water suppliers are complementary:
  - The Centers for Environment Protection are controlling the water quality in the distribution networks. The 141 Primary Centers provide a good coverage for both urban and rural water supply projects. The quantity and frequency of sampling is within the international guidelines set by WHO. However, the Centers for Environment Protection don't have the means to carry out monitoring of pollution and River water quality. This activity is under implementation. Meanwhile, it remains under Baghdad's central responsibility.
  - The water suppliers also carry out their own monitoring of the water quality in the distribution networks. Because of restricted means, this monitoring is limited to main urban water projects. This monitoring is done in co-ordination with the Centers for Environment Protection. The Centers for Environment Protection thus complement the monitoring of water suppliers, especially in the rural water projects. In addition tc distribution networks, the water suppliers monitor the river's water quality, at least at the main raw water intakes. This monitoring complements the work of the Centers for Environment Protection, which don't have currently the means of monitoring river water quality.

To conclude, the existing structure of the water quality control and surveillance, based on Centers for Environment Protection and Water suppliers, provides a good institutional framework for an efficient water quality control.

The *recommendations* will thus consists in upgrading the existing system by:

- Providing means to water suppliers to rehabilitate existing laboratories and develop project laboratories (laboratory equipment, transportation).
- Implement a capacity building program to train existing staff (new measurement techniques) and identify new staff (especially in secondary water supply projects).
- Introduce data management tools to improve the efficiency of the water quality control.

7.4.2 Recommendations

The recommendations made in this study concern the Water Suppliers (BWA, GEWS and DWS).

General recommendations are however made concerning the activities of the Centers for Environment Protection.

7.4.2.1 Centers for Environment Protection

The recommendations concern both the water quality surveillance of distribution networks and rivers.

7.4.2.1.1 Surveillance of Distribution Networks

The visits and discussions pointed out the lack of means for an efficient distributed water quality control. The following means are currently needed:

- Transportation for samples collection. The minimum recommended would be two cars dedicated to sample collection in each governorate. These cars would belong to the central laboratory. They would be used to collect samples from the staff in the Primary Centers (cars equipped with iceboxes to keep samples).
- Renewal of equipment in the central laboratories: the visits indicated that central laboratories were lacking:
    - Equipment for sterilization (autoclave and oven)
    - Fridge and freezer
    - Glassware (beakers, test tubes etc.)
    - Media for culture growth, thiosulphate....
    - Security equipment (eyewash, protection glasses, extinguishers...)
- Provision of sampling equipment to Primary Centers (in charge of sample collection):
    - Comparators for on-site free chlorine measurement
    - Iceboxes to store samples

- Computerization: the staff of central laboratories pointed out the need for a computer for data management (capture of samples, results, analysis of results). A computer in each central laboratory would greatly improve the data management, the efficiency of the reporting to central Health authorities and to water suppliers.

7.4.2.1.2 Source's Quality and Pollution

The surveillance of river's quality is currently under implementation. As stated, the need for such surveillance has been stressed in the 1992 report issued by Health Authorities.

At this stage it is important to point out the need to integrate the upgrading of the resource's surveillance laboratories into a global plan of surveillance. Such framework is a prerequisite to improve drinking water production. The main points of river resource surveillance would be:

- Survey of sources of pollution, respect of regulation.
- Definition and implementation of protection perimeters around drinking water treatment plants.
- Integration of water quality issues in the rivers' management (irrigation, regulation of dams, flow data management...).
- Source's water quality monitoring (surface and groundwater).
- Data management and analysis of: source's water quality and quantity, pollution.
- Tight co-ordination with Ministry of Irrigation and water suppliers.

7.4.2.2 GEWS (Central and South Governorates)

7.4.2.2.1 Organisation

A possible organisation has been discussed with the various people met during the consultant's visit in Iraq. It would consist in:

- A central quality control laboratory situated in Baghdad. The role of this laboratory would be to:
  - Supervise the central laboratories in each directorate (staff management, supply of chemicals and equipment, organization of training).
  - Control and provide assistance in water quality control to the central laboratories in each directorate (controlling quality of sampling and analysis, special analysis when needed).
  - Collect results of central laboratories and carry out a global data management (reporting, analysis of results). Such system should be computerized: each central laboratory should be equipped with a computer to capture the data and to transmit quickly the information to the central laboratory in baghdad.
  - Co-ordinate with gews's management and operational divisions.
  - Liaise with other authorities: ministries of irrigation. And health, centers for environment protection...

This laboratory should be dedicated to the supervision of all laboratories. There should be another laboratory in addition to this one to carry out the regular water quality control in the governorate of Baghdad.

- **Central Laboratories in Each Governorate.** The role of these laboratories would be to:
  - Carry out water quality control within the governorate:
    - ➢ Periodic chemical analysis of all water supply projects (raw and treated water).
    - ➢ Periodic bacteriological analysis of all water supply projects (distributed water).
    - ➢ Routine analysis of the water supply project where the central laboratory is implemented (preferably the main city).
  - Carry out data management (capture of samples, analysis of results, reporting) for transmission to water quality control laboratory in Baghdad, for communication to Centers for Environment Protection and water consumers. The use of a computer is recommended for such data management.
  - Co-ordination with operational divisions (production and distribution) to target the sampling, and to decide of corrective actions.
  - Co-ordination with Centers for Environment Protection through existing joint committees.
  - Supervision of project laboratories (see hereafter).
- **Project Laboratories in Each Governorates.** These project laboratories are complementary to the central laboratories. Ideally, each water supply project run by GEWS should be equipped with such a laboratory. Their role would be to:
  - Carry out daily the routine water analysis of raw and treated water (pH, turbidity, temperature, conductivity, dissolved oxygen, free chlorine).
  - Book keeping of sampling and results for transmission to central laboratories.
- **Operators of Small and Rural Water Supply Projects.** The operators are responsible for running and checking the disinfection process in the projects where small laboratories cannot be established. The water quality control in such projects is limited to a daily free chlorine measurement after chlorination, using comparators.

This structure is represented on the Figure 7-9 hereafter.

7.4.2.2.2 Laboratory Means

This organization is based on the existing structure. To implement it requires the following means:

- **Transportation means** for the central laboratories: 2 cars dedicated to water quality control are needed to collect samples in all water supply projects. Three cars for the central water quality control laboratory.
- **Creation of a Water Quality Control Laboratory in Baghdad. This laboratory currently exists.**
- **Upgrading of Existing Central Laboratories:** 15 central laboratories have to be operational to carry out full chemical and bacteriological analysis.

- **Creation of Project Laboratories**: it is proposed to create 10 project laboratories in each governorate, situated in the main water supply projects. These laboratories have to be equipped with necessary equipment to carry out routine analysis (pH, T, Conductivity, Turbidity, DO, free chlorine).

A list of equipment, with cost estimation is proposed in Table 7-8 hereafter (includes cars and computers).

Figure 7-9: Proposed Water Quality Control Organization – GEWS

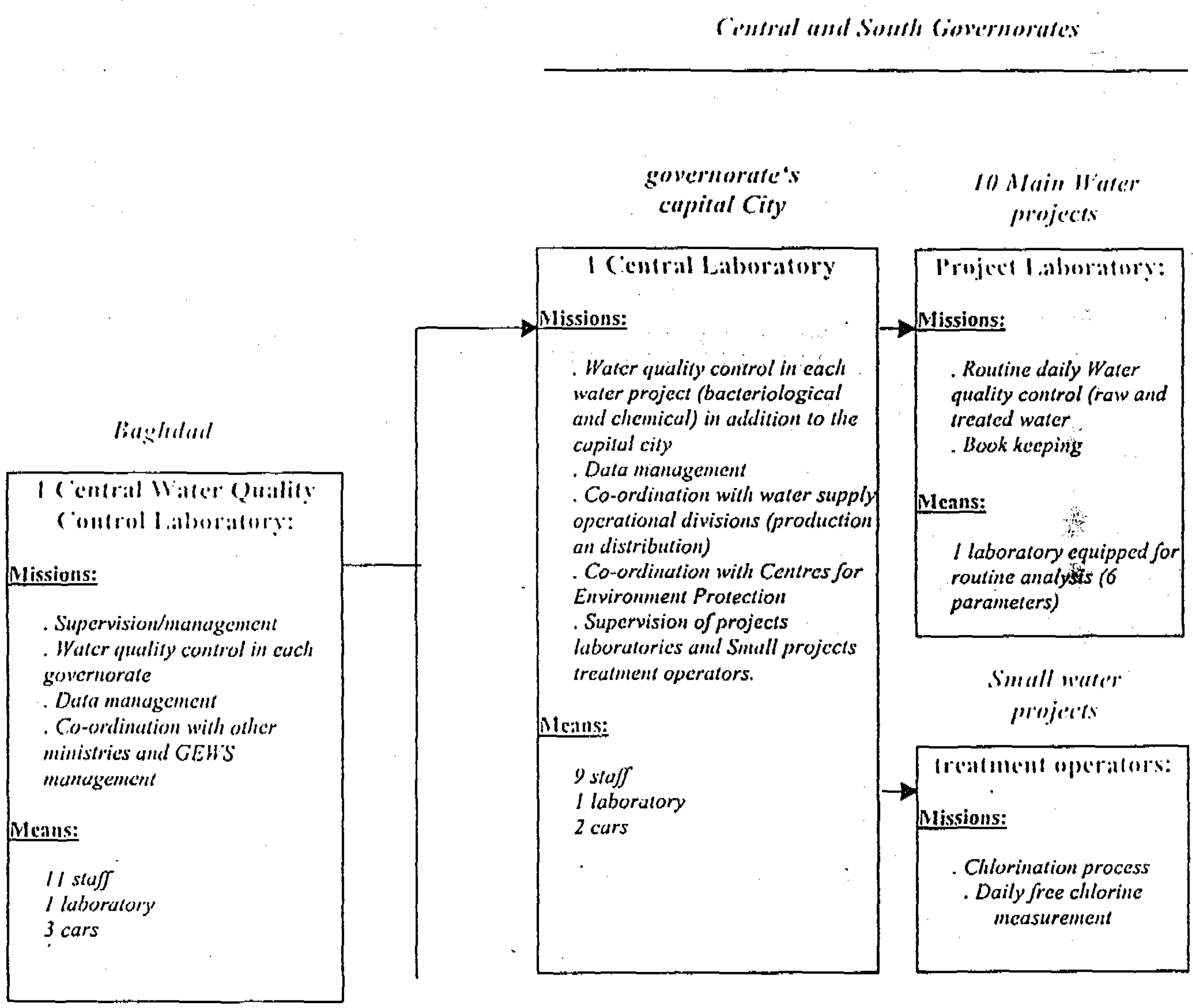


Table 7-8: Proposed Equipment for GEWS Laboratories (Central and Projects)

7.4.2.2.3 Staff

In the current context in Iraq, it is very difficult to find sufficient staff to run the laboratories. The visits of laboratories indicated that the staff currently working within laboratories is qualified and willing to get further training on water analysis techniques, treatment processes as well as computing. The capacities of the existing staff should be enhanced through a capacity building program. New staff could be employed to complete the total number of staff necessary to run the laboratories.

The following guidelines could be followed (based on discussions with water quality control staff):

- Central Quality Control Laboratory:
  - 1 manager of the water quality control system
  - 1 manager's assistant (data management)
  - 3 BSc chemistry, 3 BSc biology (one as laboratory manager)
  - 3 technicians (sampling, laboratory assistants).
- Central laboratories:
  - 3 BSc chemistry, 3 BSc biology (one as laboratory manager)
  - 3 technicians (sampling, laboratory assistants).

The **project laboratories** could be run by the staff in charge of production (2 staff should be trained to use analysis equipment).

7.4.2.2.4 Data Management

Each central laboratory should use a computer to carry out water quality management. The visits and discussions highlighted the need for such tools to capture and analyze the data collected. Some laboratories are already doing analysis (evolution of parameters over time and location) and the staff is willing to develop such activity. This data management just requires the purchase of computers (one for each central laboratory). In a later stage, network solution could be developed to link central laboratories to the central water quality control laboratory.

7.4.2.3 DWS (Northern Governorates)

The recommendations are the same as those made for GEWS. The organization of the water supply is indeed similar to the GEWS.

The difference is that DWS central laboratories have been already upgraded. Project laboratories are however needed in each governorates.

The source's water quality surveillance is already well developed by the WHO program.

7.4.2.4 BWA (Baghdad Water Authority)

7.4.2.4.1 Organization

The existing structure is suitable for an efficient water quality control. The improvements consist mainly in :

- Creating two laboratories in the water treatment plants of Wahid and Rasheed. The city will thus be covered by 7 projects laboratories, supervised by one central quality control laboratory based in 7 Nissan project.
- Upgrading existing laboratory equipment (see Table 7-9 below):
- Providing transportation means (2 cars for each project laboratory, 2 cars for the water quality control laboratory, 1 car for the manager of the water quality control department).
- Employing additional staff. Ideally, nine staff is required in each of the eight laboratories.

Table 7-9: Proposed Equipment for Laboratories (Central and Projects)

	Quality control laboratory	Project Laboratory	Units Cost $	total Cost
Turbidity meter portable	1	7	1 900	15 200
Turbidity meter fix	1	7	3 000	24 000
Multimeter PH/O2/Conducitivity/temperature	1	7	1 600	12 800
Phmeter	1	7	500	4 000
Dissolved oxygen meter	1	7	1 200	9 600
conductivity meter	1	7	570	4 560
resiual chlorine test (hach) (1 year)	1	7	150	1 200
automatic free chlorine analyser	1	7	3 000	24 000
spectrophotometer with accesories	1	1	28 000	56 000
Atomic absorption spectrometer	1	1	35 000	70 000
distiller	1	7	1 000	8 000
oven	1	7	2 000	16 000
autoclave	1	7	5 000	40 000
sensitive balance	1	7	2 900	23 200
laboratory fridge	1	7	2 900	23 200
iceboxes	2	14	1 000	16 000
Computers	1	7	2 500	20 000
incubators	1	7	4 000	32 000
lab equipment	1	7	15 000	120 000
cars Pick up	3	14	15 000	255 000
			Total $	774 760

7.4.2.4.2 Staff

In the current context in Iraq, it is very difficult to find sufficient staff to run the laboratories. Our visits to laboratories indicated that the staff currently working within laboratories is qualified and willing to get further training on water analysis techniques, treatment processes as well as computing. The capacities of the existing staff should be enhanced through a capacity building program. New staff could be employed to complete the total number of staff necessary to run the laboratories.

The following guidelines could be followed (based on discussions with water quality control staff):

- Central Quality Control Laboratory:
  - 1 manager of the water quality control system
  - 1 manager's assistant (data management)
  - 3 BSc chemistry, 3 BSc biology (one as laboratory manager)
  - 3 technicians (sampling, laboratory assistants)
- Central Laboratories:
  - 3 BSc chemistry, 3 BSc biology (one as laboratory manager)
  - 3 technicians (sampling, laboratory assistants)

The **project laboratories** could be run by the staff in charge of production (2 staff should be trained to use analysis equipment).

APPENDIX 1

Raw And Treated Water Quality Data Collected By GEWS

	Ninevah (95-00)			Salaheldin (00)			Diala (96-00)		
	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE	MAX
Turbidity NTU	1,7	5,8	26,0	2,5	19,0	50,0	3,5	26,8	250,0
PH	5,7	7,7	8,1	7,1	7,6	7,9	3,2	7,9	8,4
Electrical Conductivity as Mmnos/cr	35,3	432,7	693,0	440,0	532,5	592,0	463,0	616,2	882,0
Total Alkalinity as CaCo3	1,3	140,7	272,0	124,0	136,7	150,0	110,0	140,8	270,0
Ph Phntha Alkalinity as CaCo3							0,0	0,1	0,9
Total Hardness	160,0	227,3	301,0	208,0	234,2	274,0	137,0	259,4	416,0
Calicium as Ca	41,6	63,8	608,0	52,0	60,7	74,0	37,4	58,5	94,0
Magnesium as Mg	3,7	22,3	195,0	18,0	19,8	21,0	8,2	26,7	43,4
Chloride as Cl	6,0	22,6	121,0	17,0	21,2	29,0	12,0	31,9	78,0
Sulphate as SO4	4,8	53,9	133,0	80,0	93,3	108,0	68,0	135,9	331,0
Sodium as Na	7,9	17,0	22,8	12,0	20,0	36,0	10,6	23,1	56,0
Potrassium as k	0,4	2,9	7,2	1,1	1,6	2,3	1,3	2,0	3,3
Total Iron As Fe	41,0	260,7	373,0						
Total Dissolved Solids	206,0	305,1	516,0	244,0	305,0	348,0	250,0	386,4	596,0
Total Suspended Solids	4,0	8,0	12,0	10,0	29,4	56,0	3,4	56,8	446,0

	Wasit (96-00)			Babil (96-00)			Kerbala (96-00)		
	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE	MAX
Turbidity NTU	6,6	52,3	450,0	2,5	25,2	150,0	2,0	38,8	180,0
PH	6,8	7,6	9,2	7,5	8,1	8,4	7,3	7,9	8,5
Electrical Conductivity as Mmnos/cr	790,0	1247,3	1566,0	714,0	1045,7	1656,0	933,0	1278,3	2158,0
Total Alkalinity as CaCo3	100,0	163,1	260,0	90,0	124,8	160,0	85,0	119,4	174,0
Ph Phntha Alkalinity as CaCo3	0,0	0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,1
Total Hardness	314,0	461,6	742,0	246,0	348,9	506,0	220,0	379,9	666,0
Calicium as Ca	51,0	92,2	140,0	53,0	75,2	122,0	38,0	69,6	109,0
Magnesium as Mg	16,0	54,3	119,0	24,0	38,6	61,0	21,0	49,9	99,0
Chloride as Cl	81,0	138,0	236,0	81,0	113,0	192,0	85,0	136,8	276,0
Sulphate as SO4	235,0	327,4	397,0	125,0	228,4	450,0	120,0	274,8	713,0
Sodium as Na	31,0	98,7	139,0	48,0	78,3	122,0	28,0	112,6	185,0
Potrassium as k	1,8	2,7	3,8	1,8	3,7	6,8	1,7	3,8	5,6
Total Iron As Fe									
Total Dissolved Solids	513,0	832,0	1400,0	464,0	641,3	1024,0	604,0	839,2	1374,0
Total Suspended Solids	15,0	168,8	980,0	8,0	75,1	478,0	4,0	65,1	218,0

	Anbar (95-00)			Najaf (95-00)			Thiqar (97-00)		
	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE	MAX
Turbidity NTU	1,0	8,8	40,0	4,0	19,9	45,0	8.0	41,7	130,0
PH	6,7	7,9	8,5	7,4	7,7	8,2	7,7	8,0	9,8
Electrical Conductivity as Mmnos/cr	627,0	1233,1	3266,0	950,0	1412,2	2119,0	400,0	1803,1	5690,0
Total Alkalinity as CaCo3	70,0	149,6	590,0	106,0	173,8	222,0	120,0	130,3	145,0
Ph Phntha Alkalinity as CaCo3									
Total Hardness	214,0	386,2	799,0	258,0	385,3	553,0	240,0	473,6	650,0
Calicium as Ca	46,0	93,7	237,0	67,0	96,4	132,0	25,0	118,5	250,0
Magnesium as Mg	0,5	35,3	92,0	15,0	35,0	71,0	15,1	45,7	82,0
Chloride as Cl	61,0	126,1	412,0	122,0	177,6	215,0	90,0	261,0	700,0
Sulphate as SO4	102,0	261,3	567,0	310,0	383,5	422,0			
Sodium as Na	26,0	90,8	330,0						
Potrassium as k	1,8	5,4	26,5						
Total Iron As Fe	0.25	0,25	0,25						
Total Dissolved Solids	462,0	769,6	1792,0	648,0	999,3	1287,0	685,0	1181,2	3130,0
Total Suspended Solids	4,0	28,9	80,0	8,0	75,1	478,0			

	Missan (97-00)			Muthanna (95-00)		
	MIN	AVE	MAX	MIN	AVE	MAX
Turbidity NTU	3,5	99,5	900,0	12,5	56,6	127,0
PH	7,3	7,8	8,5	6,5	7,4	8,0
Electrical Conductivity as Mmnos/cr	1140,0	2111,3	4418,0	417,0	1104,3	1348,0
Total Alkalinity as CaCo3	92,0	141,5	233,0	73,0	130,4	181,0
Ph Phntha Alkalinity as CaCo3	0,0	0,0	0,1			
Total Hardness	338,0	574,8	1360,0	275,0	398,4	637,0
Calicium as Ca	26,0	106,0	210,0	64,0	104,8	174,0
Magnesium as Mg	41,0	77,8	203,0	1,0	36,4	97,0
Chloride as Cl	157,0	411,1	664,0	55,0	125,1	192,0
Sulphate as SO4	140,0	379,2	628,0	222,0	301,7	365,0
Sodium as Na	92,0	314,2	420,0			
Potrassium as k	2,0	3,7	5,8			
Total Iron As Fe						
Total Dissolved Solids	610,0	1289,5	2160,0	568,0	817,9	1025,0
Total Suspended Solids	20,0	78,1	200,0			

	Baghdad (99-00)					
	RAW			FINAL		
	Min	Max	Ave	Min	Max	Ave
Color	0/5	0/5	0/5	0/5	0/5	0/5
Temperature C	9	35	23	10	36	23
Turbidity N.T.U	6	1800	34	0,18	25	3,2
PH	7,5	8,3	8	7,2	8	7,65
Alkalinity as CaCo3 MG/L	98	173	132,5	92	168	127,5
Total Hardness as CaCo3 MG/L	223	576	410,5	222	597	404,5
Calcium as Ca MG/L	54	167	106	58	169	105
Magnesium as Mg MG/L	18	68	37	17	60	36
Chloride as Cl MG/L	45	196	102,5	46	187	100,5
Condictivity ms/cm	570	1620	1083,5	580	1568	1067
Alminium as Al MG/L	0	0,05	0,0095	0	0,25	0,075
Total Dissolved Solids MG/L	317	1124	773,5	319	1158	759
Suspended Solids MG/L	15	3010	85			
Iron as Fe MG/L	0,04	9	0,88	0	0,46	0,0895
Sulfate as SO4 MG/L	110	550	317	140	525	308
Fluoride as F MG/L	0,07	0,35	0,16	0,05	0,27	0,14
Ammonia as NH3 MG/L	0	0,3	0,095	0	0,2	0,015
Nitrite as NO2 MG/L	0,0004	0,025	0,005	0	0,003	0,0007
Silica as SiO2 MG/L	2	8	5,85	2	7	5,05
Nitrate as NO3 MG/L	40	113	87,5	41	106	86,5
PO4	2,1	5,6	3,8	2,1	5,5	3,8
Manganese as Mn MG/L	0,002	0,16	0,047	0,006	0,12	0,015
Cadmium As Cd MG/L	0,0003	0,0039	0,0024	0,0003	0,0028	0,00105
Lead as Pb MG/L	0,0045	0,009	0,007	0,0044	0,009	0,0065
Copper as Cu MG/L	0,002	0,031	0,015	0,002	0,035	0,0055
Zinc as Zn MG/L	0	0,0039	0,001	0	0,003	0,0007
Chromium as Cr MG/L	0,016	0,04	0,0255	0,006	0,041	0,019
Cobalt as Co MG/L	0,003	0,007	0,0055	0,004	0,008	0,006
Mercury as Hg MG/L	0,0001	0,0006	0,0003	0,0001	0,0004	0,0003
Arsenic as As MG/L	0,0052	0,0135	0,009	0,0038	0,011	0,008

	Erbil governorate december 99	
	Raw water Well	Raw water River
Turbidity	0,12	0,622
PH	7,7	7,4
Conductivity	0,423	0,629
Total Dissolved Solids	277	399
Chloride	7	178
Sodium	14	8,4
Potassium	0,8	1,3
Calcium	20	374
Magnesium	41	56
Alkalinity	178	284
Nitrates	15,4	5,5
Sulphates	199	215
Phosphates	0	0,02
Amonium	0,18	0

APPENDIX 2

GEWS- Analysis and sampling forms

DEVELOPMENT OF WATSAN PLAN FOR MUNICIPALITIES IN THE THREE GOVERNORATES OF NORTHERN IRAQ

EXECUTIVE SUMMARY as per February 2002

Objectives
To improve the performance of the Habitat settlement rehabilitation programme, a WATSAN plan will be designed for policy and implementation level.
WATSAN subject areas covered are water supply, sewerage and storm water drainage, and solid waste. Focus areas are all municipalities where Habitat is active in the implementation of settlement rehabilitation; solid waste management will not be covered in the three big cities in the three Governorates.

Methodology
A participatory approach is used with key Local Authorities responsible for WATSAN tasks at governorate level by close co-operation with them in all the activities of the WATSAN plan development. Therefore task forces have been established in the three Governorates and in the Habitat Core Team. Through workshops with all key actors, consensus is reached on approach, activities and results. In field activities, the key actors are primary responsible because of their knowledge of the local sector and areas.

Phases
Four phases are distinguished: (i) inception phase; (ii) needs assessment phase; (iii) preliminary recommendations phase: and (iv) WATSAN plan or final phase. We have just finished the third phase.

Intermediary results
- for inception for WATSAN plan development: agreed directions, planning steps in development process, prioritisation criteria, activities in development process
- WATSAN survey designed, data collected for all 130 municipalities, checked and analysed
- priority selection criteria agreed and applied for WATSAN data set. Main priority setting criteria used are total town population, population density, percentage of total population being IDPs, WATSAN service level indicators (vary by WATSAN sub-area)
- for each of the three WATSAN sub-areas, lists with priority scoring (high – medium – low) for all municipalities and per governorate. There is a significant variation in coverage and WATSAN service levels per Governorate.
- preliminary principles and recommendations for planning and implementation - institutional, technological (discussed and agreed/to be changed). Key recommendations are:
    - ♦ = planning must lead to sustainable systems and service; = planned systems/services must be within absorption capacity and affordability of municipalities (involved in management);
    - ♦ = water supply and sewerage must be integrated in planning and implementation in municipal settings (except for smaller municipalities); = focus on effective coverage;
    - ♦ = autonomous bodies responsible for service delivery; = introduce cost recovery; = reduce unaccounted-for-water; = introduce demand-management;
    - ♦ = institutionalise support and control structures; = develop legal and regulatory framewok;
    - ♦ = capacity building for technical and management staff;
    - ♦ = realistic (sustainable) consumption figures; = rehabilitation existing structures; = public awareness campaign on use and conservation, and hygiene promotion.
- still remaining: development draft WATSAN plan indicating required investments per WATSAN sub-area (to be based on unit cost indications from LA and Habitat); this will be discussed with LA and Habitat and then the WATSAN plan will be finalised.

Expected final results
- agreement on principles and recommendations for WATSAN interventions
- agreement on priority setting for WATSAN interventions among municipalities
- agreement on WATSAN (investment) plan