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Studio Tecnico Cherubini & Associates Rome - Italy
Planning, Consulting and Engineering

21514 (1of2)

ENVIRONMENTAL IMPACT ASSESSMENT OF THE INDUSTRIAL ACTIVITIES WITH SPECIAL EMPHASIS ON THE PROPOSED TANNERY WASTE TREATMENT IN THE ZABLATANI (DAMASCUS - SYRIA) INDUSTRIAL AREA

DP/SYR/92/004

FINAL REPORT

March 1996

PART ONE

EXECUTIVE SUMMARY

Back - stopping officer: Mr. Jakov Buljan
Agro - Based Industries Branch

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

VIENNA

124 p

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FINAL REPORT

GENERAL CONTENTS

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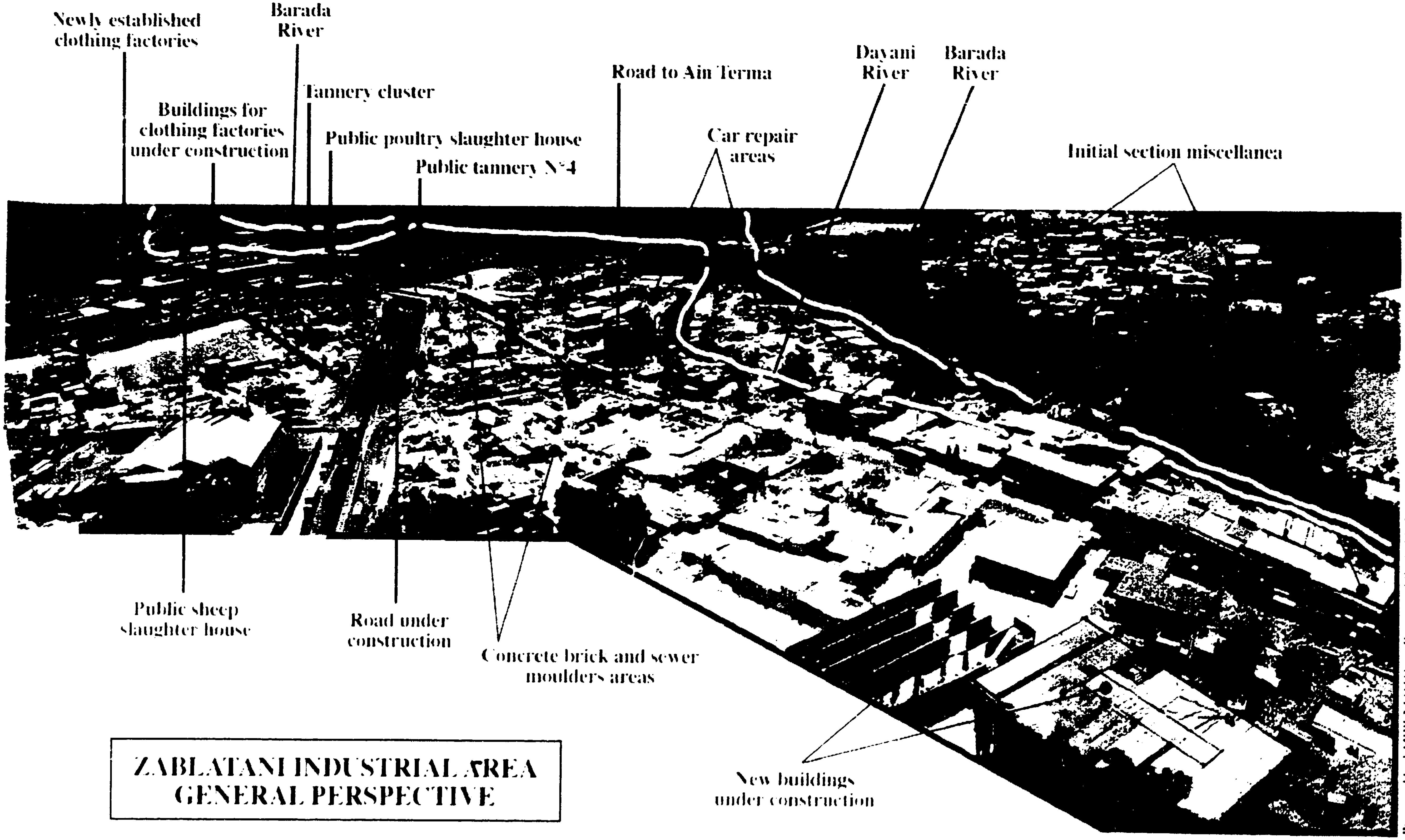
Hydrological Specialist:	**Enrico Usai**
Director:	**Alberto Cherubini**



ZABLATANI INDUSTRIAL AREA GENERAL PERSPECTIVE

Studio Tecnico Ciardini & Associates Roma Italy

EXPLANATORY NOTES

TOR	Terms of Reference
EIA	Environmental Impact Assessment
ZIA	Zablatani Industrial Area
CETP	Common Effluent Treatment Plant
MTP	Municipal Treatment Plant
SC I	UNIDO Subcontractor I **(TEH PROJEKT)** in charge for techno-economic study and tender documents
SC II	UNIDO Subcontractor II **(Studio Tecnico Cherubini and Associates)** in charge for Environmental Impact Assessment
TL	SC II Team Leader
PHE	SC II Public Health Engineer
CHS	SC II Common Health Specialist
HS	SC II Hydrological Specialist
AS	SC II Agricultural Specialist
USW	Urban Solid Wastes
USC	Urban Solid Compost
SAR	Sodium Absorbtio Ratio
ETP	Potential Evapo Transpiration
BRGH	Ref. 4 in Bibliography
LENGIPROVODKHOZ	Ref.7 in Bibliography
HHS	Ref. 3 in Bibliography
M.C.	Map Code
CRM	Car Repair and Maintenance
MSC	Various Activities
SLH	Slaughter Houses
CMM	Commercial Activities
CBM	Concrete Brick and Sewers Moulder
LMC	Limestone Polishing or Cutting

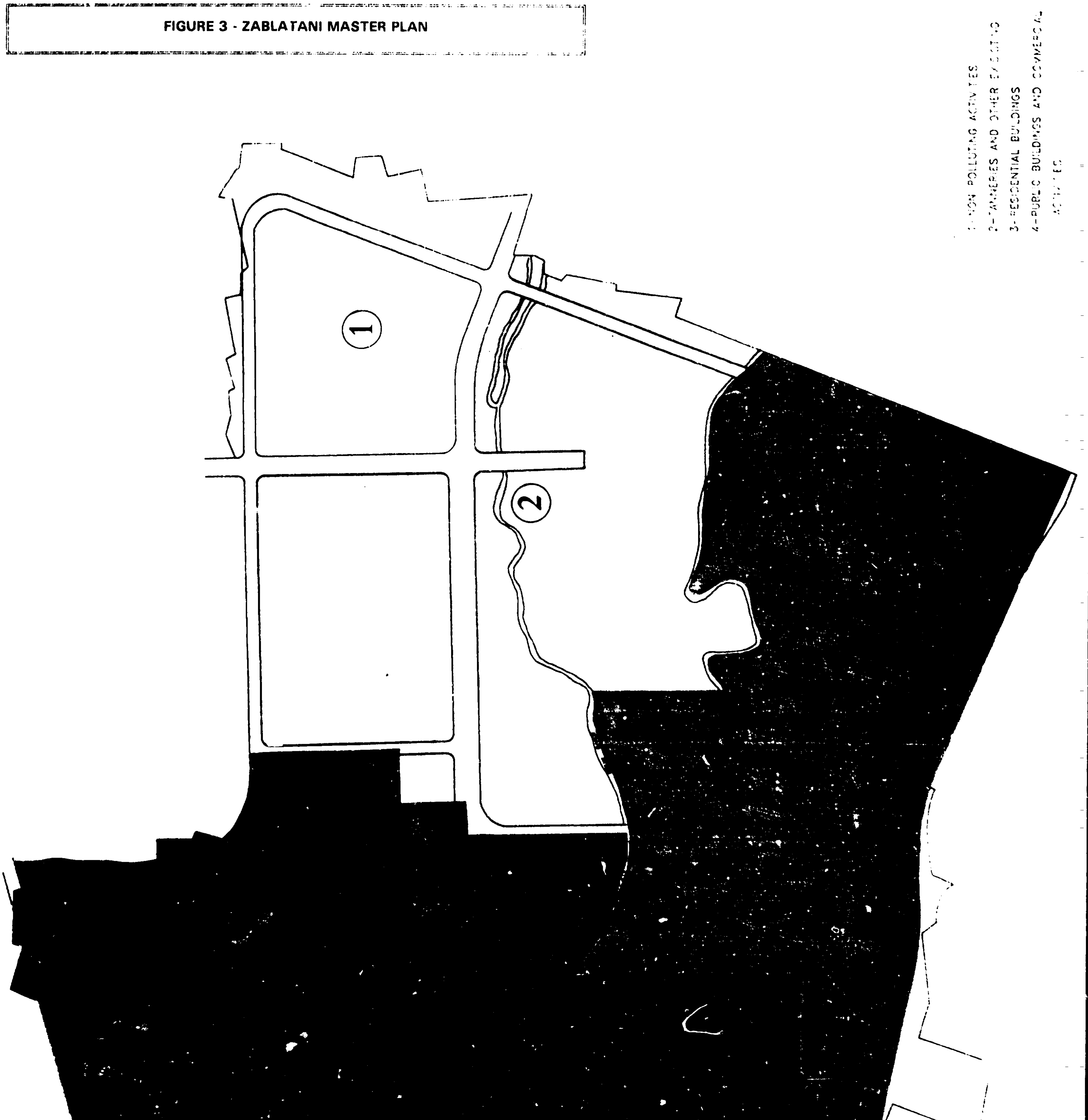
LIP	Land Impact Activities
SAW	Saw Mill
BPP	Tannery and/or S. Houses By Prod. Processing
TNR	Tanneries
BOD_5	5-Day Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
SS	Suspended Solids
SM	Setteable Matter
O & G	Oil and Grease

PART ONE

EXECUTIVE SUMMARY

TABLE OF CONTENTS

FIGURE 3 - ZABLATANI MASTER PLAN



ABSTRACT

The present Report is based upon UNIDO assignement DP/SYR/92/004/J13104, as one part of the assistance project for the Syrian Government for improving the environmental situation in the Zablatani Industrial Area, Damascus, and in the surrounding territory.

The Report is based upon field activities carried on the period between 1 to 30 July 1994, by all the five team member of the "Studio Tecnico Cherubini & Associates", ROME, with the coordination of Alberto Cherubini.

The Report has been developed in close co-operation with UNIDO Subcontractor I and with "clean leather technologies" expert Mr. Karel Kubec.

In PART ONE of the present Report conclusions are outlined in the EXECUTIVE SUMMARY. In PART TWO are enclosed:

ANNEX 1: Study area - Project situation

ANNEX 2: Zablatani Industries - their impact and technical solutions

* * * * * *

Damascus' Zablatani area is, indeed, submitted to a multi-facet environmental load originated by the local productive activities, even more so in the anticipated and welcomed event of their further expansion.

Such increasing load is inherent to the process of industrial development but experience shows that, if left uncontrolled, the environmental consequences can become such to distort, hinder if not even impede the overall development of the area. In ZIA we could already notice such concerning trends, because:

- The agriculture is effected by the decreasing river flows, decreasing water table, increasing irrigation water salinity;

-The hygienic conditions of the populations living in the areas reached by the micro biologically polluted Barada, Dayani, etc. rivers are very poor, so much that we could notice reluctance to deal with this issue among high rank public health officials;

- The tannery district itself may face problems due to lack of water of acceptable quality and quantity.

The answer is INVESTMENTS in both INFRASTRUCTURE and CULTURE, modern, private-like MANAGEMENT style and people, REALISTIC but FIRMLY ENFORCED ENVIRONMENTAL REGULATIONS.

In details, the main suggested interventions include:

1. - A centralised ZIA management organisation, structured with private sector characteristics of clear and realistic responsibilities with personal success adequately linked to the perceived quality of the services offered to the local factories. This organisation must be supported by reliable and sufficient financing;

2. - A centralised waste water treatment plant for the organic wastes to be dumped into the sewerage coasting ZIA. It is essential that such plant shall be managed by a professional staff, with adequate, reliable financing.This staff should also be responsible for the environmental management of the whole ZIA and adjacent areas, in order to be aware of the large scale consequences of any action, including the emergencies of the plant itself;

3. - Clear, simple, reasonable but actually enforced environmental regulations, possibly including both subsidies for the in-shop investments (waste water pre-treatments, air ventilation, solid waste hygienic holding, etc.) and fines for transgressions;

4. - Water consumption control and water quality monitoring organisation and hardware

5. - Solid waste collection, recycle, disposal;

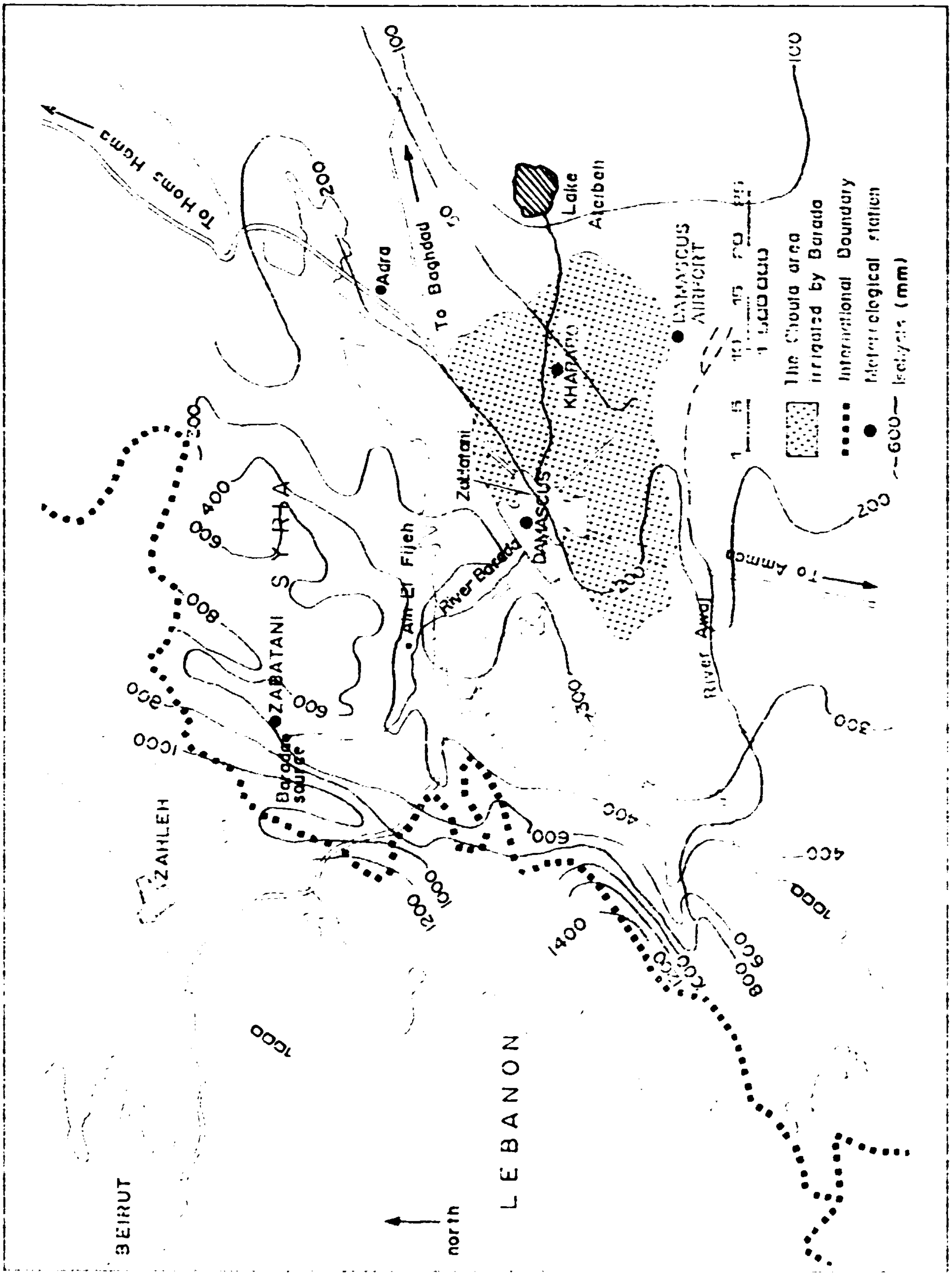
6. - Technical services and possible subsidies for improving in-shop working conditions and productivity (safety measures, electrical protections, electrical vs. mechanical energy distribution, energy savings, etc.);

7. - An on-going training programme at different levels, from workers up to technical, administrative and commercial managers, advisably provided with local facilities (quality assurance laboratories, experimental ground for better technologies, refrigerated storage areas, show room, export centre, etc.);

8. - A public health and industrial hygiene awareness programme for the medical and social workers staff operating, respectively, in the surrounding zones potentially affected by the ZIA-generated pollution and in the ZIA itself.

FIGURE 5 - THE STUDY AREA FOR AGRICOLTURE EVALUATIONS

FIGURE 8 · DAMASCUS, THE BARADA RIVER AND THE GHOUTA PLAIN; MEAN ANNUAL ISOHYETS



Source: 'Water resources use in Barada and Awage basins for irrigation of crops' feasibility study, USSR Selkhozpromexport, Moscow

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EXECUTIVE SUMMARY

1) The area and the industries

The Zablatani Industrial Area (ZIA) is a site of 80 ha., located in the rapidly expanding urban area at the east side of Damascus, There are approx 300 industries of which roughly half are tanneries and half are a miscellany of factories, mostly small, of several different types.

In details, there are 164 tanneries, 4 slaughter houses, 15 activities processing animal by-products from tanneries and slaughter houses, 8 saw mills, 31 commercial shops and 65 miscellany, including several black smiths, 2 weaving, 1 grain grinding, some fabrication of light metallic structures, frames, doors and windows, 2 small glass fibre furniture moulding, etc.

Many of these factories are small shops and, then, the environmental impact is essentially due to the high number and density of the many small factories.

The territory where the impact is felt is the Zablatani area itself, presently populated by approx 15.000 inhabitants, and the eastwards farmlands of Ain Terma and Ghouta plain, inhabited by over 50.000 people scattered among tens of rural villages.

Area planners forecast for Zablatani further civil urbanisation, a tannery section and a non-polluting industry section.

The co-existence of them all requires strict environmental controls and the development of an overall awareness from both public and private side.

2) Industrial hygiene

In terms of working conditions inside the factories in many cases only very basic safeguards and procedures are applied.

We recommend the improvement of factory working conditions by applying essentially inexpensive measures, such as:

- **Better lightening, aeration and or extraction** (with treatment of the extracted gases) in case of processes involving solvents, vapours or fumes;
- **Adequate protective garments** to be worn in hazardous working areas;
- **Installation of guards around the transmission belts** widely used to move rotating machineries inside the factories. **More diffused application of single machinery electric motors** would improve process reliability and flexibility;
- **Application of sound criteria for the implementation of in-house electric systems**, both at the level of wiring routing and connections and by installing safety switches.
- **Cultural development** at both industrialist and worker level, towards the concepts of safety, carefulness, quality;
- **Regular medical inspection and relative recording of workers** submitted to potentially hazardous environments. To be stressed that, since diseases of industrial origin do not, often, show specific symptoms, for physicians duly considering the possibility of the industrial origin of health problems, adequate background information and specific training must be ensured.

3) Air pollution

Because of the size and type of factories, **pollution of the air is mostly originated by cement and kaolin dust coming from the stone cutting and polishing industries and from open air storage of dusty raw materials**.

Winds are mostly westerly, often moderate, sometimes strong. In summertime, very regular afternoon breezes 6 to 12 m/s blow over the Damascus-Zablatani-Ghouta zone carrying around dust and pollutants. In addition, **dust storms are frequent**, enhancing airborne diffusion of pollutants.

Other problems of air pollution arise from the **exhaust gases of the** often obsolete and poorly maintained **diesel generators** used by all the vast majority of the industries to cope with the frequent black-outs of the main electric supply, or in some cases to replace entirely the lacking electrical connections.

Air pollution is also caused by the **heavy, congested industrial traffic** due to the very intense commercial activities in the area, Planners have already started the construction of additional and larger roads but **care for traffic control** must be applied.

A specific case of unbearable ill odour air pollution is generated by a factory which produces animal food by **roasting the by-products of the neighbouring private sheep slaughter house**. Other ill odour events are caused by the **glue factories winter time operation**.

To solve air pollution problems, the **following remedial actions are recommended**:

1) Apply <u>wind barriers</u> and/or flexible coverings to the dusty materials stored outside ;evaluate possibility to keep it into <u>bags</u>, or to store it within <u>silos or containers</u>, single or common, for they are located close to each other and employ much the same raw materials.

2) Improve the <u>availability</u> and <u>reliability</u> of <u>electric energy</u> distribution network. Should it be impossible to draw more energy from the existing network, (and, indeed, the whole town of Damascus suffers by frequent black-outs) a **<u>specific generating station</u> feeding the ZIA** should be seriously considered.

3) Develop <u>air pollution standards and regulations</u> to compel factories to limit atmospheric emissions of gases, vapours, fumes, etc. Design and engineering services as well as realistically adequate machineries must be surely available before drastic measures are implemented.

4) Organise, as standard service for the ZIA, procedures and personnel with adequate equipments to **conduct <u>regular environmental inspections and audits</u>** to all the industries operating in the area.

4) <u>Water pollution and treatment</u>

As far as environmental impact on the water is concerned, it must be noted that **the climate is semi-arid**, with an average yearly rainfall of approx 200 mm, widely variable both with time (no rainfall at all from June to September included) and with position along the West-East direction (rainfall drops from 1200 mm /yr. at the springs to 200 mm in Zablatani and 100 in Ghouta plain).

Therefore, the most of the recharging of the water bodies comes from the fall-winter rainfall upon the hilly area westwards of Damascus. Considerations must be given to possible storm weather run-offs of pollutants from paved areas, heaps of scraps or solid wastes, open air operations of illegal slaughter activities, improper operation and storage of raw materials.

Only solution is development, enforcement and, eventually, acceptance of <u>environmental regulations</u>, in addition to implement <u>controls and services for cleaning up common areas</u> and proper and regular <u>disposal of collected wastes</u>.

The main causes of water pollution are:

1) Many small flow rates, with relevant concentrations of mostly inorganic substances from activities such as stone cutting, stone and tile polishing, etc.;

2) Several large flow rates, with relevant organic and micro biological pollution loads, coming **from tanneries, slaughter houses and other industries processing animal by-products**.

In terms of flows, the organic type of streams are approx 10 times larger than the inorganic ones.

In terms of pollution load, too, the problems posed by organic type processes are predominant due to their effect on the quality of surface and ground waters, in turn effecting **irrigation and cropping practice**, long term **deterioration of aquifers** and **river beds** and, even, the **hygienic conditions** of the mostly farming population living along the downstream water courses, already widely affected by typical waterborne diseases.

FIGURE 14a-GROUNDWATER ELECTRICAL CONDUCTIVITY OF DAMASCUS BASIN IN Nov.-Dec. 1977 (E.C.u.m.h.o./cm 25)

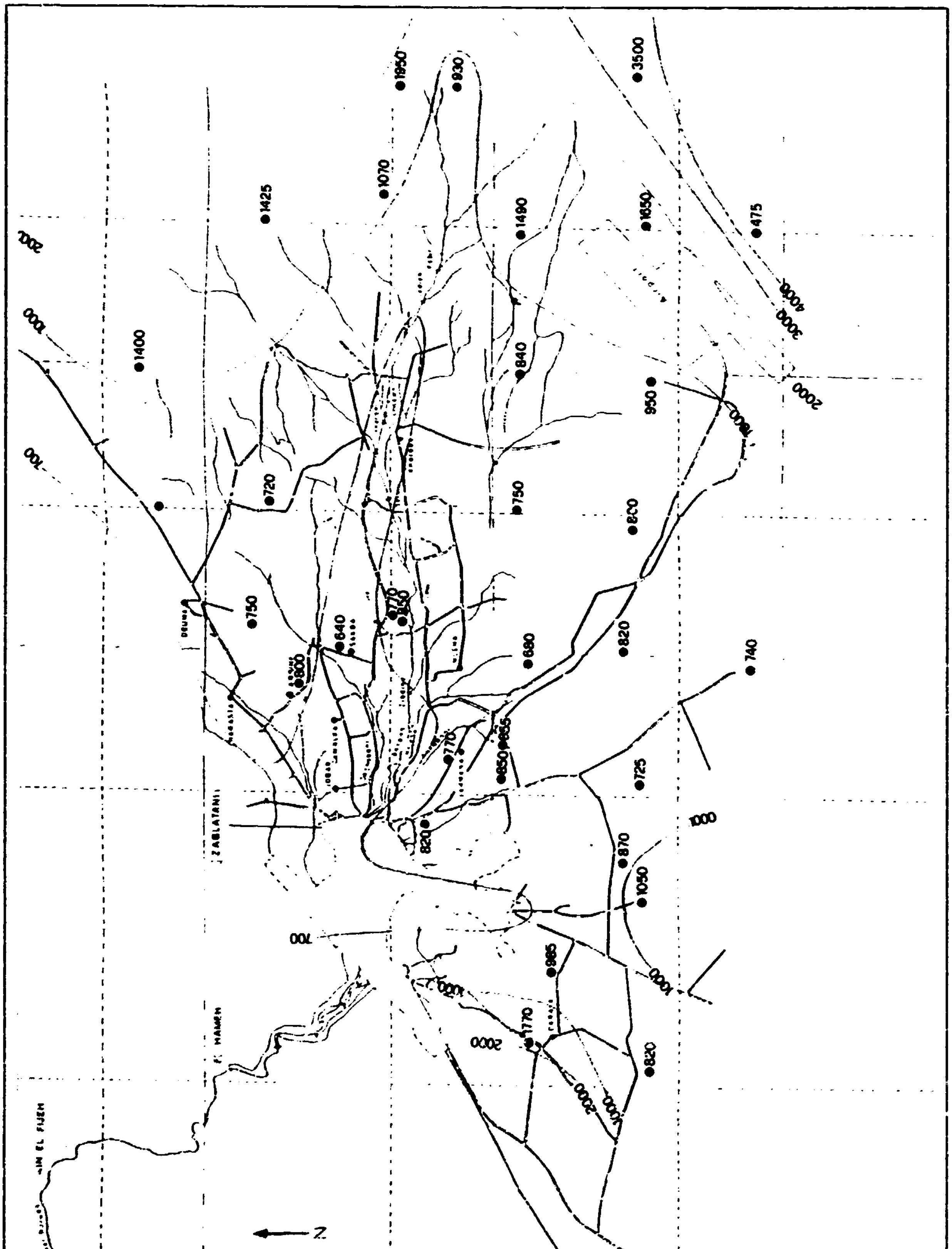

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FIGURE 14b-NITRATE CONTENT OF WELL WATER OF DAMASCUS BASIN
Nov.-Dec. 1977 (NO as mg/lN)

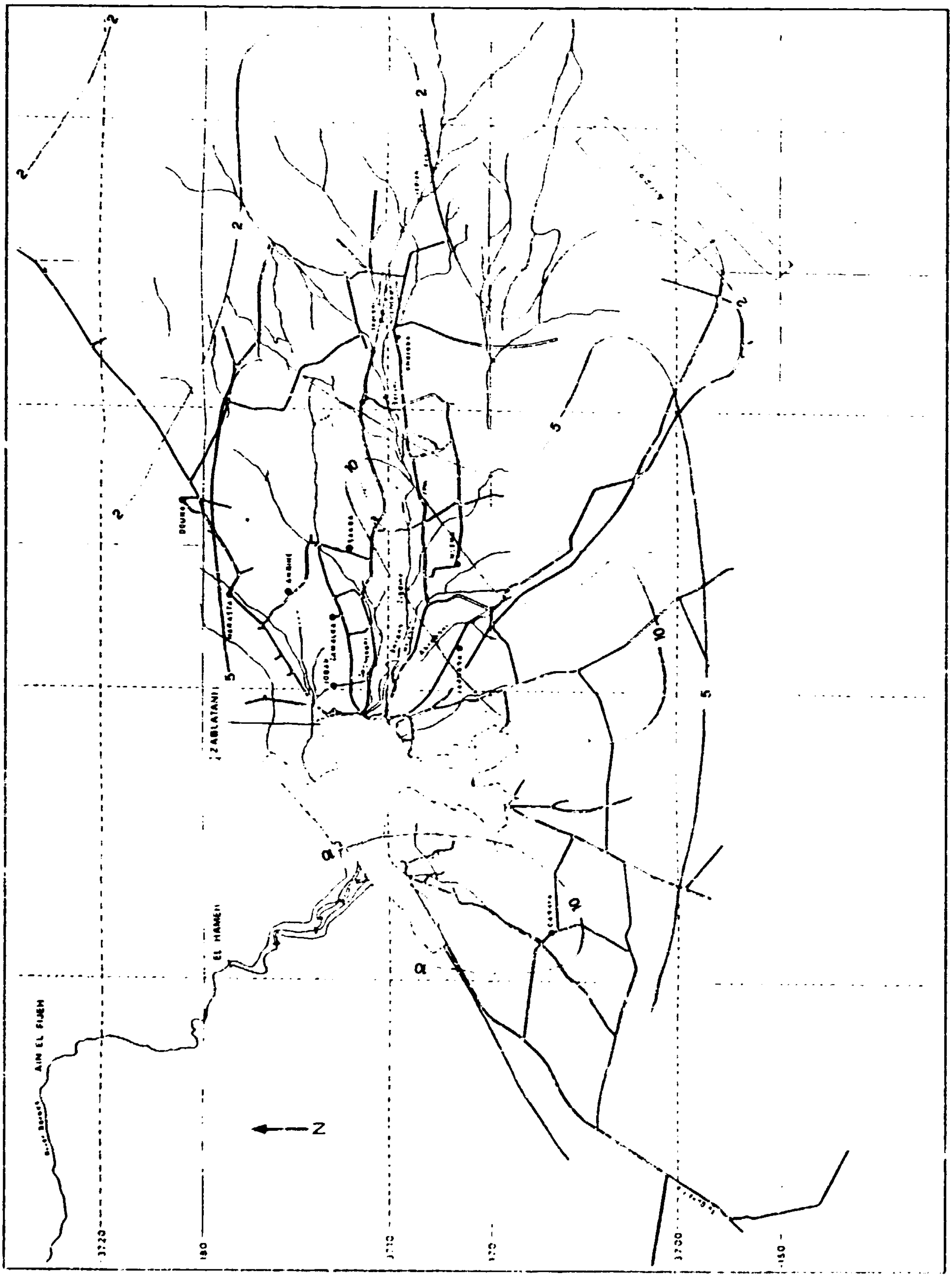


FIGURE 14c-CHLORIDE CONTENT OF WELL WATERS OF DAMASCUS BASIN
(chloride as% meq/l total anions)

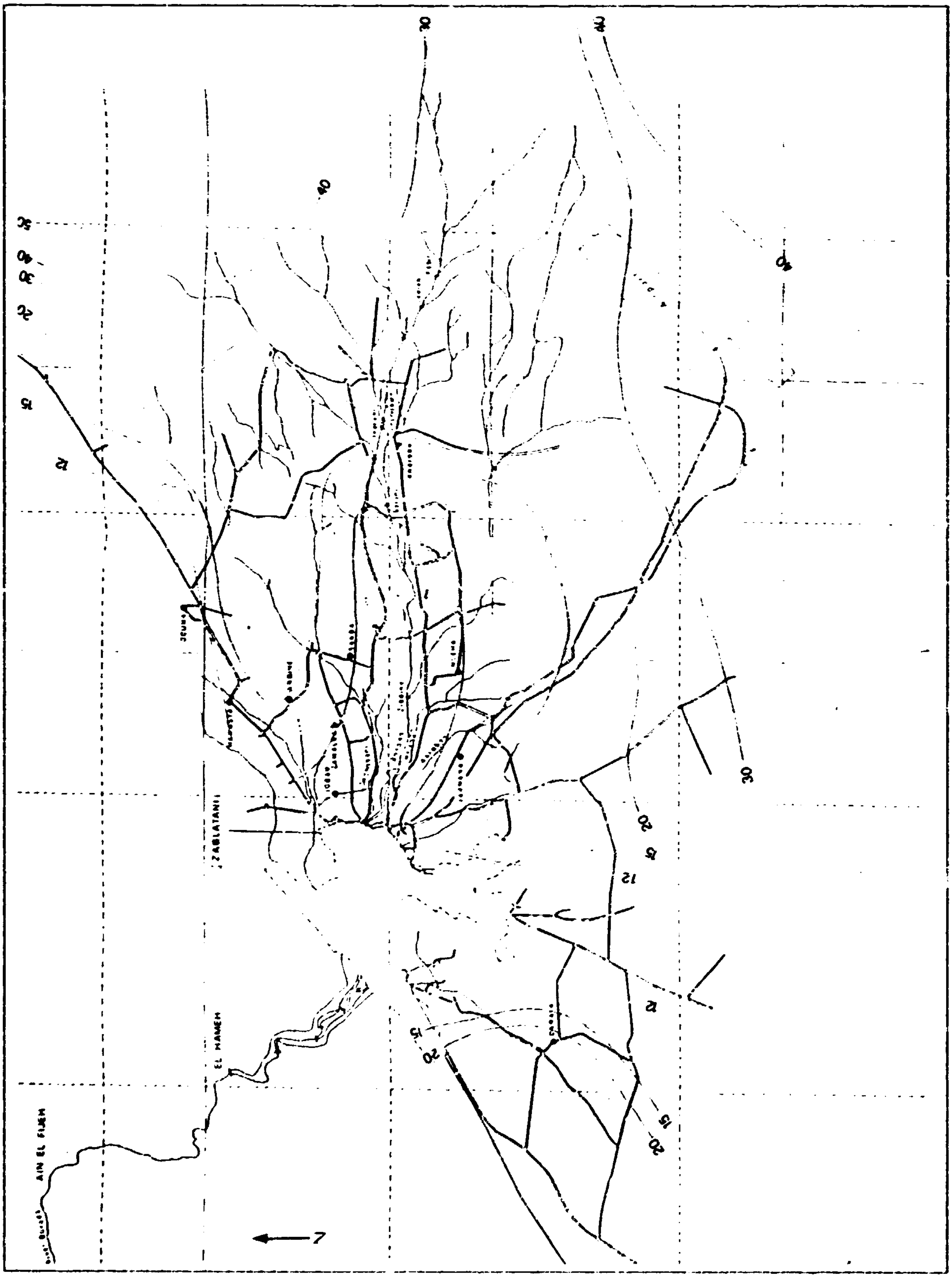
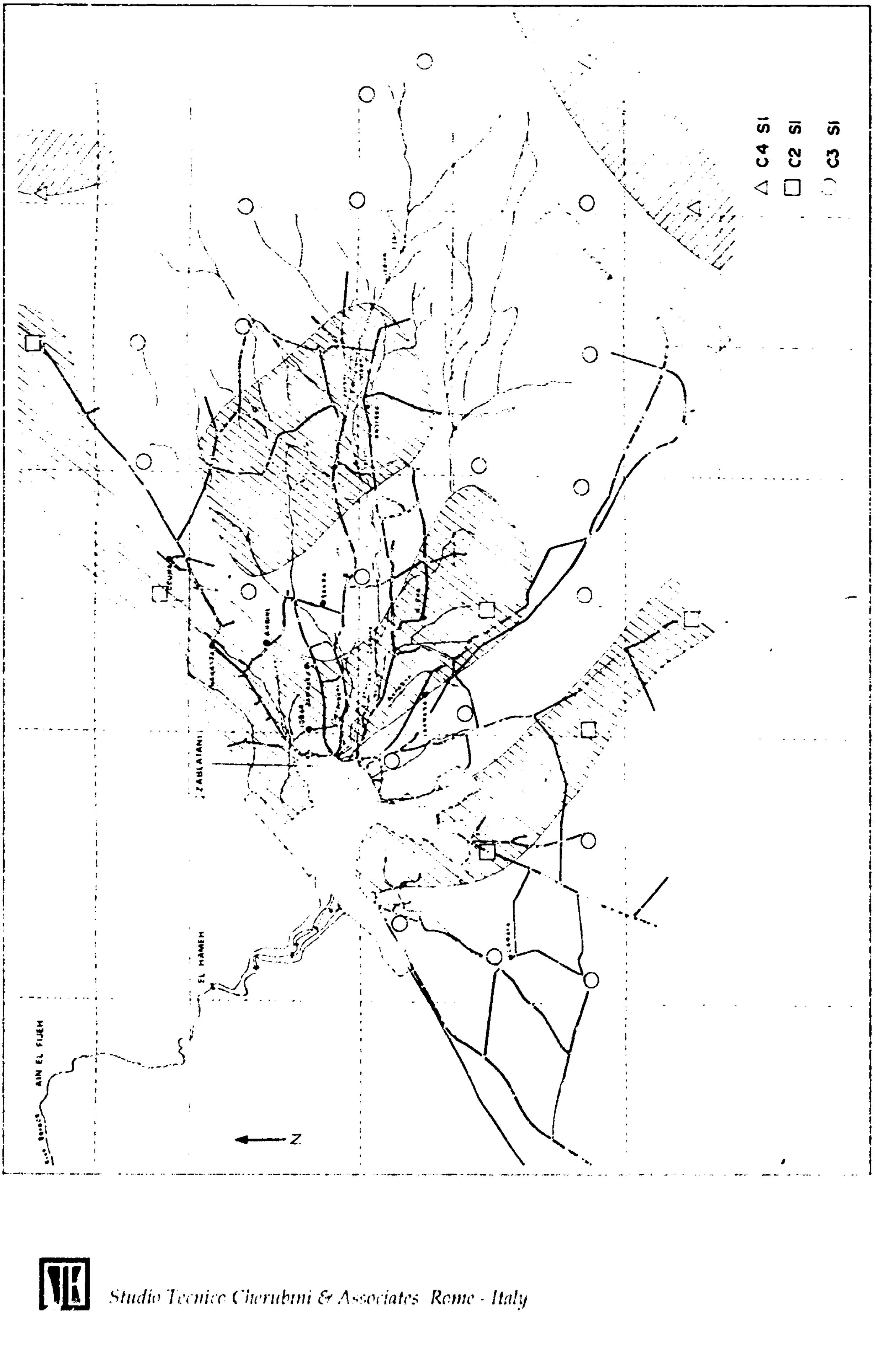


FIGURE 14d-GROUNDWATER QUALITY FOR IRRIGATION OF DAMASCUS BASIN
Nov.-Dec. 1977 U.S.D.A. CLASSES



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5) Water pollution by non-tannery industries

Also some of the **non-tannery** type industries exert a **non negligible impact** on the environment.**Simple measures, realistic for the situation, are suggested.**

For the small stone cutting, polishing, and concrete moulding, the ones located alongside the rivers mostly discharge freely into them, while the ones located inside already apply some rudimental sedimentation. **We recommend that sedimentation, recycle and discharge into sewers is applied by all such industries.**

Though formally outside the territory assigned for investigations, we must stress that **in Ain Terma, just eastside Zablatani, there are more than 20 large stone cutting factories, discharging approx 250 cm/day each(beyond 5000 cm/day overall) of very concentrated inorganic suspensions.**

Also for these large Ain Terma industries we insist to **apply in-house sedimentation and recycle of the treated water**. The discharge (and the make-up) may be in the order of 10-20 % of the polluted stream.

Should it be discharged into the river, further treatment of coagulation is recommended, while we consider acceptable the direct discharge of sedimented waters into the industrial sewers, if confirmed by a more detailed evaluation of sewers hydraulics including the risk of clogging and the relative consequences in case of sudden heavy rain.

Sedimented solids may be collected by a local organisation and recycled to furnaces, if applicable, or used as stabilising additives to the CETP sludges (after careful testing) or sent to the landfill for disposal.

For **mechanical shops, we recommend to organise a regular service,** whether private or handled by the Zablatani area itself, **which collects and, possibly, recycles car batteries, large scraps of metals, upholsteries, etc**. For exhaust lubricants we have been informed that a daily collection system does already exist. For **car washing, biodegradable detergents must be imposed**, all waste waters must be sent to the industrial sewer, and operations must be conducted in sheltered areas to prevent storm rain wash down with subsequent pollution of the soil and of the surrounding water bodies.

For **slaughter houses, we recommend to provide for the collection and drying of blood**, in order to use it as fertiliser in the adjacent agricultural area of Ghouta. From preliminary data, approx 15 tons of blood are wasted each day, sufficient to fertilise hundreds of hectares, with the additional advantage of the dried blood slow nitrogen release. In addition, **each slaughter house as well as each glue factory must be provided by a pre treatment unit to prevent greases and gross solids from entering the sewers**.

6) Water pollution by tanneries

The tanneries have the most relevant environmental impact upon waters for the quantity and quality of their wastes.

Since their wastes contain **high quantities of salts, organics and micro biological active matter**, their **direct discharge in rivers is not acceptable**, even more so considering the intense interchange between river waters, river beds sediments and the ground water, caused by the specific local hydrology and hydrogeology. The detailed description of the peculiar and environmentally critical interference between surface and deep waters is reported in the text.

Quantitative indications of the effect of ZIA wastes upon ground and surface water qualities have been obtained, also by conducting a direct, short but meaningful, sampling and analysis campaign upon Dayani river waters. As expected, significative increase of the concentrations of organic matter, salts, and metal ions have been found.

7) Water saving

The aquifer underlying ZIA can face depletion, both by the increase of drinking and industrial water capture at the springs of the Barada **and by the urban sewage scheme**, presently under completion, which shall collect all the Damascus sewage (500.000 cm/day or more), leading it, then, to the Municipal Treatment Plant (MTP) located at Adra, 25 Km north-east.

This scheme, though beneficial from an hygienic point of view, depletes the Barada of a relevant part of its waters, while it has been ascertained the importance of surface water seeping for the replenishment of the Ghouta aquifer. In the summer months, the foreseen lack of flows can even cause the drying out of branches such as Dayani, Provisions have been made for recirculating back to Ghouta the treated sewage, but to territories which do not include **Ain Terma, where, instead, up to 20 meters lowering of the water table can be expected**, causing technical and economic problems for the farmers.

Therefore, **realistic measures to reduce ground water consumption should be carefully sought after**.

Water saving may be achieved from partial, extensive recycling and re-use in the stone cutting and polishing industries, which, as seen above, can lead to some hundreds of cubic meters for the Zablatani ones, increasing to some thousands of cubic meters more if the large Ain Terma stone cuttings shall be included in the action.

Still **the water consumed daily by the tannery cluster is by far the most relevant cause of water consumption**, by drawing approx 10.000 cm/d of water by pumps, installed at each factory, kept running all the day long.

This consumption can be reduced (but the consequent increase of concentrations must always be kept under due consideration) **by:**

1.- Develop a ground water consumption monitoring and tariff system.

2.- Installing sealed water meters upon pump outlets.

3.- Replacing the present practice of water withdrawal by continuous direct pumping out from the wells with a more water-conscious practice requiring pumping the water first into level controlled tanks, which will, then, feed the process.

To decrease the **polluting load,** instead, **we suggest a wide application of the "clean technologies"**, such as:

1.- **Use <u>fresh instead than salt dried</u> skins and hides**

2.- **<u>Hand remove excess salts</u>, as much as possible, from salted skins**

3.- **<u>Recycle pickling baths</u>**

4.- **<u>Increase the exhaustion of the liming baths</u>, by recoveries, wherever applicable**

5.- **<u>Increase the exhaustion of the chromium baths</u>**

6.- **<u>Modify the degreasing section</u> by replacing the old fashioned salt-and-kerosene mixture with <u>biodegradable surfactants</u>.**

8) Environmental impact upon agriculture

The impact of environmental pollution upon agriculture is mostly related to irrigation. Farmers irrigate, in winter, with water coming 80% from river and 20% from ground water (more expensive, due to pumping costs) while, in summer, the practice of irrigation is the reverse :20% from rivers and 80% from wells. Abstraction from the aquifer for irrigation amounts, at the summer peak, to approx 20 m3/sec (20.000 litres/sec), drawn from 17.000 wells. As average, there is a well every 2.5 ha, pumping approx 1.2 litres/sec.

Potential **water table lowering would create problems of higher pumping energy costs** if not even higher **installation costs for adjusting pumps piping, replacing pump motors or even the whole pump**.

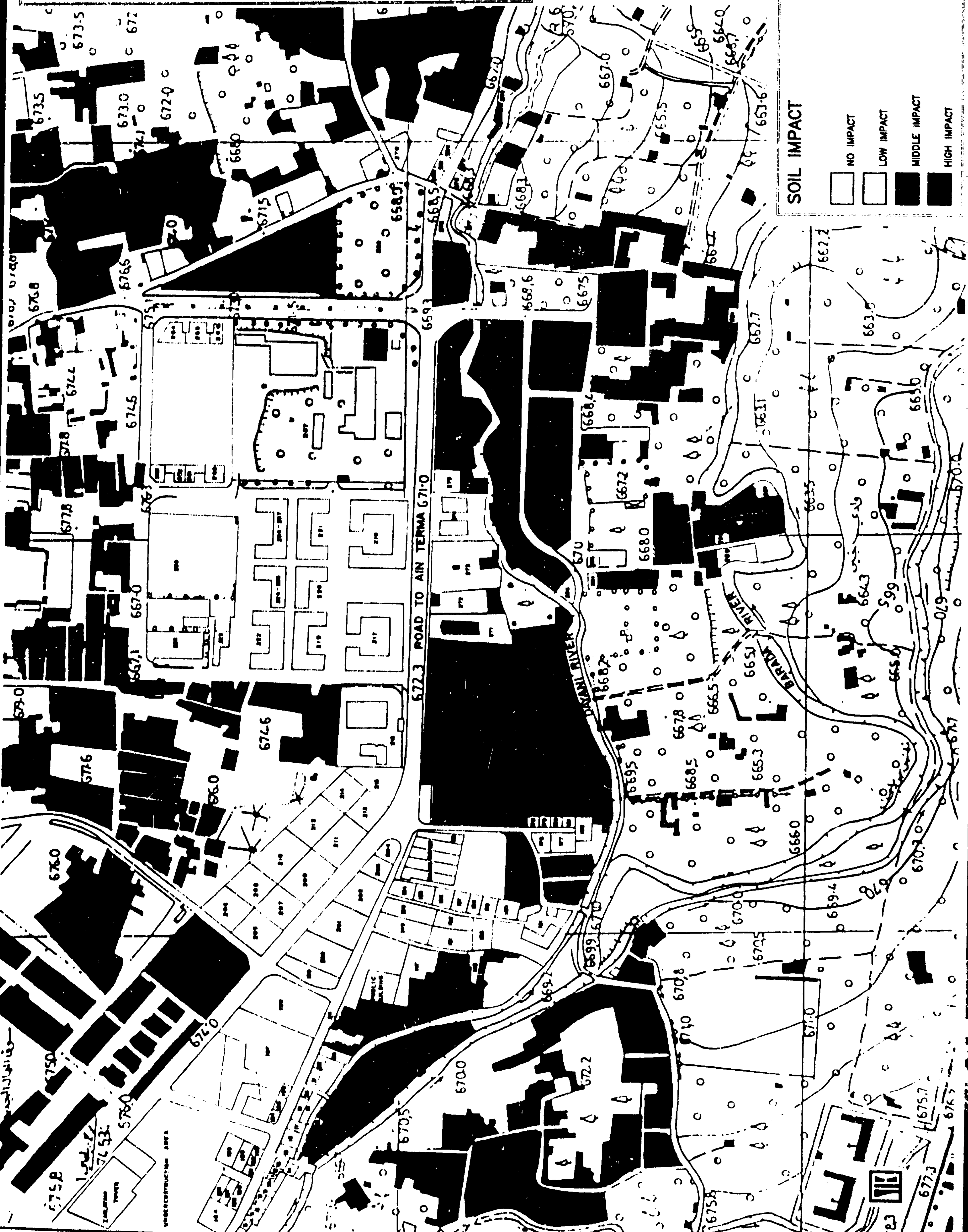
As far as water quality is concerned, the problems are mostly due to the high salinity of irrigation water, up to the point that long since types of crops less sensitive to water salinity (halophytes) had to be used. Still, ill (chlorotic) plants can be seen and, among the most likely causes, excessive concentration of carbonates into the water is considered. This could be caused or enhanced by the carbo-silicate fines coming from the stone cutting industries, which add up to the already high hardness of the Ghouta ground water.

Actually, irrigation with surface water is forbidden because of related hygienic effects but we collected direct evidence of its wide use, instead.

FIGURE 17 · ENVIRONMENTAL INDICATIVE PARAMETRES

FIGURE 18 - ENVIRONMENTAL INDICATIVE PARAMETRES

FIGURE 19 - ENVIRONMENTAL INDICATIVE PARAMETRES



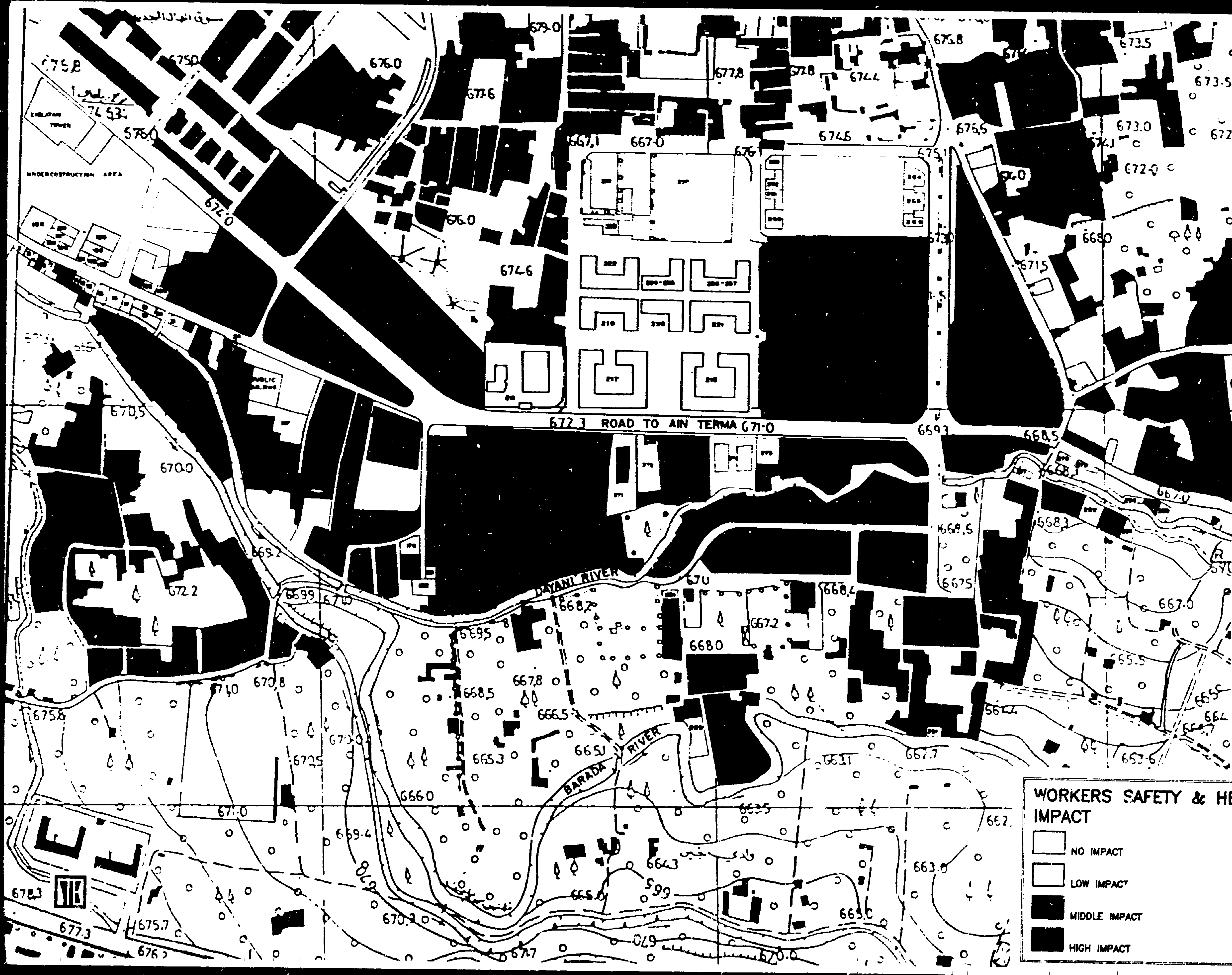


FIGURE 20 - ENVIRONMENTAL INDICATIVE PARAMETRES

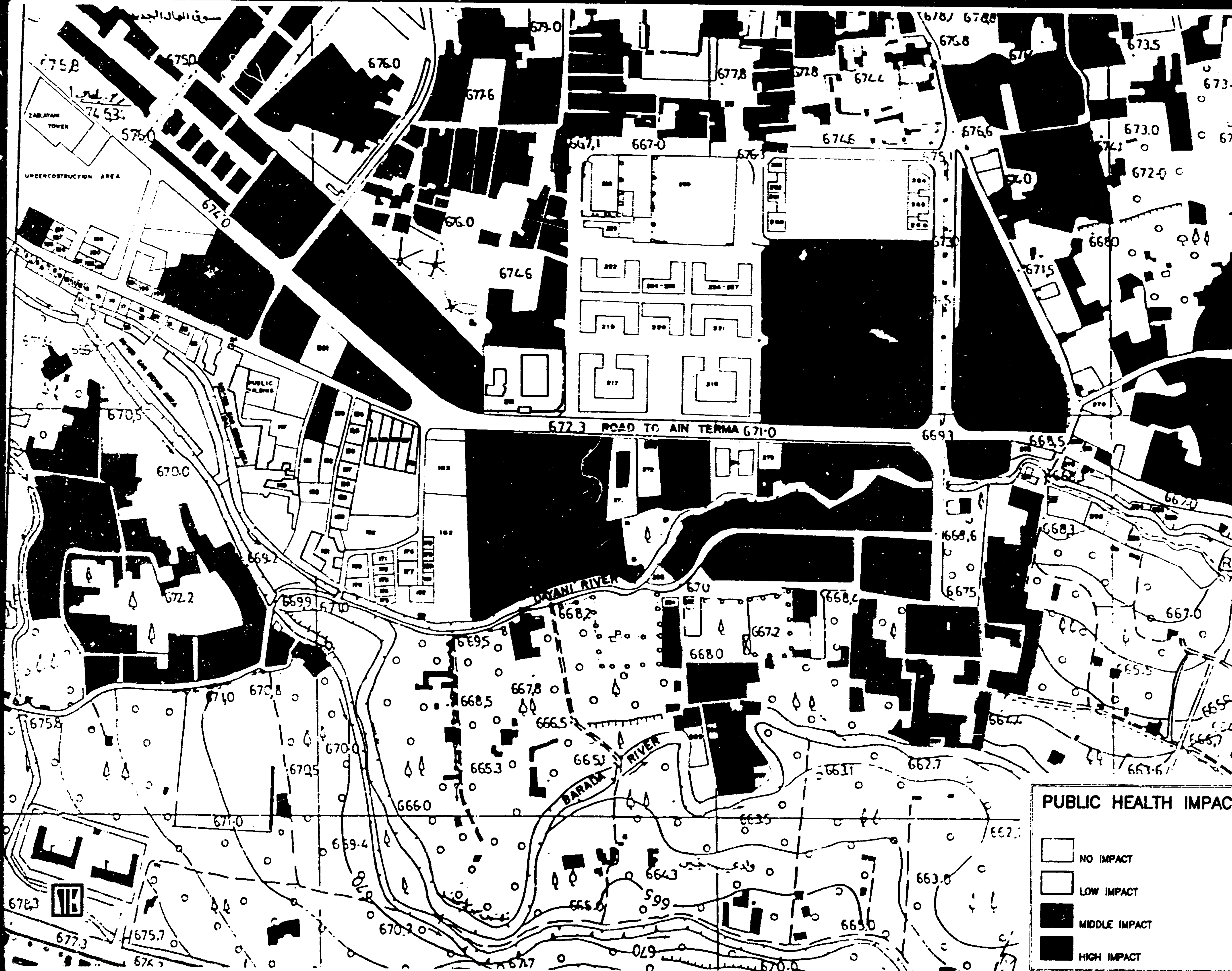


FIGURE 21 - ENVIRONMENTAL INDICATIVE PARAMETRES

9) Public health

We have noticed the **existence**, with varying frequency, of **practically all the infectious diseases** typical of densely inhabited rural areas, where biologically polluted waters are used for irrigation and there is a relevant presence of vectors such as insects, dogs and rats. These endemic diseases show **how critical the environmental situation** is,and **how urgent is a definite effort to improve it**, by controlling the causes of **micro biological pollution of the waters and the growth of vectors** such as insects and small mammals.

In addition,we believe that **official records underestimate the diffusion of these diseases,and,then, we recommend to improve the awareness of both local physicians and Health Authorities** by specific seminars,conferences,etc., typically by UNIDO, involving both public and private local health centres, possibly with incentives to the participating individuals.

10) The Common Effluent Treatment Plant (CETP)

As seen above, **raw tannery waste waters may cause relevant environmental and hygienic damages** because of the **high concentrations of sulphide, sulphate, chloride ions and micro biological activity**.

Therefore, **its free discharge into surface waters must be discontinued** for its effects upon public health and agricultural practice. Just at the east border of ZIA lays the sewer collector which carries all the Damascus sewage to the MTP. It is, then, obvious to consider such collector as the disposal site of the ZIA waste effluent.

But simple mixing untreated of tannery wastes with the Damascus sewage, because of its lower pH,**would cause the release into the air of fumes of hydrosulphuric acid, both toxic to people and corrosive to concrete structures**. Mixing, still, **would cause sedimentation by self-flocculation** of over 25 tons/day of ZIA effluent suspended solids with **consequent risk of sewerage clogging**. Finally, the **raw ZIA effluent would increase 10 to 20 % the organic load of the Adra MTP, stressing it up to the maximum** acceptable limit.

Hence, an **adequate treatment of such wastes is strongly recommended, by a Common Effluent Treatment Plant (CETP)**. In addition, to prevent clogging of the industrial sewer network ahead of the CETP, **we recommend to provide each tannery with a local coarse screen and grit/grease removal pit**. Since the residues of local pre treatments and of the CETP mechanical treatments are in the order of 15-20 tons/day, a **daily collection service must be provided** by the same organisation which will manage the CETP.

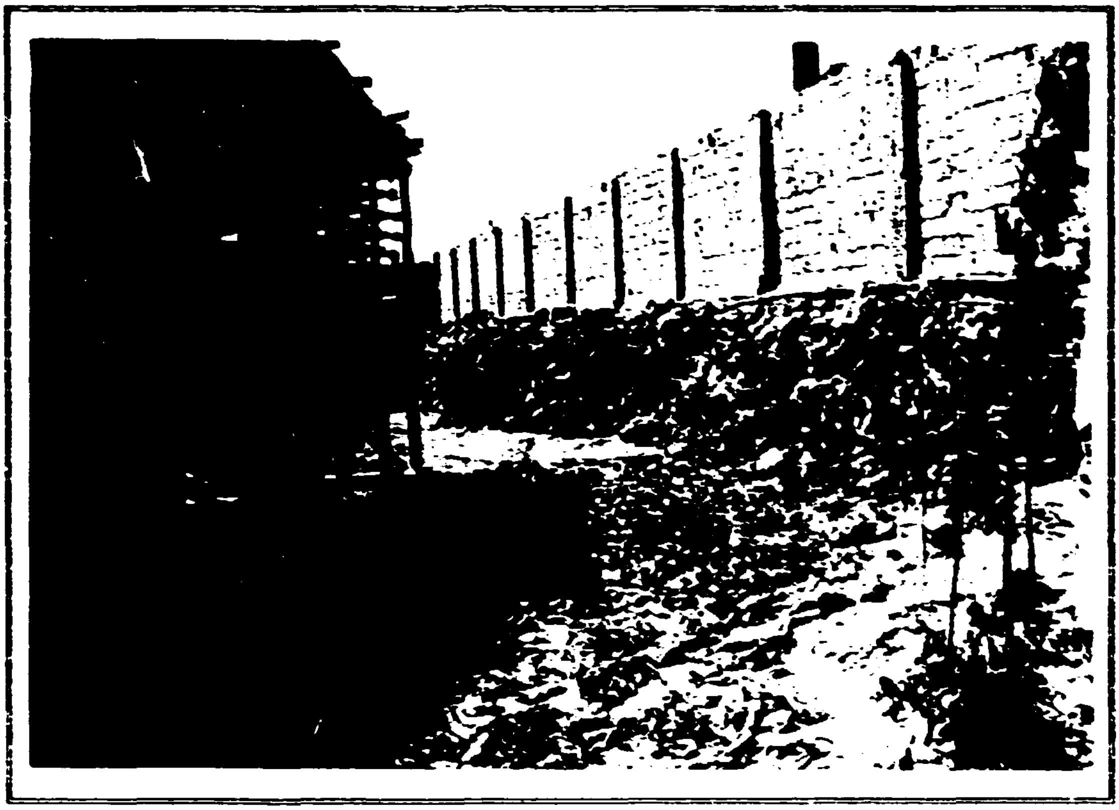
The plant will use chemico-physical processes capable to abate pollutants down to meeting Syrian standards (similar to US and European ones) for discharge into sewers, except for chlorides which are unaffected by the chosen treatment processes (other processes, specific for chloride removal are excessively expensive). In all cases, however, due to the dilution which occurs when adding the CETP effluent into the much larger urban sewage flow to Adra,(flow ratio 1:50 and more) all concentrations and flows increase negligibly, all within few percentage points. **Salinity** is the sole parameter of the Adra effluent which, not being effected by the treatment, **raises 10%,** because of the tannery waste streams. It is, then, **even more apparent the merit of applying "cleaner technologies".**

11) <u>CETP sludges</u>

The CETP produces 700-1100 tons/day of liquid sludges, which by mechanical drying will be reduced to **approx 150 t/d, to be added to the 15-20 t/d of gross solids retained by grits and traps** both at factory site and CETP inlet.

Several alternatives have been considered for the sludge disposal considering both its environmental impact and fertilising power. **Most suitable short term solution is to send them to the well managed and properly designed Dar al Hajjar landfill and compost plant.**

Possible longer term solution would be to mix them with the raw feed to the compost plant, but a specific feasibility study, e.g. by UNIDO, is recommended before this decision is taken.



BY-PRODUCTS PROCESSING: GLUE FACTORY

BY PRODUCTS PROCESSING: LIFE STOCK FEED FACTORY

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12) CETP environmental impact

Though overall highly recommendable, the CETP **does represent an environmental hazard by itself**, because of the presence and handling of large quantities of environmentally critical elements such as raw tannery wastes, raw sludges, chemicals, truck traffic, etc.

Some **recommendations to minimise the environmental impact of the CETP are**:

1.- **Sludge processing machineries to be enclosed within housing provided with treatment of the exhaust gases;**

2.- **All organic wastes to be kept inside easily cleanable zones;**

3.- **Sludges and solid wastes to be stored directly into the closed containers which are to be loaded upon the trucks going to disposal;**

4.- **The flow rate of the air fed to the desulfurisation step should be minimised since it gives bad smell. Controlling flow by actual sulphur ion concentration sensor is a possible solution;**

5.- **Noisy equipments, such as fans, compressors, etc. should be enclosed, when ever applicable;**

6.- **Tall and dense tree fencing all to be placed all around plant area.**

For further impact control the **CETP should preferably be located at Ain Terma** better than at Zablatani, for its much lower density of population, giving additional safety in case of technical or organisational failures of the CETP. It will also minimise the impact of the estimated approx 10 - 15 truck loads each day, required for the disposal of solid wastes and sludges.

13) CETP crisis scenarios

Crisis scenarios have been considered, assuming the failures of the most relevant process phases such as:

13.1- Pumping system to the CETP

In case of failure, raw tannery effluents will be discharged into the rivers. The effects of this failure are more or less critical depending on the actual flows of the rivers at the time. The CETP management will decide, upon adequate written guidelines to be purposely issued, whether (and how long) the discharge into the rivers of the raw effluent can be tolerated or, else, the industrial activities must be suspended.

13.2- Desulphurisation.

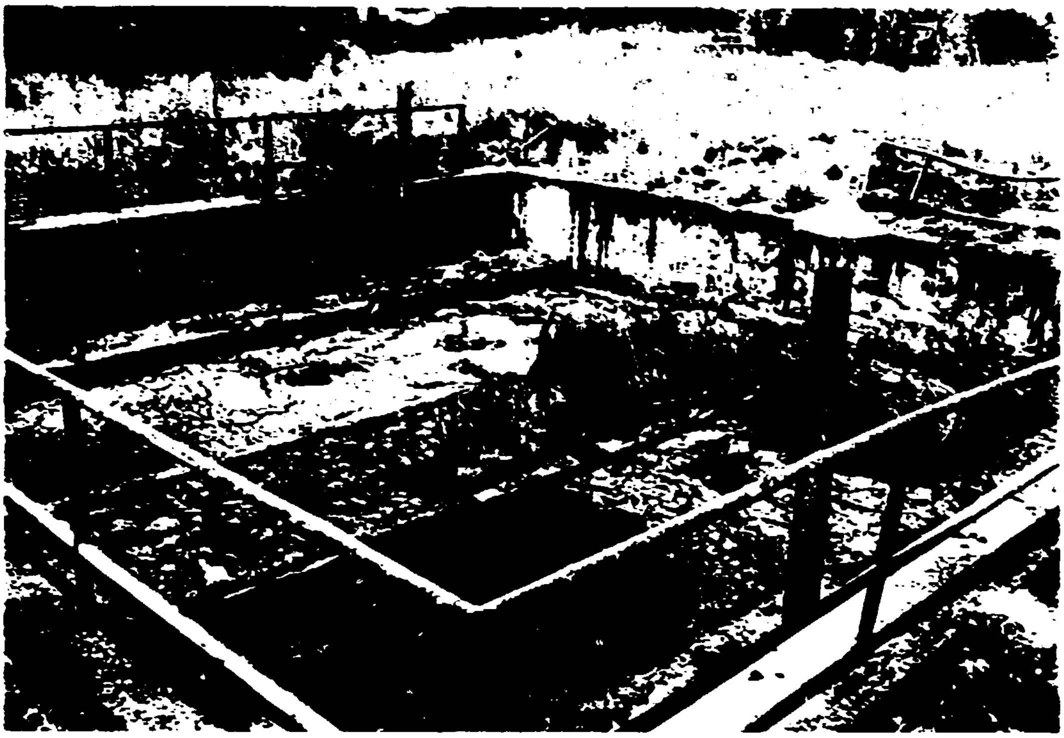
Depending upon the actual cause (failure of machineries and/or lack of reagents), the expectable duration, the concentration of H2S as detected by appropriate sensors, and the flows in the rivers, the plant management will decide to continue discharging the sulphur containing effluent into the sewer, else into the rivers or to interrupt the industrial production.

13.3- Clari-flocculation

Should machineries fail and/or chemicals be lacking, suspended solids removal would drop approx 20-30% below design values. Dumping for limited periods such reduced quality into the collector should not cause relevant damages to sewers or Adra plant.

13.4- Sludge treatment

In case of failure of the drying equipments, the volume of the material to be disposed of would increase 6-7 folds, with related increase of disposal costs and handling problems. In case of lacking specific chemicals, the volume increases approx 2 folds but still handling problems occur. In both cases, plant operation is impaired in few days.



PUBLIC SHEEP SLAUGHTER HOUSE-PRETREATMENT PLANT OUT OF ORDER

PRIVATE POULTRY SLAUGHTER HOUSE POULTRY BREEDING ZONE

14) Computer supervision system

To minimise unexpecte' risks, we recommend to install a computer supervision system, to be assembled by reliable components and user friendly human interfaces, which supervises plant equipments, process efficiency, dosing chemicals levels and consumption trends, hydrological parameters.

The system should be provided with management and administration packages to control personnel presence, administer chemicals and consumable re-ordering, manage mechanical maintenance and inspections, record alarm resetting responsibilities.

Possibly, a Decision Support System should be added, for assisting plant management to cope with emergencies and failures.

15) Tanneries Excellence Centre

We believe that in order to achieve a definite improvement of the environmental conditions of an industrial area, in addition to planning and enforcing rules, controls and auditing procedures, **it is necessary that technical, economical and social growth takes place.**

We, then, **recommend to consider the development of an "Excellence centre"**, possibly as UNIDO project, which might provide facilities for functions such as:

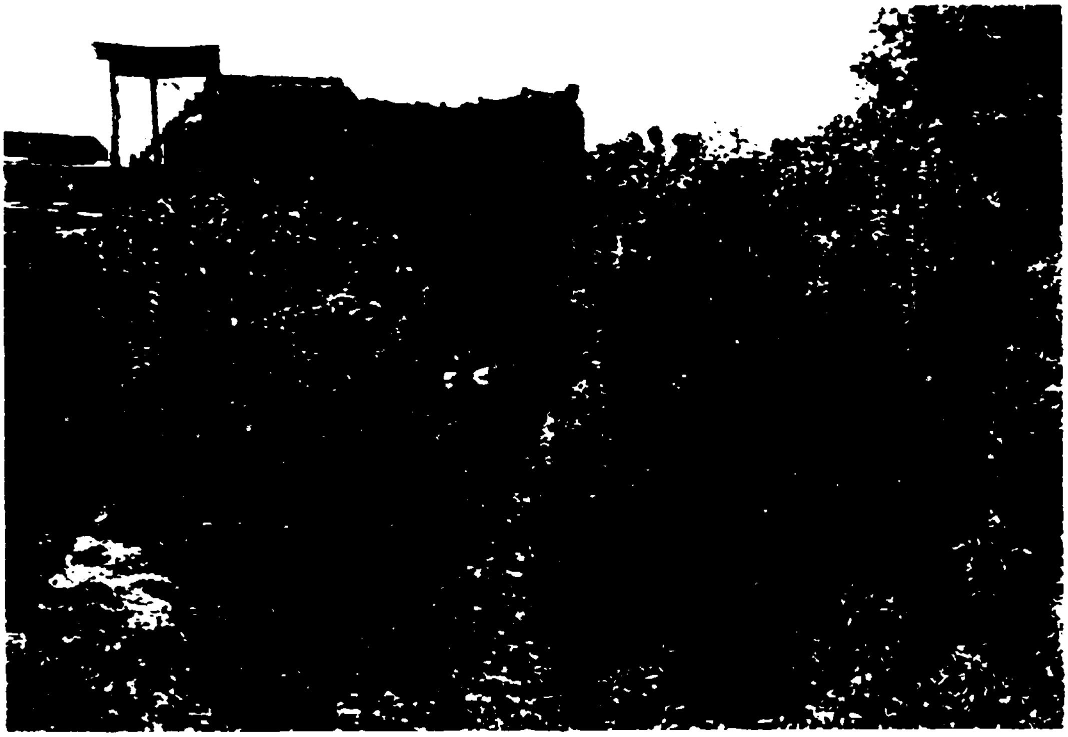
1.- Management of common services, such as machinery maintenance, waste collection and disposal, waste water treatment plant, electricity generation, refrigerated storages, etc.;

2.- Technology centre for improvement of the tanning processes, selection of machineries, engineering of process modifications, including improvement of working safety etc.;

3.- Training centre for the different levels of required skills;

4.- Quality control for both raw materials and locally produced items, including development and management of "Made in Damascus" brand for premium quality products;

5.- Market analysis, centralised purchasing and sales functions.



DAYANI RIVER BEFORE ENTERING ZABLATANI INDUSTRIAL AREA

DAYANI RIVER AT THE EXIT OF ZABLATANI INDUSTRIAL AREA

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2/514 (2 of 2)

ENVIRONMENTAL IMPACT ASSESSMENT OF THE INDUSTRIAL ACTIVITIES WITH SPECIAL EMPHASIS ON THE PROPOSED TANNERY WASTE TREATMENT IN THE ZABLATANI (DAMASCUS - SYRIA) INDUSTRIAL AREA

DP/SYR/92/004

FINAL REPORT

March 1996

PART TWO

DETAILED REPORT - ANNEXES

Back - stopping officer: Mr. Jakov Buljan
Agro - Based Industries Branch

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

VIENNA

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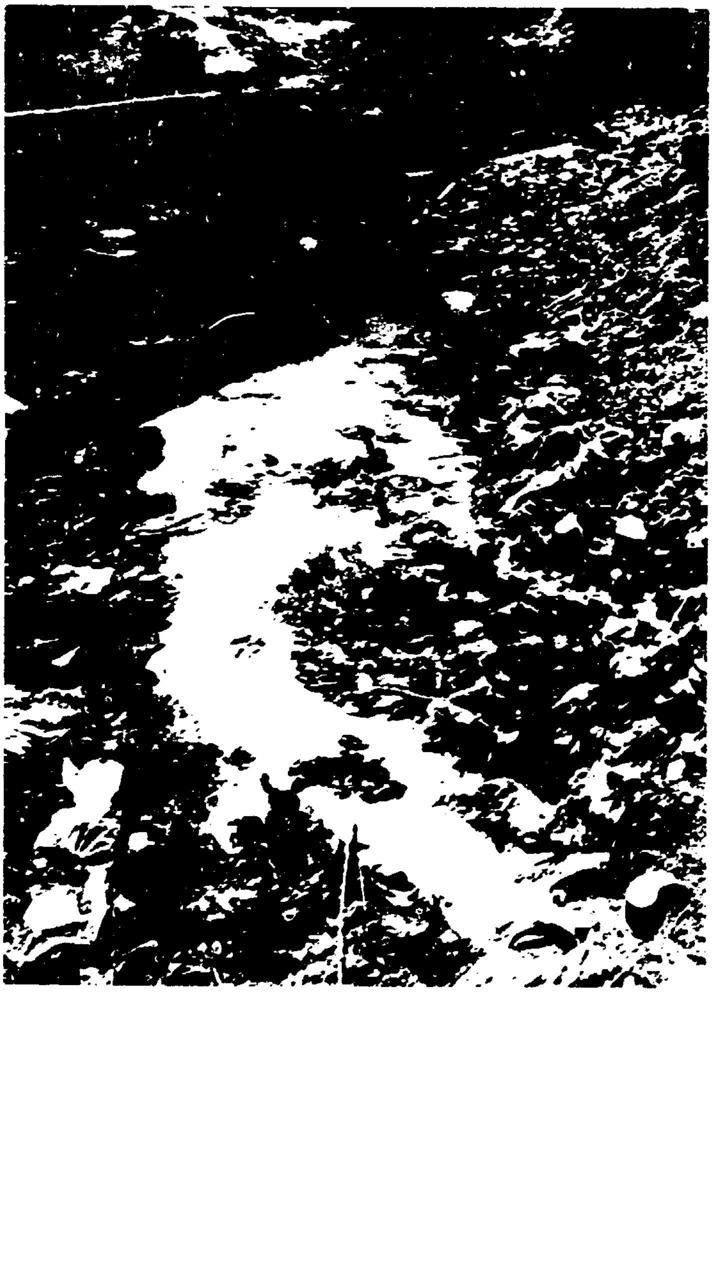

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ENVIRONMENTAL IMPACT ASSESSMENT OF THE INDUSTRIAL ACTIVITIES WITH SPECIAL EMPHASIS ON THE PROPOSED TANNERY WASTE TREATMENT IN THE ZABLATANI (DAMASCUS - SYRIA) INDUSTRIAL AREA

DP/SYR/92/004

FINAL REPORT

GENERAL CONTENTS

S.Te.C. - Studio Tecnico Cherubini & Associates TEAM:

Team Leader:	**Massimo Mendia**
Public Health Engineer:	**Alfredo Cerotto**
Common Health Specialist:	**Sergio Fati**
Agricultural Specialist:	**Leonello Cavallari**
Hydrological Specialist:	**Enrico Usai**

Director:	**Alberto Cherubini**

EXPLANATORY NOTES

TOR	Terms of Reference
EIA	Environmental Impact Assessment
ZIA	Zablatani Industrial Area
CETP	Common Effluent Treatment Plant
MTP	Municipal Treatment Plant
SC I	UNIDO Subcontractor I **(TEH PROJEKT)** in charge for techno-economic study and tender documents
SC II	UNIDO Subcontractor II **(Studio Tecnico Cherubini and Associates)** in charge for Environmental Impact Assessment
TL	SC II Team Leader
PHE	SC II Public Health Engineer
CHS	SC II Common Health Specialist
HS	SC II Hydrological Specialist
AS	SC II Agricultural Specialist
USW	Urban Solid Wastes
USC	Urban Solid Compost
SAR	Sodium Absorbtio Ratio
ETP	Potential Evapo Transpiration
BRGH	Ref. 4 in Bibliography
LENGIPROVODKHOZ	Ref.7 in Bibliography
HHS	Ref. 3 in Bibliography
M.C.	Map Code
CRM	Car Repair and Maintenance
MSC	Various Activities
SLH	Slaughter Houses
CMM	Commercial Activities
CBM	Concrete Brick and Sewers Moulder
LMC	Limestone Polishing or Cutting

LIP	Land Impact Activities
SAW	Saw Mill
BPP	Tannery and/or S. Houses By Prod. Processing
TNR	Tanneries
BOD_5	5-Day Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
SS	Suspended Solids
SM	Setteable Matter
O & G	Oil and Grease

PART TWO

DETAILED REPORT - ANNEXES

TABLE OF CONTENTS

DETAILED REPORT

PART I: STUDY AREA, PRESENT SITUATION

PART II: ZABLATANI INDUSTRIES,THEIR IMPACT AND TECHNICAL SOLUTIONS

ANNEXES

Annex A: Terms Of Reference

Annex B: List of encountered people

Annex C: Photographs

Annex D:References and Bibliography

FIGURES

TABLES

DETAILED REPORT

PART I

STUDY AREA

PRESENT SITUATION

1. ZABLATANI INDUSTRIAL AREA.

1.1. Site description.

The ZABLATANI industrial area, extended for about 80 ha, is located between the East-South East border of the city of Damascus and the region of Ain Terma farther to the East.

ZABLATANI lays for a length of about 1,700 m along the road called Road to Ain Terma and the Dyani and Barada Rivers, which flow almost parallel to the road.

The area has a width of some 30 meters in the initial section, has a maximum of 800 m in the central part and is roughly narrower in the final section. The perimeter of the area is shown in the figure 1.

The ground is slightly sloping from North-West to South-East, with a maximum difference in height of about 10 m. and a slope of about 0.8%.

The main road is the Road to Ain Terma, which crosses the whole area barycentrically from West to East.

A road still partly under construction constitutes the northern border, while the Barada and Dyani Rivers constitute the southern border. Subsidiary roads cross the main road to Ain Terma.

1.2. Infrastructures.

1.2.1 Sewerage

Close to the Zablatani/Ain Terma border are situated three main sewer junctions, called:

BERZE (cross section mm. 1,400) which comes from the northern part of the town
BARADA (cross section m. 4.5x2.25), which comes from the central part of the town
MEZZE (cross section m. 2.20 x 3.00) which comes from the southern part of the town

The sewers constitute the terminal part of the mixed sewerage network that collects the majority of Damascus waste water, previously discharged in the two rivers.

From the junction the waste water will be carried by the ZABLATANI-AIN TERMA collector (cross section m. 2x2.20x2.90) to Municipal Treatment Plant (MTP) under construction in ADRA, 20 Km. downstream

The main sewage characteristic are.

Dry weather	av. 5,613 l/s-485,000 mc/d
	max.8,420 l/s-727,500 mc/d
Rain weather	11,226 l/s-970,000 mc/d
BOD_5 (MTP influent)	275 mg/l O_2
BOD_5 (MTP effluent)	20 mg/l O_2
S.S. (MTP influent)	412 mg/l O_2
S.S. (MTP effluent)	30 mg/l O_2

The process line is constituted by:

-Biological digestion by extended aeration

-Anaerobic sludge digestion

-Sludge drying beds

The effluent will be lifted back and used for the irrigation of the areas upstream from the plant. while the sludges will be used in agriculture.

The municipal facility will be completed in 1996. At present time, the waters discharge in the Barada River with an overflow located in the crossing Zablatani/Ain Terma.

During the inspections it was possible to determine that only five industries (a poultry public slaughter house, a sheep public slaughter house, a military slaughter house, a livestock-feed factory and a limestone-cutting) are currently discharging in the sewerage system.

The tanneries and all of the other plants discharge in the two rivers, directly or using earth channels or local sewerage systems. These are represented in figure 2.

1.2.2. Aqueduct

The area is connected to the public aqueduct, but all of the companies use water from wells. Only one ice-making plant uses water from the aqueduct for the production of ice, and river water for cooling.

FIGURE 1 - ZABLATANI INDUSTRIAL AREA AND CEPT POSSIBLE LOCATION

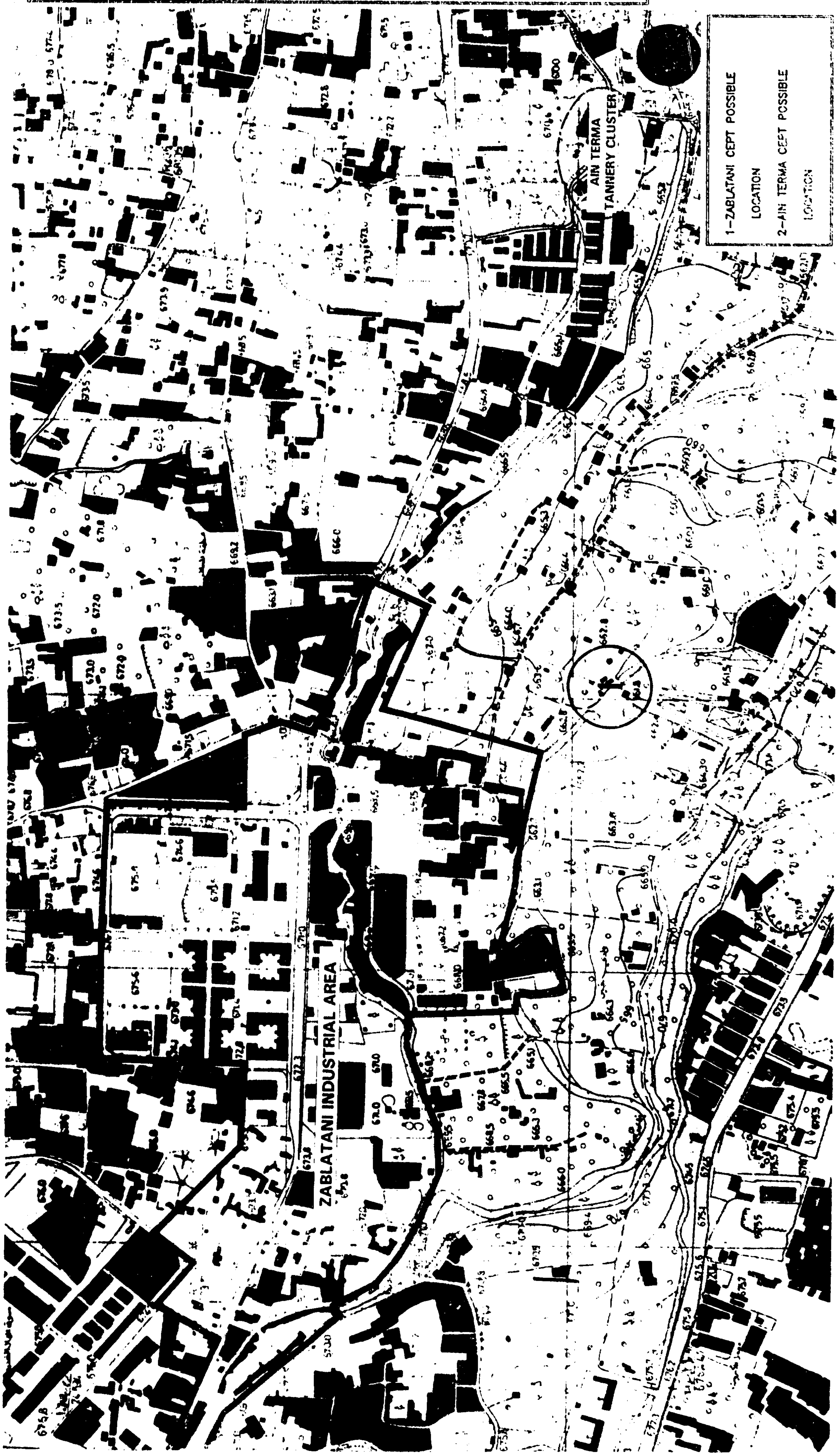
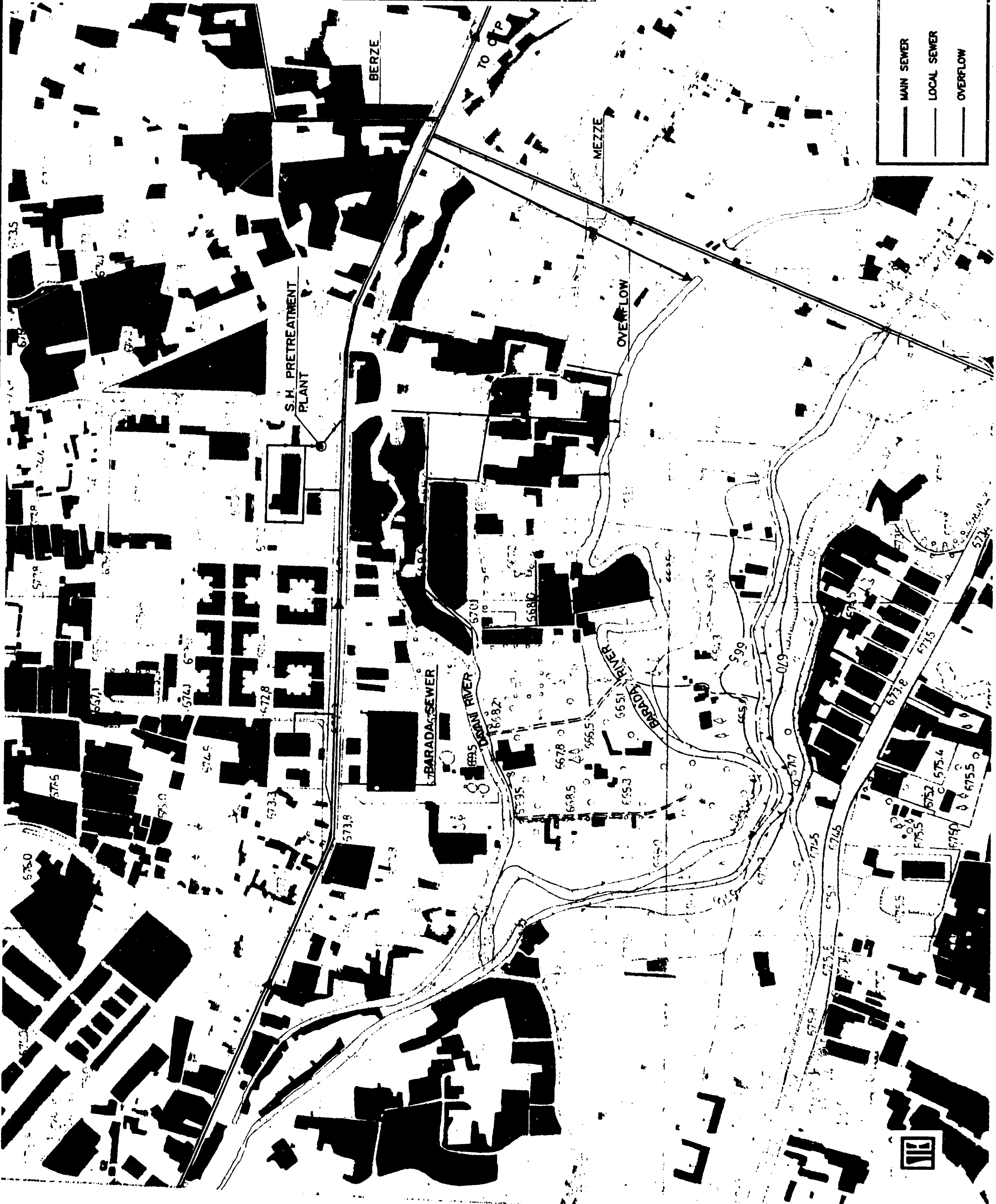


FIGURE 2 - ZABLATANI INDUSTRIAL AREA: SEWERAGE NETWORK



1.2.3 Electricity

The area is served by an electric network. The plants close to the road to Ain Terma are connected to the electric network, and the main ones have a generator in stand by because of the frequent power outages. Plants located further away from the road, since not connected to the network make constant use of diesel generators.

1.3. INDUSTRIES

1.3.1. Present situation

For years, in Zablatani there was a tannery cluster and some public slaughter houses, whose development was determined by the favourable characteristics of the area, which at the time of the installation were:

- Distance from the residential areas, since ZABLATANI is located at the farthest suburbs of Damascus;

- Availability of ground water supplies suitable for production process;

- Possibility to discharge in the Dyani and Barada Rivers;

- Understatement of the environmental impact connected to the release of pollutants carried mainly towards East in the direction of Aim Terma and the Valley of Ghouta through the Dyani and Barada Rivers and by the wind blowing West-East.

These favourable conditions, connected with the improvement of the economy, which is growing at a rate of 5.5-6% (GNP growth rate in 1993), later caused the chaotic and uncontrolled development of a myriad of small economic activities of the most different kind, small family-run tanneries, born in the immediate surroundings of the pre-existent tanneries, together with facilities for the treatment of the tannery and slaughter houses by-products; private slaughter houses; plants for the manufacturing of construction materials, such as cement, marble, aluminium frames etc.; auto repair shops, blacksmiths and numerous other commercial activities.

Each one of these activities, when considered by itself, has a very moderate environmental impact, but their concentration in a limited area, with pre-existing polluting industries (tanneries and slaughter houses), has definitively compromised the environmental situation.

At the same time, the city of Damascus suffered a tumultuous demographic expansion and passed from the expected 2.5 million inhabitants to the estimated 4.5 of today.

Due to such demographic pressure, an increasing number of people, moved to the Zablatani surroundings and to the Ain Terma area immediately downstream.
The situation became environmentally critical both for the immediately surrounding residential areas and for the sensitive agricultural area of the Ghouta, located downstream the Zablatani.

1.3.2. Planning

The danger was felt by the Authorities and the Governor of Damascus is planning to:

- Move the polluting activities to another location;
- Employ the liberated areas for residential areas and public constructions;
- Allow the collocation in Zablatani only of non-polluting activities.

Still, to be realistic, many factors hinder the short-term completion of such a definitive, drastic solution.

1)Some hundreds industries of all sorts already exist at that location, offering work opportunities to several thousands of people; and

2)It is neither easy, nor immediate to replace the traditional industries, entered into the culture and the habits of the population, with several ones for which both cultural, financial and market background still need to be developed; and

3)The relocation of tanneries and slaughter houses, which have complex technologies and high installation costs, requires a long-term techno-economic planning; and

4)The relocation of the less complex activities is possible in short term, but not immediately, and anyway not before the predisposition of newly equipped areas

The complex situation was exhaustively examined and it was planned to divide Zablatani in four sections (Figure 3.)

- 1 East section in the northern part destined to non-polluting activities.

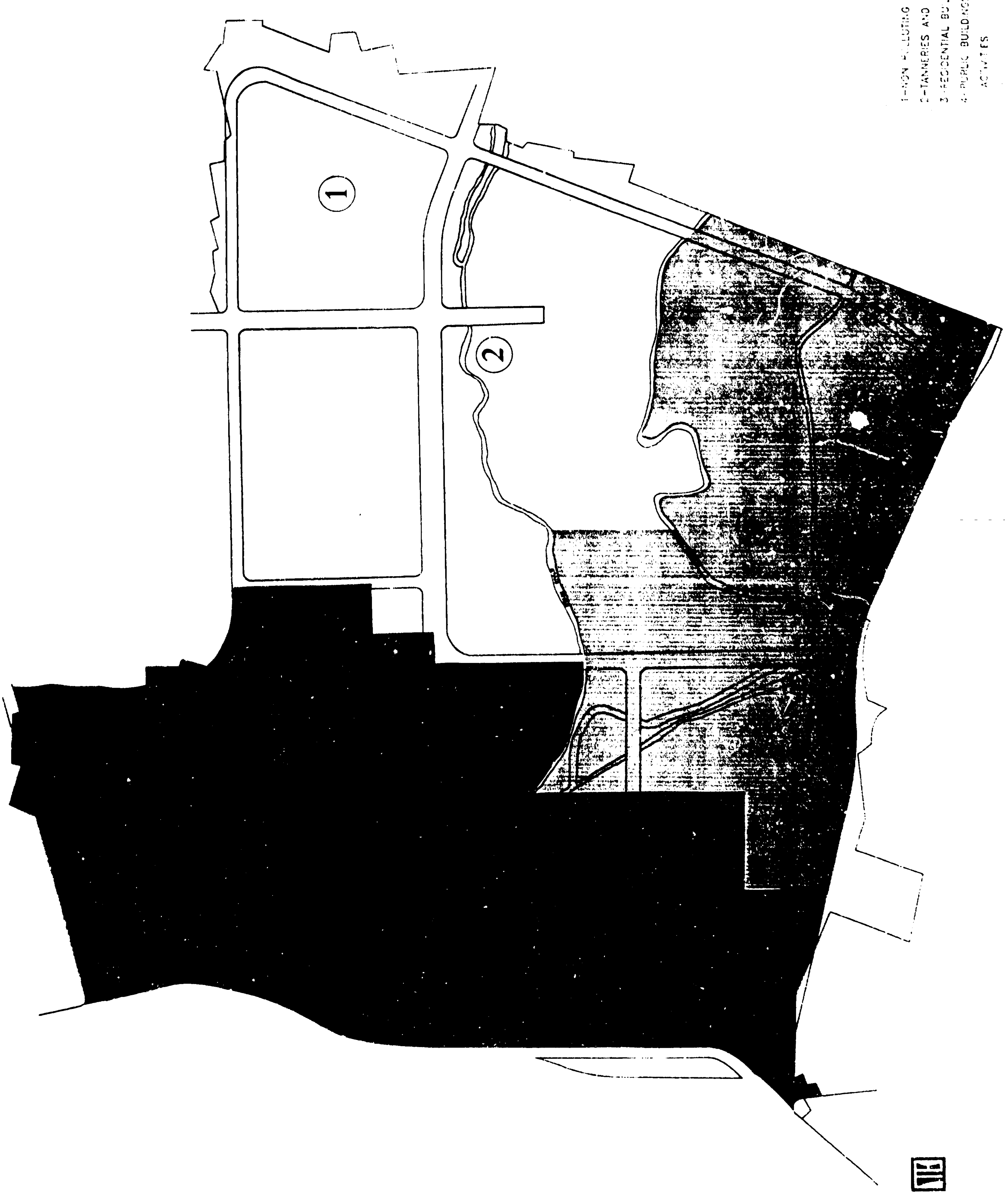
- 2 East Section in the central part comprised between the Road to Ain Terma and the Barada River destined to tanneries and other existing activities.

- 3 East Section in the southern part destined to residential buildings, with a 10% building index

- 4 West Section close to Damascus' border destined to housing, public buildings and commercial activities (partly already existing).

Considering the expected layout of the area, it is necessary to take immediate measures to minimise the environmental impact of the existing industries. It would be better to adopt solutions suitable to be reused if and when relocation should occur, preferring simple, cost-effective and immediately actuable preventive measures for the activities that will be more quickly relocated.

FIGURE 3 - ZABLATANI MASTER PLAN



2. THE GHOUTA PLAIN.

2.1. Site description.

The Ghouta plain, situated eastwards of Damascus, begins just downstram the Zablatani industrial area and includes the rivers Dayani and Barada.

The irrigated land, about 49,000 ha wide, interests two areas, the B-I-1 and the B-I-3 (see figure 4), having respectively 25,850 ha and 23.270 ha. The former is proluvial and the latter is alluvial with smaller soil grains.

The study area for agriculture evaluations is indicated in figure 5; villages have also been indicated when of direct interest to the survey.

The area includes three agricultural districts and the villages of Erben, Zibdin, Haza, Zamalica, Ain Terma, Jober Damascus, Sakba, Kafrbatna, Jesre, Aftrees, Mohamadia, Betsawa, Meleha, Derasafeer, Hetetajarasa.

The utilisation of the territory for the year 1993 divided into the administrative boundaries is reported in table 1. that group the data per village:

The cultivable land is 65.1 percent of the total administrative surface area; all cultivable soils are irrigated: 60,2 percent by ground water, the remaining 4,9 percent by river.

The soilwater balance of the region is typical of an arid climate with rainfall of about 200 mm per year, a dry period of four to six months, irregular and casual precipitations and ETP of over 8 mm per day in the dry season (June to August); for this reason the growth of non halophytes plants is hindered.

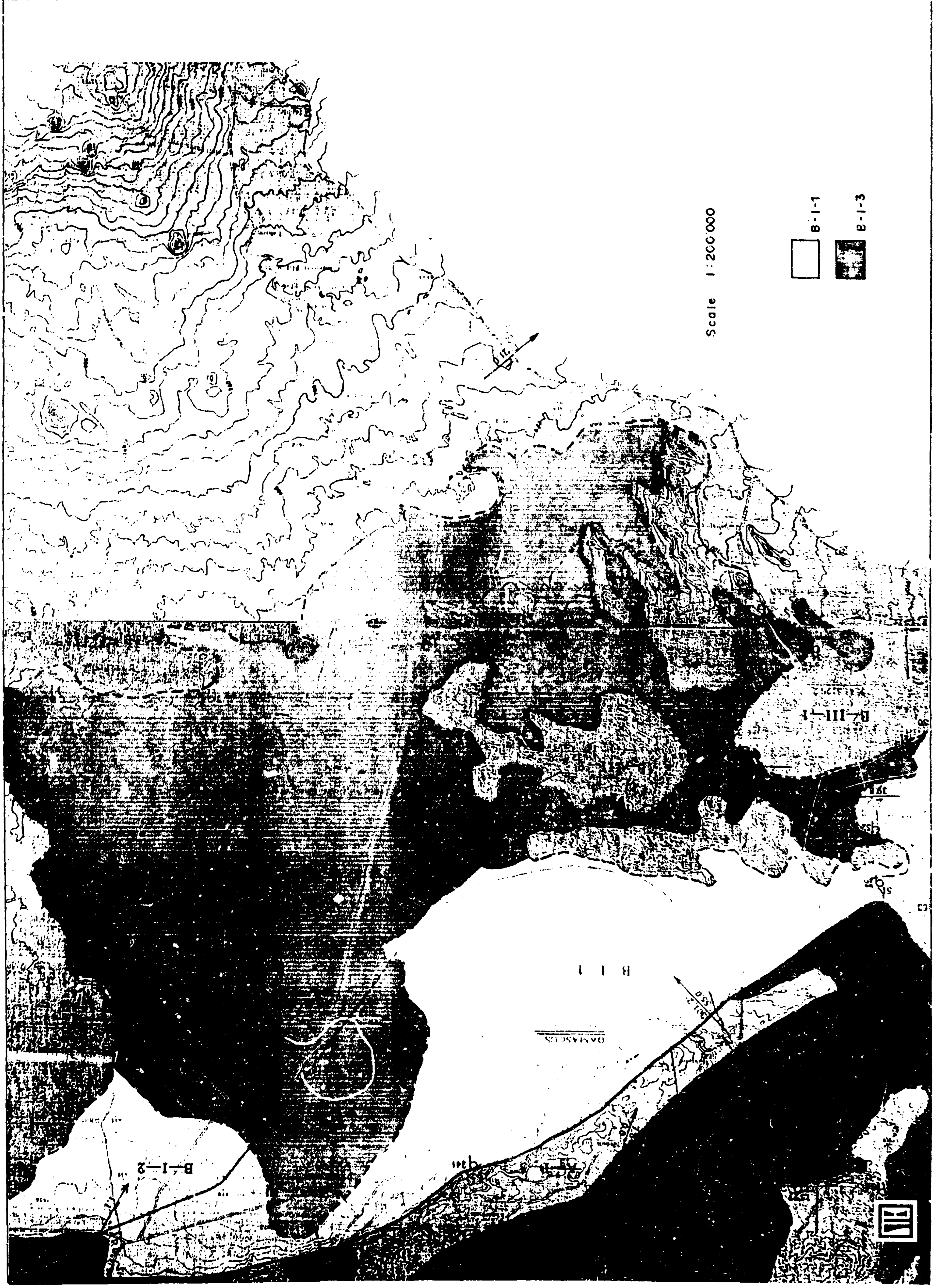
Governmental Extension Services of the Ministry of Agriculture are active in supporting the farmers in the optimisation of the agricultural activity; penalty for infraction committed against legislative provisions are considered and the area agriculture engineer is responsible for any error.

By law it is not possible to cultivate vegetables to be consumed raw and informations are given to people regarding the health risks by consuming raw vegetables or fruit without adequate hygienic precautions.

Tab. I - Land Use, by village, for the year 1993 (Donam = 1,000 mq)

VILLAGE	CULTIVABLE LAND CROPS/TREES	UNCULTIVABLE LAND ROCKY SANDY	 RIVERS LAKES	 BUILDING ROAD	 TOTAL	STEPPE AND PASTURE	FORESTS	TOTAL	IRRIGATION 1993 FROM WELL	 BY RIVER
1 SAKBA	968		100	1073	1173		238	2379	770	198
2 KAFRBATNA	1809		120	1601	1721		400	3930	1809	
3 JESREN	5143		200	1307	1507		590	7240	4692	451
4 HAZA	930	200	20	650	870	60	70	1930	930	
5 AFTIRES	1550		130	810	940		210	2700	1550	
6 NOHAMDIA					0			0		
7 BETSAWA	2560		70	127	197		83	2840	2208	352
8 ERBEN	3007	600	10	2663	3303	10	10	6360	2707	300
9 AINTERMA	2015	200	25	785	1010		900	3925	1845	170
10 ZIBDIN	7500		300	1196	1496		759	9755	7500	
11 HETETAJARASH										
12 DER ASAFER	10608		260	763	1023		219	11880	10608	
13 MELEHA	1536		200	2071	2271		623	7430	3650	886
14 ZAMALICA	645	400	20	905	1325		50	2020	645	
15 JOBER (DAMA)	163		1	73	74			237		163
16 BASATER (DAMA)	669			1409	1409			2078		669
TOTAL (Donam)	42103	1400	1486	15433	18319	70	4212	64704	38914	3189

FIGURE 4 - THE AREAS B-I-1 AND B-I-3 IN THE GHOUTA PLAIN



Source: water resources use in Barada and auvage basins for irrigation of crops feasibility study, USSR Selz Khoz Promexport, Moscow

FIGURE 5 - THE STUDY AREA FOR AGRICOLTURE EVALUATIONS

2.2. Crops

The main crops cultivated in the Ghouta plain are indicated in figure 6 wich reports the periods of crop harvesting; the crops cultivated in the study area are indicated in figure 7.

For 1993 the mainly cultivated crops were wheat (7,550 Donams), alfa-alfa (1,193) grazing vetch (1,175) and grazing barley (1,073), followed by maize (570 Donams), haricot beans (535) squash (495) and egg plant (417).

The fruit trees mainly cultivated in the study area are:

- Peaches (133,466 trees on 3,127 Donams with a density of 427 trees per Ha)

- Green plums (50,951 trees on 784 Donams with a density of 650 trees per Ha)

- Apricots (168,066 trees on 5,962 Donams with a density of 282 trees per Ha)

- Olives (28,499 trees on 2,260 Donams with a density of 126 trees per Ha)

- Plums (48,015 trees on 1,579 Donams with a density of 304 trees per Ha)

The rotation mainly adopted by the Ghouta farmers is:

Grazin veach	Maize	
Grazin clover	Weat	Vegetables
Green Beans	Oats	
Broad beans		

Soils are intensively cultivated all year round; the cropping pattern of the study area indicates that the annual crop intensity is relatively high, up to five plantations of radish per year.

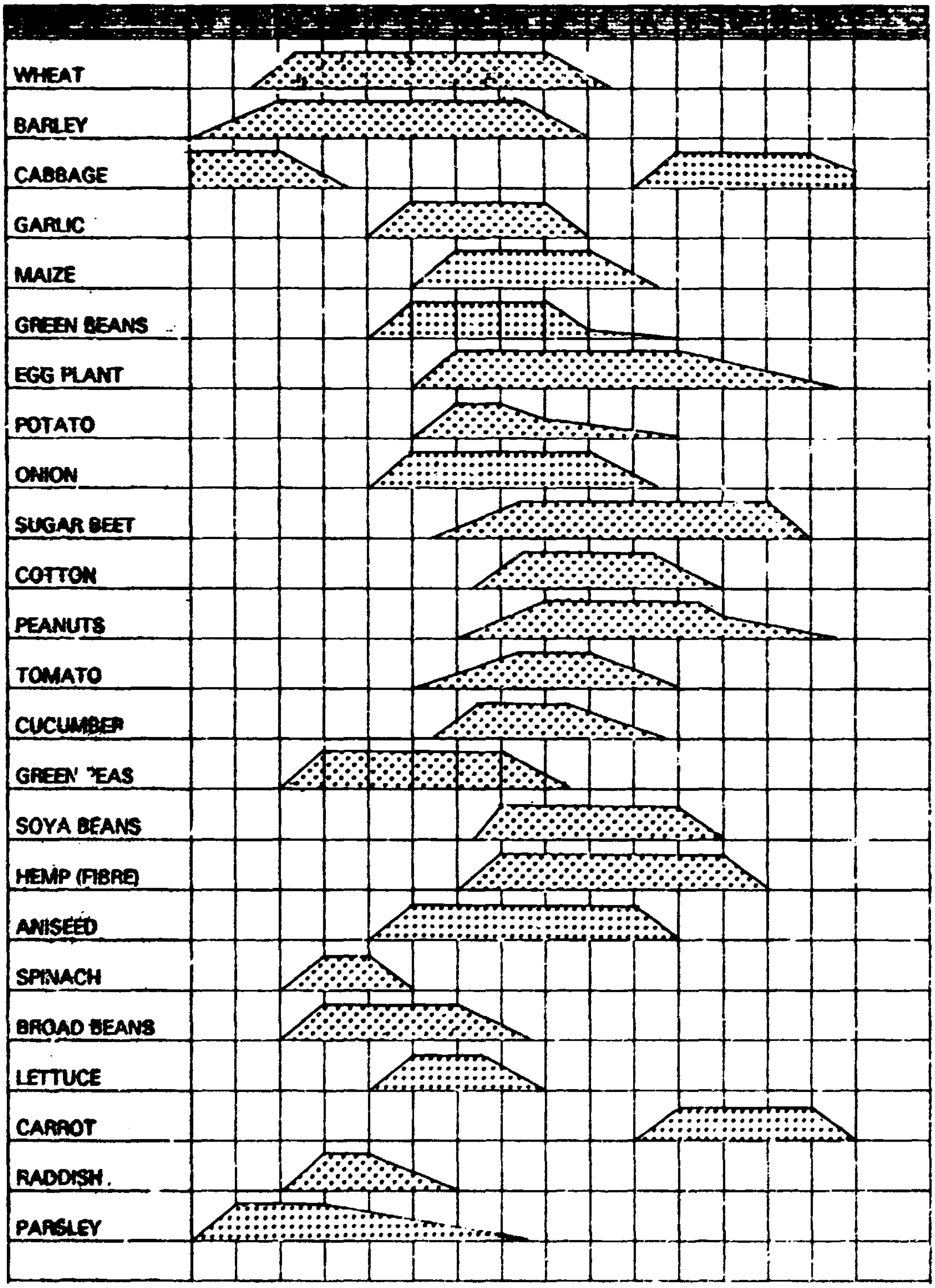
The quantities of fertilisers applied in the area are as follows:

Table 2 Fertiliser application in the Ghouta.

fertiliser	%	Kg/donam	Kg/Ha
Ammonium nitrate	33 N	25	80 N
triple phosphate	46 P	20	100 P
Potassium sulphate	50 K	15	75 K

Phosphorus and potassium are always applied; nitrogen is not applied in the case of leguminous plants. The ammonium nitrate, when given to irrigated soils, is a fertiliser of high environmental impact. Every three years organic manure is applied to the soils at a rate of 1-2 tons per Ha (Syrian fertiliser).

FIGURE 6-MAIN CROPS OF THE GHOUTA



Based on UNSF Project 101 Damascus Research Station Report by Kunert H. & Ali Jabri 1965

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FIGURE 7

FIGURE 7a - Herbaceons Crops per Donam (1000 mq) for the year 1993

VILLAGE	H.P WHEAT Donam	GRAZIN VETCH Donam	GRAZIN BARLEY Donam	GREEN BEANS Donam	DEAP BEAT Donam	LETUCE Donam	CABBAGES Donam	GRAZIN CLOVER Donam	SPANES Donam	CAULI FLOW Donam	RADICH Donam	MAIZE Donam	GREEN HARIC Donam	TOMATO Donam	EGG PLANT Donam	OKRA Donam	CUCUMBER Donam	SQUASH Donam	GRAZIN ALFA Donam	BROAD BEANS Donam	GREEN ONIONS Donam	VETCH Donam	HARICOT BEANS Donam	POTATO Donam	OTHER VEGET Donam	GREEN B BEANS Donam	TOTAL Donam
1. SAKRA	160	1	6									30	60		50		3	10	90				5		15		429
2. KAFERAT.	250	40	15											10			5	30	246	5			10		13		614
3. JEBRIN	760	59	62			5	10		5		5			10	10				136	6		3			10	25	1109
4. HAZA	140	15	180	16		20			15			100	70				10	60							140		740
5. AFTERRES	280	32	24										45	5	5												386
6. NOHAND.																											0
7. BETBAWA	510	55	82			5	29		25	5		100	100	5	82		10		74	10		7			5		1094
8. KERBEN	450	105	190			10						50			85			70							30		990
9. AINTIGAMA	303	25	170		15	10			10		20	75	15		50	50		25	100						85		970
10. ZIRDIN	1100	44	49		20	30			35	50	25	76	30				25	40			25		40		25	50	1658
11. BETTATAL																											0
12. DER ASAF	2720	693		20	25	25			30	40	20	20	150	70			75	170	352	78	25	47	160	60	25	50	4777
13. MELEHA	780	25	45	5			10						5			15		25	95	7		1		10	45		1061
14. ZAMAL.	100	30	150		10	50			15		30	25	15	20	35	30		15	25						10		540
15. JOBER		50	100		30	100	3	25	5	5		100	50	60	100	15	10	50	75						300	10	1080
TOTAL	7550	1175	1073	35	100	275	54	25	140	100	100	570	535	170	417	90	140	495	1193	106	50	58	215	70	703	135	15468

FIGURE 7b - Orchards per Donam (1000 mq) for the year 1993

VILLAGE	FIGS n.trees	FIGS Donam	OLIVES n.trees	OLIVES Donam	PEARS n.trees	PEARS Donam	APRICOTS n.trees	APRICOTS Donam	GREEN PLUMS n.trees	GREEN PLUMS Donam	PLUMS n.trees	PLUMS Donam	PEACH n.trees	PEACH Donam	POMME GRANATE n.trees	POMME GRANATE Donam	APPLES n.trees	APPLES Donam	QUINCE n.trees	QUINCE Donam	GRAPES n.trees	GRAPES Donam	TOTAL
1 SAKRA			50	2	8 340	278	2 300	100			1 050	35	1 120	28									443
2 KAFERAT			60	2			920	40	300	10			1 120	28									80
3. JEBRIN			160	5			9 200	400			4 410	147	10 000	250									802
4 HAZA	100	20	1720	200			4 410	210	1 343	4			75	3	160	20	70	3					460
5 AFTER			200	8	4 500	150	14 000	350	1 500	50	7 500	250	10 800	270			2 800	70	600	15	2 000	50	1 213
6 NOHAMDIA																							
7 BETBAWA	30	10	970	280	1 428	50	735	32	2 172	50	6 405	200	2 314	100	237	5	200	50	615	75	1 505	50	902
8 KERBEN	305	45	19 470	1 240	125	5	11 110	455	250	5	1 500	15	500	20	1 160	130					1 820	105	1 970
9 AINTERMA	100	20	395	85	200	10	2 310	110	4 620	110	1 680	70	2 750	270	180	20	480	20	330	20			735
10 ZIRDIN	295	35	150	6	6 000	200	45 000	1 500	16 000	230	7 770	259	33 560	339	220	8	400	100	730	18	430	10	2 675
11 BETTAJARASH																							
12 DER ASAFER			1 430	186	720	24	57 300	1 910	9 920	124	10 710	357	38 573	963			3 760	94			710	25	3 683
13 MELEHA			720	10	2 700	90	17 300	839	13 600	170	5 400	180	30 920	773			4 720	118			10 675	265	2 445
14 ZAMALICA	200	40	1 790	144	500	25	1 050	50	940	20	1 440	60	750	30	185	20	480	20			610	40	449
15 JOBER	595	30	1 879	91			284	12	236	10	65	2	148	6	695	25	26	1	191	7	1 487	47	234
16 BASSADEN	51	2	15	1	30	1	145	4			65	4	689	47	124	4	220	7	65	3	1 210	101	205
TOTAL	1726	202	28 499	2 260	24 523	833	168 056	5 962	5 981	7[illegible]	48 015	1 579	135 466	3 127	2 926	235	13 156	483	2 571	138	20 657	653	16 296

2.3. Irrigation.

In the Ghouta plain there are both surface water and groundwater.

The surface water comes to the Ghouta plain by the river Barada and the derived canals. At present the utilisation for irrigation of the surface water is forbidden, because of the actual high pollution. Previously the water was taken from the course upstream the utilisation by a small and provisional earth barrage and a small earth canal. The time of derivation conformed to affixed time schedule.

In the period 1975-1984 the total mean annual discharge of the Barada river and the canals at Raboue was (table 4) 9.18 m3/s and the mean annual discharge of the Barada river at Hameh 7.53 m3/s. As said in the paragraph 4.1.1., the mean monthly discharge for the last period 1984-1993 at Hameh in the dry months of August, September, October and November was respectively 2.9 m3/s, 2.2 m3/s, 1.2 m3/s, and ? m3/s.

These values are only indicative, because of the many derivations of water, the interconnection with the groundwater, and the many immissions of waste water along the Barada river and the canals between Hameh and the Ghouta plain.

As indicated in the table 5, the mean daily discharge of the Barada river at Raboue was sometimes zero or very low in the period 1974-1989.
Due to the increasing volume of water derived in the Barada basin for water supply (Paragraph 4.3.), it is logical to foreseen for the future a decreasing of natural water and an increasing of waste water.
In the past during the dry months the groundwater has been mainly utilised for the irrigation, and the surface water during the wet months.
According to the informations collected at the Ministry of Irrigation, there were about 17.000 drilled wells in the Ghouta plain in the year 1990.
The water is pumped and conveyed by pipes or earth canals to the field to be irrigated.
The pumps are electric of submerged type, and the depth of the well screen ranges between 40 m and 60 m.
The total abstraction from the aquifer is in summer about 20 m3/s, which corresponds to a mean discharge of 1.18 l/s for each well, but the discharge can vary between 1 l/s and 20 l/s. The average diameter of the wells is in the range of 20 cm-30 cm. With a drawdown of 1 m a discharge between 1 l/s and 5 l/s can be obtained in the plain according to the transmissivity value.

Previously surface water from the Barada and distributaries used to provide about 35 %, and groundwater about 65 % of the total irrigation water requirement in the Ghouta area.

In summer about 80% of groundwater and 20% of surface water were utilised for irrigation, while in winter the proportion reverses to 80% of surface water and 20% of groundwater.

In relation to the climate all the cultivable soils are irrigated, table 6 shows the irrigation scheduling in the Ghouta for tree crops.

The water applications for the tree crops have a maximum frequency of one irrigation every ten days (1 per week for the quince and continuous irrigation for walnuts).

Irrigation by surface waters is utilised on 8 percent of the total irrigated area and is prohibited during the summer season; however, as shown from our field survey of the study area, surface irrigation is widely applied also in the summertime with secondary canals still utilized during this period.

The periods of water application are decided at village level following an ancient use; the water application has a basis of 24 hours

In particular, the Director of the Agriculture Regional Office of Kafrbatna Eng. Agr. Mahmod Hason gave us detailed information about the agricultural activity of his district.

Table 3 The agriculture in Kafrbatna district.

Villages:	Kafrbatna, Sakba, Jesrin Haza, Aftrees, Mohandia		
Inhabitants:	52.000		
Ground water:	water table	average	4 - 8 meters
		maximum	2 - 12 meters
		fluctuation	6 meters

Water supply for irrigation:

Winter:	from river 80%	from wells 20%
Summer:	from river 20%	from wells 80%

Irrigation scheduling with the Barada river: 24 hour basis

Water quality: the yield are reduced by the use i) of polluted surface waters and ii) of calcareous water pumped by wells.

In the study area the groundwater is shown to be of good quality but in some parts of Barada and Dayani the water quality is poor.

Magnesium is a serious problem with the Ghouta deep waters; in a magnesium dominated water (ratio of Ca/Ma) <1) the potential negative effect of sodium may be slightly increased. In other words a given SAR value will show slightly more damage if the Ca/Mg ratio is less than 1; the lower the ratio, the more damaging is the SAR. One concern, however, is that productivity is sometimes reported to be low on soils being irrigated with high magnesium water even though infiltration problems may not be evident. The effect may be due to a magnesium induced calcium deficiency caused by high levels of exchangeable magnesium in the soil.

TAB.4

ZABADANI: Mean monthly and annual climatic values — Lat.33.43 Long.36.07 Elev. 1200 m

	J	F	M	A	M	J	J	A	S	O	N	D	YEAR
RAINFALL (mm)	115	107	78	37	17	0	0	0	1	13	53	99	520
TEMPERATURE (C)	4.7	5.2	8.4	[illegible]	16.4	21	23.[illegible]	24	20.8	16.3	10.8	6.1	14.1
TEMPERATURE (C) (Mean Max)	9	10.2	13.7	18.1	23.7	28.7	31.2	31.[illegible]	29.2	24.4	17.5	11.1	20.7
TEMPERATURE (C) (Mean Min)	0.3	0.3	3.1	6.1	9	13.4	15.9	16	12.4	8.2	4.2	1	7.5
TEMPERATURE (C) (Mean of the day)	6.3	7.1	10.3	14.[illegible]	19	23.8	26.3	26.7	23.7	19	13.1	7.7	16.4
TEMPERATURE (C) (Mean of the night)	3.5	3.9	6.9	10.3	13.9	18.3	20.5	20.6	17.1	12.5	7.7	3.6	11.6
WIND SPEED (m/s) (2 m above the soil)	1.9	2.3	2.8	3	2.9	3.3	3.5	2.9	2.1	1.8	1.5	1.6	2.5
POTENTIAL EVAPOTRANSPIRATION (mm)	22	34	72	105	159	217	246	214	142	89	34	19	1353
SUNSHINE (%)	50	54	60	65	73	85	87	85	81	72	67	55	69.5
TOTAL RADIATION (Cal (cm*day))	209	275.5	371.1	467	556.7	642.5	641.8	585.5	490	366	270.8	204.2	42[illegible].3
VAPOUR PRESSURE (Millibars)	6.6	6.4	6.9	8	9.7	10.7	11.9	12.5	12.5	10.9	8.9	7.1	9.3

Source: FAO-Agroclimatic Data Base

TAB. 5

BARADA RIVER AT HAMEH: Min. daily discharge: Period 1931-1984

YEAR	RABOUE (RIVER BED ONLY) m3/s	RABOUE Date	HAMEH m3/s	HAMEH Date
1931-32			1.2	29-31/1:1/2
1932-33			3.2	12-13/1
1933-34			5.5	25-30/9
1934-35			5.5	9-13/10
1935-36			5.1	26-28/10
1936-37			5.1	5-7/11
1937-38			5.8	1/1.25/9
1938-39			6.0	2/10
1939-40			4.5	29/10
1940-41			4.2	8/11
1941-42			5.4	12-14/10
1942-43			9.0	6-7/10
1943-44			8.5	28/1-1/2
1944-45			8.2	26-27/1
1945-46			5.8	25-30/9
1946-47				
1947-48			4.2	28-29/11
1948-49			6.5	1-2/23:26-28/10
1949-50			6.9	3-4/1
1950-51			5.1	21-25/9
1951-52			4.4	24-28/11:1-6/12
1952-53			5.9	22-24:27-30:10
1953-54			8.1	11/12
1954-55			5.3	21-2/9
1955-56			5.3	30/9
1956-57			4.9	4-7:12
1957-58			4.4	22-29:11
1958-59			3.4	9/9
1959-60			2.3	17/9
1960-61			2.1	26/7
1961-62			3.2	29/8:15-30/9
1962-63			3.3	19-20/10
1963-64			3.6	6.21.25/9
1964-65			3.8	6-9.17-23/12
1965-66			3.2	30-31/11
1966-67			3.1	22-24/11:1.2.30/12
1967-68			5.0	17-19/11
1968-69			4.3	7/12
1969-70			3.7	30/9
1970-71			3.0	12/12
1971-72			3.2	24/9
1972-73			1.5	27-30/9
1973-74			1.5	1/10

1974-75	0.09	8/9	1.9	18-21/9
1975-76	0.15	1/10	1.8	2/11
1976-77	0.09	/7	3.2	9-11/10
1977-78	0.04	/8	2.8	9/10
1978-79	0.00	25-26/8	0.94	13-23/8
1979-80	0.17	3/10	1.30	0.30
1980-81	0.18	7/10	3.02	1.2.29.30/10:12/11
1981-82	0.001	22/9	1.02	1-3/2;18-20/9
1982-83	0.01	1-2/10	1.02	4-5/10
1983-84	0.09	8/12	1.42	26/9
1984-85	0.45	1-2/8		
1985-86	0.95	1-3/10		
1986-87	0.00	/7		
1987-88	0.22	21-26/10		
1988-89	0.17	28-31/10		

PERIOD	1974-1989		1931-1984
No of values	15.00		52
AVERAGE	0.17		3.98
MAX.VALUE	0.95		9.00
MIN.VALUE	0.00		0.94

PERIOD	1969-1984
No.of values	15
AVERAGE	2.09
MAX.VALUE	2.28
MIN.VALUE	0.94

PERIOD	1931-1969
No.of values	37
AVERAGE	4.74
MAX.VALUE	9.00
MIN.VALUE	1.20

	1975-1984
	9
	1.83
	3.20
	0.94

Source: Ministry of Irrigation

GHOUTA TREE CROP CALENDAR - HARVEST PERIODS AND IRRIGATION APPLICATIONS

CROP		J	F	M	A	M	J	J	A	S	O	N	D
OLIVES	Irrn.	-	1	-	1	2	2	2	2	2	1	1	1
	Picking										5	15	7
GRAPES	Irrn.	1	1	1	2	3	3	3	3	2	1		
	Picking							20	30	50			
APRICOTS	Irrn.	1	2	2	3	3	3	3	3	2	1	1	1
	Picking						20	12					
APPLES	Irrn.	1	1	1	1	2	2	3	3	2	2	1	1
	Picking								24	24			
WALNUTS	Irrn.	Trees grown alongside canals - continuous irrigation											
	Picking									15	25		
PEARS	Irrn.	-	1	1	1	2	3	3	3	2	1	1	1
	Picking								24	24			
PEACHES	Irrn.	1	2	2	3	3	3	3	3	2	2	1	1
	Picking						40	20	20				
PLUMS	Irrn.	1	1	1	1	2	3	3	3	2	1	1	1
	Picking								20	20			
GREEN PLUMS	Irrn.	1	2	2	3	3	3	3	3	2	1	1	1
	Picking					15	25						
QUINCE	Irrn.	1	1	2	3	3	4	4	4	4	3	2	1
	Picking								6	10			

NB Picking units on man days per dunum i.e. man days per 1/10 ha.

Table 6

2.4. Soils.

The soils in the Ghouta are man made and considerable variation in physical characteristics occur over short distances; they are generally black heavy textured clays of varying depths overlying unconsolidated rock. They are highly calcareous heavily manured over centuries.

In the study area one profile of a well structured alluvial soil having a depth of 2 meter, fine roots up to 150 cm has been described

The permeability rates of the Ghouta soils are high enough to be considered suitable for surface irrigation and ground water recharge.

The fact that the soils are alkaline in reaction is a favourable element for their utilisation for waste distribution but the clayey texture of the first horizon is a negative element for the use of waste waters distribution.

At the same time the high permeability of the deep horizons and of the underlying strata is a negative element when irrigation is made with polluted waters and pollutants reach the capillary fringes of underground sources before purification occurs.

Soils appear degraded possibly because they are intensively cultivated all year round; the annual crop intensity is relatively high, up to five plantations of radish per year

2.5. Agriculture.

From field reports and interviews with agricultural experts and farmers information it has been noted a negative environmental effect by the use of polluted waters and urban composts not always suitable for this particular environment.

There is evidence of diffuse plant injury. The annual crops show a good vegetational status but for trees the most evident and largely diffused phenological symptom is the chlorotic status of the leaves often associated with necrosis and death of the young woody parts of the plant.

The chlorotic status of the crops (peaches in particular) is likely related to the high content of carbonates in the soil.

In Wady street, 50 meters from Dayani river has been noted a field of cash crop consisting of "populus" 2 years old irrigated with surface water, completely destroyed.

The crops also suffer because of the soil degradation; the yield decreased in recent years because of the increase of soil salinity, water and soil pollution and the high cropping pattern.

The chloride concentration of the water of wells 61 and 14K is higher than the values accepted as upper limits for the leaf injury of crops.

Other problems concern the excess nitrogen in waters. Sensitive crops may be affected by nitrogen concentration above 5 mg/l; most other crops are relatively unaffected until nitrogen exceeds 30 mg/l. For example grapes are sensitive crops and may continue to grow late into the season at the expense of fruit production; yields are often reduced and grapes may be late in maturing and have a lower sugar content. Experience in Libya indicated that almost no fruiting occurred in grapes when a water containing more than 50 mg/l of N was used continuously. Maturity of fruit such as apricot may be delayed and the fruit may be poorer in quality. In many grain crops excessive vegetative growth produce weak stalks resulting in severe logging; logging is a serious problems in areas with high winds or periodic heavy rains.

The agricultural framework of the area has changed by introducing new species and varieties which are more resistant to diseases while still economically viable.

There is a different vegetative situation in relation to trees and herbaceous crops; the first show chlorotical suffering (peach in particular).

The agricultural framework of the area has changed during the last few years by introducing new crops more resistant to soil salinity.

2.6. Livestock

The livestock presence in the area is given in table 1; we have directly recorded the presence of cow sheds with over 50 cows.

The main problems arising for the breeders, as verified during our survey, come from the low quality of drinking water; animals are said to refuse drinking water coming from some wells close to the river beds.

The water quality guide on livestock and poultry indicated by FAO [1] indicates for a suitable water a concentration less than 21 me/l of magnesium; in some cases the magnesium concentration of the wells of the study area is over the limit (well 105K) or near the limit (well 61)

For what regards the nitrogen content of the deep waters, ruminants are sensitive to nitrogen and heavy applications to pastures used for direct or indirect livestock feed may cause excessive quantities to accumulate in the forage.

For what concerns surface waters there are a number of toxicants which include many inorganic elements, organic wastes or pathogenic organisms that may be directly toxic to animals. These agents make the water unpalatable or accumulate in the animal.

Toxicity problems for livestock are amplified when the used forage is also irrigated with the same potentially toxic water combining to exceed the critical levels.

Livestock poisoning by nitrates or/and nitrites do not occur with actual levels; though high nitrogen concentration may cause growth of algae in watering points with possible presence of toxins.

3. CLIMATE.

The climate of the project area is illustrated in the tables 7, 8, 9, where mean monthly and annual values are indicated for the stations of Damascus-International Airport, Damascus, and Kharabo (See figure 8). The sources of the climatological data are [25], [26], and [15], and the Ministry of Defence-Meteorological Department. The climatic parameters include rainfall, temperature, wind speed, potential evaporation and evapotranspiration, sunshine, total radiation, relative humidity, vapour pressure. The three stations are very close together, but have different above sea level elevation ranging from Damascus (729 m) situated inside the city and the two stations situated in the Ghouta plain, namely Damascus-International Airport (611 m) and Kharabo (620 m).

In the follow text the stations of Damascus-International Airport, Damascus, and Karabo will be called respectively A, B and C.

The annual rainfalls are 190 mm in A, 229 mm in B, and 167 mm in C.

The highest monthly rainfalls are 46 mm in A, 58 mm in B, and 37 mm in C all of them in December.

In June, July, August, and September the rainfalls are zero in the three stations. The maximum rainfall in one day was recorded in C in November with 78 mm.

The mean annual temperatures are 15.4 °C in A, 16.3 °C in B, and 15.6 °C in C.

The highest mean monthly temperatures are 26.1 °C in A in August, 27.2 °C in B in July, 24.9 °C in C in July.

The lowest mean monthly temperatures are 6.6 °C in A, 7.2 °C in B, and 6.1 °C in C, in January.

The highest values for the mean maximum monthly temperature are 35.7 °C in A in July and August, 36.1 °C in B in August, and 36.1°C in C in August.

The lowest values for the mean minimum monthly temperature are 0.6 °C in A, 2.6 °C in A and B in January.

For the daily hours in B the mean annual temperature is 18.4 °C, the highest mean monthly temperature is 30 °C in August, and the lowest mean monthly temperature is 9.2 in January.

For the night-hours in B the mean annual temperature is 13.5 °C, the highest mean monthly temperature is 22.9 °C in August, and the lowest mean monthly temperature is 6.1 in January.

The highest value of the absolute maximum temperature in C was 44 °C in July and August.

The lowest value of the minimum absolute temperature in C was -11 °C in December.

The mean annual wind speed in A is 2.5 m/s, in B is 2.3 m/s, and in C is 1.4 m/s.

The highest values of the mean monthly speed are 4.1 m/s in A in July, 3.4 m/s in B in June an July, and 1.9 m/s in C in March.

The maximum wind speed in C is 23 m/s, and these values were recorded in January, February, March, and December.

The prevailing wind direction is West in all months, except for July when is West-SouthWest.

The annual potential evapotranspiration is 1525 mm in A, and 1667 mm in B.

The mean daily evaporation is 3.6 mm in C, corresponding to a mean annual evaporation of 1314 mm.

The mean annual sunshine is 66.3 % in A and 68.7 % in B, while in C the mean daily sunshine is of 8.9 hours.

The mean total radiation is 396.1 Cal/(cm*day) in A and 404.9 Cal/(cm*day) in B

The mean annual relative humidity is 42.9% in A, where the highest mean monthly humidity is 70% in March and the minimum is 27.8%in June. In C the maximum monthly recorded value was 100% in all months, except September (99%), and the minimum monthly recorded value was 2% in April.

The mean annual vapor pressure is 10.0 millibars in A and 8.9 millibars in B.

In the table 4 the same climatic parameters considered in the tables 7, 8, and 9 are indicated for the station of Zabadani,which has elevation of 1200 m a.s.l. and is situated in the upper part of the Barada river (See Fig.8). It is interesting to point out here the value of the mean annual rainfall, which is 520 mm and is quite different from the values of the other three examined stations.

In the figure 8 a general plan of the Barada river basin is represented, together with the mean annual isohyets in mm. From this figure rainfall of more than 1000 mm can be observed in the upper Barada river basin, and rainfall less than 100 mm in the last reach of the river.

The hydraulic alimentation of the Barada river basin occurs therefore mostly in the mountains, where the precipitations are quite high.

TAB. 7

DAMASCUS-INTERNATIONAL AIRPORT: Mean monthly and annual climatic values

Lat.33.25 Long.36..3114 Elev.611 m

	J	F	M	A	M	J	J	A	S	O	N	D	YEAR
RAINFALL (mm)	35	32	24	12	5	1	0	0	0	10	25	46	190
TEMPERATURE (°C)	6.6	8.3	11.5	15.8	20.1	24.3	26.1	26	22.7	18.1	12.3	7.9	16.6
TEMPERATURE (°C) (Mean Max)	12.6	15.1	19.2	24.3	29.6	34	35.7	35.7	32.7	27.7	20.3	14.3	25.1
TEMPERATURE (°C) (Mean Min)	0.6	1.6	3.9	7.3	10.7	14.5	16.6	16.3	12.8	8.6	4.2	1.6	8.2
WIND SPEED (m/s) (2 m above the soil)	2.2	2.5	2.8	3.2	2.9	3.2	4.1	3.4	2.4	2	2	2	2.7
POTENTIAL EVAPOTRANSPIRATION (mm)	28	45	86	151	196	235	276	234	156	107	45	26	1585
SUNSHINE (%)	52	61	63	64	77	83	85	87	85	82	67	56	71.8
TOTAL RADIATION (Cal (cm²·day))	223.6	304.1	389.1	467.9	571.1	618.5	616.4	580.4	496.3	394.6	273.7	213.8	429.1
RELATIVE HUMIDITY (%)	70	65.3	50.6	42	36	27.8	31.7	33.9	37.7	42.3	53	67.2	46.5
VAPOUR PRESSURE (Millibars)	7.4	7.5	7.9	9.5	11.1	13.1	15.6	16.8	14.3	10.6	8.9	7.8	10.9

Sources: FAO-Agroclimatic Data Base; FAO-"Agroclimatological Data-Asia-Vol.2"-1987

TAB. 8

DAMASCUS: Mean monthly and annual climatic values

Lat.33.29 Long.36.14 Elev.729 m

	J	F	M	A	M	J	J	A	S	O	N	D	YEAR
RAINFALL (mm)	54	37	25	15	7	0	0	0	0	7	26	58	229
TEMPERATURE (°C)	7.2	8.7	11.7	16.2	21.1	25.5	26.9	27.2	23.9	20	14.1	9.4	17.7
TEMPERATURE (°C) (Mean Max)	12.2	14.1	17.8	22.9	28.4	33.7	35.7	36.1	32.1	27	19.9	14.3	24.5
TEMPERATURE (°C) (Mean Min)	2.6	3.2	5.2	8.6	12.6	16.3	17.1	17.5	15	12.3	7.9	4.4	10.2
TEMPERATURE (°C) (Mean of the day)	9.2	10.7	13.8	18.4	23.4	28.1	29.7	30	26.5	22.1	15.9	11	19.9
TEMPERATURE (°C) (Mean of the night)	6.1	7.2	9.7	13.6	17.8	21.9	22.7	22.9	19.8	16.2	11	6.9	14.7
WIND SPEED (m/s) (2 m above the soil)	2.1	2.3	3	3.1	2.9	3.4	3.4	2.9	2.1	1.8	1.5	1.8	2.5
POTENTIAL EVAPOTRANSPIRATION (mm)	32	47	97	152	207	267	277	243	163	107	46	29	1667
SUNSHINE (%)	53	59	68	71	79	88	90	90	87	77	75	56	74.4
TOTAL RADIATION (Cal (cm*day))	225.4	298.6	405.3	495.2	579.7	640.9	638.3	592.5	503.2	380	291.2	213.5	438.7
VAPOUR PRESSURE (Millibars)	7.2	7.2	7.4	8.2	9.5	10.4	12.4	13.3	12.1	10.2	9	8.3	9.6

Source: FAO-Agroclimatic Data Base

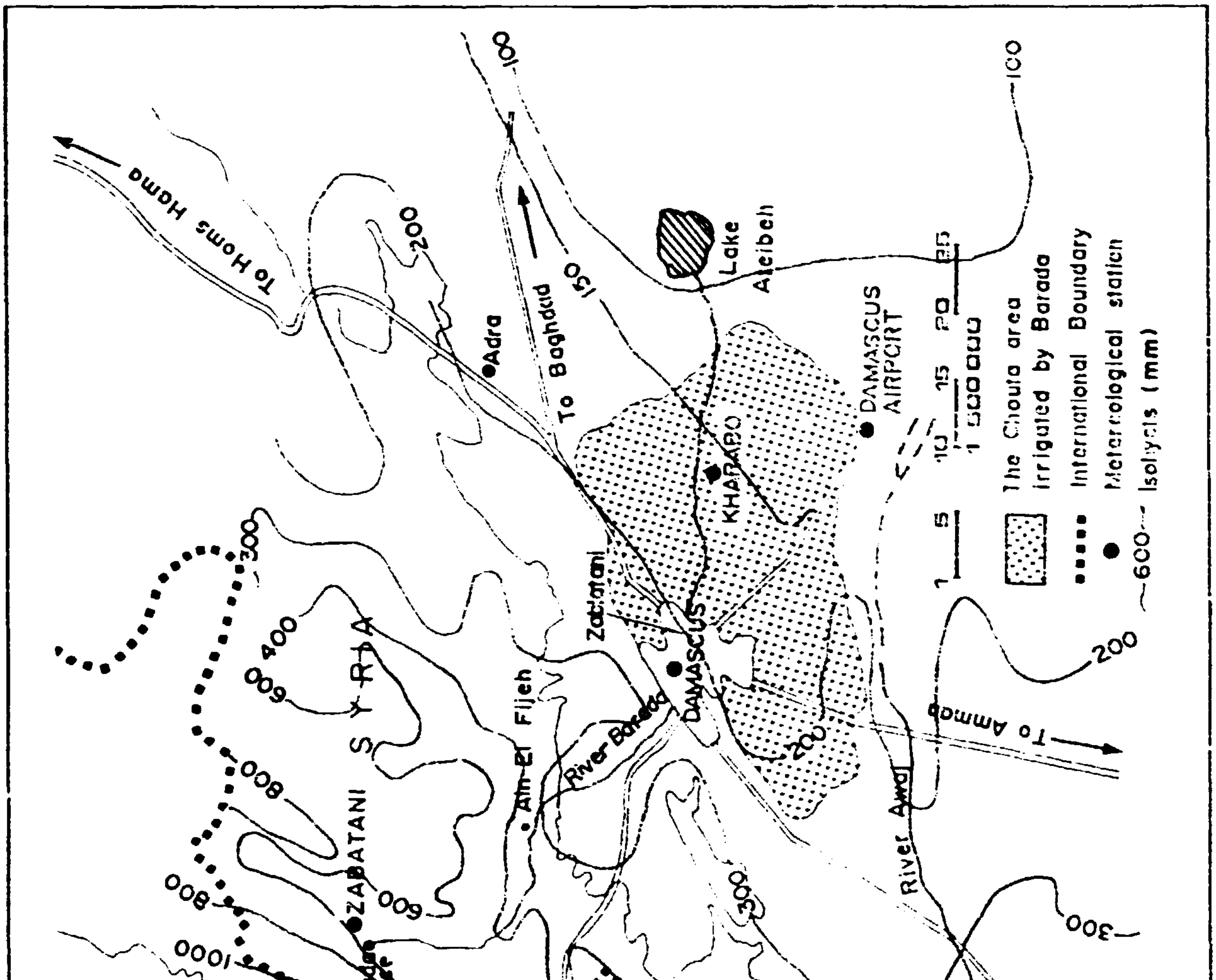
TAB 9

KHARABO Mean monthly and annual climatic values — Lat 33 30 Long 36 28 Elev 620 m

	J	F	M	A	M	J	J	A	S	O	N	D	YEAR	PERIOD
RAINFALL (mm)	33.3	29.5	18.9	13.6	5.5	0.1	0	0	0.1	5.9	22.8	37.3	167	1946-1984
TEMPERATURE ( )	6.1	7.6	11.1	15	19	23.2	24.9	24.5	21.9	17.3	11.9	7.3	15.8	1956-1983
TEMPERATURE ( ) (Mean Max	12.2	14.2	18.1	23.2	28.8	33.6	35.8	36.1	33.1	27.8	20.7	13.9	24.8	1946-1983
TEMPERATURE ( ) (Mean Min)	0.6	1.4	3.9	6.3	9.1	11.5	12.5	12.9	10.7	7.4	4.1	1.4	6.8	1946-1983
ABSOLUTE MAXIMUM TEMPERATURE ( )	23	25.2	32	35	38	41	44	44	39.5	37	30	24.4	44	1956-1983
ABSOLUTE MINIMUM TEMPERATURE ( )	-10.6	-8	-2	2	1.7	5	7.1	6.3	3	-1.9	-8	-11	-11	1956-1983
WIND SPEED (m/s) (2 m above the soil)	1.7	1.8	1.9	1.8	1.4	1.5	1.3	1	0.8	0.9	1.1	1.3	1.4	1968-1983
PREVAILING WIND DIRECTION	W	W	W	W	W	W	WSW	W	W	W	W	W	W	1958-1984
MAXIMUM WIND SPEED (m/s)	23	23	23	16	20	20	20	13	16	16	20	20	23	1958-1984
HIGHEST RELATIVE HUMIDITY (%)	100	100	100	100	100	100	100	100	99	100	100	100	100	1968-1983
LOWEST RELATIVE HUMIDITY (%)	13	10	9	2	5	5	6	6	8	4	4	16	2	1968-1983
DAILY AVERAGE EVAPORATION (mm)	1.2	1.9	2.7	3.5	4.5	5.9	6.3	6.6	4.5	3.1	2	1.3	3.6	1964-1983
MAXIMUM RAINFALL IN ONE DAY (mm)	19.4	28.4	30.1	20.2	26.4	0.2	0	0	1.9	22.4	77.7	40.6	77.7	1956-1984
DAILY SUNSHINE (hours)	5.1	6.3	7.5	8.5	10.5	12.2	12.2	11.8	10.5	9.3	7.3	5.3	8.9	1968-1983

Sources Ministry of Defence-Meteorological Departement-Damascus

FIGURE 8 - DAMASCUS, THE BARADA RIVER AND THE GHOUTA PLAIN; MEAN ANNUAL ISOHYETS



Source: 'water resources use in Barada and auvage basins for irrigation of crops' feasibility study. USSR Selz Knoz Promexport. Moscow

4. WATER RESOURCES.

4.1. Surface waters.

4.1.1. Balance.

The river Barada flows through Damascus (See figure 8), where its basin is of about 840 km2, after an initial course about 34 km long and 0.01 pendent. This river has its source at the foot of the calcareous Lebanon mountains, at an elevation of 1100 m a.s.l. Due to a dam constructed immediately downstream the source, a little artificial lake is formed, where pumping stations for irrigation and water supply purposes are installed.

On the left side of the river, at elevation of 823 m, there is another important source, the Ein Al Fijeh spring, which has a mean discharge of about 8 m3/s. A large part of this discharge, that is about 7.5 m3/s, is conveyed by tunnel to the Damascus aqueduct.

At Hameh (See figure 9) begins the derivation of water from the river into six canals or branches.

Six kilometres downstream, at Raboue, just upstream of Damascus, where the narrow valley ends, all the six man made and very old canals are already derived. These canals are: Mezzauoi, Dirani, Kanawat and Banias on the right side, and Yazid and Tora on the left side

All the six derived canals have a limited course, since their waters are used for the irrigation or because they seepage through the soil.

The Barada river after Raboue has a course 38 km long, and its final destination is the lake Aateibe, which is now nearly always dry.

In the figure 8 another important river can be seen, the Awaj, which flows eastwards South of Damascus and, just as the Barada river, it ends in the Ghouta plain.

The discharge of the Barada river is continuously measured immediately downstream of the inlet of the effluent of the Ain El Fijeh spring by a limnimeter, at Hameh by a limnigraph and at Raboue by a limnimeter.

In the table 10 the mean annual discharge for all the years of the period is indicated for the Barada river downstream the Ain El Fijeh spring (1941-1984), at Hameh (1931-1993), at Raboue (1975-1988) for the river only and (1975-1986) for the river plus the six canals and for the canals only (1975-1986). The source is the Ministry of Irrigation.

In the table 10 the mean, the maximum, and the minimum value of the period is also indicated.

The mean values of the whole period are: 7.9 m3/s downstream the Ain El Fijeh springs, 10.3 m3/s at Hameh, 3.1 m3/s at Raboue for the river only, 9.2 m3/s for the river plus the canals, and 5.2 m3/s for the canals only.

From table 10 it can be observed that at Hameh the mean annual discharge of the latest period 1969-1993 (6.6 m3/s) is quite lower than the former period 1931-1968 (12.6 m3/s). That may be mainly due to the increasing derivation for the aqueduct of Damascus from the Ain El Fijeh spring. Furthermore there is an increasing abstraction of water from the river and from the aquifer by the villages of the Barada basin upstream of Damascus.

It is also interesting to note that at Raboue, in the period 1975-1984, the mean annual total discharge of the Barada river plus the canals (9.2 m3/s) was higher than the mean annual discharge of the upstream station in Hameh (7.5 m3/s). That is almost certainly due to the infiltration of groundwater into the water courses.

All the canals branch off from the Barada river through an intake constituted by a weir, such as that the discharge of the Barada river is proportionally distributed among the canals.

Therefore the monthly discharges of the canals and the Barada downstream the deviations are estimated by the local authority assuming for each water course a fixed percentage of the total discharge measured at Raboue. These percentages are also in conformity to the rights of the users.

In order to give an idea about the potential mean annual discharge of the canals and of the Barada river at Raboue after the deviations, their values for the year 1975-1976, just as they have been considered in the "Damascus Sewerage Master Plan Study" of the year 1978 [2], are here indicated:

on the right side:

- Mezzauoi	0.30 m3/s
- Dirani	1.19 m3/s
- Kanawat	0.36 m3/s
- Banias	0.86 m3/s
Tot.	2.71 m3/s

and on the left side:

- Yazid	1.49 m3/s
- Tora	1.99 m3/s
Tot.	3.48 m3/s
Tot. canals	6.19 m3/s

- Barada river after the derivations: 4.14 m3/s

The total discharge of the canals and the Barada river at Raboue was therefore estimated at 10.3 m3/s.

The discharge percentage of each canal and of the Barada river (in m3/s) results:

- Mezzauoi	0.03
- Dirani	0.12
- Kanawat	0.04
- Banias	0.08
- Yazid	0.14
- Tora	0.19

- Barada river after the derivations: 0.40

It must be said that the percentages were calculated for each canal and for each month, and for each canal the monthly values resulted quite different.

According to the Ministry of Irrigation, at Hameh the mean monthly discharges of the river (in m3/s) for the period 1931-1993 are:

J	F	M	A	M	J	J	A	S	O	N	D
7.3	10	15.1	21.6	18.6	11.5	7.6	6.1	5.3	5.1	5.4	8.3

and the mean annual discharge is 10.3 m3

It must be pointed out that for the last ten years (1984-1993) the mean monthly discharges at Hameh were quite lower, that is:

J	F	M	A	M	J	J	A	S	O	N	D
2.5	3	9.8	23.2	23.8	12.5	5.3	2.9	2.2	1.2	2	1.9

and the mean annual discharge 7.5 was m3/s

For the present study it is important to point out that the Barada river and the Dayani canal pass trough the Zablatani Industrial Area. This canal and the Akrabani canal are derived from the Barada river about 1.5 km upstream of the industrial area, and so the discharge of the river is divided in three parts.

The minimum monthly values of the discharge (in l/s) in dry periods and in the driest month (September) were calculated for the Barada river and the canals Dayani and Akrabani near the industrial area of Zablatani, in the "Damascus Sewage Master Plan Study" [2]. These values have a return period of 5 years and are concerned to the years 1977 and 2001. They are:

Dayani	105 l/s for the year 1977	82 l/s for the year 2001
Barada	123 l/s for the year 1977	88 l/s for the year 2001
Akrabani	306 l/s for the year 1977	118 l/s for the year 2001

The minimum monthly sewerage discharges are indicated for the same reaches of water courses in the "Damascus Sewage Master Plan" [2]. They are:

Dayani	596 l/s
Barada	184 l/s
Akrabani	288 l/s

The evaluation of the discharge above indicated and the percentage discharge of each canal and of the Barada river downstream Raboue was made taking into account the results of a campaign of hydrologic measurements and researches carried out during the studies for the Master Plan. During a year the daily discharge of the river and canals was measured at Raboue and compared with the total discharge in the same site, in order to obtain for each day and for each water course the discharge percentage.

It is necessary however to remark that, according to informations collected by the Ministry of Irrigation, only one discharge measurement every two years is at present carried out in the canals at Raboue. Furthermore neither limnimeters nor limnigraphs are installed in the canals. A good appreciation of the percentage of the Barada discharge deviated into each canai seems therefore quite unlikely, and in any cases perhaps valid near the intakes. Even more unlikely it looks when applied to the downstream reaches considering, mostly in Damascus, the frequent mixing between surface water and groundwater.

Regarding the minimum discharge of the Barada river and the Dayani canal at Zablatani, reference can be made to the table 4 (Source: Ministry of Irrigation), where the minimum annual value of the discharge at Hameh and at Raboue is indicated respectively for the periods 1931-1984 and 1974-1989. From the table 10 can be observed that:

- at Hameh the minimum daily discharge of the period 0.94 m3/s during the days from 13th to 23rd August 1979;
- at Raboue the minimum daily discharge was zero or close to zero at least five times in the last eleven years;
- such as for the mean annual discharge (table 10) also the minimum daily discharge has decreased in the last years.

It can be therefore concluded that in some past days at Zablatani the Barada river and its derived canal Dayani didn't have natural discharge coming from Raboue. It cannot be excluded anyway that in the same days a not assessable discharge had been present, besides the waste water, due to infiltration from the aquifer. In the future the possibility exists of other days without any natural discharge in the Barada river at Raboue and consequently at Zablatani.

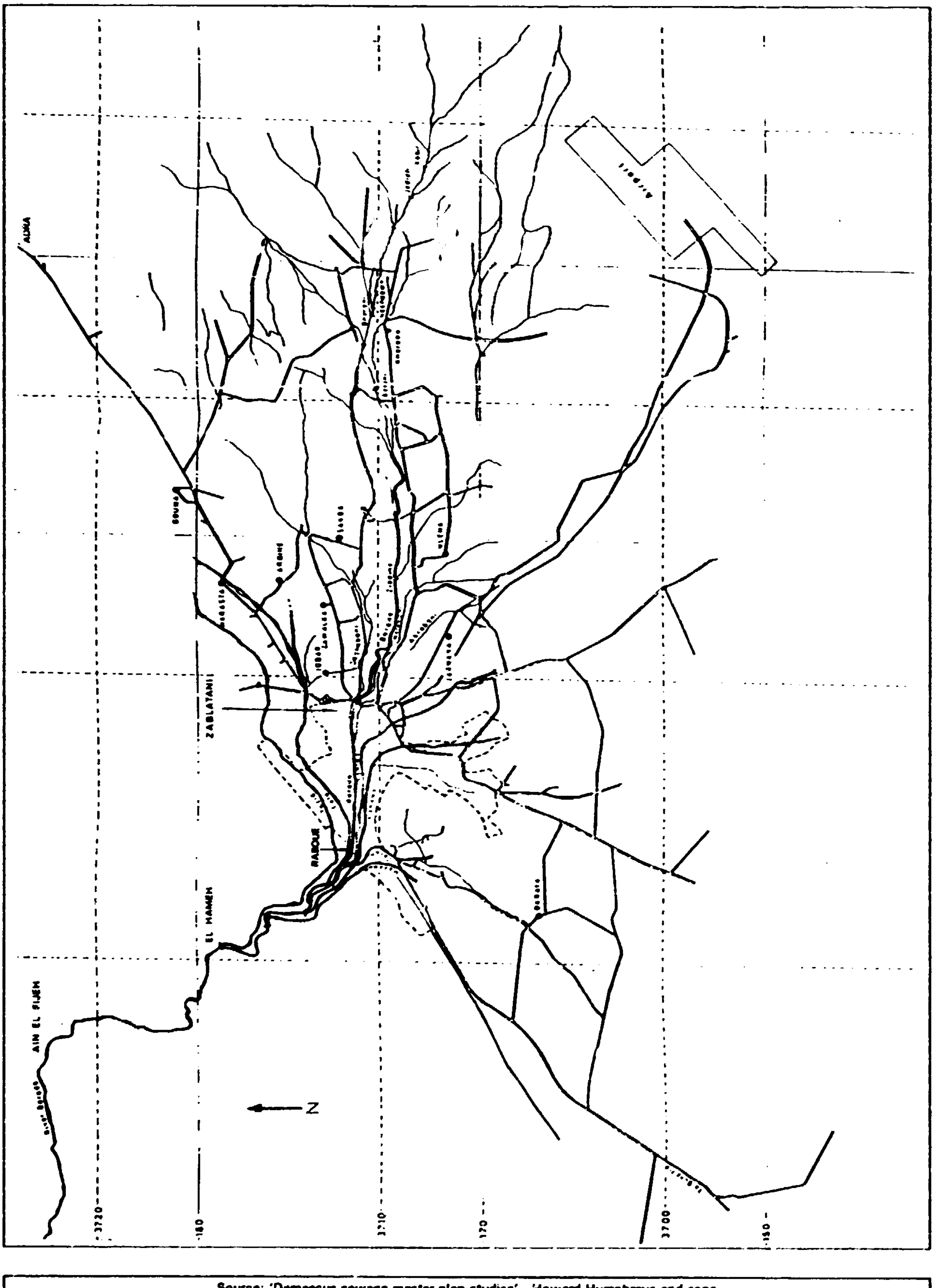
TAB.10

BARADA RIVER AT HAMEH AND RABOUYE, AND AIN EL FIJEH SPRINGS: Mean annual discharges (m3/s)

YEAR	RABOUE	HAMEH	AIN EL FIJEH	RABOUE	CANALS
	(RIVER BED ONLY)		SPRINGS	(BARADA+CANALS)	
1931-32		24,2			
1932-33		15,9			
1933-34		16,7			
1934-35		23,5			
1935-36		18,1			
1936-37		10,4			
1937-38		14,3			
1938-39		13,5			
1939-40		12,1			
1940-41		13,0			
1941-42		15,5	11,60		
1942-43		15,6	10,50		
1943-44		17,0	10,60		
1944-45		19,2	11,60		
1945-46		14,1	8,82		
1946-47		-	7,82		
1947-48		11,3	8,42		
1948-49		15,4	10,90		
1949-50		13,6	10,30		
1950-51		8,63	6,69		
1951-52		13,9	10,40		
1952-53		16,4	12,20		
1953-54		17,8	12,80		
1954-55		9,45	6,51		
1955-56		10,8	7,69		
1956-57		9,02	6,56		
1957-58		8,47	5,87		
1958-59		7,57	5,08		
1959-60		4,08	2,67		
1960-61		4,66	3,53		
1961-62		8,62	6,53		
1962-63		8,42	6,39		
1963-64		9,10	6,85		
1964-65		10,50	8,01		
1965-66		6,51	5,76		
1966-67		12,20	9,42		
1967-68		12,80	10,40		
1968-69		17,50	12,90		
1969-70		8,74	7,28		
1970-71		8,88	7,23		
1971-72		7,40	6,81		
1972-73		4,16	4,96		
1973-74		7,68	6,37		
1974-75		6,50	5,96		
1975-76	4,14	8,75	8,52	10,3	6,16
1976-77	4,60	8,71	7,67	10,7	6,10
1977-78	5,33	10,10	8,39	12,4	7,07
1978-79	0,73	3,64	4,52	4,75	4,02
1979-80	4,80	8,99	7,70	11,2	6,40
1980-81	6,18	9,60	7,68	12,3	6,12
1981-82	2,15	4,47	5,77	5,42	3,27
1982-83	4,36	7,52	7,86	8,64	4,28
1983-84	3,28	5,99	7,11	6,93	3,65
1984-85	1,30	5,15			
1985-86	1,81	2,96			

1986-87	0,90	7,25			
1987-88	1,21	9,02			
1988-89		2,39			
1989-90		1,78			
1990-91		2,74			
1991-92		9,90			
1992-93		7,36			
PERIOD	1974-1988	1931-1993	1941-1984	1975-1984	1975-1984
No.of values	13	62	43	9	9
AVERAGE	3,14	10,31	7,92	9,18	5,23
MAX.VALUE	6,18	24,20	12,90	12,40	7,07
MIN.VALUE	0,73	1,78	2,67	4,75	3,27
PERIOD		1969-1993	1969-1984		
No.of values		24	15		
AVERAGE		6,65	6,92		
MAX.VALUE		10,10	8,52		
MIN.VALUE		1,78	4,52		
PERIOD		1931-1968	1941-1968		
No.of values		38	28		
AVERAGE		12,63	8,46		
MAX.VALUE		24,20	12,90		
MIN.VALUE		0,00	0,00		
		1975-1984			
		9			
		7,53			
		10,10			
		3,64			
Source: Ministry of Irrigation					

FIGURE 9-BARADA RIVER AND DERIVED CANALS



Source: 'Damascus sewage master plan studies' - Howard Humphreys and sons

4.1.2. Quality.

The main problems are the very high degree of pollution of the surface waters at any level (chemical, physical, biological) and the moderately high degree of ground water pollution. The surface water and the ground water are under continuos surveillance because of their actual and potential pollution risk.

The water carried in the Ghouta rivers and streams is considered to consist of a proportion of base flow (BF) and a proportion of sewage waters (SEWA); the ratio BF/SEWA ranges from about 10 to 1, in the mountain area and/or during the rainy season and 0.1 to 1 after Damascus city and/or during the dry season. For this reason, the salt concentration in the river water that normally is a product of rainfall, erosion, mineralisation and ground water accessions, in the Goutha plain is mainly a product of natural water from springs and of sewage waters with a fraction of ground water inflows and runoff.

An algal development and a high quantity of organic and mineral sediments in the Barada and Dayani river beds has been verified; no life form such as mammal or fish is present in the river except rats. The Melehani river shows a lower pollution level which is indicated by the survival of high green aquatic plants into the river bed.

Studies on the surface water have been carried out by many international teams and the results have always shown the high pollution level; in the following table the chemical characteristics of water samples collected from Barada and Dayani rivers in the month of June 1977 by HHS [3] are shown.

Table 11 Chemical characteristics of the Barada and Dayani waters collected in June 1977.

River	Barada		Dayani		White Barada	
	mg/l	me/l	mg/l	me/l	mg/l	me/l
pH	7.00		7.29		7.77	
EC mho/cm	1.14		0.85		0.92	
HCO_3	234	3.8	189	3.1	226	3.7
Cl	117.1	3.3	60.7	1.7	52.1	1.5
Na	69.6	3.0	56.6	2.5	30.0	1.3
K	10.0	0.25	10.5	0.27	2.9	0.07
Ca	123.6	6.2	196.8	9.8	121.6	6.1
Mg	13.6	1.1	13.2	1.1	18,4	1.5
SAR	1.58		1.05		0.67	
Adj	3.63		2.41		1.54	
Fe	0.48		3.9		0.14	
Cd	< 0.001		0.005		< 0.001	
Zn	0.123		0.184		0.026	
Cu	0.056		0.063		0.021	
Ni	0.013		0.030		0.005	
Mn	0.023		0.057		0.004	
Cr	0.34		0.20		0.06	
B	< 0.04		0.30		< 0.04	
Al	0.02		0.11		0.01	

Table 12 shows the general trend of pollution of the Barada river during the months of January and July as determined by BRGM [4] in 1990.

From the biological point of view in the year 1990 the waters showed high levels of Colibacter (from 100,000 to 4,000,000 Coli/100 ml), approaching urban waste waters levels (BRGM).

A direct water analysis survey has been conducted on the days 22 and 27 July 1994 at the following locations:

- site 1): Rivers Dayani and Barada at Zablatani bridge (El Nassira) just before the Zablatani industrial area
- site 2): River Dayani at Tahonet el Abid and River Barada at El Babal El Sharki just before the point of release of the Ain Terma, Jobal and Zamalka sewage waters, outside the Zablatani industrial area.
- site 3): Dayani river after the cutting stone factories
- site 4): Melehani river at the same geographical position of the site 2

The identification number of the samples are

- D1 and B1: Dayani and Barada rivers at sites 1
- D2 and B2: Dayani and Barada rivers at sites 2

An operational schedule of one sample collected every two hours for a period of 12 hours was adopted and, for all the samples the following parameters were controlled:

Colour and odour; Settled Solids; air and water temperature; BOD_5; pH; E.C. ; Chlorides; Carbonates and Bicarbonates; Nitrites; Ammonia. The T.D.S. and Sulphates presence has been obtained by calcuiation ; the presence of surfactants, sulphides and specific characters have also been examined.

Because the Zablatani industrial area has a 8,00 am to 5,00 p.m. working time (after this time no more than 10 percent of the factories are operating) from the samples collected on day 22 July (non working day) the baseline data and the anthropic pollution has been obtained; the rest day Damascus inhabitants do not wake up before 9-10 am.
From the samples collected the day 27 outside of the hours indicated, data related to the anthropic pollution has been obtained
From the samples collected on day 27 inside the hours indicated the data of the pollution from anthropic and industrial activity has been obtained

In the following table 13 are given the laboratory data.

Because:

i) the high water table.

ii) the intense irrigation practise and

iii) the soil and subsoil permeability

there is a continuos and intense contact between surface water and ground water.

This is the reason why we have considered with great interest the transport of contaminants between the surface and the subsoil.

Chemical transport in the subsurface flux is generally a complex process; at a local scale (study area) one might model a leacnate plume moving from a landfill into a ground water system and a larger scale (Barada and Dayani rivers) one might consider regional salinization leading to degradation of both water supplies and soil

Station de prelevement		Toc	pH	O2 mg/l	MES	DBO	Conductivité	NH3	Cl	Débit m^3/s
Source du Barada (1)	01/90	12.3	7.7	5	75	1	230	2,32	20	2,088
	07/90	16.2	7.5	7.7	24	12	210	4,39	20	1,652
Amont Figeh (4)	01/90	11.9	7.57	6.5	252	4	250	1,59	25	1,556
	07/90	16.3	7,86	3	115	22	330	3,90	35	0,041
Aval Figeh (6)	01/90	13.2	7.90	6,3	62	4	250	0,92	30	1,095
Haameh	07/90	27	8.04	5,1	150	20	400	3,66	40	-
(10)	01/90	12.3	7,31	5,8	24	10	390	3,42	45	0,185
	07/90	24,3	8,21	4	82	24	480	0,49	60	0,082
Zone des tanneries (12)	01/90	12,6	7,31	1	317	120	725	26,84	95	0,662
	07/90	21,9	7,03	0,1	139	100	520	24,4	75	0,500
Zone industrielle (31)	01/90	11,6	7,36	4,4	65	55	450	9,52	50	0,246
	07/90	23.5	7.3	0,2	142	240	550	23,15	65	0,304
Jaramana (35)	01/90	12.2	8.06	1,5	311	280	1350	103,7	205	0,039
	07/90	24.9	7.65	0	545	260	1200	81	190	0,046

Tab. 12 - Water quality of Barada river (BRGM , 1990)

Tab. 13 Chemical analysis of surface waters

Sample	Ref. Code	Point	Water sampling time H.min	Air Temp	Water Temp	Color	Odour	Settled solids mg/l (1)	EC mS/cm	TDS mg/l	Cl me/l	SO4 me/l	HCO3 me/l	CO3 me/l	Diss O2 mg/l	NO2 mg/l	NH4 mg/l	pH	Su
22 July																			
B11	111	1 B1	830	26	22	0	0	10	0,72	0,46	0,8	1	5,4	0	4,4	0,1	>10	7,2	
B12	121	1 B1	1020	29	22	0	0	10	0,72	0,46	1,2	0,6	5,4	0	3,9	0,01	>10	7,1	+
B13	131	1 B1	1205	35	24	0	0	10	0,78	0,5	1,2	1	5,6	0	2,9	0,4	>10	7,1	
B14	141	1 B1	1400	34	24	0	0	10	0,78	0,5	1,1	1,5	5,2	0	2,2	0,01	>10	7,1	
B15	151	1 B1	1810	33	24	0	0	10	0,72	0,46	1	0,6	5,6	0	2,2	0,01	>10	7,2	
B16	161	1 B1	2030	30	23	0	0	10	0,69	0,44	0,9	0,8	5,2	0	2,6	0,2	>10	7,1	
B21	211	2 B2	815	26	22	0	0	10	0,94	0,6	2	0,2	7,2	0	2,6	0,1	>10	6,9	
B22	221	2 B2	1000	29	22	T	H2S	10	1,44	0,92	2,5	5,3	6,6	0	0,8	0,1	>10	8	+
B23	231	2 B2	1150	35	24	R/T	H2S	50	2,2	1,41	1,2	13	7,8	0	0,9	0,1	>10	7,2	+
B24	241	2 B2	1455	34	24	T	0	50	1,85	1,18	6,7	4,8	7	0	3	0,3	>10	7	
B25	251	2 B2	1745	33	24	0	0	10	1,22	0,78	3,7	1,7	6,8	0	2,8	0,2	>10	7,1	
B26	261	2 B2	2010	30	23	0	0	10	0,72	0,46	1,7		7	0	3	0,1	>10	7,1	
D11	112	3 D1	830	26	22	0	0	10	0,72	0,46	1,1	0,5	5,6	0	1,7	0,5	>10	7,1	
D12	122	3 D1	1020	29	22	0	0	10	0,76	0,49	1,5	0,3	5,8	0	3	0	>10	7	
D13	132	3 D1	1205	35	24	T	0	10	0,78	0,5	1,4	0,6	5,8	0	2,6	0,6	>10	7	
D14	142	3 D1	1400	34	24	0	0	10	0,76	0,49	1,1	0,7	5,8	0	2,6	0,1	>10	7	
D15	152	3 D1	1810	33	24	0	0	10	0,86	0,55	1,3	1,9	5,4	0	[illegible]	0	>10	7,2	
D16	162	3 D1	2030	30	23	0	0	10	0,7	0,45	1	0,6	5,4	0	2,7	0,2	>10	7,1	
D22	222	4 D2	940	29	22	0	0	0	1,27	0,81	4,7	1,4	6,6	0	[illegible]	0,1	>10	7,1	
D21	222	4 D2	730	26	22	0	0	10	0,76	0,49	2,2		6,2	0	[illegible]	0,1	>10	7,1	
D23	232	4 D2	1130	35	24	0	0	10	0,95	0,61	1,8	1,5	6,2	0	1,9	0,2	>10	7,2	+
D24	242	4 D2	1440	34	24	0	0	10	0,97	0,62	1,6	2,3	5,8	0	2,4	0	>10	7,1	
D25	252	4 D2	1730	33	24	0	0	10	0,7	0,45	1	0,4	5,6	0	2,9	0,2	>10	7	
D26	262	4 D2	1950	30	23	0	0	10	0,78	0,5	1,4	0,2	6,2	0	3,4	0	>10	7,1	
27 July																			
B11	111	1 B1	935		22	0	0	200	0,75	0,48	0,8	0,9	5,8	0	5,2	0,2	>10	7,1	
B12	121	1 B1	1250		23	0	0	100	0,78	0,5	1	1	5,8	0	4,9	0,1	>10	7,2	
B14	141	1 B1	1510		24	0	0	10	0,85	0,54	4,9		7,4	0	3,6	0,2	>10	7,1	
B15	151	1 B1	1745		21	0	0	100	0,78	0,5	1,4	0	6,4	0	1,9	0	>10	7,2	
B16	161	1 B1	2020		23	0	0	50	0,79	0,51	1,2	0,7	6	0	1,5	0,2	>10	7,1	
B21	211	2 B2	920		22	T	+	200	3,14	2,01	1,5	22,5	7,4	0	3,7	0	>10	7,7	+
B22	221	2 B2	1240		23	0	0	300	2,74	1,75	13,9	7,1	6,4	0	3,8	0	>10	7,1	
B24	241	2 B2	1500		21	SR	0	50	2,54	1,63	11,9	6,5	7	0	1,6	0,5	>10	7,1	+
B25	251	2 B2	1730		24	R	H2S	200	1,97	1,26	9	3,9	6,8	0	0,1	0,3	>10	7,2	
B26	261	2 B2	2010		23	T	0	100	1,65	1,06	6,5	3,2	6,8	0	1,5	0,1	>10	7,1	
D11	112	3 D1	935		22	0	0	100	0,81	0,52	1	1,7	5,4	0	4,5	0,3	>10	7,2	
D12	122	3 D1	1250		23	0	0	100	0,8	0,51	1	1,6	5,4	0	3,8	0,2	>10	7,1	
D14	142	3 D1	1510		24	0	0	10	0,81	0,52	1,4	0,3	6,4	0	3	0,5	>10	7,1	
D15	152	3 D1	1745		24	0	0	100	0,8	0,51	1	1	6	0	1	0,3	>10	7,1	
D16	162	3 D1	2020		23	0	0	50	0,79	0,51	1,2	0,7	6	0	1,9	0,3	>10	7	
D21	212	4 D2	910		22	T	0	300	1,74	1,11	9,2	1,8	6,4	0	4,9	0,1	>10	8	
D22	222	4 D2	1230		23	0	0	300	1,23	0,79	3,3	2,6	6,4	0	3,6	0	>10	7,7	
D24	242	4 D2	1450		24	0	0	50	1,12	0,72	2,5	1,9	6,8	0	2,1	0	>10	7,6	
D25	252	4 D2	1715		24	0	0	300	0,97	0,62	1,8	1,7	6,2	0	0,1	0,1	>10	7,2	
D26	262	4 D2	1955		23	0	0	200	0,92	0,59	1,4	2	5,8	0	2,1	0	>10	7,1	

Remarks

(1) evaluation classes with approx. concentrations

R Red

SR Strong red

T Turbidity

4.1.3. Considerations.

The rivers Barada and Dayani are polluted both with biological and industrial pollutants; the river Melehani is mainly concerned with biological pollution

The water pollution varies with: 1) location, 2) time of sampling, 3) period of the year, 4) hour of the day

The Barada river is already slightly polluted from its springs where it receives sewage waters coming from residential buildings; inside the city of Damascus the pollution load increase because of the release of urban sewage waters and is very high after Z.I.A.

By comparing on a qualitative basis the data collected in different places of the rivers, it is evident that the pollution of the surface water has increased from 1977 to date.

For a better understanding of long period variations of the water quality, a comparison has been made between the laboratory results obtained from water samples collected from Barada and Dayani rivers by HHS [3], at the end of June 1977 , by BRGM [4] in January and June 1990 and by the actual survey on July 1994.

Table 11 shows the relationship and the pollution trends in the rivers, indicating the presence of Heavy metals such as Chromium, Copper, Iron, Nickel, Manganese and Zinc at concentrations of 0,01-0,5 ppm. This confirms the industrial pollution of the rivers dating back since at least 1977.

The daily and hourly distribution of pollutants into the rivers is relative to the activity of the Damascus inhabitants.

The laboratory data of table 13 apparently well correlated with the environment are dissolved oxigen, BOD, Electrical Conductivity, and chlorides; because of the high concentration it was not possible to find a correlation between the ammonia values at inlet and outlet of ZIA

In July 1994 the waters of Barada river show the following concentrations as showed by table 14 which is an elaboration of the data of table 13

Table 14 Chemical balance of pollutants

SITE	Diss O_2 mg/l	BOD_5(a) mg/l	EC µS/cm	Solids mg/l	NH_3 mg/l	Cl mg/l
0) Before Damascus city.						
	5	20	300-400	-	1-4	30-40
1) Before Z.I.A.						
	2-4	100	500-600	0-10	>10	35-70
2) After Z.I.A						
	0,5-2,5	250	600-2000	50-200	>10	35-450
3) Difference (2-1)						
	1,5	150	100-1400 TDS g/l 0,1-0,9	50-200	-	0-380

Dissolved Oxygen decreases by 1,5 mg/l after ZIA while the BOD increases by 150 mg/l. As for chlorides at the hours of higher pollution they are up to ten times the maximum concentration recorded before ZIA.

The pollution load of Dayani and Barada rivers is evidently determined by the activity of the ZIA

During the sampling of the Barada waters at site 2 the water was red coloured,may be by blood. Blood is an interesting valuable resource as considered in alternative to the lack of fertility resulting by the abandoning of the waste-waters for irrigation. Dry blood contains slow release Nitrogen at a rate of about 14 percent.

By elaborating the data about the height of the water table which it comes to only 2 meters below soil level, its wide variations (more than 14 meters of excursions are recorded in some places), and the relevant summer time ground water usage for irrigation (approx. 20,000 lt/sec), it is evident that there is a direct relationship between the surface and the ground waters in relation to the period of the year and the location; in some periods and places the surface water reaches the water table and in others the ground waters recharge the river. This mutual relationship is a confirmation of the high vulnerability of the aquifer and, consequently, of the risks of the ground water for human consumption.

At present the wells in the neighbourhood of the rivers are not degraded but the wells close to the river beds could probably be polluted as demonstrated by the fact that animals often refuse to drink this water

The beds of the river and of all the canals are covered by a sediment having a high degree of both organic and industrial pollution. We do not know exactly the thickness (during the field survey we obtained approximate values between 20-40 cm) and the pollution level, but it is reasonable to suppose that, because the quantity of pollutants released into the river waters and the duration of pollution, the pollution of sediment is very high, similar to toxic sludge. At our advise, for the critical position of interface between the surface and ground water, polluted sediment is the most relevant agent of the ground-water pollution.

The sources of pollution can be divided into diffuse and punctual sources; the first group consists of:

- 1) pollutants in solution

- 2) pollutants in suspension adsorbed on suspended solids

the second one:

- 3) pollutants continuously released by river sediment

- 4) pollutants originated by the discharge of solid wastes

- 5) pollutants released by critical point of water stagnation.

each of this pollution has a proper significance and a typical behaviour:

- The concentration of the pollutants in the waters is variable daily and seasonally.

- The release of pollutants from sediments is constant in time and correlates only to the capacity of surface water to dissolve it and to the exchange between surface and ground water.

- For what concerns point 4 the release of pollutants is correlated to the materials discharged in the river beds and banks; point 5 depends on the duration of contact and on the pollutants concentration.

4.2. Ground water.

4.2.1. Balance.

The whole Barada river basin is interested by very important flows of groundwater. The rocks of the mountains are mainly calcareous, and karstic phenomena are very frequent. Karstic phenomena originate the source of the Barada river, the Ain El Fijeh spring and many other springs. The water table of the aquifer exists also inside the mountains, while the hydrogeological and hydrological basins are not exactly correspondent. The hydrogeological basin of the Ain El Fijeh spring has for instance an area of about 700 km2 and lies in large part outside the hydrological Barada basin. And other outside hydrogeological basins feed the Barada hydrological basin, where the direction of the flow lines follows only approximately the direction of the main valley upstream of Damascus.

In the town of Damascus the water table is very shallow and in some zone may feed both the river and the canals. Inside the city many wells are utilised for urban and private water supply (See paragraph 4.3.).

Downstream of Damascus, in the Ghouta plain, the isophreatic and the flow lines (See figure 10) show the aquifer being fed not only from North-West, parallel to the Barada river, but also from South, that is from the Awaj river [2].

In the figure 10, representing the isophreatic and flow lines of the year 1966, an area appears, near the Aateibe lake, where the isophreatic level is the lowest, and on where all the flow lines converge. In this area, which has also the lowest elevation of the surrounding zone (about 600 m a.s.l.), the horizontal velocity of the groundwater is nearly down to nothing, and the last flow is evaporated. From the figure 10 the aquifer of the Awaj river results apparent, parallel to the water course West of Damascus, and converging northwards and mixing with the Barada aquifer in the Ghouta plain. Here the mean slope of the water table is about 0.004.

In the Ghouta plain there are also various springs, many of which perennial. According to the Ministry of Irrigation, the most important of them are:

Arush	with a mean and maximum discharge of	465 and 1,100 l/s
Kalaia	with a mean and maximum discharge of	147 and 1,200 l/s
Der Al Asafir	with a mean and maximum discharge of	173 and 770 l/s

The approximate depth of the water table in the Ghouta groundwater aquifer is generally less than 12 m (See figure 11), but in peripheral areas it is more. At Zablatani the mean depth seems to be less than 10 m [2].

The thickness of the sedimentary layer of the aquifer is evaluated to range between 200 m and 250 m, and the loose material are mainly gravel and sand. There are also limited silty beds.

During the year the excursion of the water level is about 4 m, but in some zones can be higher.
At the end of the dry season, the water table has the minimum level, while after the rainy season it reaches the maximum.

The storage coefficient for the Ghouta area is estimated to be about 0.04-0.05 [2]. The trasmissivity value is very variable (see Fig.12) in the Barada aquifer [2]. In two areas of 25 km2 and 4.5 km2 it is >500 m2/day, in an area of 197 km2 it ranges between 100 and 500 m2/day, and in the remaining area it is <100 m2/day.
At Zablatani the transmisivity value seems to be about 390 m2/day.

In the Ghouta area the aquifer is utilised, together with the Barada river and the canals, for irrigation purposes and for various local water supply.

In the Ghouta plain the annual alimentation of the aquifer comes both from the upstream groundwater, and from the other important sources, whose the most important are:

- the rainfall;
- the seepage from the bed of the Barada river and the canals keeping into account that these courses convoy natural and sewerage water;
- the seepage from the fields during the irrigation both by surface water and by groundwater;
- the springs of the area.

The main losses of water from the aquifer are:

- the evaporation;
- the outflow of the groundwater;
- the outflow of the surface water;
- the groundwater pumped for irrigation and not coming back to the aquifer by seepage, being utilised by the crops.

The surface water is the most important item for the recharge of the aquifer, and the whole volume coming in the plain disappears, because of crops requirements, evaporation from free surfaces, and seepage to aquifer. The seepage is a high percentage of the surface volume. By the aquifer the groundwater is pumped for irrigation, and also in this case a high percentage of water comes back to the aquifer.
In the "Damascus Sewage Master Plan Studies" [2] a 65% of surface water coming to the Ghouta plain and a 24% of the pumped groundwater were evaluated to leak to the aquifer.
Very important appears therefore the vertical movement of the water, to and from the aquifer.

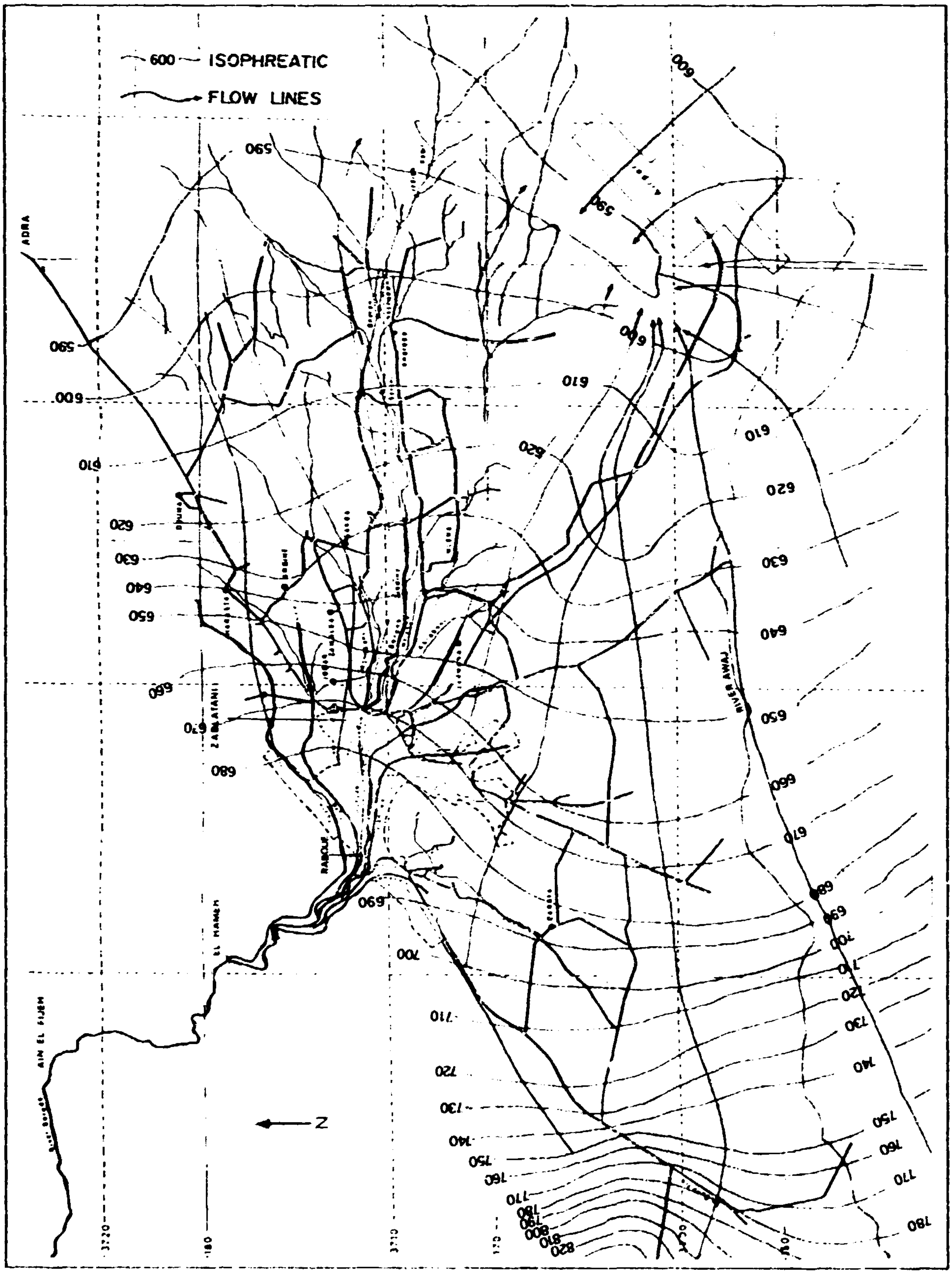
About this subject it is important to remember that, according to the Darcy law, the vertical velocity of infiltration from the soil to the aquifer is much higher than the horizontal velocity in the aquifer, which is due, in the Ghouta plain, to the water table slope, which is of a few unit per thousand.

The Ministry of Irrigation makes reference to the following input and output values, included in the feasibility study of the year 1986 "Water Resources Use in the Barada and Auvage basins for irrigation of crops" [5]:

Input	Millions of m3
- groundwater from another area	210
- rainfall	292.5
- surface water inflow	484.8
- from springs and from other basins	164.5
Tot. Input	1151.8

Output	Million of m3
- evaporation	276.4
- outflow of groundwater	62
- surface water outflow	105.2
- from boreholes for irrigation	343.0
- from surface water for irrigation	396.1
- from groundwater for water supply	67.3
Tot. Output	1250.0

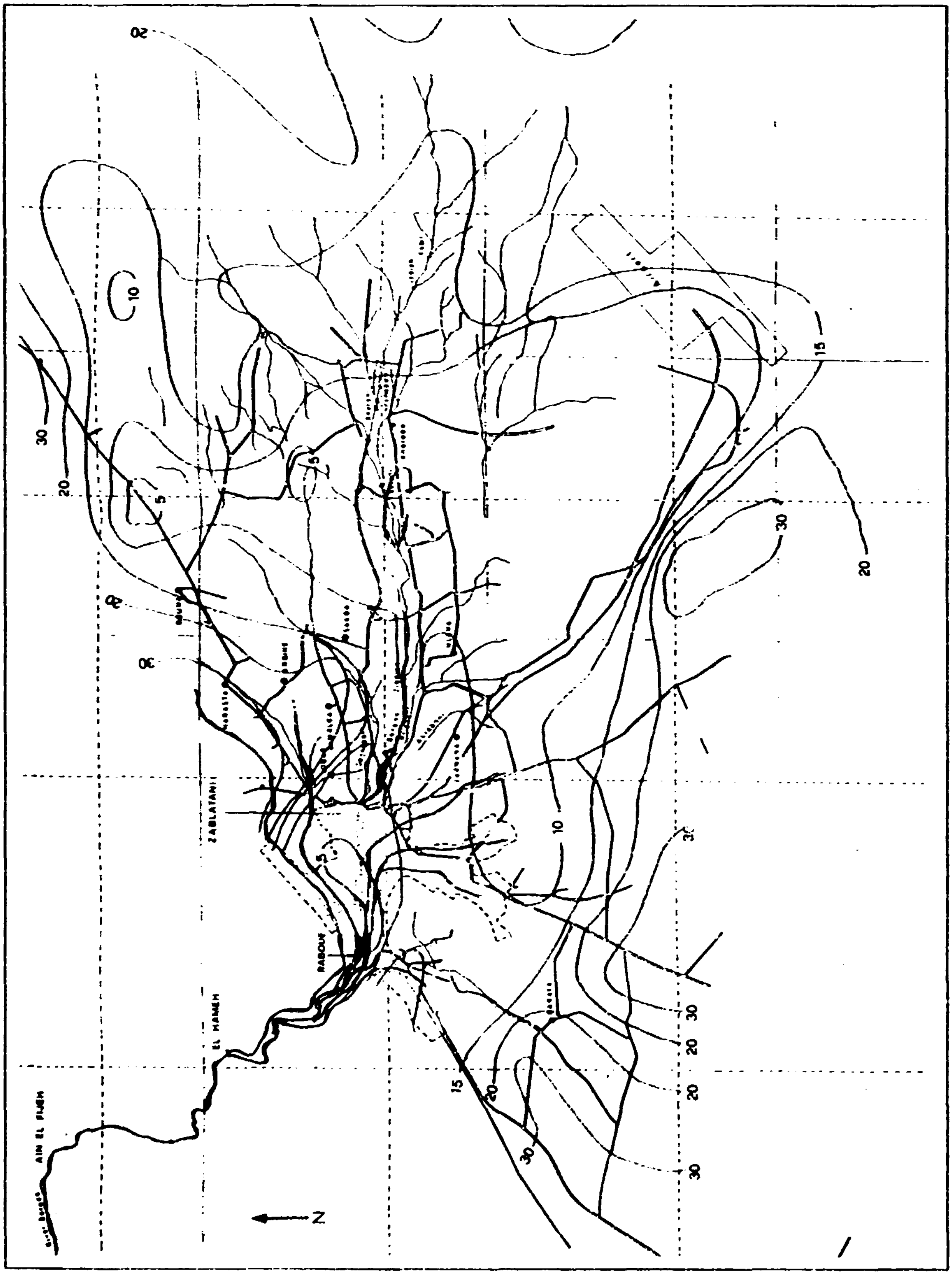
FIGURE 10 - ISOPHREATIC (ma.s.l.) AND FLOW LINES IN THE GHOUTA PLAIN



Source: 'Damascus sewage master plan studies' · Howard Humphreys and sons

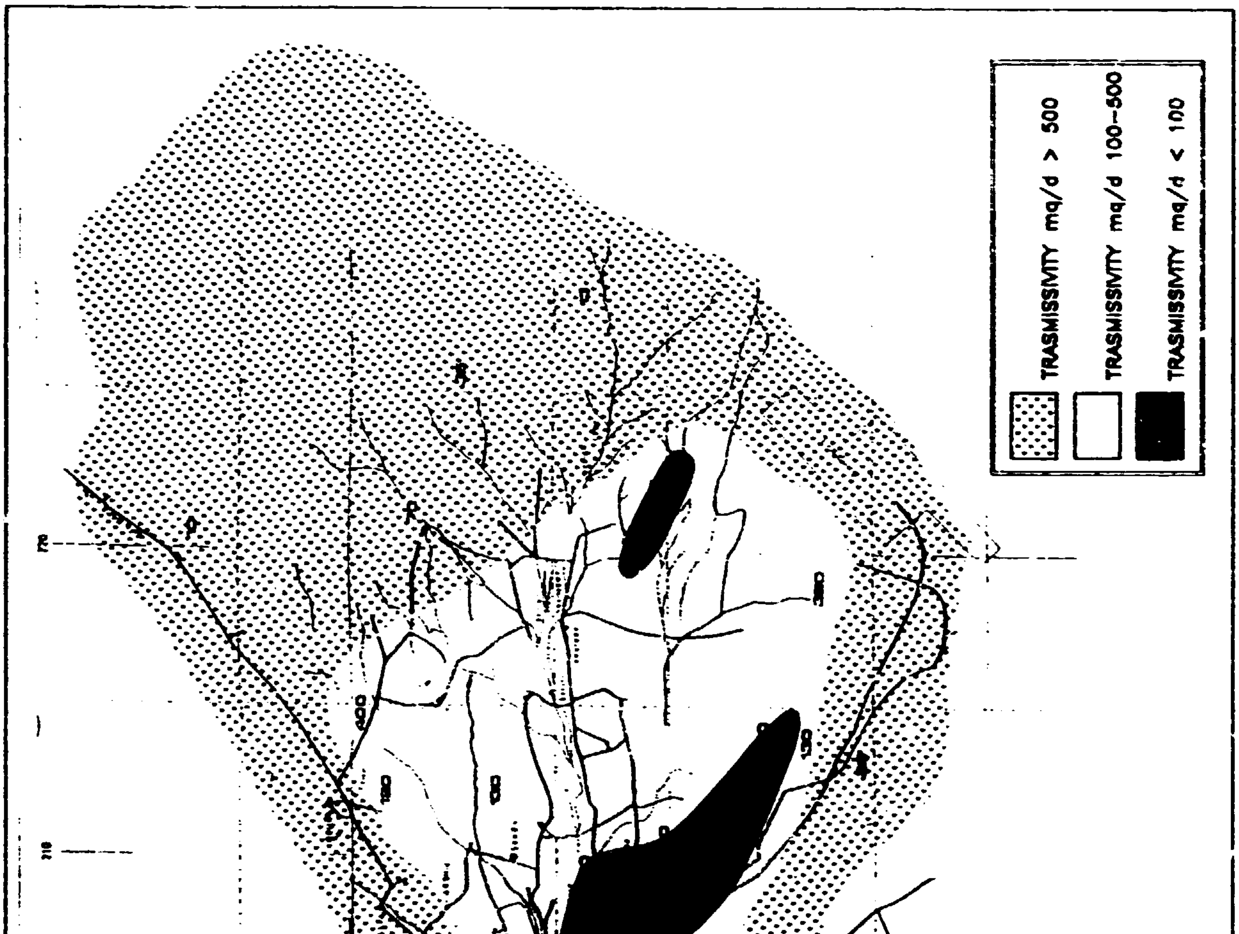
Studio Tecnico Cherubini & Associates Rome - Italy

FIGURE 11-WATER TABLE DEPTH (m) - (October 1977)



Source: 'Damascus sewage master plan studies' · Howard Humphreys and sons

FIGURE 12-ACQUIFER TRASMISSIVITY (mq/d) IN THE GHOUTA PLAIN



Source: 'Damascus sewage master plan studies' Howard Humphreys and sons

4 2.2. Quality.

The effects of salt migration in soils were well recognized in ancient Mesopotamia where the capillary rise of water from shallow water tables carried dissolved salts to the soil surface with significant effects on agriculture [6].

The water movement in the subsoil should be as follows:

- the water table rises to about 2 meters depth; the capillary fringes rises to about 0,2-0.3 meters

- soils are irrigated by surface irrigation with high volumes of water (at least 60-80 mm of water in 100 cm of soil profile) and the volumes of water are high enough to permit about 40-50% of the water supply to drain to the deeper strata.

The water movement in the soil profile at critical points should therefore be:

depht		water	water	water	remarks
cm		type	fate	movement	
0		dry	Evap.	¦	salt concentration by EV
20	-	irrigation	¦	¦	
40	-	irrigation	root	Up	
60	-	irrigation	adsorbtion		
80	-	irrigation	¦		
100	-	irrigation	drainage	Down	possible
120	- -	drainage	¦	¦	salt concentration,
140	-	drainage	vadose	¦	cracks, vertical pores,
160	- - -	capillary	zone		coarse material
180	-----	watertable		Irregular Up & Down	
200	-----	groundwater	¦	¦	

For these reasons the contact between the drainage water and the water-table is close enough to permit i) a continuos and intense exchange or ii) an intermittent but frequent exchange between the front of the drainage water and the watertable.

The movement of solutes through the vadose zone, to groundwater, is of increasing concern as greater pressure is put on the environment. Solutes of particular concern are pesticides and heavy metals which are substantially adsorbed into soil particles; however there are other chemicals that may contaminate groundwater resources.

Following this mechanism even if the subsoil is able to fix the chemicals that it receives from the soil, the groundwater pollution, for wet and dry alternance, is directly related to the salts not fixed by the soil.

This mechanism is always active in the river beds where we found a constant degree of water pollution and a stationary very polluted sediment in close contact with the water table and consequently with the ground-water. The surface water, polluted or not, therefore will drain into the sediment and transport the dissolved salts in the ground-water.

There is a definite possibility of movement of a concentration peak of a nonadsorbed, nonreactive solute through soils for constant "q". The movement of the peak of a solute concentration profile through a uniform soil is described assuming that there is no preferential movement of water through soils or wetting front instability effects, the soil drains to a constant water content following infiltration (field capacity) non significant soil-solute interactions or chemical transformations occur, crop water uptake is uniform with depth to the bottom of the root zone, and the profile is at field capacity below the root zone.

Because of its importance for human consumption the groundwater quality is continuosly monitored by Governamental services and Authorities.

In order to investigate the relationship between surface and ground-waters, all the data made available by Syrian Authorities concerning the analysis of the wells in the study area have been collected. In figure 13 is indicated the position of the wells, boreholes and springs inside and within the neighbourhood of the study area

In table 15 are given, for the 1977, the chemical characteristcs of ground waters at locations indicated in figure 13

Table 15 Analysis of ground water from Howard [3]

Sample	pH	EC	Na	K	Ca	Mg	Cl	NO_3	SO_4	HCO_3	Mg/Ca	SAR
T8	7.1	620	33	4.2	72	62	30	7.0	30	332	1.4	0.7
T13	7.0	850	49	1.9	84	133	45	12.7	31	424	2.6	0.8
T14	7.0	680	29	2.0	70	82	47	7.4	44	370	2.0	0.6
T19	7.0	650	31	2.4	80	70	40	4.6	26	357	1.5	0.6
T25	7.4	640	33	2.4	67	98	97	4.6	44	338	2.4	0.6
T30	7.3	1070	32	1.9	70	140	125	4.5	50	308	3.3	0.5
T31	7.4	1490	80	1.1	91	204	120	0.9	200	321	3.7	1.05
T34	7.2	1950	84	1.8	82	334	272	0.9	300	367	6.8	0.9
T35	7.5	930	44	2.4	48	140	75	0.5	145	289	4.9	0.7

Remarks: EC mmho/cm; NO_3 mgN/l; SO_4 mgSO_4/l; HCO_3 mg$CaCO_3$/l; others mg/l

The Ministry of Housing gives the following data representing the composition of ground water.

Table 16 Groundwater: chemical and microbiological composition

Nitrates	20 - 30 mg/l	with upper limit of	60 mg/l
Nitrites	0 - 0.2 mg/l	with upper limit of	0.2mg/l
Phosphates	0 - 0.3 mg/l	with upper limit of	0.6mg/l
Ammonia	0 - 0.1 mg/l	with upper limit of	1.6mg/l
T.M.C. 37°C	0 - 50 col/ml	with upper limit of	>400
Coliform	0 - 1 col/100 ml		

At present the water from wells very close to the river beds is utilised for irrigation, with some caution for livestock use., never for Human consuption.

For what concerns the Zablatani Industrial Area, the hydrogeological data for some well are as follows:

Table 17 The wells inside the Zablatani Industrial Area

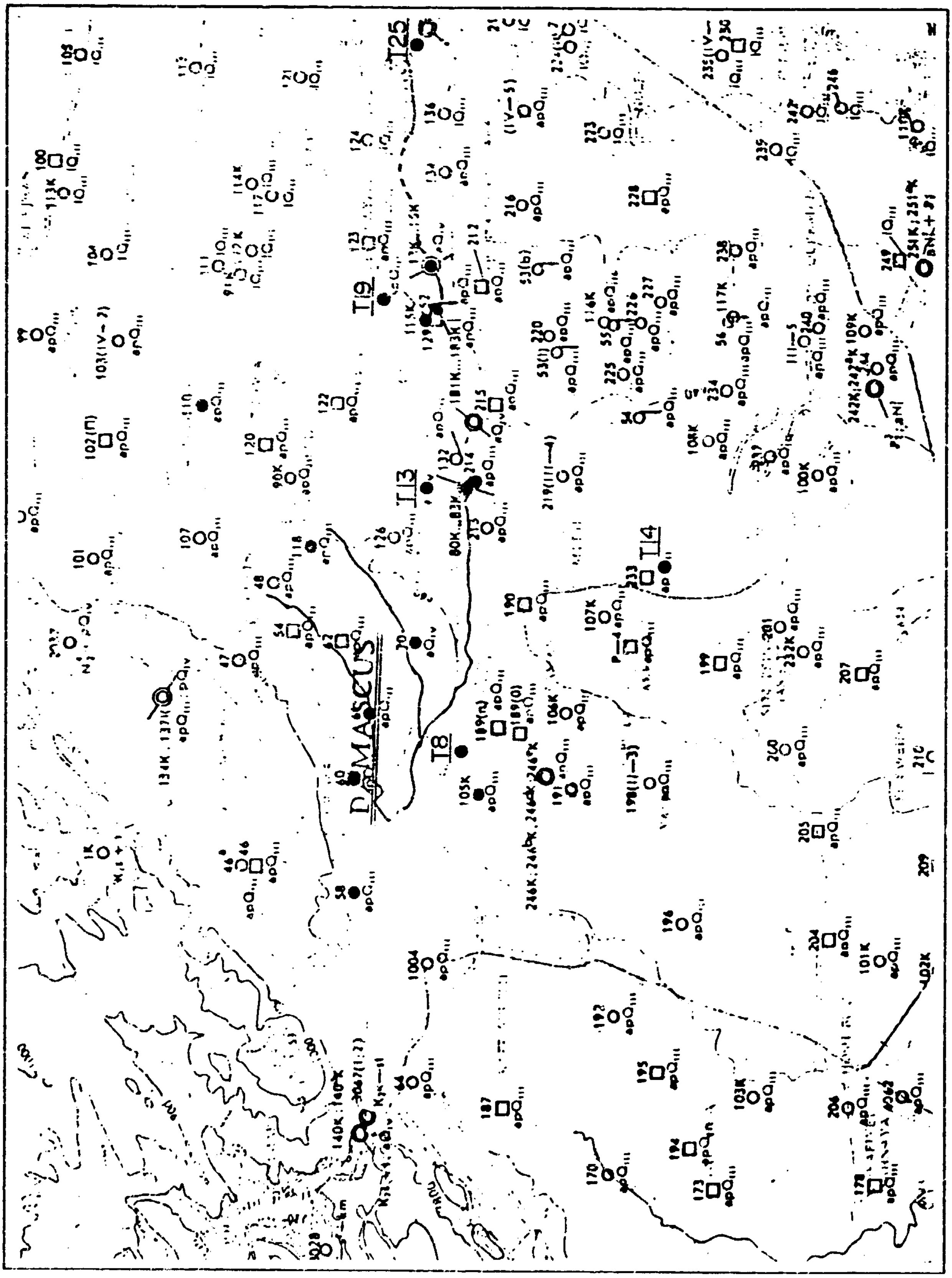
Well N.	206	207	70
Location	Chicken s.h.	Chicken s.h.	Sheep s.h.
deph in m	66	66	70
Flow Rate m3/h	44	46.5	60
Static lev. m.	8	8.5	11
Fluctuation m.	14	9.5	-

and the water quality is:

Table 18 Chemical analysis of water samples collected in date 15.05.94 from wells in the tanneries area

W.	pH	EC	Mg	Ca	TH Ca	TH Mg	TH	SO_4	Cl	TAC	TA	TDS	PO_4	BOD_5	Cu	Cr	Fc
		µS/cm	mg/l														
1	7.22	450	12	64	50	160	210	11	0.3	220	0	225	0.45	1	75	45	0
2	7.38	1,100	12	180	50	450	500	58	2.0	520	0	530	0.85	1	50	25	0
3	7.44	1,050	9.6	120	40	300	340	68	1.9	420	0	525	0.20	1	50	25	0

FIGURE 13-POSITION OF WELLS BOREHOLES AND SPRING IN THE NEIGHBOURHOOD OF THE Z.I.A.



4.2.3 Considerations.

By comparing the irrigated surface area (50,000 Ha) with the number of wells (more than 17,000) the resulting density is of a well every about 2.5 Ha. This value expresses the high vertical water motion confirming the high risk of pollution over the whole Ghouta aquifer. Following Howard [3] and others, the water chemistry of the area reflects the local contamination by infiltration from polluted surface waters and salinity increase to the east in accordance with reducing ground-waters throughput.

In the table 19. Z it have been assembled the laboratory data obtained by LENGIPROVODKHOZ [7] and BRGM [3]; from a more detailed analysis the data have been analysed for the following 3 hypothesis:

1st correlation: Samples grouped per season:

- 1st group: Jul-Aug-Sep-Oct
- 2nd group: Nov-Dec-Jan-Feb
- 3st group: Mar-Apr-May_Jun

2nd correlation: Samples grouped per same date

3st correlation: Samples grouped per potential areas of hydro geological influence with surface waters

the following information has been obtained:

1st correlation

- The content of NO3 is higher during the months of Mar-Jun and is at its minimum during Nov-Feb when can be noted the rise of chlorides and sulphates as well as the magnesium concentration; the calcium concentration is constant. The sodium concentration shows the tendency to decrease in the period Mar-Jun

The 2nd correlation does not show interesting elements; from the 3rd correlation the following information can be obtained:

- By evaluating the groundwater in relationship to the direct contact with the surface waters considering that the water table is 6 meters deep in Damascus city, 2-5 meters deep along the Barada river and over 10 meters deep along the Dayani and Akrabani rivers a high concentration of nitrates in the Damascus and Dayani groundwaters, and a contemporarely sharp decrease in the nitrates concentration of the Barada groundwater can be seen.

- Magnesium shows high concentrations immediately outside of Damascus city, drop to very low values in the middle Barada valley and increases again in the lower Barada valley. The Dayani and Akrabani groundwaters show a magnesium concentration higher than that obtained by analysing the Damascus groundwater: both sodium and chlorides show the same trend.

The Dayani groundwater shows a greater biological pollution load than the Barada groundwaters.

For the year 1977, maps indicating the quality of the groundwaters referring to Electrical Conductivity, Chloride, Nitrate and water quality for irrigation according to USDA [3] are available as shown in the following figures 14 a/b/c/d.

From these figures it can be clearly noted the area of interference of surface waters with groundwaters; the lines of same concentration of chlorides and total salts follows the Barada river eastwards from Damascus city.

Chlorides and T.D.S. concentrations are low in the groundwater recharge area where the Barada surface water can recharge the more saline groundwater; this situation, apparently more favourable, can be considered negative for the exchange of pollutants between surface and groundwater.

We can conclude that a high contamination of the ground water actually exists in relation to the high level of pollution of the surface water and sediments resulting from the infiltration of the surface waters into the sub-soil and from direct contact of the main ground water with the river groundwater; this situation is enhanced during the dry periods. The direct consequence is the high level of pollution of the wells adjacent to the rivers; wells utilized at present for irrigation and rarely for human and livestock consumption.

For drinking purposes the ground-waters are polluted by phosphates, nitrates, nitrites and ammonia, often in high concentration.

Magnesium is another serious problem since Ghouta deep waters are utilised for irrigation

Tab. 19 Chemical analysis of ground-water

1st correlation: samples grouped for time of collection: 100=JASO, 200=MAMJ, 300=NDJF

Ref.	I Corr Code	III Corr Code	well borehole spring N.	Area	Water sampling depht m	Date DMY	Month	Color	Odour	EC	Dry Res mg/l	P mg/l	Cl me/l	SO4 me/l	HCO3 me/l	CO3 me/l	NO3 mg/l	NO2 mg/l	HPO4 mg/l	NH4 mg/l	K me/l	Na me/l	Mg me/l	Ca me/l	Fe me/l	pH	TH mM/l	CH mM/l	Free CO2 mg/l
4	101		61	Dirani		131075	Oct	0	0		2690	0	20,8	18,1	6,6	0	0	0	0	0	20	42	17,3	7,8	0	7,2	25,1	6,6	13,2
4	102		52	Barada		160778	July	0	0		558	0	1,83				0	0	0	0									
4	103		82K	Barada	5,2	311082	Oct	0	0		438	0	2,5	0,9	4,7	0	12	0,1	0	0	0,05	2,6	1,7	3,3	0	8,1	5	4,7	
4	104		58	Damascus	6	030883	Aug	0	0		314	0,01	1,1	0,48	4	0	17,7	0,04	0,04	0,05	0,08	1,4	1,4	1	0	6,7	4,4	4	2,2
4	105		60	Dirani	15,2	060883	Aug	0	0		312	0,04	0,85				2,2	0,01	0,02	0,05									
4	106		79	Dirani	11,2	290983	Sept	0	0		317	0	1,5				9,7	0	0,24	0,49									
4	107		60	Dirani	23,1	290983	Sept	0	0		513	0,04	2,1				22,5	0,09	0,03	0									
4	108		58	Damascus	6,3	021083	Oct	0	0		234	0	1,1	0,2	3,1	0	14,4	0	0,18	0,39		0,72	1,5	2,4	0	7,2	3,9	3,1	8,8
4	109		58	Damascus		131084	Oct	0	0		359	0,04	1,2	0,4	4,6	0,1	30,1	0	0,63	0,41	0,07	1	2,1	3,6	0,01	8	5,7	4,7	
4	110		60	Dirani	15,2	111084	Oct	0	0		287	0	0,9				23	0	0,02	0,05									
4	111		70	Dirani	10,1	131084	Oct	0	0		322	0	1,2				23,9	0	0,75	1,14									
3	201		T25	Barada		77	NovDec			640	410		2,8	0,9	5,5	0	4,6				0,06	1,4	8,2	3,35		7,4			
4	202		52	Barada		030378	March	0	0		514	0	2,2				0	0	0	0									
4	203		52	Barada		200478	Apr	0	0		500	0	1,5				0	0	0	0									
4	204		60	Dirani	13,3	220682	June	0	0		267	0	1,13				30	0,07	0	0									
4	205		214	Barada	2,6	130682	June	0	0		412	0	1,3	0,51	5,7	0	17,2	0,03	0,06	1,1		0,62	0,7	6,3	0	7,5	7	5,65	4,4
4	206		52	Barada		[illegible]	May	0	0		316	0	0,6				13,3	0,18	0,94	0									
4	207		52	Barada		130484	Apr	0	0		444	0	1,2				3	0	0,05	0									
4	208		105K	Akrabani	8,7	080584	May	0	0		359	0	1,5	0,6	4,7	0	9,3	0,8	1	0,5	0,18	1,43	3,15	1,9	6,4	7,4	5	4,7	4,4
4	209		14K	Barada		160584	May	0	SB		1263	0	16,2	0,1	5,5	0	76,6	0	0,7	0	0,3	13,4	6,3	2,7	0,02	7,6	9	5	8,8
4	210		70	Dirani	10,1	130385	March	0	0		417	0	1,5	0,58	5,5	0	22,1	0	3	1,5	0,2	0,14	2,26	5,5	0	7	7,76	5,5	13,2
4	211		13K	Barada		180385	March	0	0		176	0	1,5	0,2	2	0,1	2,2	0	0,1	1,3	0,02	0,1	2,4	1,2	0,05	7	3,6	2,1	
4	212		60	Dirani	15,2	250385	March	0	0		231	0	1	0,08	5,1	0	26,5	0	0	0,64		0,2	2,96	3,6	0	7,5	6,56	5,1	4,4
4	213		52	Barada		[illegible]	May	0	0		452	0	1,5				22,1	0,09	0,12	1,29									
4	214		52	Barada		220585	May	0	0		351	0	1	0,81	4,5	0	13,3	0,31	0	0									
4	215		15K	Barada		190585	May	0	0		298	0	1,3	0,2	1,2	0,1	40,7	0	0,5	0,1	0,2	0,5	2	2,6	0,2	8,3	4,6	3,3	
4	216		52	Barada		210685	June	0	0		405	0	1,2	0,62	5,6	0	0,02	0	0,03	1,16	----	4,56--	0,2	2,6	0	7,4	2,8	2,8	8,8
4	217		70	Dirani	10,7	220682	June	0	0		380	0	2,25				20,2	0,06	0	0									
3	301		T13	Barada		77	NovDec			850	544		1,3	0,6	7	0	12,7	12,7			0,05	2,1	11,1	4,2		7			
3	302		T8	Bar/Acrab		77	NovDe			620	397		0,9	0,6	5,4	0	7				0,11	1,4	5,2	3,6		7,1			
3	303		T30	Barada		77	NovDec			1070	685		3,6	1	5	0	4,5				0,05	1,4	11,7	3,5		7,3			
3	304		T31	Barada		77	NovDec			1420	954		3,4	4,1	5,3	0	0,9				0,03	3,5	17	4,55		7,4			
3	305		T34	Barada		77	NovDec			1950	1248		7,8	6,1	6	0	0,9				0,04	3,65	27,8	4,1		7,2			
3	306		T35	Barada		77	NovDec			930	595		2,1	3	4,7	0	0,5				0,06	1,9	11,7	2,4		7,5			
3	307		T19	Barada		77	NovDec			650	416		1,1	0,5	5,9	0	4,6				0,06	1,35	5,8	4		7			
3	308		T14	Akrabani		77	NovDec			680	435		1,3	0,9	6,1	0	7,4				0,05	1,26	6,8	3,5		7			
4	309		52	Barada		151277	Dec	0	0		609	0	1,8				0,1	0	0	0									
4	310		52	Barada		170279	Feb	0	0		551	0	1,6				0	0,2	0	0,2									
4	311		115K	Barada	3,1	250183	Jan	0	0		587	0,1	2,4	1,6	6,5	0,1	8	0,3	0,1	0	0,1	3,7	1,9	5	0,1		6,9	6,6	
4	312		82K	Barada	1,8	300183	Jan	0	0		409	0,05	3,2	0,8	3,1	0	6,4	0,1	0,1	0	0,1	3	0,4	3,8	0		4,2	3,2	7,2
4	313		214	Barada	2,7	081183	Nov	0	0		211	0,04	1,4	0,19	2,4	0	4,4	0	0,27	0,21	0,07	1,39	0,3	2,3	0		2,6	2,4	8,8
4	314		52	Barada		230184	Jan	0	0		328	0	1,8				17,7	0,01	0,12	0,2									
4	315		52	Barada		120285	Feb	0	0		441	0	1,6				22,1	0	0,14	1,29									
4	316		118	Dirani	19,5	250285	Feb	0	0		243	0	0,9	0,44	3,5	0	5,7	0	0,14	0		0,03	2,9	2	0	7	4,9		4,4

3st correlation: samples grouped per potential zones of influence by surface waters

Ref.	I Corr Code	III Corr Code	well borehole spring N.	Area	Water sampling depht m	Date DMY	Month	Color	Odour	EC	Dry Res mg/l	P mg/l	Cl me/l	SO4 me/l	HCO3 me/l	CO3 me/l	NO3 mg/l	NO2 mg/l	HPO4 mg/l	NH4 mg/l	K me/l	Na me/l	Mg me/l	Ca me/l	Fe me/l	pH	TH mM/l	CH mM/l	Free CO2 mg/l
4		1	58	Damascus	6	030883	Aug	0	0		314	0,01	1,1	0,48	4	0	17,7	0,04	0,04	0,05	0,08	1,4	1,4	3	0	6,7	4,4	4	2,2
4		2	58	Damascus	6,3	021083	Oct	0	0		234	0	1,1	0,2	3,1	0	14,4	0	0,18	0,39		0,72	1,5	2,4	0	7,2	3,9	3,1	8,8
4		3	58	Damascus		131084	Oct	0	0		359	0,04	1,2	0,4	4,6	0,1	30,1	0	0,63	0,41	0,07	1	2,1	3,6	0,01	8	5,7	4,7	
3		110	T8	Bar/Acrab		77	NovDe			620	397		0,9	0,6	5,4	0	7				0,11	1,4	5,2	3,6		7,1			
3		120	T13	Barada		77	NovDec			850	544		1,3	0,6	7	0	12,7	12,7			0,05	2,1	11,1	4,2		7			
4		131	82K	Barada	5,2	311082	Oct	0	0		438	0	2,5	0,9	4,7	0	12	0,1	0	0	0,05	2,6	1,7	3,3	0	8,1	5	4,7	
4		132	82K	Barada	1,8	300183	Jan	0	0		409	0,05	3,2	0,8	3,1	0	6,4	0,1	0,1	0	0,1	3	0,4	3,8	0		1,2	3,2	7,2
4		133	13K	Barada		180385	March	0	0		176	0	1,5	0,2	2	0,1	2,2	0	0,1	1,3	0,02	0,1	2,4	1,2	0,05	7	3,6	2,1	
4		134	15K	Barada		190585	May	0	0		298	0	1,3	0,2	1,2	0,1	40,7	0	0,5	0,1	0,2	0,5	2	2,6	0,2	8,3	4,6	3,3	
4		141	214	Barada	2,6	130682	June	0	0		412	0	1,3	0,51	5,7	0	17,2	0,03	0,06	1,1		0,62	0,7	6,3	0	7,5	7	5,65	4,4
4		142	214	Barada	2,7	081183	Nov	0	0		211	0,04	1,4	0,19	2,4	0	4,4	0	0,27	0,21	0,07	1,39	0,3	2,3	0		2,6	2,4	8,8
4		150	115K	Barada	3,1	250183	Jan	0	0		587	0,1	2,4	1,6	6,5	0,1	8	0,3	0,1	0	0,1	3,7	1,9	5	0,1		6,9	6,6	
4		160	52	Barada		151277	Dec	0	0		609	0	1,8				0,1	0	0	0									
4		170	14K	Barada		160584	May	0	SB		1263	0	16,2	0,1	5,5	0	76,6	0	0,7	0	0,3	13,4	6,3	2,7	0,02	7,6	9	5	8,8
3		180	T25	Barada		77	NovDec			640	410		2,8	0,9	5,5	0	4,6				0,06	1,4	8,2	3,35		7,4			
3		190	T34	Barada		77	NovDec			1950	1248		7,8	6,1	6	0	0,9				0,04	3,65	27,8	4,1		7,2			
3		191	T35	Barada		77	NovDec			930	595		2,1	3	4,7	0	0,5				0,06	1,9	11,7	2,4		7,5			
4		211	60	Dirani	13,3	220682	June	0	0		267	0	1,13				30	0,07	0	0									
4		212	60	Dirani	15,2	060883	Aug	0	0		312	0,04	0,85				2,2	0,01	0,02	0,05									
4		213	60	Dirani	23,1	290983	Sept	0	0		513	0,04	2,1				22,5	0,09	0,03	0									
4		214	60	Dirani	15,2	111084	Oct	0	0		287	0	0,9				23	0	0,02	0,05									
4		215	60	Dirani	15,2	250385	March	0	0		231	0	1	0,08	5,1	0	26,5	0	0	0,64		0,2	2,96	3,6	0	7,5	6,56	5,1	4,4
4		220	61	Dirani		131075	Oct	0	0		2690	0	20,8	18,1	6,6	0	0	0	0	0	20	42	17,3	7,8	0	7,2	25,1	6,6	13,2
4		311	70	Dirani	10,7	220682	June	0	0		380	0	2,25				20,2	0,06	0	0									
4		312	79	Dirani	11,2	290983	Sept	0	0		317	0	1,5				9,7	0	0,24	0,49									
4		313	70	Dirani	10,1	131084	Oct	0	0		322	0	1,2				23,9	0	0,75	1,14									
4		314	70	Dirani	10,1	130385	March	0	0		417	0	1,5	0,58	5,5	0	22,1	0	3	1,5	0,2	0,14	2,26	5,5	0	7	7,76	5,5	13,2
4		320	118	Dirani	19,5	250285	Feb	0	0		243	0	0,9	0,44	3,5	0	5,7	0	0,14	0		0,03	2,9	2	0	7	4,9		4,4
3		400	T8	Bar/Acrab		77	NovDe			620	397		0,9	0,6	5,4	0	7				0,11	1,4	5,2	3,6		7,1			
4		410	105K	Akrabani	8,7	080584	May	0	0		359	0	1,5	0,6	4,7	0	9,3	0,8	1	0,5	0,18	1,43	3,15	1,9	6,4	7,4	5	4,7	4,4
3		420	T14	Akrabani		77	NovDec			680	435		1,3	0,9	6,1	0	7,4				0,05	1,26	6,8	3,5		7			

FIGURE 14a-GROUNDWATER ELECTRICAL CONDUCTIVITY OF DAMASCUS BASIN IN Nov.-Dec. 1977 (E.C.u.m.h.o./cm 25)

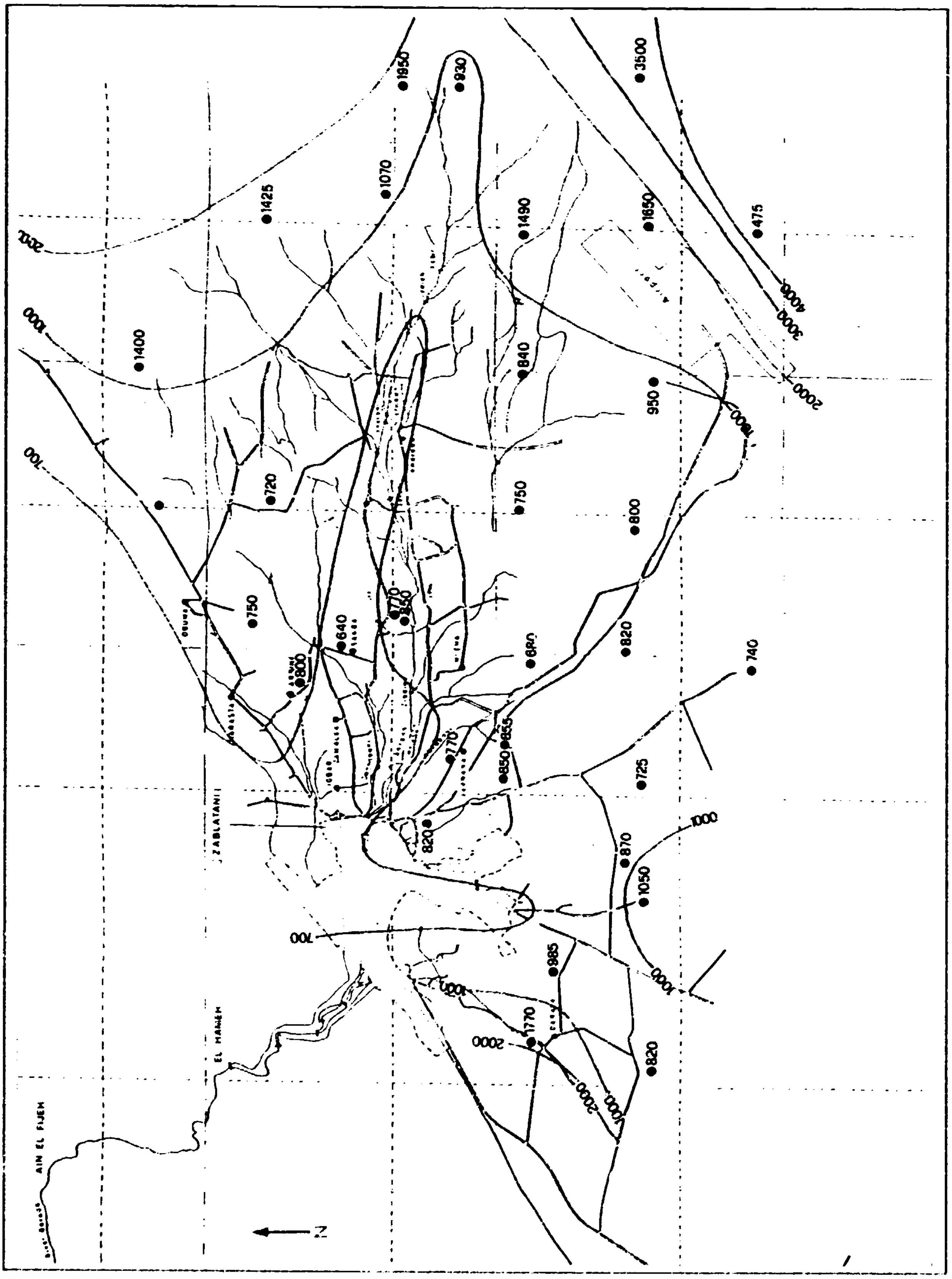


FIGURE 14b-NITRATE CONTENT OF WELL WATER OF DAMASCUS BASIN Nov.-Dec. 1977 (NO_3 as mg/lN)

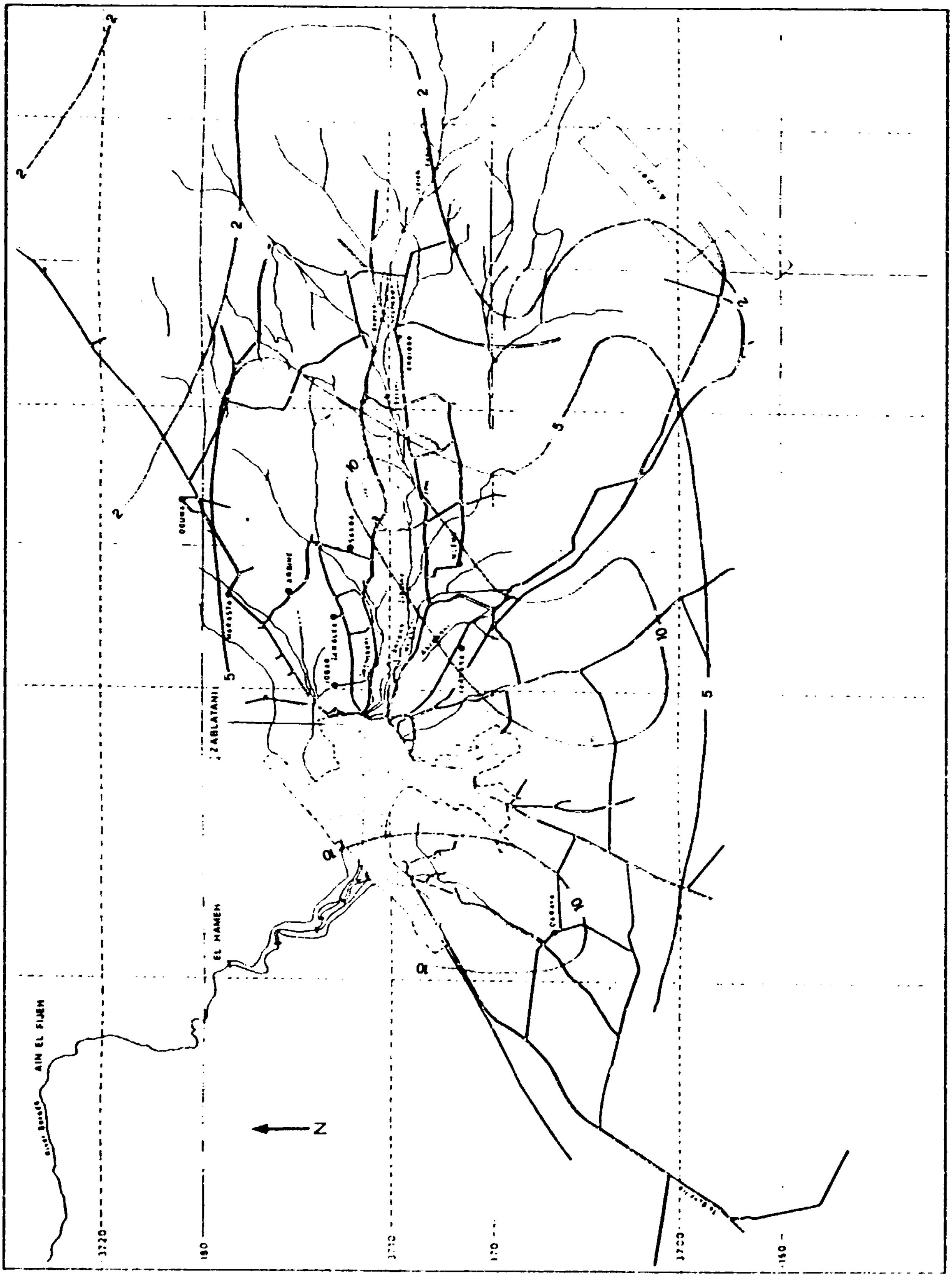


FIGURE 14c-CHLORIDE CONTENT OF WELL WATERS OF DAMASCUS BASIN
(chloride as% meq/l total anions)

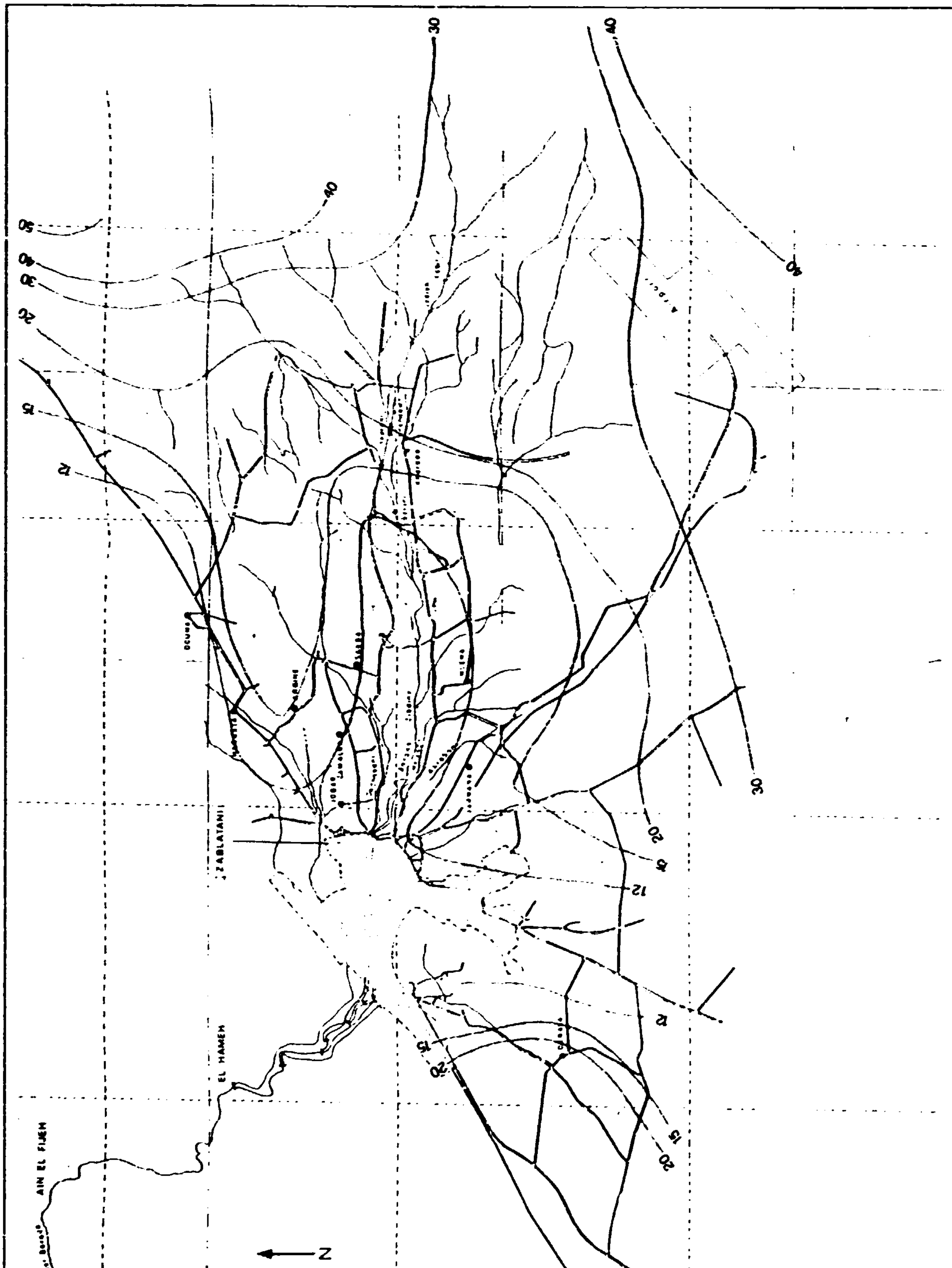


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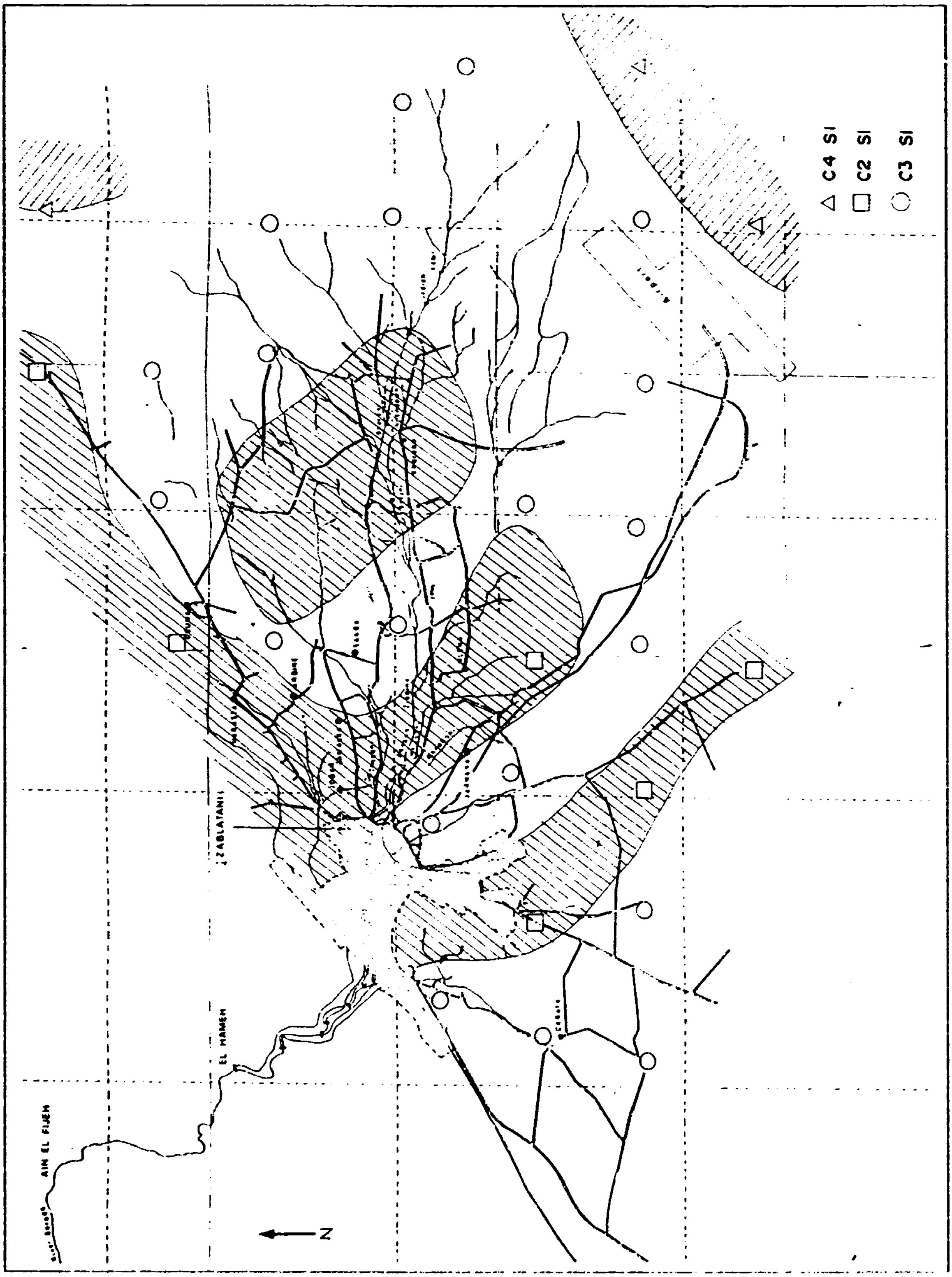
FIGURE 14d-GROUNDWATER QUALITY FOR IRRIGATION OF DAMASCUS BASIN Nov.-Dec. 1977 U.S.D.A. CLASSES



4.3. Water supply.

For the water supply of Damascus three main sources are available: the Barada source, the Ain El Fijeh spring and the groundwater of the city.

According to the Director of the Drinking Water Supply of Damascus, from the Barada source a discharge of 1.1 m3/s will be derived by gravity. In few months the source will be connected to the Ain El Fijeh spring by a pipe 20 km long with diameter of 1000 mm, but the discharge of 1.1 m3/s is not yet utilised. The mean discharge of the source is 4 m3/s up to a maximum as high as 10 m3/s.

The Ain El Fijeh spring is utilised since the year 1902, and now 7.5 m3/s are derived by gravity to the Damascus aqueduct, while the mean discharge of the source is 8 m3/s, with a maximum value of 28 m3/s. An oval concrete tunnel 15 km long connects Ain El Fijeh spring to Damascus.

In Damascus city itself there are 130 wells, divided in 13 groups of 10, which pump water into the distribution network. In the dry period a daily volume of 170,000 m3, corresponding to a mean discharge of 2 m3/s, is abstracted by the wells from the aquifer. By the end of the dry period the mean discharge from wells decreases to 1.5 m3/s

The population served by the city distribution network are at present about 4.5 millions, the mean distribution water supply is 7.5 m3/s, therefore the available quantity of water per inhabitant is of about 144 litres/day.

It must be pointed out that about a thousand other private wells are active in the city of Damascus for various purposes.

In the upper rural area of the Barada river basin there are 14 villages and towns, and about 200,000 inhabitants. In particular in the Ghouta plain there are about 500,000 inhabitants. In the rural area the available quantity of water per inhabitant is 125 litres/day.
The total annual volume of water for the whole rural area is therefore of about 32 millions m3, and for the plain about 22 millions m3. Almost all this volume, corresponding to a total mean discharge of about 1 m3/s, is obtained by pumping wells.

It is interesting to remark that the population served by the water supply systems is at present growing at an annual rate of about 5%, and therefore corresponding should be the water requirement.

For the next years an increasing utilisation of the water resources for water supply purpose can be easily foreseen. An increasing volume of waste water will be therefore delivered to the Barada river and to the derived canals, and in these courses the volume of natural water will be less and less. More and more frequent the days will be with natural discharge zero.

4.4. Sewerage.

The ratio between the mean discharge of the sewerage and the mean discharge of the aqueduct is 0.8, and so at present the mean discharge of the sewerage can vary from 6 m3/s to 7.6 m3/s, that is roughly from 190 millions m3/year and 240 millions m3/year.

The sewerage is of mixed type, and can pour waste water everywhere along the canals and the Barada river.

There are 72 main pouring points and a very high number of secondary pouring points.

Considering that in dry periods the discharge in the Barada river or in the derived canals may be zero, it is possible to suppose that sometimes the sewerage discharge only constitutes the discharge of these courses.

This is what can happen in the reaches of the Barada river and Dayani canal, which flow on the limit of the Zablatani industrial area.

In the future the already built collector about 20 km long will collect and transport by gravity from Ain Terma all the waste water to the treatment plant of Adra, at present in course of construction.

The treated water will come back to the Ghouta plain, and it will be necessary to utilise it for the irrigation and for the recharge of the groundwater.

According to the Deputy Director of Directorate of Irrigation and Water Resources, from Adra four lined canals, from 11.1 km to 15 km long and roughly following the contour lines, will convey the treated water by gravity westwards (See figure 15). Four pumping stations are also foreseen for morphological reasons. From the lined canals the water will be derived to a large number of earth canals and utilised for the irrigation.

The whole municipal drainage and treatment system has been designed on the basis of the following parameters:

- Dry weather discharge: mean 5.613 m3/s; max. 8.42 m3/s
- Rain weather inflow at the MTP: 11.226 m3/s

In the rural areas each village has its sewerage network, and the pouring lines come out without treatment to the nearest canal or to Barada river, where the water has always been derived for irrigation purposes.

Anyhow, as previously said, the use of this surface water is now prevented.

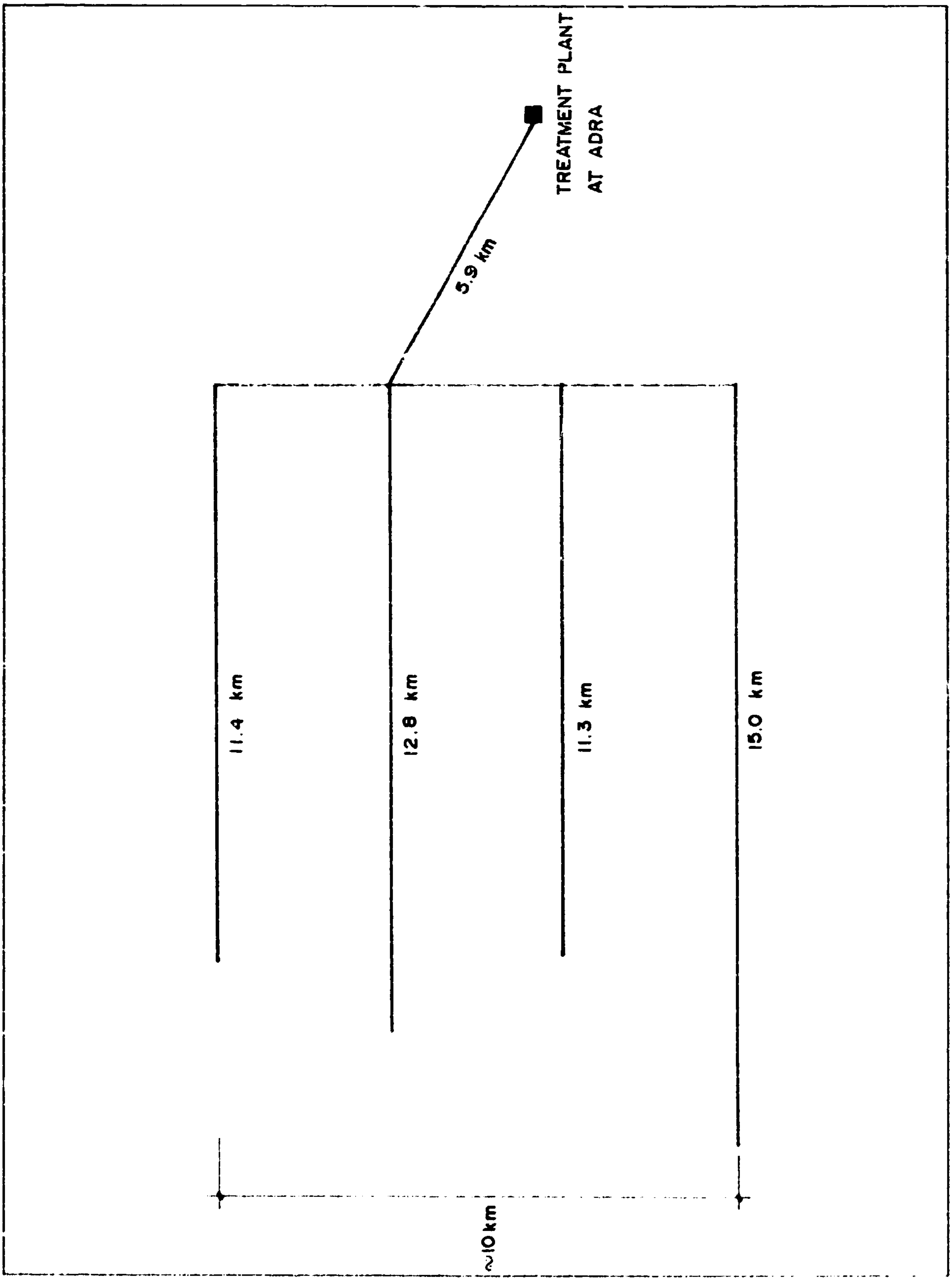
Recently the Ministry of Housing decided to make a plan for the construction of treatment plants for villages and groups of villages.

For the villages of the Ghouta plain situated near the collector to Adra it was decided to join their pouring lines to this collector in the next years.

The available water resource in the Barada basin is now more and more utilised for water supply purpose, and this resource is so more and more transformed into waste water discharged in the Barada river and in the canals.

Without a treatment plant the ratio in these courses between polluted and natural water is increasingly higher, and in some periods the flow can be constituted by waste water only. If it is considered that the surface water is the most important recharger of the aquifer, and would be utilised for irrigation, it results apparent the great utility of the treatment plant in Adra.

FIGURE 15-SCHEME OF THE IRRIGATION CANALS DOWNSTREAM OF ADRA TREATMENT PLANT



4.5. Conclusions.

Keeping in mind what has been previously said, some considerations can be made, such as:

- in the months between July and February the mean natural discharge of the Barada river at Hameh for the period 1984-1993 was 2.6 m3/s;

- in the Barada river and in the Dayani canal near the Zablatani industrial area the natural daily discharge can be zero at present and in the future with increasing probability. In these days the only possible discharge is the waste water discharge;

- when the treatment plant in Adra will be operating and all the waste water will be conveyed there, the possibility exists for the bed of the Barada river and of the Dayani canal to be dry;

- with the treatment plant in operation, a very high discharge will be absent in the water courses. The total discharge of the Damascus aqueduct will be in a short time 8.6 m3/s during the wet months (7.5 m3/s from Ain El Fijeh and 1.1 m3/s from the Barada source), and 10.6 m3/s during the dry months (other 2 m3/s from the wells in the city). The waste water conveyed to Adra will range therefore approximately between 6.9 m3/s and 8.5 m3/s;

- the high discharge conveyed to Adra is subtracted from the irrigation of the Ghouta plain, and it must come back to the Ghouta plain, close to the area of subtraction, or else the aquifer will lose its most important source of alimentation;

- the total lack of the effluent of the Adra treatment plant for the Ghouta plain aquifer may happen if this effluent will be released near the plant definitely or while waiting for the construction of the four designed lined irrigation canals departing from the plant. The release of the effluent near the plant must be absolutely excluded. From the figure 10 it can be observed how in Adra the water table has an elevation of about 590 m and the isophreatic lines range in the irrigated area between 660 m and 590. If released near Adra, the effluent can only go uselessly to the Aateibe lake;

- in the future it will be necessary to monitor continuously the aquifer in order to check a possible lowering of the water table and the condition of the pollution;

- it must be pointed out that the aquifer is now utilised in the Ghouta plain both for the irrigation and for the water supply of about 500,000 inhabitants.

5. PUBLIC HEALTH IN ZABLATANI AND SURROUNDING RURAL AREAS.

The overall observations of the health situation and particularly of the rural areas served by the rivers which pass through the industrial area having collected the water-borne refuse of the city of Damascus, derive from contacts, official and unofficial, with representatives of the sanitary Authority of the Health Ministry, doctors from the public health service. In addition they arise from official documents and, in particular those provided by the Health Service of the Suburbs of Damascus, and also from confidential information from doctors in the rural areas.

Unfortunately, there is very little documentation, so that very many infectious diseases escape official epidemiological notice, as the doctors do not report them, particularly family and private doctors. The records which do exist refer in the most part to serious illnesses which require hospitalisation.

All the following observations derive therefore both from what CHS. observed in the field and from what up to date medical science knows about the health situation in which Damascus and its surrounding areas finds itself.

From an inquiry into the most widespread diseases reported in Syria and in the town of Damascus, conducted by some English engineers during the years 1972-1976, it results that the must common diseases were, besides cholera, typhoid fever, poliomyelitis, viral hepatitis and dysentery. This was, having been carried out by a non-medical team, an extremely limited account, taken from statistical annual reports of the Ministry of health which, unfortunately, as noted before, are, even today, partial, fragmentary and incomplete. Because of this, infectious diseases in the urban and rural areas are obviously epidemiologically underestimated, even if everybody interviewed is convinced that the reality is much more serious than the official figures demonstrate.

This certainty derives in particular from today's high density of population, which has almost tripled since 1977, and from the scanty volume of water in the rivers which receive both the sewage waste from the town and industrial emissions. The industries, like the population, have grown in number, size and productive capacity. Therefore, despite the Health Authority's commendable efforts to promote campaigns for the spread of hygiene regulations to limit the risks of infectious diseases in the population, and to carry out periodical checks on the river waters, there still exist serious dangers of the spread of diseases of various nature and origin. In fact, the present reality leads one to believe that in the rivers which pass through Damascus, but particularly those which collect the industrial waste of Zablatani, there is present in notable quantities biological organic pollutants (bacteria, spores, fungi, virus, parasites), organic material (blood, gelatines, remains of decomposing animals), inorganic pollutants (metals, mineral dusts), chemical pollutants (salts, solvents, acids, bases).

This unquestionably explains the high risks of human contagion of varying types and intensity. From personal sources and from facts emerging from documents with ware provided to CHS., there is evidence of a high number of cases of diarrhoea and dysentery (amebic, bacillary, shigella, parathyphoid) as well as influenza, especially in the winter season. There are very frequent cases, particularly in the rural areas, of viral hepatitis A and B, brucellosis, jaoundice. The cases of salmonellosis are less frequent and those of choleric diarrhoea rare (and anyway less frequent after August 1993). Because of the geographical situation the cases of malaria by anopheles and pulmonary TBC carried by import skin or bovine meat are extremely rare.

There are numerous cases of renal sand chemically constituted of calcium salt in children (presumably connected with the use of very hard water) and of anaemia in children and pregnant women.

CHS. received from the Health Service of the Suburbs of Damascus and from the local public health workers documentation concerning infectious diseases reported in the extra-urban villages of Kiswe, Jarmana, Zamalka, Douma, Zakie, Harasta, Sabka, Canakir, Deratie, Nebk, Hegireswed, Eltil, Katana, Sabora, Kutsia, Daria, Jabadin, Kataifa, Sahnaya, Modinie, Artoz (see the attached table 20). In these villages 52,000 people live, 50% of whom work in agriculture and 50% in small local industries.

The large numerical discrepancies in the official data between 1993 and the first 5 months of 1994 do not necessarily mean that the present health situation is considerably worse but rather that there has been a greater effort on the part of the health authorities to deal with the problems.

It is certain, however, from this partial data and from unofficial information that the number of cases of infectious diseases, above all those connected with water, are undoubtedly underestimated, and that the health situation is more serious than shown by the official data. This is particularly so bearing in mind that this data refers to a rural population of 52,000 and that the population of Damascus is now more than 4 million.

The river water, much of which is used more or less illegally to irrigate the fields under cultivation, is certainly highly polluted. Even if the seriousness of the pollution can only be confirmed scientifically by careful bacteriological, chemical, toxicological, etc., investigations, an indirect proof is offered by the fact that the authorities have prohibited the cultivation and eating of green leaf vegetables.

Apart from other possible pollutants such as metals, chemical products, minerals, biological derivants (bacteria, virus, parasites, etc.) deriving from the industrial area, from the river water and from the possible consequent pollution of the water-bed, wells, irrigation canals, the soil, etc., the urban and rural populations can also suffer from various diseases.

Some of these diseases of viral origin, such as poliomyelitis which is very rare today, those caused by coxsachie, adenovirus, rheovirus, echovirus and epidemic hepatitis are transmitted orally by vegetables, fruit, uncooked food, polluted by water contaminated by human or animal faeces.

The bacterial such as typho-paratyphoid fever and salmonellosis, bacillary dysentery, cholera, enteritis, enterocolitis caused by pseudomonas and escherichia coli are also transmitted by mouth and strictly connected to the assumption of polluted water, fruit or vegetables.

Brucellosis can be contracted both cutaneously and through the mucous membranes of animal, tetanus which is found in sheeps intestine can be introduced through wounds infected by spores deposited on the ground in the faeces.

Leishmaniasis is transmitted to man by sting of a phlebotome which lives in warm dump environment while leptospirosis is transmitted through the urine of rodents and dogs, seen in large numbers near authorised and unauthorised dumps, immediately next to water courses, through cutis, mucous membrane or in an endemic way caused by the contact with marshy or infectious water courses.

Fungi infections (such as candidiasis), dermatopathies (such as those caused by Dermatophagoides), and epidermophitons are possibly carried by water and are therefore ubiquitarian.

Amoebic dysentery, giardiasi, balantidium choli dysentery are connected to the presence of unicellular protozoa in water and therefore contracted by mouth.

The common intestinal parassitosis as the ones due to oxyuries, ascarididae, whip worms, taenia are transmitted by mouth as well and carried by infected water or food.

Even if comparative epidemiological studies have not been carried out on the effect of infective, parasitic diseases or transmitted by animals in the civilian population originated by infected water of area of Zablatani and the other areas of Damascus city, on the basis of actual knowledge can be certainly admitted that some diseases found in the population referred above, have been caused by water pollution produced particularly by slaughter houses, tanneries, glue factories etc., as referred in the chapter related to the environmental impact assessment.
Unfortunately we do not have official and unofficial information about diseases contracted by the local population caused by pollutants coming from the industrial area such as lead, chromium, carbon monoxide poisoning, bronchitis, pneumoconiosis etc..

Presumably, given the considerable amount of chemical substances unloaded into the sewers and through these, into the rivers, these diseases could be occurring now, but they are ignored or are confused with common illnesses. It is already known in fact that the majority of industrial toxics cause non-specific biological damage which are not easily identifiable in their provenance if the origin and seriousness of the polluting source is not known. To all this should be added the great impact on the atmospheric environment of the heavy motor traffic and particularly the very large lorries which use the roads through the industrial area of Zablatani.

Particular attention should be paid moreover to the hygiene and safety in the work environment and to the care of workers' health by means of environmental improvement and the adoption of appropriate systems of individual prevention, which at present are very much lacking. These measures are necessary to prevent accidents and work related illness, and because of the danger to the local population, in particular the families of the workers, by means of passive transmission of pollutants from the work environment.

In conclusion since the expected annual grow of the Damascus and Rural population is more than 5% and because of industrial increase, in a few years the sanitary situation could become dramatic. This if no water purifying plants and severe controls of public and industrial hygiene will be introduced.

	INFLUENZA	ENCEPHALITIS	RABIES	Q FEVER	VISCERAL LEISHMANIASIS	CUTANEOUS LEISHMANIASIS	TYPHUS	BRUCELLOSIS	CHOLERA	A HEPATITIS	B HEPATITIS	DIPHTHERIA	PERTUSSIS	MEASLES	VARICELLA	PAROTITIS	RUBELLA	POLIOMYELITIS	TUBERCOLOSIS	EPISTAXIS	PEDICULOSIS	VESICULOSE	SCABIES	TOT
jan-93					8	15		1		4	1			6	5	13		1	2				2	58
feb-93						1				1				3	5	11							7	28
mar-93					1	1	3	1		3	1			19	1	17	1						5	53
apr-93		3			1	3		2		1			21	17			12		2		1		17	80
may-93		2				1	1			1			1	3		2					2	5		18
jun-93		2										1		27		11						1	1	43
jul-93																5							3	8
aug-93									1		1					1							1	4
sept-93										1														1
oct-93								3		5	4			5		13							2	32
nov-93																2								2
dec-93										1	1					7							4	13
TOT	0	7	0	0	10	21	4	7	1	17	8	1	22	80	11	82	13	1	4	0	3	6	42	340
jan-94	175						2			3	3			2			1			4	4		14	208
feb-94	499		7			140	10			30	7			9			7			24	5		59	797
mar-94	248			2		135	3			10					12		4			15	7		25	461
apr-94							2			2										11			19	34
may-94	122				6	26	11			10	7		1	10			3			51	9		32	288
TOT	1044		7	2	6	301	28	0		55	17			21	12	0	15	0	0	105	25		149	1788

Table 20 - Incidence of infectious diseases in rural areas (years 1993-94)

DETAILED REPORT

PART II

ZABLATANI INDUSTRIES

THEIR IMPACT AND TECHNICAL SOLUTIONS

6. INVENTORY

The team analysed into details the present situation of the activities located into ZIA. TL, CHS, and PHE visited all existing activities to evaluate the present pollution problems and obtained data about the pollutants emanating from non-tanneries. In the meantime 150 private tanneries and 4 public tanneries were investigated by SC I.

Moreover, SBC1 inspected 12 tanneries outside of ZIA, located in Ain Terma, which were also considered in the EIA. Ain Terma area is marked in the figure 1

During the investigation, it was proved that in Ain Terma, outside the area inspected, there are about 20 other limestone cutting factories that discharge high quantities of carbonates. We suggest that the same preventive measures as for Zablatani limestone cutting be adopted also for these facilities.

Actually the total number of activities reckoned with in the area have been 299, including two glue factories located in Ain Terma, five factories out of order (four glue factories and one public velvet factory), and six clothing factories under construction.
The data from one military slaughter house are restricted, therefore we assumed, only for calculation, the same ones as for the public sheep slaughter house, but it is possible that they do not respond to the truth.

All the activities are listed in the following table 21, which also indicates:

- one map code, responding to the location in figure 16.
- number of workers, as counted in the field or referred by factory managers.
- one activity code, whose meaning is:

CRM:	car repair and maintenance.
CBM:	concrete brick and sewers moulders.
LMC:	limestone cutting and/or polishing.
SLH:	public and private slaughter houses.
BPP:	tannery and/or SHL by-products processing.
SAW:	saw mills.
LIP:	activities with relevant land impact.
CMM:	commercial activities.
MSH:	various activities.

Table 21 List of ZIA industries

MAP CODE	ACTIVITY CODE	ACTIVITIES	WORKERS
1	MSC	GRAIN GRINDING	2
2	MSC	WEAVING	10
3	MSC	IRON SMITH	2
4	CMM	BRICK SHOP	3
5	MSC	WEAVING	5
6	MSC	ALUMINIUM DOORS AND WINDOWS FACTORY	3
7	MSC	STOVE FACTORY	4
8	SAW	SAW MILL	6
9	SAW	SAW MILL	12
10	LMC	LIMESTONE POLISHING	12
11	CMM	SHOP	2
12	CMM	SHOP	2
13	MSC	IRON SMITH	4
14	MSC	GAS BOTTLE FACTORY	6
15	CMM	BRICK SHOP	3
16	CMM	BRICK SHOP	5
17	CMM	BRICK SHOP	4
18	MSC	ICE FACTORY	12
19	MSC	MARBLE LAPPING MACHINES FACTORY	5
20	CMM	ICE SHOP	1
21	CMM	BRICK SHOP	2
22	LMC	LIMESTONE POLISHING	9
23	LMC	LIMESTONE CUTTING	8
24	CMM	TIRES SHOP	3
25	MSC	GLASS REINFORCED PLASTICS MOULDING	5
26-103	CRM	CAR REPAIR AREA (N°78 FIRMS)	350
104	MSC	GLASS REINFORCED PLASTICS MOULDING	2
105-146	CRM	CAR REPAIR AREA (N°42 FIRMS)	180
147	MSC	PUBLIC VELVET FACTORY (OUT OF ORDER)	0
148	SLH	PRIVATE POULTRY SLAUGHTER HOUSE	20
149	CBM	CONCRETE BRICK AND SEWERS MOULDER	6
150-161	LMC	N° 12 LIMESTONE POLISHING	50
162	LIP	SCRAPS-IRON DUMPING	0
163	LIP	SOLID WASTE DUMPING	0
164-167	SAW	N° 4 SAW MILLS	30
168	LMC	LIMESTONE POLISHING	5
169-175	LIP	N° 7 SCRAPS-IRON RECOVERY	32
176	CMM	MACHINERY STORAGE	0
177	SAW	SAW MILL	4
178-179	MSC	N° 2 MOULD FACTORY	10
180	MSC	FURNITURE FACTORY	8
181	MSC	DRUM FACTORY	5
182	MSC	IRON SMITH	3
183	LIP	OPEN SHEEP MARKET & SLAUGHTER HOUSE AREA	40
184	LIP	BRICK OPEN STORAGE AREA	0
185-186	CMM	N° 2 SHOPS	5
187	CMM	STOCK YARD	0
188	CMM	MARBLE SHOP	2
189	MSC	MECHANICAL	2
190	CMM	MARBLE SHOP	2
191-193	CMM	N°3 SHOPS	6
194	SAW	SAW MILL	3
195	MSC	ALUMINIUM DOORS AND WINDOWS FACTORY	4
196	MSC	IRON SMITH	3
197-200	CBM	N° 4 CONCRETE BRICK AND SEWERS MOULDERS	35
201	LMC	LIMESTONE POLISHING	6

202-215	CBM	N° 14 CONCRETE BRICK AND SEWERS MOULDERS	85
216	SLH	PUBLIC POULTRY SLAUGHTER HOUSE	30
217-222	MSC	N°6 BUILDINGS FOR CLOTHING F. UNDER CONSTRUCTION	0
223-257	MSC	N° 35 CLOTHING FACTORY	280
258	CMM	BATH FITTINGS STORAGE	15
259	CMM	TRUCK COMPANY	50
260-266	CMM	N° 7 BAKERY	30
267	SLH	PUBLIC SHEEP SLAUGHTER HOUSE	150
268	BPP	LIVE-STOCK FEED FACTORY	15
269	SLH	MILITARY SLAUGHTER HOUSE	150
270	LMC	LIMESTONE CUTTING	12
271	CMM	TOBACCO WHOLESALER	10
272	CMM	STOCK YARD	0
273	CBM	CONCRETE BRICK AND SEWERS MOULDER	7
274	CMM	FRUIT COLD STORE	7
275	CMM	CHEMICALS SHOP	4
276	LIP	TANNERY SOLID WASTES COLLECTION	5
277	SLH	PRIVATE POULTRY SLAUGHTER HOUSE	20
278	CMM	SHOP	2
279	MSC	WORKSHOP	4
280	LMC	LIMESTONE POLISHING	7
281	LMC	LIMESTONE POLISHING	5
282	CBM	CONCRETE BRICK AND SEWERS MOULDER	4
283	LMC	LIMESTONE CUTTING	5
284	MSC	WORKSHOP	3
285	LMC	LIMESTONE POLISHING	6
286-287	BPP	N° 2 MEAT PROCESSING	8
288	BPP	GUT FACTORY	4
289-297	BPP	N° 9 GLUE FACTORY (4 OUT OF ORDER)	16
298-299	BPP	N° 2 GLUE FACTORY (AIN TERMA)	8
		TOTAL	1.885

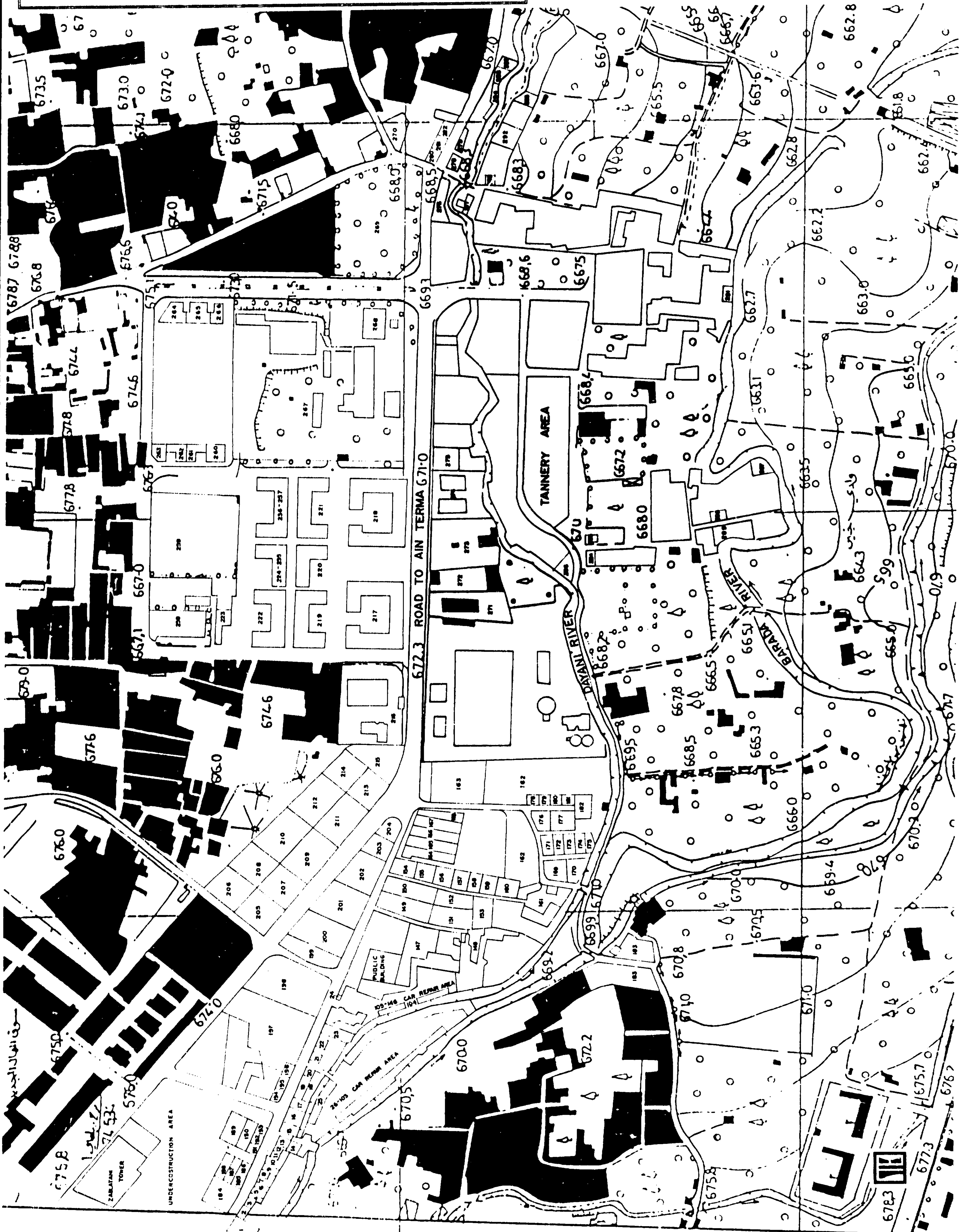
The summary, according to the different categories of activities is:

Table 22 Summary of ZIA industries

M.C.	ACTIVITIES	Nr OF FIRMS		WORKERS
CRM	CAR REPAIR AND MAINTENANCE	120		530
MSC	VARIOUS ACTIVITIES	64	(1)	382
SLH	SLAUGHTER HOUSES	5		370
CMM	COMMERCIAL ACTIVITIES	32		158
CBM	CONCRETE BRICK AND SEWERS MOULDER	21		137
LMC	LIMESTONE POLISHING OR CUTTING	22		125
LIP	LAND IMPACT ACTIVITIES	12		77
SAW	SAW MILL	8		55
BPP	TANNERY AND/OR S. HOUSES BY PROD. PROCESSING	15	(2)	51
TNR	TANNERY	164	(3)	1.075
	TOTAL	299		2.960

Remarks: (1) one out of order, six under construction. (2) four out of order. (3) inventored by SC I

FIGURE 16 - ZABLATANI INDUSTRIAL AREA INDRUSTIAS LOCATIONS



7. ENVIRONMENTAL IMPACT ASSESSMENT AND INDUSTRIAL HYGIENE.

The following schedules contains, for each main category of industries, the most likely discomforts and diseases, and at the same time suggest preventive and/or remedial measures.

7. 1. Slaughter Houses

7.1.1. Public Sheep Slaughter House

The workforce at the slaughter house consists of 150 people. Slaughter takes place between 7.00 p.m. and 12.00 midnight and an average of 2-5 thousand animals a day are slaughtered. The opera ion takes place on two floors.

The animals to be sacrificed, without any pre treatment (washing, disinfestation, etc.) arrive on the upper floor by way of a corridor in single file, and are then weighed on hooks attached by a posterior hoof to a moving track on the ceiling, and they move slowly towards the area where their threats are cut so as to cause death by bleeding, The blood mixed with water to the amount of 1/3 runs directly into the sewerage system (on average 10 tons a day).

Proceeding via successive stations the animals are eviscerated and the selected contents (heart, liver. etc.) fall through appropriate openings in the floor and are collected on the lower level in differentiated containers. At the end, the animal is skinned and the skin, also collected on the lower floor, is sent to the tanneries.

The hoofed part of the foot is cut from the rest of the body and the body is sent in part to be refrigerated for later sale and in part to be frozen.

The small intestine is sent to gut factories for musical instruments; the hooves to animal food factories for further treatment.

IMPACT ON THE WATER : This is represented both by organic material (above all blood which in itself constitutes a vehicle for infection by micro-organisms (bacteria, virus, fungi) present both in biological material deriving from the animals (urine, faeces) and on the fur, hooves etc., and by macrorganisms (helminths, nematode) which flow directly into the sewers with the waste washing water.

IMPACT ON THE AIR: This is practically non-existent as chemical substances and other volatile products are not used.

IMPACT ON THE SOIL: This is modest and is connected prevalently with animal residuum (hairs, parts of the carcass, clumps of fur, etc.) or their excretions (faeces, urine).

PREVENTATIVE MEASURES: 1) Remove the most contaminated parts of the animal during the processing (hairs, hooves, intestines etc.). 2) Alternate moments of cleaning the floor and the utensils. 3) Replace workers protective clothing for every shift (overalls, gloves, etc.). 4) Take care that air and water flow go in the opposite direction from the animals, or from the cleanest to the least clean and not vice versa. 5) Where possible collect or destroy the blood which, as has been noted, in addition to being a possible carrier of infection from the animals, is an excellent culture ground for the growth and reproduction of several micro-organisms and which, flowing directly into the sewers can contribute to the amount of infectious material present in the environment. 6) Pay attention to the cleaning, disinfection and maintenance of the plants. 7) Provide periodic rodent control. Rats are the carriers of many diseases for man.

7.1.2. Poultry Slaughter House

There are one public slaughter houses and two private slaughter houses.

In the public slaughter house there are 30 workers and a maximum 8,000 animals a day are sacrificed, coming from breeders in the surrounds of Damascus.

The blood of the animals sacrificed, mixed with water, runs directly into the sewerage system.

After they have been showered the feet are removed and they are eviscerated, and then some are sent to market and some are refrigerated or frozen. Most of the operation is carried out automatically by machine.

Once the various phases of the work are finished the work areas are washed and disinfected with formaldehyde.

In the private slaughter houses there is a total of 40 people working. In one of these there are rooms where the chickens stay until they are sacrificed.

IMPACT ON THE WATER: 1) Direct transfer into the sewers of bacteria and parasites present in the animals feathers by means of the waste washing water used for plucking and showering; 2) growth in the amount of infectious material present in the environment due to the direct flow of the animals blood into the sewers; 3) the entry into the urban sewers of the remains of the disinfection of the floors and, for the private slaughter house which has the rooms where the animals stay, their excretions during the cleansing operations.

IMPACT ON THE AIR: Nothing for the public slaughter house where good hygienic measures have been adopted. Possible but modest for the private slaughter house with accommodation for the chickens (dispersion of feathers with parasites, powder deriving from contaminated dried excrement).

IMPACT ON THE SOIL: Modest for the private slaughter houses and deriving from excrement, feathers, remains of decomposing interior organs, etc. Nothing for the public slaughter house.

PREVENTATIVE MEASURES: These should pertain in particular to the private slaughter houses. where supervision should be carried out of environmental and work hygiene rules.

7.2. By products processing

7.2.1. Live-stock feed factory

The work takes place in a two-storey building situated inside the public sheet slaughter area.
The work cycle consists of drying the bones or other discarded parts of the animals which cannot be used commercially. These come partly fro the public slaughter house, but mostly are brought from outside in lorries. The last part of the process consists of grinding the material. Bones and other

material are dried in containers on the upper floor by means of the heat produced on the ground floor by boilers and then ground into animal feed.

IMPACT ON THE WATER: The absolute lack of any rules of hygiene means that all types of rubbish are emptied into the sewage system, both solid (small remains of animals in the early stages of putrefaction) and bacterial, viral and mycotic elements, etc.

IMPACT ON THE AIR: As a consequence of the direct discharge into the atmosphere of the smoke from the burning of bones and other animal parts, there is a bad smell which justifies the complaints of the inhabitants of the area immediately surrounding the plant.

IMPACT ON THE SOIL: There are numerous fragments of organic material left on the ground during the transport and/or the unloading of animal parts to be treated, which, in the heat, tend to decompose rapidly, constituting a vehicle for many infectious elements.

PREVENTATIVE MEASURES: Pay attention to the cleansing of the work environment and particularly provide for its disinfection and for the accurate cleaning and disinfection of the open work areas, removing organic material. Channel into the atmosphere through high chimneys, containing filters, the fumes from the drying of the organic material, so as to dilute them in the air and so eliminate the arrival of bad smells in the surrounding area.

7.2.2. Glue factory

These are small factories producing animal glue based on gelatine obtained by extraction with hot water of a mixture of soluble proteins derived from the remains of skin and animal bones.

Gelatine obtained in this way is laid out on specially designed frames and solidifies by drying in the sun. The workers use no protective clothing.

IMPACT ON THE WATER: Increase in the fluvial bacteria by means of the entry into the sewage system of refuse water, which may be polluted by bacteria and virus. Animal gelatine in fact represents an excellent breeding ground for many pathogenic germs (so much so that in bacteriology it is used as a culture for the development of various species of bacteriological flora) for example bacteria type Achromobacter, Bacillus like Subtilis, Micrococcus Roseus, Staphylococcus Aureus, etc.

IMPACT ON THE AIR: This derives from the process of putrefaction, from mould, etc., which can develop from remains of skin and bone left to dry in the sun before the extraction by heat of the gelatine, operations which take place in the winter

IMPACT ON THE SOIL: Bacterial and rodent contamination of the residual skin, left to dry in heaps in the sun before being treated to extract the gelatine. It should be remembered that rodents also by means of their excretions left on the soil can be possible vehicles of infection.

PREVENTATIVE MEASURES: Periodical rodent control.

7.2.3. Gut factory

The operation consists essentially of the manual emptying of the alimentary contents of the animal's small intestine. This is emptied directly into a big tank fed with running water. The water and its contents is then emptied directly into the sewage system. The operation is carried out with bare hands.

IMPACT ON THE WATER: Introduction into waste water of pathogenic bacteria, nematode and helminths, with a modest increase in the bacterial and parasitic flora of the sewage.

IMPACT ON THE AIR: Nothing. The operation is carried out in a damp atmosphere.

IMPACT ON THE SOIL: Modest and caused by the unloading of solid refuse.

PREVENTATIVE MEASURES: Provide for the periodic disinfection of the tank with chlorine.

7.3. Concrete brick and sewers moulders

There are 21 in total concentrated in a fairly limited area and employing 137 workers.

The main materials consist of cement, sand, chalk and gravel which are collected in piles without any protection against the climatic elements (wind and rain), in the same way as the finished goods ready for sale.

The work process (production of cement pipes, bricks and tiles, etc.) is carried out manually in the open air, pouring into appropriate moulds a paste made of the various materials and water depending on the goods to be manufactured.

There are no wind barriers, despite the very strong winds in this area, to protect the materials in use.

IMPACT ON THE WATER: Nothing, as water is used to make the paste.

IMPACT ON THE AIR: Caused by the various powders which, carried by the strong wind which blows in this area, reach the houses located immediately behind these factories. Their inhalation by the local population represents a real danger of contracting respiratory illnesses. It should be borne in mind that the force of the wind can carry the lightest dust (that is, the most dangerous because it can be inhaled directly and reach the deep lung) a long way from the industrial area.

IMPACT ON THE SOIL: Practically nothing.

PREVENTATIVE MEASURES: Bearing in mind the danger of the powders in question and their capacity to cause respiratory diseases, it is necessary that the piles of primary material should be enclosed with anti wind barriers or covered with plastic sheets, at least when work is finished.

7.4. Limestone cutting and polishing

In the industrial area of Zablatani there are 3 companies which cut limestone and 19 companies who work it. The cutting of large pieces takes place in the open, under a continuous jet of water which both cools the blade and removes the dust which is produced, with saws of a suitable size and strength for the stone to be cut. The water, mixed with lime dust, runs directly into the river. For the operations of polishing rough shapes from slabs of marble, water is collected and recycled using small decanting bowls. The finishing of the pieces is carried out in the open with a angle grinder and this operation produces a great quantity of dust.

IMPACT ON THE WATER: This involves, particularly for the factories which cut the large limestone, the direct introduction of finely ground lime into the water courses and its consequent dispersal at great distances from the polluting factory.

IMPACT ON THE AIR: As the cutting takes place under a continuous jet of water and this runs directly into the river, the danger of air pollution and direct inhalation of dust is very reduced. This dust, however, can form from the dried residuum which is not swept into the river and so enters the atmosphere.
A massive impact consequent upon the dispersion of the dust into the air is, on the other hand, present in the finishing operations which use the angle grinder, because this work is done dry and the dust, of which the granules are all small enough to be respired or inhaled, disperse directly into the environment and when carried by the wind can represent a danger of respiratory disease for the local population (broncopathies, pneumopathies).

IMPACT ON THE SOIL: Nothing.

PREVENTATIVE MEASURES: Use of methods which allow the decanting of the lime material before the water enters the river. Provide for the removal of the dust by aspiration at the work station during the finishing operation with the angle grinder, and pay attention to the cleansing of the environment where the dust is produced.

7.5. Car repair and maintenance

In the industrial area there are situated, in two distinct adjoining areas, workshops for the repair of cars and lorries (engines and body work), and for maintenance (oil changes and lubrication of the mechanical parts, cleaning of carburators, radiators, etc.).

One area comprises 78 workshops situated along the bank of the Dayani and Barada rivers Of these around 20 carry out the painting of body work.

In the other area situated along the bank of the Dayani river, there are another 42 workshops, mostly carrying out repairs of engines and the maintenance of big lorries. The materials found in the workshops are mechanical parts of engines, grease for the lubrication of mechanical parts, oils (already used or new) for the lubrication of pistons, brake oil, clutch oil, solvents for degreasing mechanical parts, etc. The implements in use are those in normal use for mechanical operations. The materials found in the body workshops comprise nitro-cellulose varnishes, varnishes containing lead, in which are present solvents, such as toluene and xylen, methyl-ethyl-keton, together with colouring pigments. From the labels it is not possible to know if benzene is present. This substance is prohibited in Europe because it can cause leukaemia as well as less severe anaemias.

All the motor repair, mechanical part operations on the cars, and the painting work are carried out in an open environment without any system for sucking away the fine spray produced by the compressed air pistol.

IMPACT ON THE WATER: 1) Possible pollution of the river when the waste oil, solvents, waste cleaning water, etc., are swept into the river; 2) the pigments removed from body work with the mechanical emery polisher can fall into the river and/or spread over the surrounding land, as can the dust from the filler used on the body work, being carried by the wind and possibly polluting the water bed.

IMPACT ON THE AIR: Dispersion and carrying for long distances by the wind of solvent vapours and atomised paint.

IMPACT ON THE SOIL: The possible falling of atomised paint containing lead and blown by the wind onto the surrounding vegetation or into the river, with entry into the food chain if animals normally used in human alimentation eat the vegetation or drink the river water. Carrying by the wind onto the ground and surrounding vegetation of filler and paint finely ground by the angle grinder and polisher used to remove the body work paint (some paints also contain lead).

PREVENTATIVE MEASURES: Collect grease, used oil, solvents, dirty washing water in appropriate containers to send to dumps or for recycling. Carry out all the operations of paint removal and painting in closed environments, provided with aspirators and dust and paint spray filters.

7.6. Activities with relevant land impact

In the industrial zone of Zablatani there are some areas where scrap metal of all types and solid urban waste are deposited, one open sheep and goat market and slaughter-house and an area where tannery solid wastes are collected.

This situation certainly causes environmental risks:

7.6.1. Scrap metal dumping

IMPACT ON THE SOIL AND WATER: caused by rust powder, iron products, paint, lacquer and powdered resins from the atmosphere dispersed over the soil and in the water, and also found at long distances from the dumps.

7.6.2. Solid waste dumping

IMPACT ON THE SOIL AND WATER: this is important, and is caused by the dispersion in the environment of rubbish blown by the wind and moved by scavenging animals (cats and dogs, etc.) which search among the rubbish for food; by the processes of putrefaction of organic material with the consequent danger of infectious diseases; and by the increase in the number of rats which themselves are a possible source for the transmission of disease to man.

IMPACT ON THE AIR: characterised by the bad smells which arise from the putrefaction of organic material, increased by the high temperatures.

7.6.3. Open sheep market and slaughter house area and tanneries' solid wastes collection

IMPACT ON THE SOIL AND WATER: caused by the dispersion into the surrounding environment of hairs, dandruff, faeces, urine, blood, skin, interior parts of the animals awaiting slaughter or already slaughtered, or by decomposing of tanneries' solid wastes.

IMPACT ON THE AIR: bad smell originating from animal excrement.

PREVENTATIVE MEASURES: Leachate from tanneries' solid wastes must be conveyed to sewerage. Referring to other activities, the only preventative measure is the elimination both of the dumps and the sheep and goat market, or, where this is not possible, their removal a long way off and their proper isolation from inhabited areas.

7.7. Other industrial activities

Some minor industries, except Gas Bottle Factory and Glass Reinforced Plastics Moulding, are not referred to in this present report because their impact on the soil, water and air is extremely small or completely absent. However the extent of the impact of the individual industries on the region can be seen in the summarising table.

7.7.1. Gas bottle factory

The operations consist in welding the various components of the gas bottle and are carried out in badly lit environments, made particularly cramped due to the high concentration of the work material and implements that are distributed around the work area without any order. The welding of the parts is carried out with an electric welder with electrodes of basic and/or rutilic type, without any system for the removal of the welding fumes which invade the work atmosphere.

IMPACT ON THE WATER: Practically non-existent.

IMPACT ON THE AIR: This is caused by carbon monoxide (CO) produced at the tip of the welding tool and dispersed into the environment, by the fumes, vapours or small drops, and above all by atmospheric pollutants deriving from welded metals (iron, etc.) and from the corresponding oxides and from Cr, Mn, Hg, Cd, Be, As, Cu, Sb, Ni, Pb present in the coating of the electrodes, from the ozone (0_3) produced by the atmospheric oxygen by the ultraviolet radiation and by the nitrous vapours synthesised by atmospheric 0_2 and N_2.

IMPACT ON THE SOIL: Nothing

PREVENTATIVE MEASURES: Aspiration of the fumes at the point of welding by means of hoods, vacuum tubes, etc., and with elimination of dust by means of filters, thermic, electrostatic precipitators, etc

7.7.2. Glass reinforced plastics moulding

There are two small factories employing 7 workers in total. the work consists in the preparation of table tops or small parts of car body work, layering wool glass fibre specially shaped moulds. These fibres are stuck together with metil-ethil-keton peroxide (MEK) put into the mould with brushes or sponges.

IMPACT ON THE WATER: Very modest and represented essentially by the remains of wool glass fibre waste water from washing the moulds, etc.

IMPACT ON THE AIR: This caused by fragments of wool glass fibre carried away by the wind and by MEK peroxide, a chemical compound with a low boiling point, which therefore evaporates easily particularly because of the high environmental temperature. The impact on the air is small due to the tiny number of factories and the very low production.

IMPACT ON THE SOIL: As these operations are carried out in the open air, residual traces of the wool glass fibres or of solid refuse, offcuts from the moulds, sprays of MEK peroxide etc can land on the soil. Also here the impact is small, for the reasons given above.

PREVENTATIVE MEASURES: 1) positioning on the work benches of extractor hoods and filters for the MEK peroxide vapours and fragments of wool glass fibres; 2) the collection of the remains of chemical compounds to avoid the discharge of toxic waste.

7.8. Tanneries

We visited public and private tanneries with the aim of gaining an idea of the characteristics of the work in the various factories.

The normal production cycle followed, given some exceptions because of small differences in usage and variations in the working environment (covered, partially covered, in the open), is more or less the same. In general there are variations in the size of the plants, the amount of machinery and numbers of workforce, the productive capacity and certain phases of working (as for example the use in some working phases of a tub instead of a drum, the prevalence of skin dyeing with rods (by hand) rather than with compressed air pistols, and the way of tanning (with chrome, with tannins).

IMPACT ON THE WATER: 1) Increase in salinity due to sodium chloride; 2) Increase in the bacterial flora of the water caused by micro biological pollutants both of the viral type (Pox-virus, Papovavirus, Rhinovirus) and of the bacterial type (Bacillus Antracis, Micobacterium, Staphylococcus, Pseudomonas, Clostridium, etc.), of the fungal type (Dermatophagoides, Aspergillus) and the protozoan type (Trypanosoma, Besnoitia), or by helminths (genus Filaria) deriving from hair, dandruff, animal skins. In fact the micro biological risk can be considered absent only after pickling. Some spores, like tetanus, are resistant to the very strong chemicals used in this operation; 3) Elements producing decomposition of organic material; 4) Acidification of the waters due to the introduction of weak acid (formic, lactic, etc.) and strong (sulphuric) 5) alcalinity of the water due to the introduction of base (lime, natrium hydroxide, natrium bicarbonate); 6) Introduction into the waters of large quantities of chrome and vegetable and/or synthetic tannins; 7) Introduction into the waste waters of sulphates (ammonium, sodium, etc.), of tryptic enzymes, dyes, sulphonated or synthetic oils, etc.

IMPACT ON THE AIR: 1) Production and development in the atmosphere of sulphur dioxide and hydrogen sulphide with a consequent bad smell; 2) In some working phases, according to the tanneries' chemist, tetrachloroethane, a volatile substance, belonging to class 3A of the IARC, develops, inhalation of which can cause not only irritation of the respiratory pathways or hepatic damage, but, according to some epidemiological studies, also causes cancerogenisis in man; 3) Acid vapours with possible damaging effects on the surrounding vegetation; 4) Dispersion by means of the atmosphere of aerosol paint used to colour skins. In addition, this operation is carried out with a spray gun directly in the environment without any system of vacuum removal.

IMPACT ON THE SOIL: On the whole these are indirect and connected to the movement into the soil, and possibly the water bed, of the chemical substances transported by the water, particularly when this is used for irrigation purposes.

PREVENTATIVE MEASURES: 1) Channelling of the waste water from the drums and pits; 2) Good ventilation of the enclosed rooms and sucking away of the toxic vapours at the point of origin;

3) Provide systems of vacuum removal during varnishing whether done with a spray pistol or with rods.

7.9. Summary of industries' environmental impact

To allow a correct and exhaustive comprehension of the actual situation, one table and maps were developed, with the objective to present in a rational way the situation of the industrial area.

Results have been quantified in order to emphasise the intensity of the impact upon water, air, soil, workers safety and health and public health and the consequent necessity and urgency to adapt the suggested preventive measures.

Evaluation results are listed in following table 23 as values ranging between 0-3. Higher values correspond to higher impact.

The meaning is:

0. No environmental impact;
1. Low impact, no action is required;
2. Relevant impact. Preventive actions are required;
3 Very relevant impact. Urgent and drastic actions are required.

Figures 17,18,19,20 and 21 report, in a chromatic scale, the values from the EIA tables. Stronger colours stress higher risks.

Table 23 Summary of ZIA industries' impact

Activity Code	ACTIVITIES	WATER	AIR	SOIL	workers safety & health	Public Health
CRM	**CAR REPAIR AND MAINTENANCE**	2	1		3	1
CBM	**CONCRETE BRICK AND SEWERS MOULDERS**	0	3	0	3	2
LMC	**LIMESTONE CUTTING AND POLISHING**					
	LIMESTONE POLISHING	1	1	0	3	1
	LIMESTONE CUTTING	2	0	0	3	0
SLH	**SLAUGHTER HOUSE**					

	PRIVATE POULTRY SLAUGHTER HOUSE	3	1	1	2	1
	PUBLIC POULTRY SLAUGHTER HOUSE	2	0	0	1	1
	PUBLIC SHEEP SLAUGHTER HOUSE	3	0	1	3	2
	PRIVATE POULTRY SLAUGHTER HOUSE	3	0	0	1	1
BPP	**BY-PRODUCTS PROCESSING**					
	LIVE-STOCK FEED FACTORY	3	3	3	3	2
	MEAT PROCESSING	2	2	0	2	1
	GUT FACTORY	3	0	1	2	1
	GLUE FACTORY	2	3	2	1	1
SAW	**SAW MILLS**	0	1	0	2	!
LIP	**LAND IMPACT**					
	SCRAPS-IRON DUMPING	1	0	2	2	0
	SOLID WASTE DUMPING	1	1	2	2	0
	SCRAPS-IRON RECOVERY	1	1	2	2	0
	OPEN SHEEP MARKET & SLAUGHTER HOUSE AREA	3	2	3	2	3
	BRICK OPEN STORAGE AREA	0	3	0	1	2
	TANNERY SOLID WASTES COLLECTION	2	2	1	2	1
MSC	**MISCELLANEA**					
	ALUMINIUM DOORS AND WINDOWS FACTORY	0	0	0	1	0
	CLOTHING FACTORY	0	0	0	1	0
	DRUM FACTORY	0	0	0	1	0
	FURNITURE FACTORY	0	1	0	2	1
	GAS BOTTLE FACTORY	0	2	0	3	0
	GLASS REINFORCED PLASTICS MOULDING	1	1	1	3	0
	GRAIN GRINDING	0	0	0	0	0
	ICE FACTORY	0	0	0	1	0
	IRON SMITH	1	0	0	1	0
	MARBLE LAPPING MACHINES FACTORY	0	0	0	1	0
	MOULD FACTORY	2	0	0	2	0
	STOVE FACTORY	0	1	0	1	0
	WEAVING	0	1	0	3	0
	WORKSHOP	0	0	0	1	0
TNR	**TANNERIES**	3	1	2	3	2

FIGURE 17 - ENVIRONMENTAL INDICATIVE PARAMETRES

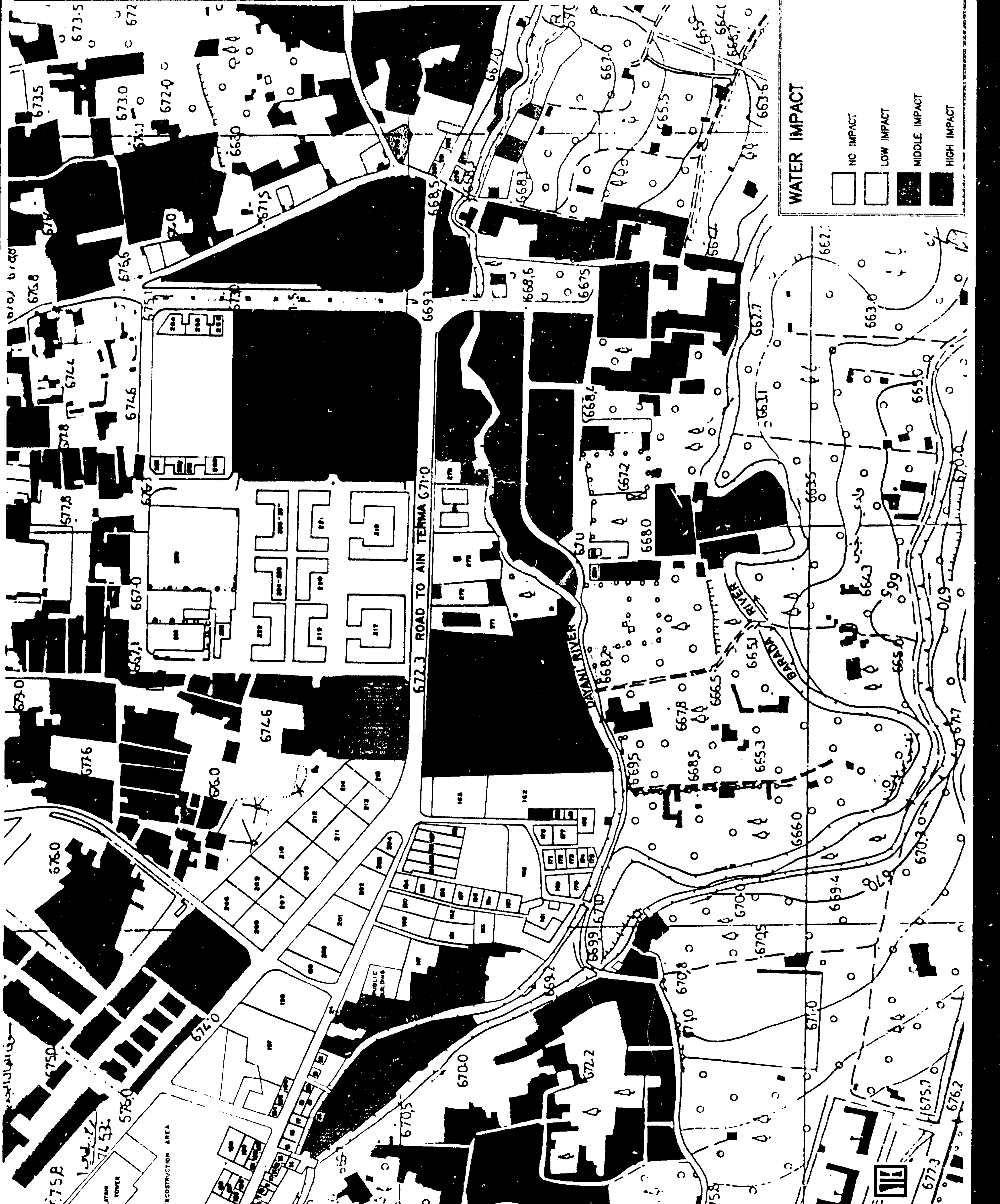
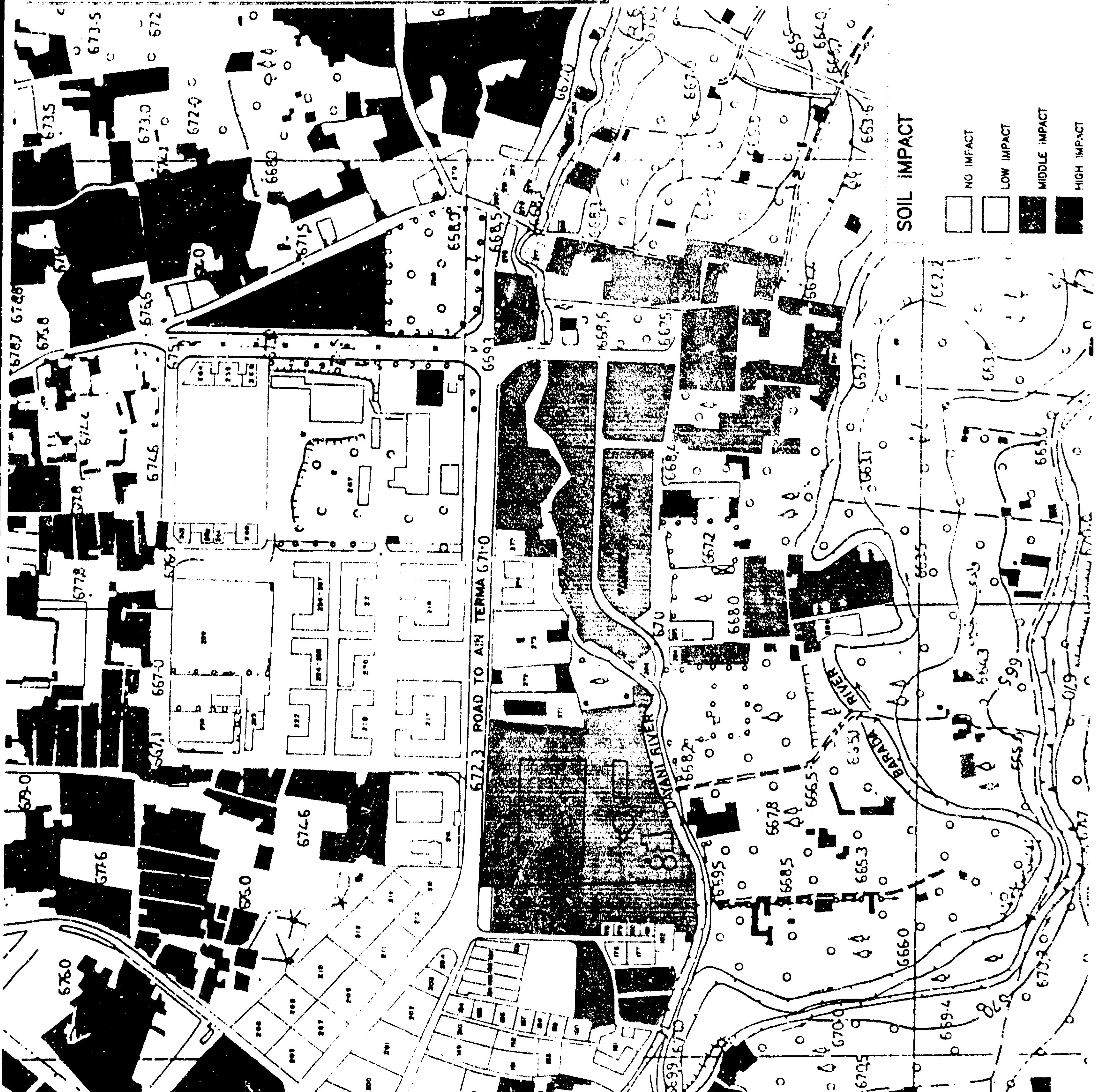


FIGURE 18 - ENVIRONMENTAL INDICATIVE PARAMETRES

FIGURE 19 - ENVIRONMENTAL INDICATIVE PARAMETRES



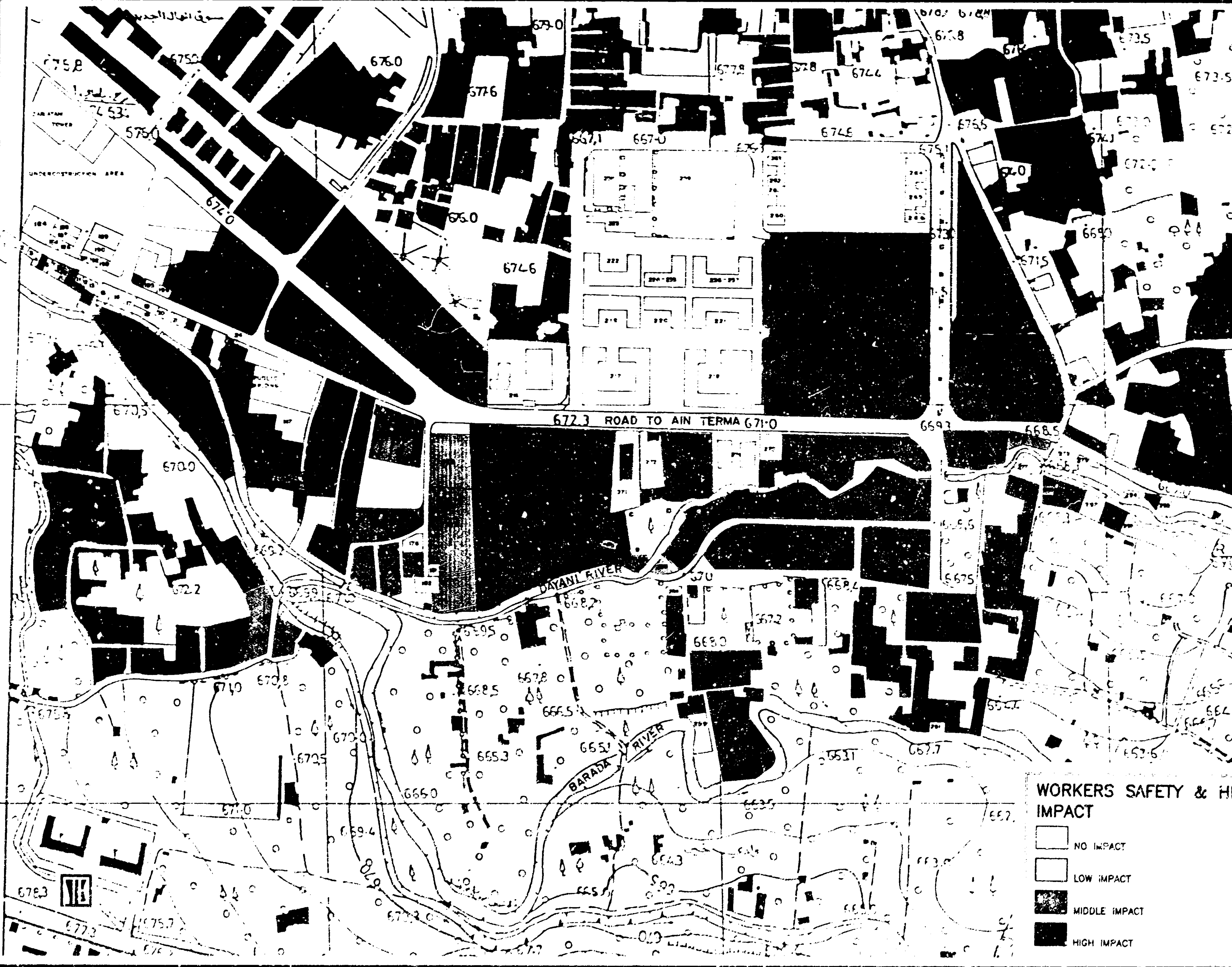
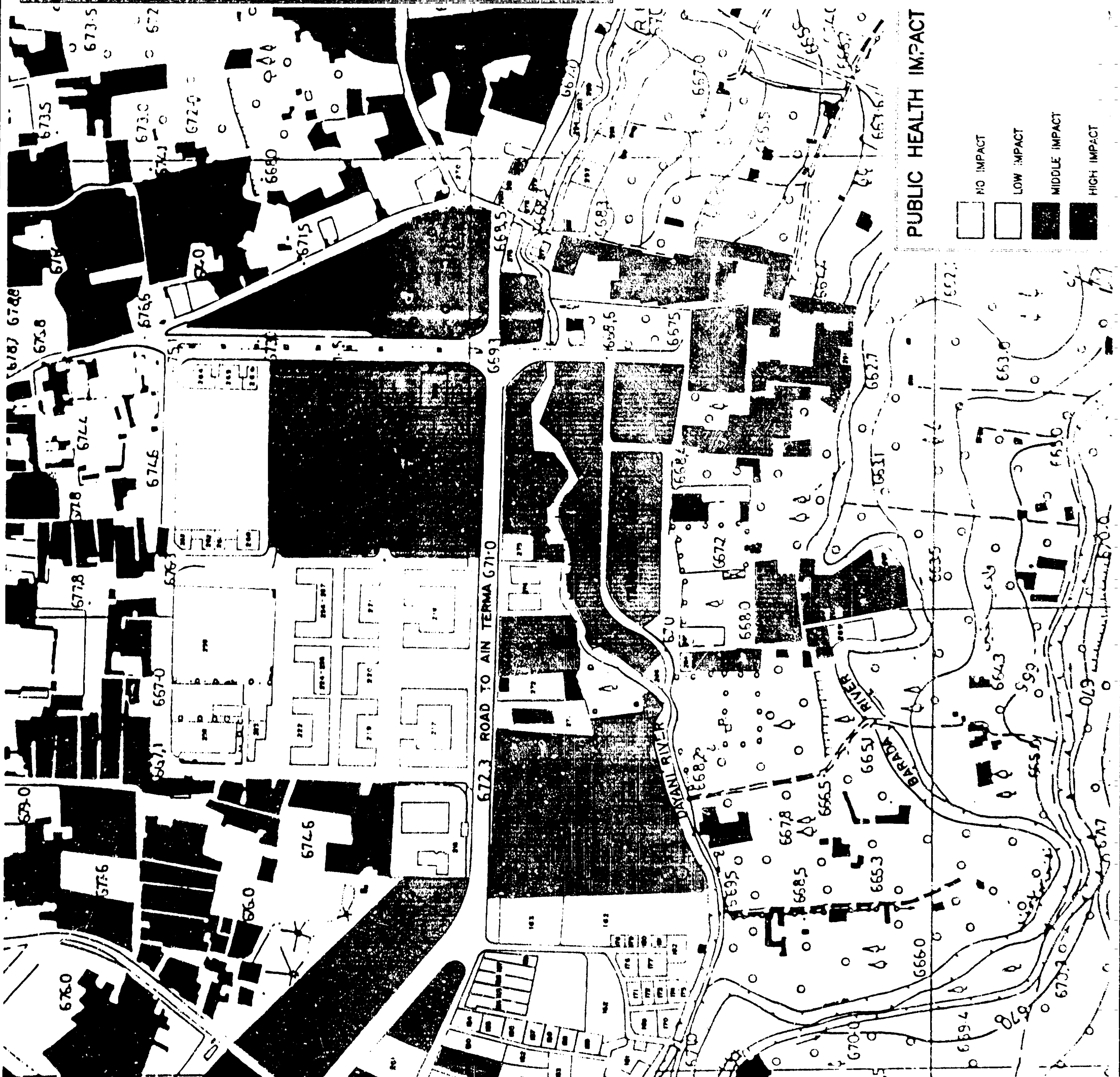


FIGURE 20 - ENVIRONMENTAL INDICATIVE PARAMETRES

FIGURE 21 · ENVIRONMENTAL INDICATIVE PARAMETRES



8 WASTE WATERS CHARACTERISTICS

8.1. Non tanneries

The categories of factories that extensively use process waters are as follows:

- 5 Public and private slaughter-houses
- 22 Limestone cutting or polishing
- 11 Tannery and/or S.H. by-products processing

Only the Public Poultry S.H. (M.C. 216), the Public Sheep S.H. (M.C. 267), the Livestock Feed Factory (M.C. 268), the Military S.H. (M.C. 269) and 1 Limestone Cutting (M.C. 270) they discharge in the city sewer system.

In addition to that, small quantities of waters come from cars and mechanical parts washing and are polluted by surfactants, oil, grease and heavy metals .

For each category of industry, the following aspects have been evaluated.

- Quantity and quality of waste waters;
- Water saving possibility;
- Possibility of reducing pollution by modifications to the production cycle;
- Pollution control measures.

Data have been supplied by company managers or, else, drawn upon personal experience, direct observation of actual situation, bibliographical references [8].

8.1.1. Slaughter-houses

8.1.1.1 Characteristics of the wastes.

Waste waters are polluted by remarkable quantities of grease and gross material coming from stomach contents. Organic load (measured as BOD_5) is due in part to washing and rinsing during the slaughtering process, and in part from the blood. The average characteristics of such waters are shown by table:

Table 24 Slaughter houses' waste waters characteristics

FACTORY	ANIMALS SLAUGHTERED PER DAY	FLOW RATE mc/d	ORGANIC LOAD (SLAUGHTERING PROCESS) Kg. BOD_5/d	ORGANIC LOAD (BLOOD) Kg. BOD_5/d	TOTAL ORGANIC LOAD Kg. BOD_5/d
Public sheep S.H.	4,000(1)	300(3)	2,000(5)	1,200(7)	3,200
Public poultry S.H.	8,000(1)	160(1)	96(6)	56(8)	152
Military S.H.		300(2)	2,000(2)	1,200(2)	3,200(2)
Private poultry S.H.	4,000(1)	80(4)	48(6)	28(8)	76
Private poultry . S.H.	4,000(1)	80(4)	48(6)	28(8)	76
TOTAL		920	4,192	2,512	6,704

REMARKS:(1) Managers' statement. (2) Assumed data. (3) Calculation made on a sample drawn from a well. (4) 20 l/animal [9]. (5) 500 gr. BOD5/animal [10]. (6) 12 gr. BOD5/animal [11]. (7) 3 l of blood/animal (8) 120 gr of blood/animal (1 litre of blood= 100.000 mg. BOD5).

8.1 1.2. Water saving

Public Poultry S.H. water consumption corresponds to the values usually accepted while for Sheep S.H. consumption seems to be quite low. A reduction of water usage can have negative consequences on working hygiene, therefore there are no possible saving.

8.1.1.3. Reduction of pollution load

30% of the pollution load can be reduced by collecting the blood in a tank placed right under the jugulating point

8.1.1.4. Precautionary measures

All slaughter-house waste waters should be sent to a treatment plant (CETP or MTP). Before discharging into the sewer, waters should be pre-treated in house with a coarse screen and a oil and grease pit to remove gross material .

8.1.2 Limestone cutting and/or polishing

8.1.2.1. Characteristics of the wastes

The factories use water for cooling and lubricate machineries that cut or polish limestones. Pollution

is of an inorganic type due to the removed calcium carbonate . The majority of the Limestones-

polishing shops already recirculate water and discharge it into ditches, from which it will partially evaporate or be absorbed by the soil. The Limestone-cutting factories do not recirculate water, discharging it, instead, into the river (two firms) or into the city sewer (one firm).
Total flow is:

Table 25 Limestone cutting waste waters characteristics

FACTORY	Nr. of FACTORIES°	FLOW RATE (mc./d each)	TOTAL FLOW RATE (mc./d)
LIMESTONE-CUTTING	3	250 mc/d (1)	750 mc/d
LIMESTONE-POLISHING	19	12 mc/d (1)	228 mc/d
		TOTAL	978 mc/d

Remark: (1) capacity measured on the discharge of a representative firm

It is pointed out that in the area of Ain Terma there are over 20 large limestone cutting, in total discharging into the river Dayani thousands of cubic meters per day, causing serious pollution. In fact the white colour of the polluted waters can be noticed for miles down stream.

8.1.2.2. Water saving

Limestones Polishing recirculate already the waters, then no additional savings can be realistically sought after .
Limestones-cutting, instead, can achieve relevant water saving by recirculating the waste waters .
The water saving can reach up to 90 percent, however accurate values can only be determined by experimental tests.

8.1.2.3. Reduction of the pollution load.

The pollution load can be slightly reduced by modifying some production technologies, but the obtainable results are not justified by the cost .

8.1.2.4. Precautionary measures

Waste waters can be dumped into sewers after removal by sedimentation of the suspended solids In case, instead, of dumping them into the rivers, the treatment must include clari-flocculation.

8.1.3. Slaughter-houses and tannery by products processing

8.1.3.1. Characteristics of the wastes

Factories that belong to this category produce a discharge polluted meanly by organic substance and by suspended or dissolved grease and oil.

Characteristics of the discharges are recapitulated as shown in table 26:

Table 26 By-products processing' s waste waters characteristics

FACTORY	Nr. of FACTORIES	FLOW RATE (mc./d each)	ORGANIC LOAD Kg. BOD_5/mc.	TOTAL FLOW (mc./d)	TOTAL ORGANIC LOAD Kg. BOD5/d
Live-stock feed F.	1	20(1)	0,65(1)	20	13
Glue factory.	7	20(2)	0,60(2)	140	84
Meat processing	2	20(2)	2,00(3)	40	80
Gut factory.	1	18(2)	0,30(2)	18	5
TOTAL				218	182

REMARKS: (1) Personal experiences. - (2) Stated values. - (3) Assumed

8.1.3.2. Water saving

It is difficult to expect a relevant reduction in water consumption since it might induce a loss of quality of the product.

8.1.3.3. Reduction of pollution load

Substantial reductions are not expected. A tentative can be made in Glue factories by increasing the recovery of proteic fractions.

8.1.3.4. Precautionary measures

All discharges should be conveyed to a treatment plant (CETP or MTP).

Industrial wastes should be submitted to in-house treatment for removing gross solids, oils and greases

8.2. Tanneries

8.2.1. Characteristics of the wastes

The SC 1 has carried out an accurate inquiry on 150 private tanneries (one of which is out of order) located in the Z.I.A., 12 private tanneries are situated in Ain Terma and 4 Public ones (one of which is out of use).

As a result the following flows and pollution loads have been roughly estimated though confirmation must come from detailed plant design.

Table 27 Tanneries' equalised effluent rough waste waters characteristics

PARAMETERS	MIN	MAX.
Daily flow (mc/d)	7,000	11,000
pH	6	10
BOD_5 (mg/l)	1,200	1,500
COD (mg/l)	3,000	4,000
SS (mg/l)	1.500	3.500
SM (mg/l)	40	80
Cr^{+++}(mg/l)	70	100
S_2^{--} (mg/l)	150	200
O. & G. (mg/l)	50	1,000
Cl^- (mg/l)	1,600	2,280
SO_4^{--} (mg/l)	1,100	1,475

8.2.2. Water saving

The SC I and the Leather Expert, Mr. Kuber, have analysed the working cycle of all tanneries and their advise is by far the most significative for determining the optimal choices for improving the tanning process adopted in Zablatani from both the productive and environmental point of view.

On our side, our considerations are as follows.

Damascus is located in a semi arid zone (200 mm yearly rainfall) and the water balance of the underlying aquifer is already at the limit of depletion because of the increment of population and the growth of the economy, even more so should the peace process in the area proceed as we all expect

Most of the tanneries do draw continuously water from the wells during all the working day, wasting to sewers good part of it. A relevant saving can be obtained by feeding the process through intermediate storage tanks, the level of which automatically regulates well pumping .

Additional savings could be stimulated by imposing the installation of sealed water-meters upon pump outlet pipes with relative ground water consumption tariff system .

8.2.3. Reduction of the pollution load

Since the conditions of the aquatic environments are critical, maximum attention must be exerted towards reducing waste waters and solids. Precious results can be obtained by introducing the process modifications such as the introduction of "Clean Technologies" . Some of them, considered to be particularly effective in the specific situations are:

- Reduce the discharge of chlorides preferring the purchase of fresh skins to the salted ones, using as much as possible manual cleaning for salt removal and re-using more than once, if possible, the pickling bath.

- Reduce the discharge of sulphates by increasing the exhaustion of liming's baths and evaluating the cost-benefit and practicality of recovering the baths.

- Reduce the discharge of chrome, increasing the exhaustion of baths.

- Replace the Kerosene/salt degreasing mixture with biodegradable surfactants.

Nevertheless, it is well known by writers that, because tanners are very traditional in their process technology, suggestions of innovative procedures, though sound, can well be disregarded.

To actually achieve the implementation of the clean procedures it is necessary, in our opinion, to develop locally a Leather Industry Excellence Centre also considering the experiences of the C.T.C. of Lyon or of the Leather Experimental Institute in Naples.

The Centre may perform the following functions:

- Test new tanning technologies particularly those that can get better quality product, savings of water and chemical products.
- Tanneries should be provided with assistance to upgrade environmental and working conditions.
- Establish training courses for young personnel
- Analyse the quality of tanned products and auxiliary chemical analysis
- Make research on national and international markets to indicate the most favourable conditions for the purchase of machines and raw materials or for the sale of finished products.

This latter function can be very important to favour the establishment of a Commercial Service for buying -selling, leading to a far superior contractual power compared to any single tanner alone. Still, we expect some tanners to be reluctant to share this sort of services, but we do strongly recommend to give serious attention to the development of this spirit of co-operation and of industrial quality culture, since environmental restrictions can only be accepted

1) If permitted by the level of the industrial gross margin.

2) If supported by the general perception of the population, workers and industrialists.

This Institute could become a landmark for other countries in the Middle East ; it should be directed by expert tanners, open to updating by frequent interchanges with similar foreign centres and it should be assisted by qualified international experts.

The Institute should have its own buildings, and, specifically, in addition to offices, conference rooms, and a library, it should be provided with:

- A Lab for chemical analysis
- A Lab for testing products
- A Lab to test tanning cycles with pilot machineries

The final characteristics of the Institute could be determined by the Tanners Association with the assistance and the supervision of international organisations (e.g. UNIDO).

8.2.4. Precautionary measures

The factory precautionary measures depend by the characteristics of the net collection of the tannery discharges and the treatment plant, therefore, they will be indicated in the chapter relative to the CETP.

8.3. Summary of the waste characteristics

In the table 28 shown below the average power values are summarised and the organic charge divided by category of factories for the discharge in the river or in the Public sewer:

Table 28 Summary of ZIA industries' waste waters characteristics

DISCHARGE	FACTORY	Nr. of FACTORIES	TOTAL FLOW (mc/d)	TOTAL ORGANIC LOAD (Kg. BOD5/d)
RIVER	GLUE FACTORY	7	140	84
RIVER	MEAT PROCESSING	2	40	80
RIVER	GUT FACTORY	1	18	18
RIVER	PRIVATE POULTRY S.H.	2	160	152
RIVER	LIMESTONE-CUTTING	2	500	0
	TOT. NON TANNERIES	14	858	334
RIVER	TANNERIES	164	9,000	13,500
	TOT. RIVER DISCHARGE	178	9,858	13,834
CITY SEWER	LIVESTOCK-FEED F.	1	20	13
CITY SEWER	PUBLIC POULTRY S.H.	1	160	152
CITY SEWER	PUBLIC SHEEP S.H.	1	300	3,200
CITY SEWER	MILITARY S.H.	1	300	3,200
CITY SEWER	LIMESTONE-CUTTING	1	250	0
	TOT. C. SEWER DISCHARGE	5	1,030	6,565
	GRAND TOTAL	183	10,888	20,399

The percentage of flow rates and of pollution loads relative to the non-tanneries is marginal when compared to the pollution loads induced by tanneries and related industries. The ratio between the daily average flow is 858/9,000=9.5%, while the ratio of the average organic mass load is 334/13,500=2.5%.

Therefore, in the following considerations and calculations the values of the tannery discharges can be directly used with acceptable approximation.

8.4. Possible waste waters' reuse.

Agriculture is the major user of water and can accept lower quality water than domestic and industrial users. There will surely be a growing tendency to look towards irrigated agriculture for solutions to the overall effluent disposal problem.

Waste water contains impurities, careful consideration must be given to the possible long term effects on soils and plants from salinity, sodicity, nutrients and trace elements that occur naturally or are added during use or treatment.

The reuse of sewage effluent for agricultural water resources is an old concept but today the presence of industrial effluents, of degraded very polluted waters, of high microbial population is a limiting element for their reuse.

The evaluation of waters for their suitability for irrigation is given in the chapter "agriculture". In the following is given the criteria to adopt for the evaluation of sewage-waters for irrigation.

The following table indicates the minimum waste water characteristics and the minimal microbial contamination required for irrigation

Table 29 Minimum waste water characteristics required for irrigation

Reclaimed waste water applications	primary effluent	secondary and disinfected	secondary coagulated filtered disinfected	Median total coliform/100 ml
Crop irrigation:				
fodder crops	X			NR
fiber	X			NR
seed crops	X			NR
eaten raw (surface irr.)		X		2,2
eaten raw (spray irr.)			X	2,2
Processed prod.(spray)		X		23
Landscape irrigation:				
golf courses, freeways		X		23
parks, playgrounds			X	2,2
Recreational impoundments:				
No public contact		X		23
boating and fishing only		X		2,2
body contact (bathing)			X	2,2

Waste water destined to provide fertiliser and irrigation for the production of food and the restoration of greenery requires pre treatment to remove constituents that are toxic to crops or present a health hazard to man or beast.

In the following tables it has been given the standard values recommended by the "Damascus Sewerage Project" for irrigation waters:

Table 30 Standard for irrigation recommended by the Damascus sewerage project.

Element	maximum permissible level mg/l	Element	maximum permissible level mg/l
Al	5	As	0.1
Cd	0.01	Cr	1
Co	0.2	Cu	0.2
Fe	1	Pb	5
Mn	0.5	Ni	0.2
Zn	2		

Source: Damascus Sewerage Project

and the standard limits for the presence of heavy metals in irrigation waters adopted by the Federal Water Pollution Control Administration (1968) and by Environmental Protection Agency.

Table 31 Heavy metals: USA and Italian limits for irrigation.

Element	Sewage water	Drainage water	FWPCA limits for irrigation	EPA limits for irrigation	Ital. limits (1)
Cadmium	0.01-0,07	0.0036	0.005	0.01	0.02
Chromium	0.55-1.00	0.07-0.09	5	0.1	2
Copper	0,45-0.64	0.074	0.2	0.2	0,1
Zinc	1.00-1.30	0.183	-	-	0.5

Remarks: (1) Following the tab.A of Italian Law n. 319/76

By comparing tables 30 and 31 it can be seen that the Syrian limits adopted for the irrigation waters are in accordance to the USA and Italian limits.

Tannery effluents contain a low level of P, K, and Mg. Besides carbon, the predominant fertilising elements are Ca, Sulphur, Nitrogen and, in effluents, water.

The Sulphur, in tannery waters, is in the form of sulphates and is therefore directly adsorbed but at the same time it may readily be leached owing to the solubility and the poor retention of SO_4^{--} ion on colloids.

The sulphite content of tannery wastes is minimal; it has to be limited as far as possible for its toxicity to crops.

Among the fertilising elements contained in tannery wastes are ammonia compounds and nitrogen which seems to be, as SO_4^{--} ions, of greatest interest. Nitrates are practically absent.

The chromium oxide has no effect on calcareous soils; the same for the most soluble chromium sulphate.

The long-term behaviour of Chromium accumulated in surface horizons is not well known but it appears that the chromium given as liquid or solid fertilisers, at the normal rates of application to the soil, is unable to pollute the ground-waters [12]

In evaluating possible reuse of tanneries' effluents, we must consider that in the Ghouta area the main problems for their utilisation are:

1) high water table
2) high quantities of adopted irrigation water
3) relatively high subsoil permeability useful for the ground water recharge but dangerous for ground water pollution

In climatic and pedological situation almost similar to Syria the concentration of heavy metals that are able to pollute the ground-water is very low but not absent at least not in the situation of close contact between the drainage water and the water table.

The evaluation is complicated by:

i) the particular environment existing in the Ghouta,
ii) the techniques adopted to overcome the problems of the soil salinity (i.e. the adoption of new crop varieties),
iii) the lost of fertility in relation to the decrease of the surface waters for irrigation (mainly for Nitrogen and Phosphorus content)

In the Ghouta, and in particular in the study area, is recorded presence of:

i) high water needs for crop production,
ii) high water demand for ground water recharge
ii) decreased quality of the ground water and surface waters.

The abandoned utilisation of the surface waters in summer season for irrigation is directly correlated to an increase of the soil salinity because the ground-water appears to be not completely suitable for irrigation.

In conclusion our opinion is that the waters released by tanneries, both if directly used as if treated up biological step, are in any case unsuitable for irrigation mainly due to the following reasons:

1) the water quality is very poor and outside the limits of suitability adopted for irrigation waters relating to chlorides and sulphates.

2) With the onset of the Adra treatment plant the rate of flows of all the canals will be drastically reduced and will often drop to zero in the summer season, so that dilution rate will be very low just when the water demand for irrigation is at its maximum

3) In quantitative terms the volume of waste water available for re-use by irrigated agriculture is negligible when compared with the overall volume of water used for irrigation. The volumes of water released every day with a flow of rate of 10.000 mc/day is sufficient to irrigate with intervals of 10 days not more than 200-300 Ha (or 2.000-3.000 Donams) if the loss of water in the canals is kept under control and if the natural water into the canals is enough to mix with the sewage water without causing risks to health.

4) There are also complex interactions of both surface and ground-waters with the soil and the crops.

In conclusion, avoiding waste waters reuse, the current fertilisation power of the surface waters will be lost but, at the same time, will be lost also any potential risk of chemical pollution of the soils by addition of pollutants.

On our opinion it is possible to irrigate with waste water, if necessary, only the external fields of the Ghouta plain close to desert where the ground water cannot return back

9. COMMON EFFLUENT TREATMENT PLANT (CETP)

The first aspect that has been examined was the soundness of proposing a chemical-physical treatment of all the tannery and tannery -like wastes, then conveying the treated effluent into the city main sewers collector, leading to the Adra urban sewage treatment plant.

The answer is doubtless positive, for several reasons.

In fact, it is not possible to continue to discharge the effluent in the river because it will compromise even further the quality of the water of the river and, since the interchanges of the river bed sediments with ground water, the quality of the soil will become deteriorated right while the Government is putting into practice politics for the overall improvement of environment and agriculture.

According to the results of agricultural studies, in fact, irrigation with raw polluted water, although potentially welcomed because of the arid climate, is not possible because of its high content of micro biological pollutants and salts. Because of the latter, actually, irrigation by tannery water, though chemical-physically or even biologically treated, is not recommendable, specially in the Zablatani-Ghouta situation where plants do already show cases of sufferance by excessive salinity .

But even excluding the agricultural re-use, it is not possible to dump the raw sewage into the city sewage collector, leading to the treatment plant, because of the overload to the Adra MTP and because of the problems which would come from the release of hydrogen sulphide gases and subsequent hazard to workers and corrosion of concrete structures. As far as MTP overload is concerned, it comes from the relevant organic matter concentration of the ZIA raw wastes, measured as COD. In comparison with the design assumptions of the MTP, the ZIA organic load would cause an increase of 44 tons/day, or 20% above the estimated 200 tons/day design input, which, by themselves do already represent a relevant increase to the early design assumption of 134 tons/day, superseded by the Damascus population increase. The ZIA COD overload would stress the biological oxidation step, though the applied process is the ratther flexible prolonged aeration type. However, the COD overload would affect the much less flexible anaerobic digestion sludge line. In addition, since the wastes carry large quantities of suspended solids, very significant amounts of them (up to 25 tons/day) could precipitate for self-flocculation, with both risks of clogging and seeding of anaerobic phenomena inside the collector to Adra. It has been, then, evaluated if the proposed physico-chemical treatment would have been sufficient to avoid dysfunction to the city sewer and to the MTP.

In order to answer to this point, the following aspects have been evaluated:

- Characteristics of the sewer system in the tannery's cluster
- The effluent impact on the city sewer and the MTP
- Environmental impact.

Finally the possible crisis scenarios of the CETP have been evaluated with indications of the consequences and related suggested containment measures. Structural failures of CETP basins have not been considered since good engineering practice can readily be expected in Damascus. Evaluations are made on each one of the aspects mentioned above.

9.1. Zablatani sewer network

Tanneries' discharges are characterised by huge quantities of suspended substances, gross materials, sand and aggressive chemical products.

The concentration of suspended particles has been estimated between 1,550 - 3,500 mg/l for a total inclusive load of 24,5 to 38 t/d.

Gross materials come from working cycles of the tanneries (fleshings, trimmings, hairs, etc.) and from other industries (chicken feathers, stomach contents, processing residues, etc.).

Sand comes from tanned skins, from working areas and from impurities by the use of lime for the liming process.

When waters are discharged in the sewer, a typical spontaneous phenomenon of flocculation takes place, because of the presence of chromium hydroxide, by which suspended matters flocculate and sediment, while the problems of such sedimentation are aggravated by the presence of the gross materials.

Moreover, by meeting waters at lower pH, as typical while mixing with the much larger flow of raw city sewage, the dissolved sulphides contained in tannery effluents release hydrogen sulphide, which by subsequent transformations into sulphuric acid and in presence of specific bacteria can cause rapid deterioration of the sewers concrete structures.

Because of same reason it is advisable that tannery cluster industrial sewers were separated for the two types of acid and basic waste waters, as more and more applied world-wide.

The benefits of having two separate acid/basic sewers arise from the weed of preventing the release of this fumes, and the relative hazards for the workers and damages to the structures when basic and acid waste waters mix.

Anyhow, presently, this problem is not critical because:

- Strong winds, frequent in the zone, permit rapid dispersion;
- The waste waters are spilled out by many small factories distributing the effect upon the length of the network;
- Tanneries work with much similar processes and timing the occurrence of mixing too different waste streams

Therefore, the sewer's system of the tanneries' cluster must respect the following recommendations:

- As possible separate basic from acid discharge.

- Install, at each factory site, a mechanical pre treatment composed of a coarse screen and grit/grease chamber.

- The total quantity of collected materials from these devices has estimated on the basis of practical experiences at about 5% of the soaked weight. Consequently the quantity of the solid wastes retained by the mechanical pre-treatment will be about 7.5 to 14 t/d for an average quantity per factory of 50-100 Kg/d. To insure the correct periodic maintenance of the pre treatments, it is advised to organise a Service System (managed by the CETP team) daily collecting the screened solids, disposing them together with the screened material collected by the primary phase of the CETP itself.

- The average speed of the flows should insure the cleaning of ducts ; the pipes should have adequate size to obtain an average speed of not less than 0,30 mt/sec. Lower speed can be accepted in secondary sections should it be impossible otherwise . In such case, the inspection manholes should be located at intervals no longer than 20 mt.

- Rain water should not be allowed into the sewer because in case of an overflow, hazardous pollutants may spill over to surface waters.

- The location of the plant should be such as to minimise mechanical lifting of sewage since this step is most frequently cause of malfunctions. Should pumping be unavoidable, then the following guidelines are recommended:

  - Should be located as near as possible to control areas;
  - Abundance of redundant stand-by equipments
  - Protective screen, with automatic cleaning;
  - Electrical supply directly from the CETP, to which an alarm system must be connected.

- The industrial sewer should be made with material capable to resist chemical attacks, such as PVC, regularly adopted for this type and concentrations of wastes ;furthermore, its surface smoothness permits lower inclinations, which is a favourable feature for the application.

9.2. City collector to Adra and MTP impact

The proposed treatment plant is physico-chemical type composed of homogenisation phase for 24h., followed by catalytic oxidation of sulphides and clari-flocculation.

Standards have been fixed for the dumping of industrial waste flows into the city sewerage.

In the following table, the homogenised parameters of the effluent are compared with the standards. In addition, the necessary abatement efficiencies are compared with those measured in the treatment plant treating the effluents of the Tannery Cluster of S. Croce sull' Arno [13] since the latter applies the same processes as the ones considered for the CETP.

Table 32 Minimum CETP efficiency required compared with similar existing plant yeld

Parameter	Equalised effluent (max.)	Standard	Min. required efficiency	Actual efficiency yield reached at S.Croce plant
pH	6 - 10	6 - 10	-	-
Suspended solids (mg/l)	3,500	500	67%	98%
C.O.D. (mg O_2/l)	4,000	3,000	25%	80%
Sulphides (mg S^{--}/l)	200	3	98,5%	99%
Chrome (mg Cr^{+++}/l)	100	5	95%	99%
Chlorides (mg Cl^{-}/l)	2,280	1,000	44%	0
Sulphates (mg SO_4^{--}/l)	1,475	1,000	68%	Not reported.
Oil & grease (mg/l)	1,000	100	90%	Not reported

Hence, for all the considered characteristics the plant may reach the target reduction, except for chlorides, while for sulphates and oils actual plant data were not available. For each significative parameter the impact upon the receptive system has been estimated.

9.2.1. Flow

The treated flow of the CETP is 11.000 mc/d. : 24 h = 460 mc/h

The ratio between the CETP effluent and the influent to the Adra municipal waste water plant is shown below in table 33:

Table 33 CETP/MTP flow ratio

	CETP	MTP	FLOW-RATIO
Av. Flow	460 mc/h	20,200 mc/h	2,3%
Max. Flow	460 mc/h	30,300 mc/h	1,5%

The increase of flow is not relevant for the MTP, taking into account the buffer volume formed by the city sewer, designed for a rain water flow equal to 1,3 times the maximum dry weather flow.

9.2.2. Suspended solids

The phase of clari-flocculation insures an abatement of over 95%, according to S. Croce experience. Considering 95% only, as safe value, the out flow of Suspended Solids from the CETP is estimated as follows:

38,5 t/d x 0,05=2 t/d, which is 1% of the load of 200 t/d S.S. expected at the entrance of the MTP. thus exerting no real effects on the MTP water or sludge line .

In addition to the suspended solids, gross solid and sand must be considered, both the quantities removed by the in-house pre-treatments and the materials removed by the mechanical treatment steps placed at the entrance of the CETP to avoid damage to the pumps. The mechanical treatment should include bar screening and a sand trap on the pump intake and a fine straining immediately afterwards.

9.2.3. C.O.D

With an 80% removal rate the effluent from the CETP will contain 44 t/d x 0,2 = 8,8 t/d of COD. representing the 4% of the about 220 t/d expected to enter the MTP.

This additional flow is irrelevant. It is, instead, necessary that the flow of effluent from the plant is kept constant into the 24 hours to avoid peak loads.

9.2.4. Chrome III

The concentration of Cr III in the equalised flow has been estimated from 70 to 100 mg/l for a total flow of 0,5 to 1,1 t/d.

The Cr III is soluble in acid ambient, while it precipitates in the alkaline ambient as in the sedimentation phase, such as to cause the almost total removing of the chrome.

Even in case the effluent had the highest level of Cr III concentration allowed by the standards, (5 mg/l), still the daily quantity released by the plant will be equal to 35-55 Kg/d, insignificant quantities when compared with the potentiality of the MTP, where, at worse, traces of chrome could be found in the sludges

Yet, it could be advantageous to reduce the quantity of chrome in the flow mostly since the salts of Chrome are imported and are very expensive.

To reduce the quantity of the discharged chrome and to increase the exhaustion of the baths gives economical benefits to tanners. Again, it would be better to look at the recovery of chrome.

9.2.5. Sulphates - Chlorides

Both exceed the standards, as shown next:

Sulphates	1,475 (mg SO_4^{--}/l)	16,22 t/d
Chlorides	2,280 (mg Cl^-/l)	25,08 t/d

The treatment process does not remove of chlorides. The reduction of sulphates is not theoretically well quantified depending on various factors, important among which the type of additives utilised. However, it is reasonable to expect a reduction of not less than 20%. In any case, because of the dilution ratio, the impact of both salts on the MTP effluent is negligible, as reported next, where for maximum safety, calculations do not assume any abatement of these salts.

Sulphates	33.4 (mg SO_4^{--}/l)
Chlorides	51.7 (mg Cl^-/l)

In fact, maximum acceptable concentrations for these salts into activated sludges could reach 25-50 g/l for sodium sulphate, and 5-10 g/l for sodium chloride [14].

To be considered that for the irrigation purposes foreseen for the Adra effluent, up to 980 mg/l of sulphate and 140 mg/l of chlorides [1] could be acceptable. Still, in order to control chlorides content, the adoption of "cleaner technologies " is recommended.

9.2.6. Sulphides.

The concentration of sulphides in the equalised effluent is evaluated at 150 to 200 mg/l as S^{--} for a total load of 1,6 to 2,2 t/d. The sulphur of sulphides dissolved in water is partly found as free gas H_2S, and partly as hydrosulphidric ion HS^- : percentages depend upon pH.
Example: at 20 °C the percentage of H2S is 90% at pH6; of 50% at pH7 and 99% at pH9 [16]. Then, at the point of immission of the effluent of the CETP into the city sewer, release of H_2S will occur, the quantity of which depends upon the concentration of the latter in the effluent of the CETP. To prevent this occurrence, the acceptable standard concentration should non be exceeded

In such case, should the almost total removal of sulphurs be obtained, also considering the anaerobic conditions of the sedimentation lines, the final concentration of sulphur in the effluent is about 10 mg/l of S^{--} according to practical experiences .
To make sure that standards are strictly respected it is necessary to install an aeration step before the effluent enters the sewer.

9.2.7. Oils & Greases

A concentration of up to 1.000 mg/l of oil and grease in the discharge has been assumed by the SC I team, but no informations are available about heir form, dissolved or emulsified.
It is suggested to perform oil removal by air flotation the entry of the plant, with an estimated removal efficiency of the dissolved fraction of about 70% . The emulsified fraction, instead, can be removed as surface scums during sedimentation, since the addition of flocculation chemicals has the additional effect to help breaking the emulsions. The oil and grease can be disposed of together with the solid wastes

9.3. Impact on the environment

Emissions that produce impact are composed of:

- Solid wastes produced in the first phases of screening including mechanically removed materials.
- Sludges produced in the sedimentation phase.
- Odours from treatment and sludge facilities.
- Noises by machineries in production processes.

9.3.1. Solid wastes

The quantity and the quality of solid wastes that will arrive at the initial phases of the CETP, cannot be exactly predetermined, since it may vary as a function of the efficiency of the single pre treatments. Instead, it can be estimated that the overall quantity of raw waste produced in the cluster and removed on the whole by both in-house and plant pre treatments is equal to about 5% of soaked weight of tanned skins, varying between a minimum of 155 t/d to a maximum of 290 t/d, then between 7,7 to 14,5 t/day, for an average of 11 t/day.
The composition of wastes and the evaluation of their re-use potential could only be determined after a period of plant steady state operation.

At the beginning the wastes will be discharged cautiously with sands, the quantity of which is estimated by 3 to 5 t/d. Eventually, the quantity of wastes will be 20 t/d produced partly at the factories and part at the plant. The quantities are such to suggest the organisation of a common collection system, then carrying it to a disposal site. This duty, as said, should be directly managed by the CETP.

9.3.2. Sludges

As aforesaid, we assume that in the sedimentation phase, 95% of the S.S. of sludges will be removed from the stream, to which the additives dosed during the treatment, estimated about 500 mg/l of treated sewage, should be summed, giving a total dry sludge production of 28 to 44 t/d. The liquid sludge quantity, with an assumed 4% dry matter concentration, normal in chemical plants, comes to 700 to 1,100 mc/d. Considering this very high volume, transportation of sludges will be feasible only after volume reduction by a dehydration treatment that is possibly performed with technologies such as drying beds, centrifuges, belt presses and filter presses. In the present case, the following technologies are considered unsuitable.

- Drying beds, since occupy excessive lands and cause ill-odour emissions.
- Centrifuges because do not permit to reach the dry matter content, necessary for ease of handling and transportation.

Hence, the choice is between filter presses and belt presses, for which it must be remembered that:

- The belt presses have lower capital costs, simpler operation, less space occupation, but reach lower levels of dry matter content (about 24 to 26%)
- The filter presses have higher capital costs, higher operating costs and bulkier, while permitting higher levels of dryness (about 36 to 38%).

As a consequence, the two alternative choices of sludge volumes are:

	Min.	Aver	Max.
Belt presses (25% dry)	112 t/d	144 t/d	176 t/d
Filter presses (37% dry)	75 t/d	97 t/d	119 t/d

The composition of sludges produced by each of this types of equipments varies within rather narrow limits, as shown in the table below where there are recent analysis performed on sludges of the S.Croce Sull' Arno plant, and the average results of a research made on sludges produced by 40 tanneries treatment plants. [17]

Table 34 Composition of sludges produced by a tannery cluster pretreatment plant and by 40 (average) tanneries' treatment plants

PARAMETER (% ON DRY SUBSTANCE)	S.CROCE S.ARNO PLANT	AVERAGE ON 40 PLANTS
TOTAL RESIDUE ON EVAPORATION 105 °C	38.3%	36.8%
PH IN DISTILLED WATER	9.1%	NON DECLARED
TOTAL FIXED RESIDUE 550 °C	61.0%	54.3%
TOTAL VOLATILE RESIDUE (ORGANIC MATTER)	39.0%	48,2%
ORGANIC CARBON	21%	26.1%
TOTAL NITROGEN	2.1%	4%
TOTAL P_2O_5	0.42%	0,02%
TOTAL K_2O	0.01%	NON DECLARED
TOTAL $CaCO_3$	41.4%	33.4%
CHROMIUM VI	ABSENT	ABSENT
TOTAL CHROMIUM	2.23%	3.6%

Pollutants removed from waters are concentrated in the sludges, then their management constitutes one of the major risk factors for the environment perplexities are relative mainly to Chromium VI and III. Chromium VI is not expected while, in the CEPT case it can be forecasted that the quantity of Chromium III in sludges will be about 2,5% dry, this value is aligned with experimental results. Two alternatives have deserved consideration : agricultural utilisation and landfill disposal.

9.3.2.1. Agricultural use of sludges

Following the agricultural study results, the possibility to use sludges in agriculture is excluded because of the possible release of pollutants to the aquifer, possibility greatly enhanced by the soaking/drying cycle of the soil envisaged as a consequence of the relevant vertical movements of the water table. In addition, there is concern for the very high level of chromium concentrations, the effects of which are not well known in case of prolonged utilisation in arid climates. Still,

- Uncompleted or nil stabilisation of sludges causes obnoxious emissions in the disposal sites.

- Relevant micro biological activity, which limits the areas and crops to which tannery sludges can be safely applied. On the other hands, the sludges have an interesting agronomic value owing to the contents of organic material and of nitrogen

Referring to chromium III, it should be noted that:

- The trivalent Chromium is essential to life and its absence in the diet can cause pathological syndromes at a vascular level [18];

- The use of chromium containing tannery sludges has been demonstrated as not causing the accumulation of chromium in Indian corn plants, wheat and rice [19].

- Tests performed with tannery sludges have shown the effectiveness of these substances as fertilisers for wheat and Indian corn [20];

- The poor mobility of Chrome III in the soil may, indeed, limit the problems to the water table, but at the same time causes build up of chromium in the soil, even if possible negative consequences may happen only in the long range [21];

Conclusively, to dispose of sludges on fields, it is necessary to reduce the concentration of the pollutants by dilution with other fertilisers such as sludges produced by the MTP or the compost made by the DAR EL HAJJAR installation. In both cases sludges should be stabilised.

Three possibilities exist:

1) Digest sludges at the CETP

- Advantages: lower costs of transportation for further reduction of about 20 to 25% of the dry substance. Favourable energetic balance or at least in parity in the case of anaerobic digestion.

- Disadvantages: High costs of installation, above all in the case of anaerobic digestion Reduction of the organic fraction

2) Digest sludges at the MTP

Having examined all alternative aspects, we do not recommend this solution for the following reasons:

- The overload, caused by the CEPT sludges on the anaerobic digestion step of the MTP, requires redesign and technological modifications, for which do not exist money nor time

- To our knowledge there are no significative experiences of re-dissolution of dehydrated sludges, and we feel that the immission in the digestors of high contents of dry matter , may alter the functional parameters of the processes.

3) Digest sludges at AL HAJJAR installation.

That one appears the most favourable application. The compost obtained in Al Hajjar plant from the solid wastes of Damascus city have been utilised by farmers for many years with apparently positive trend between crop productivity and soil fertility.

The Damascus solid wastes are continuously controlied both for content of selected matter and for chemical composition with the exception of heavy metals content.

Raw fresh and rotted composts are graded according to the process of decomposition; variation is caused by the type of material being composted.

The composition of the Damascus U.S.W. obtained from the Garbage Company by collecting the main refuses is:

Table 35 Damascus Urban Solid Wastes composition

N.	Materials composing	Wet weight (Kgs)	Percent content %	Water content %	Material content %
1	< 20 mm	55.5	23	54	12.42
2	Paper, hard paper	29	12	57.5	6.9
3	bones, skelton	7.5	3	15	0.45
4	metals	3.5	1.5	0.0	
5	glass, stones, ceramics	2	1	0	0
6	materials, clothes	12.5	6	25.4	3.32
7	rubber, plastic	25.5	10.5	10	1.05
8	veg., food wastes	105.5	43	67.8	29.15
	TOTAL	241	100		53.29

The following table gives the main parameters useful for the characterisation of a typical Damascus U.S.C. obtained after 36 days of fermentation, normally utilised for agricultural purposes.

Table 36 Damascus Compost composition

determination	MU	content
Water content	%	34
Mineral	%	1.2
Nitrogen	%	1.3
Organic carbon	%	25
Organic matter	%	44
pH	%	6.9
C/N ratio	%	19.3

As result advantages and disadvantages are:

- Advantages: Sludges would be mixed to the entering wastes so there would be no extra installation costs but only more handling complexity. Having checked personally the efficiency and capacity of how the installation is directed, no real difficulties can be anticipated.

- Disadvantages: Excessive humidity (>60%) in the wastes entering the composting plant, inhibits the process. The feasibility of this alternative is tied up to the acceptance by compost plant management of sludges with dry matter content variable between a minimum of 24% (belt press) and a maximum of 38% (filter press).

In conclusion there are possibilities of using sludges in agriculture but the complexity of the question does not permit definite indications . The alternative possibilities should be examined in a *separate* study which evaluates the feasibility and the convenience.

9.3.2.2. Landfill disposal

Despite the problems for its handling and disposal costs, landfill disposal is a realistic and immediate solution In fact, the Italian experience about the treatment of [22] tannery sludges indicates the following:

- Organic substances contained in sludges, tend to mineralise in very short time.

- There is no actual fear of sulphur emissions in mechanically dehydrated sludges. Every control has demonstrated that in the locations of disposal of tannery sludges, there is no increase of pollutant concentration in the ground and in the surrounding environment.

- All tests made in the Italian landfills for conditioned tannery sludges confirm that there is no spontaneous percolation, and liquors are produced only by rain.

Further tests made with E.P. Toxicity and TCLP test procedures have demonstrated that less than 5% of chrome contained in tanned wastes is washed away, while in the usual running conditions at pH 6-9 the release of Chrome is not expected.

Furthermore, it should be remembered that Chrome III has a scarce mobility in the ground, particularly in clay soils, and it does not have negative effects for human health, differently from chrome VI, which, instead, is an extremely toxic chemical [23]. At this respect, we should stress:

A) The chromium in the waste is exclusively or nearly exclusively trivalent;.

B) The waste is generated from an industrial process which uses trivalent chromium exclusively or nearly exclusively and where the process does not generate hexavalent chromium.

C) The waste is typically and frequently managed in non-oxidising environments.

We confirm that there are no risks if the landfill is provided with:

- waterproof clay bottom

- collecting system of the percolate liquors

Therefore, sludges can be disposed of in the landfill presently under construction at DAR EL HAJJAR that has the essential requisites. It is equipped with the system of biogas collection, the production of which will be increased by the organic fraction of non-stabilised sludges.

9.3.3 Odours, noises

Disturbing airborne emissions (sulphurs, hydrogen sulphide, mercaptans, etc.) come from all the basins of the plant, mostly from the sludge treatment facility, and by the open air storage of putrescible substances.

Noises come from all moving machineries, particularly by compressors and by in-house means of transport.

Emissions are not dangerous but they cause disturbance to inhabitants in the area near the installation and effects can be perceived at hundreds of meters further off. In this case, the constant wind in the East-West direction favours the dispersion of emissions but at the same time it amplifies the disturbances in the immediate areas located east wards.

9.3.3.1 Odours

To reduce trouble following preventative measures must be adopted:

- The sludge settling tanks for thickening sludges should be covered and the emissions treated with wet scrubbers.
- The open air storage of putrescible substances should be avoided; consequently it is confirmed reccomendation not to use open sludge drying beds.
- Mechanically treated sludges should be processed inside closed shed, the place should be ventilated and extracted air should be treated with wet scrubbers.

To avoid worker's health damages caused by the indoor climate [24] extraction air flow from shed of approximately 30 volumes per hour is suggested.

Solid wastes and sludges should be stored into sealed containers frequently removed, possibly applying automatic conveying. In this case the number of tractors necessary for the transportation will be two or three. The number of dewatered sludge (average 25% D.S.) daily transports, by utilising standard containers of 20 mc with a filling factor capacity of 75%, will be:

(176 t/d Sludges + 20 t/d S.W.) / 20 T x 0,75 = 13 transportation pick up daily.

It is suggested to consider the possibility of future complete plant enclosure since preliminary design phase; execution may follow later, in case of intense urban development of the surrounding area.

A relevant ill-odour emission is constituted by the air from the desulphuration tank. The quantity of air should be limited to the minimum necessary interlocking air compressors to a sulphide meter.

Since in some hours, responding to a low sulphide concentration, water stirring by forced air will not be sufficient, mechanical agitators must be installed in the tank. That solution allows to save energy by replacing air stirring with more energy efficient mechanical stirring, for periods the former would not be required by the oxidation process.

9.3.3.2. Noises

In reference to usual standards the following maximum values of noise emissions should be measured in accordance with the characteristics of the territory around the plant:

1) Populated areas	50 dB
2) Industrial areas	70 dB

It is advisable to refer to value 1) for Zablatani and to value 2) in case of Ain Terma
Still, whenever applicable we would suggest:

- Install compressors within enclosures
- Cover pumping stations
- Fence the whole plant with dense and tall tree barrier.

These last safety measures will also contribute to reduce the expansion of ill-odours.

9.4. Crisis scenarios

The CETP is surely necessary to reduce to acceptable levels the impact of the water pollution. Still, it must be noticed that, in absence of the plant, the impact on the surrounding environment will be as dispersed as per now, while after the construction of the plant, a failure of it would cause a very concentrate source of impacts.

At a design level, then, all possible measures must be foreseen and implemented to prevent operational problems, such as:

- Ensure flexibility by dividing the process phases into parallel lines.
- Install redundancy of all the critical process equipments.
- Ensure reliable electrical energy supply, by an electric generator
- Install large storage capacities for process chemicals and provide for accurate management of chemicals supply.

To further anticipate potential problems and their relative possible remedies, the most probable scenarios of crisis have been envisaged and analysed in the following.

9.4.1 Inlet pumping station

In this case, all untreated waste waters would be dumped into the rivers. This situation is critical since hydrogen sulphide may develop at the discharge point, surface waters would become polluted and even infiltration into ground waters might occur. The criticity of this occurrence depends by the flow rates of the rivers, at the time. Therefore, based upon written guidelines to be issued together with CETP start-up, the plant management will decide whether and how long to continue the free discharge into the river or, else, to order the interruption of the industrial production. The decision of dumping untreated waste waters into the environment must be immediately reported to and authorised by Sanitary Authorities.

9.4.2. Intermediate pumping stations

The urgency of the decision is smoothed down by the time factor connected to the buffer volumes of the basins downstream the failed station. Should the time be too short for remedying the situation, a decision as for the point above will be taken by plant management.

9.4.3. CETP effluent pumping station

The treated effluent causes, indeed, less problems should it be discharged into the river. Still, in case of low flows, the input of treated waste waters could reach such a percentage of the total flow to cause problems in the long run. In addition, the micro biological load of the CETP effluent is unacceptably high. Therefore, the plant management will evaluate how long effluent discharge into the river is acceptable for the given conditions, provided that:

- No more than few days outage is ensured
- Discharged effluent is chlorinated
- Sanitary authorities are informed and have granted their permission, possibly taking restrictive measures for the use of polluted waters, drinking waters extraction from effected wells, etc.

9.4.4. Desulphurization phase

The crisis may occur because of failure of the machineries or by lacking of the chemicals. From personal communications about pilot tests, the efficiency of sulphur removal in absence of catalyst is approx. 50%, which means that, in such conditions, the concentration of sulphur in the effluent would reach 100 mg/l or 45 kg/day. Since the effects would be worse the lower the oxygen concentration, it is better to dump the semi treated effluent into the rivers, for very short times though, than into the sewerage. We suggest to install an H2S continuous sensor, on the very point of connection to the sewerage, to monitor the actual values of the discharged stream.

9.4.5. Clariflocculation phase

The crisis may occur because of failure of the machineries or by lacking of the chemicals. In both cases spontaneous clariflocculation occurs, leading to an abatement of approx. 60-70%. In this case approx. 15.4 tons/day will be left into the partially treated effluent, which, by constituting approx. 8% of the total amount reaching the MTP should not cause excessive problems for short times. Still, since the reduction of removal will concern other characteristics as well the discharge of the partially treated effluent is permitted for short time only and, anyhow, must be reported to and authorised by the CETP.

9.4.6. Sludge treatment

In case of failure of the drying equipments, the volume of the material to be disposed of would increase 6-7 folds, with related increase of disposal costs and handling problems.

Sludge thickeners can be overloaded and permit 2-3 days of containment. To dispose of the liquid sludges in the landfill would cause problems of transport, distribution onto the landfill surface, increase of percolate liquors, which should provoke unacceptable plant malfunctions in few days.

In case of lacking specific chemicals, the volume increases approx. 2 folds, also causing problems in handling and transportation. Also in this case, technical and economical problems would not permit more than few days of operation at reduced efficiency.

9.5. PLANT LOCATION

Recently, two locations have been cleared, the first one in the area of ZABLATANI at the south-east border of the Cluster; the second in the AIN TERMA's area South of the existent tanneries. The two locations are indicated in table 1. From an environmental impact point of view the CETP should preferably be located at Ain Terma better than at Zablatani, for its much lower present and anticipated density of population, giving additional safety in case of technical or organisational failures of the CFTP. It will also minimise the impact of the estimated approx. 10 - 15 truck loads each day.

9.6 CONCLUSION

It is our opinion that even by applying all the suggested safety measures, the only real guarantee of a correct operation of the treatment plant depends by developing a well thought Body of environmental regulations and standards and, most important than all. establish a fully competent and powerful local Authority which is empowered with valid instruments and with the authority to enforce its decisions.

The Authority will rule both the operation of the plant itself and will have the maximum possible power to manage the correlated operations, including the power to limit the industrial production, perform environmental inspections. interfere with agricultural and sanitary centres in the plain.

As far as the operation of the plant is concerned, a comprehensive operation manual must be issued, providing for at last the following measurements to occur.

Table 37 CETP inlet and outlet suggested measurement

Flow rate:	continuous with recording
pH:	continuous with recording
COD:	daily upon equalised sample
BOD_5:	weekly
SS:	twice a day
TDS:	twice a day
SO_4^{--}:	twice a day
Cr III:	twice a day
Oil:	twice a day
Cl^-:	twice a day
S^{--}:	continuous with recording
Conductivity:	continuous with recording

Table38 CETP sludge line suggested measurement

Total residue on evaporation 105 °C	Daily
pH in distilled water	Daily
Total fixed residue 550 °C	Daily
Total volatile residue (Organic Matter)	Daily
Organic carbon	Weekly
Total nitrogen	Weekly
Total $P_2 0_5$	Weekly
Total $K_2 0$	Weekly
Total $CaCO_3$	Weekly
Chromium VI	Daily
Total Chromium	Daily

It is suggested that the plant be provided with its own analysis laboratory, capable to perform at least these mentioned analysis. It is also necessary for the health of the inhabitants that two hydrogen sulphide detectors be installed. The first detector should be located near the point of the immission in the sewer; the second on the perimeter down wind .

Both detectors should continuously report the alarm signal to a recorder located on a console table or desk.

In order to ensure proper plant operation and clear definition of responsibilities, it is recommended to provide the CETP with a computer supervision and control system .

The system should have both administrative and technical functions, such as:

- Administration of personnel and presence control by magnetic badges
- Control and management of chemicals and spare parts storage and automatic re-ordering
- Automatic supervision of the critical mechanical aspects of plant machineries, to prevent unexpected failures
- Automatic control of all relevant plant parameters for which reliable automatic sensors exist (levels, flows, pH, Redox, sulphur, etc.)
- Supervising "intelligent" software which, in addition to manage alarms related to the reached values can give indications about the actions to take in case of failures, malfunctions, etc.

In order to stimulate plant personnel to act responsibly, system resetting after alarms must be achieved by personalised badges, such as to leave traces of who has done what.

ANNEXES

ANNEX A

19 October 1993

TENTATIVE TERMS OF REFERENCE FOR THE SUBCONTRACTOR TO CARRY OUT AN ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON THE INDUSTRIAL ACTIVITIES IN THE ZABLATANI INDUSTRIAL AREA WITH SPECIAL EMPHASIS ON THE PROPOSED TANNERY WASTE TREATMENT

1. ENVIRONMENTAL ISSUES TO BE ADDRESSED

In order to achieve the aims of the project the subcontractor shall:

1.1. Determine the Present Environmental Impact of the Zablatani Industry on the Environment

1) Collect and process all the data available on pollution emanating from industrial activities in Zablatani. Since the other subcontractor (for the Techno-Economic Study on the CEPTP) will elaborate in detail the data on pollution emanating from the leather processing, the emphasis should be put on other industries, taking into account liquid, solid and gaseous wastes.

2) Determine the present pollution load from each industrial activity in the Zablatani industrial area and its environmental impact, including human health.

1.2. Recommend Pollution Control Measures

1) Prepare outlines of pollution control measures for the range of industrial and manufacturing activities represented in the Zablatani industrial area (except leather processing).

1.3. Estimate the Environmental Impacts after having implemented the Pollution Control Measures

1) Estimate the effects of the pollution control measures and the expected improvements

2) Estimate the different situations arising from normal and breakdown conditions in waste treatment plants (with special emphasis on tannery CEPTP).

3) Estimate the impacts of dumping/disposal of solid wastes on sites to be identified, with emphasis on their potential use for soil conditioning.

4) Estimate the impacts of the disposal of liquid wastes on sites to be identified, with emphasis on their potential use for irrigation.

2. EIA TEAM AND SPECIALISTS REQUIRED

It is proposed that the EIA team should be made up of the following specialists:

1) Team leader
2) Hydrologist
3) Agriculturalist
4) Public Health Engineer
5) Community Health Specialist

The team will work in close cooperation with the other subcontractor, UNIDO consultants as well as with the local experts from the Ministry of Environment, the Tanners Craft Society and the Municipal Government of Damascus, who will coordinate the data collection on production processes, waste water and solid waste recipients, and will provide local expertise (laboratory water and waste water analyses and soil surveys).

The coordination and supervision of the progress and quality of the EIA would be carried out by UNDP/UNIDO and representatives of potential donor(s) to the project.

The Job Descriptions of these specialists would be:

1. Team Leader: Responsible for overall completion of sub-contract; and delivery of final report. Responsible for recommending appropriate pollution control measures, assessing their impact on the municipal effluent sewerage/treatment system, on the environment and on downstream water users and the potential use of the treated waste.

Estimated time required: - field: 5 weeks - home : 6 weeks

2. Hydrologist: Responsible for the data collection on quality of the ground and surface water flows, establishing the level of pollution load in these waters. In addition, responsible for assessment of hydrological hazards emanating from the solid waste disposal site.

Estimated time required: - field: 2 weeks - home : 2 weeks

3. Agriculturalist: Responsible for checking agricultural and livestock baseline data and collecting information relating to agricultural crops and livestock adjacent to the Dirhani and Barada rivers and solid waste disposal site. Assessment of risks to crops and livestock irrigated/watered/conditioned with contaminated waters or solid waste. Estimate effects on agricultural production and quality of products as a result of the implemented pollution control measures.

Estimated time required: - field: 2 weeks - home : 2 weeks

4. Public Health Engineer:

Responsible for evaluation of recommended pollution control measures for leather industry and proposing specific measures for other Zablatani industries. Responsible for assessment of effects of the pretreated effluents discharge into the municipal severage/treatment system as well as the public health risks resulting from the effluent and solid waste pretreatment and disposal.

Estimated time required: - field: 2 weeks - home : 2 weeks

5. Community Health Specialist:

Responsible for assessing the social and public health baseline data, and collecting other relevant data available from municipal and health authorities. To evaluate the concerns of the local population about environmental problems and proposed pollution control measures and to assess the number of inhabitants likely to be affected in different zones of influence. Assessment of improvements in public health and standards of living as a result of the proposed measures (i.e. compared to the present situation).

Estimated time required: - field: 2 weeks- home : 2 weeks

TOTAL ESTIMATED TIME FOR THE TEAM REQUIRED: 7 m/m

4. THE PRELIMINARY WORK PLAN AND TIME SCHEDULE

4.1. Work plan

1) The Team Leader will be fielded in Damascus for about 1 month in order to prepare a detailed work plan for the other members of the Team who will join him 2 weeks thereafter.
During the total period of its one-month field mission the Team will collect all the necessary data for the preparation of the EIA. This field mission should be carried out at the same time with the other subcontractor's second field mission (presentation of the Techno-Economic Study on Tannery Effluent Treatment), so that the latter can inform the former about all previous activities related to the subject.

2) The team would process the collected data and elaborate the Draft EIA at home-base during the period of one month.
The Draft EIA will be sent to the other subcontractor (via UNIDO/UNDP) who is obliged to take into consideration all the remarks of the EIA when finalizing the Techno-Economic Study on Tannery Effluent Treatment and Tender Documents for the First Phase of Implementation.

3) The Draft EIA will be scrutinized by UNIDO experts and their remarks taken into consideration during the elaboration of the final version.

4.2. Time Schedule

The final work plan and time schedule will be prepared once the subcontractor has been selected. The tentative time schedule, starting from the date the contract has been awarded would be:

1)	Briefing the Project Team Leader in Vienna	000 - 003 day
2)	First field mission of the Team Leader (other members 2-3 weeks)	003 - 035 day

3)	Work at home-base; elaboration and submittance of the "Draft EIA". Complete team.	035 - 065 day
4)	UNIDO review of the Draft EIA	065 - 080 day
5)	Finalization and submittance of the EIA	080 - 100 day

ANNEX B

STUDIO TECNICO CHERUBINI PROJECT TEAM :

- Team leader : Massimo Mendia

- Public health engineer : Alfredo Cerotto

- Agricolturalist : Leonello Cavallari

- Hydrologist : Emilio Usai

- Community health specialist : S. Fati

ACKNOWLEDGEMENTS

We wish to aknowledge the supporet received by several Institutions and Individuals, which provided us with the necessary data they had available, enriching them with their personal, valuable, experience.

Specifically, we have really appreciated the support and the goodw committed towardcour mission by the following persons :

GOVERNORATE (MOHAFAZAT) OF DAMASCUS

- Eng. Maan Kanawati, Director of the industrial area of Zablatani, acting as National Project Director (NPD) gave us complete background of industrial and environmental issues and supported us all the way during the field visits to the Zablatani area,facilitating our contacts with local entrepreneurs.
- Eng. Wadiya Youha, Director of enivironmental affairs, permitted us to achivie rapid and effective contacts with the Institutions we envisaged as potentially usuelf for the project.
- Eng. Khalil Hayash, Chief Engineer of the Governorate of Damascus extensively presented to our team the facts,the rationale and the consequences of the large sewer and waste treatment scheme for the whole town of Damascus.

UNDP

- Mrs. Nadia Kosak , UNDP Project Officer supported us relentlessly establishing contacts at very high ministerial levels, in addition to providing relevant background informations about the Syrian environmental and economic situation .

- Mr K.H. Hla , UN Resident Representative encouraged us to look , in wider terms, at the positive consequences that an environment-conscious development would have for Syria.

DAMASCUS SYSTEM for SOLID WASTE MANAGEMENT

- Eng. Sami Dibs, Director of the Damascus composting plant in additiction to showing and describing in details the functioning of his plant gave us informations about the overall present and future philosophy of solid waste management.

- Eng. Nidal Khouri , Responsible for the collection and trasportation of Damascus urban solid wastes, explained us in detail the actual situation.

UNIVERSITY OF DAMASCUS

- Prof. Shibly Al-shami, professor of environmental engineering at the University of Damascus, disclosed how the knowledge relevant to us was distributed among various institutions, including names of potentially helpful people.

MINISTRY OF IRRIGATION

- Eng. Salem Ayoubi, from the Department for Barada river, gave us access to all the data they had. Such data proved precious for understandig of the local hydrology.

- Eng. Shawaf, Director of the environmental department, and his assistant, eng. Athif Dib gave us general informations about the chemico-physical characteristics of the relevant waters.

- Eng. Mohammad Daabaji , agriculturalist gave us tata about the crops and irrigation techniques prevailing in the rural areas downstream Zablatani.

- Eng. Aziz Ghadban, Director of projects, introduced to us the design principles to be applied for the overall scheme for the recycling of the waters treated by the Damascus waste water treatment plant, applied for the overall scheme for the recycling of the waste water treatment plant,presently under completion at Adra.

ASSOCIATION OF THE TANNERIES OF DAMASCUS

- Mr, Kamel Sheir, Chairman of the Association, provided us complete background of the local tanning market, technologies and praxis. In addition, mr. Kamel gave us very efficient logistic support to establish meaningful relationship with his associates and with other private industries of the Zablatani area.

ACSAD (ARAB RESEARCH CENTER ON ARID ZONES)

- Mr. Jean Khouri and Dr. Abdallah Droubi gave us important maps and very competent comments about the responsivennes of the aquifers andemeath the areas relevant to our study.

DEPARTMENT OF DRINKING WATER TOWN OF DAMASCUS

- Eng. El Miskye, Director of the Department , gave us relevant informations about the hydrology of the area of Damascus just upstream our site and competently commented upon our early assumptions about the foreseeable evolution of the surface water situation.

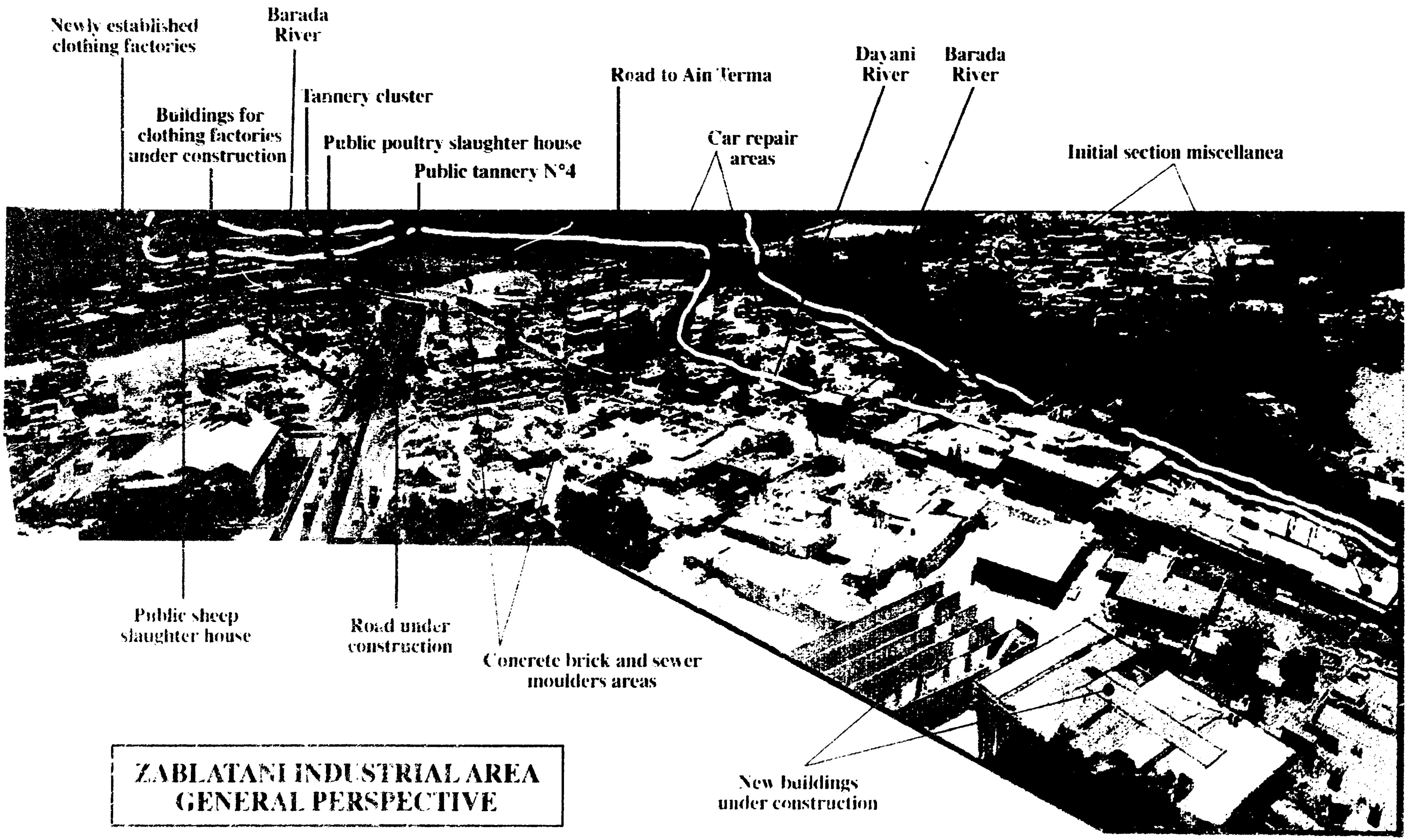
MINISTRY OF HEALTH

- Prof. Mrs. Dayeh, Deputy Minister of health, supported our efforts tto obtain meetings and informations from other relevant persons of Ministry staff, including:
  - Dr. Al Jorf Samir, Director of Public Health Center,
  - Dr. Misbah Ghali , Chief of Environmental Dept.;

- Dr. Mani Lahhan, Chief of Epidemiology Deps., who gave us a wide picture of the public health situation in Syria.
- Dr. Walld Al Turk, Director of the Health Services of the Rural Areas of Damascus gave us medical record for the last 12 months into his territory;
- Dr. Rabe Alhomsi and nurse Amina Madaman, from the medical centre in Ain Terma, gave us valuable, practical experience about health in the small rural villages ;

Last but surely not least we want to thank the other partners of the project, such as Sdrjan Selanec, team leader of subcontract 1,for his sharing with us his introductions to the key people and his previous ground breakink work.

ANNEX C



ZABLATANI INDUSTRIAL AREA
GENERAL PERSPECTIVE

Studio Tecnico Cherubini & Associates Rome - Italy

DAYANI RIVER BEFORE ENTERING ZABLATANI INDUSTRIAL AREA

DAYANI RIVER AT THE EXIT OF ZABLATANI INDUSTRIAL AREA

BARADA RIVER BEFORE ENTERING ZABLATANI INDUSTRIAL AREA

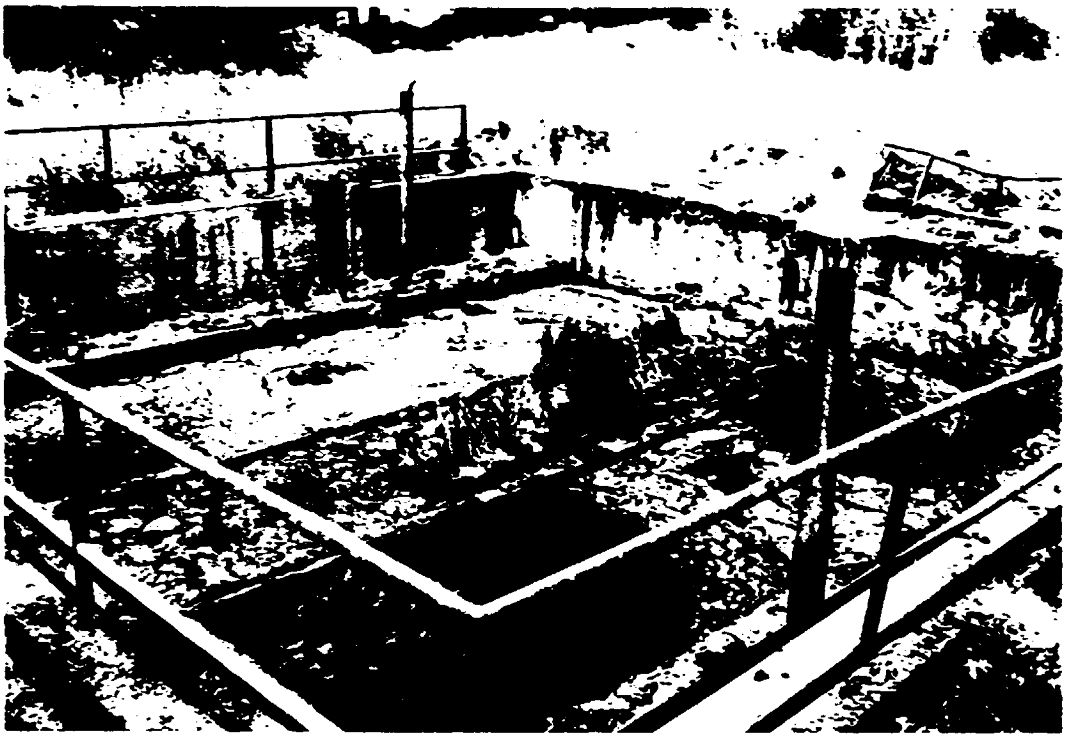
BARADA RIVER AT THE EXIT OF ZABLATANI INDUSTRIAL AREA

ZABLATANI TANNERY CLUSTER: SOME OF THE LARGEST FACTORIES

ZABLATANI TANNERY CLUSTER. SMALLER FAMILY TYPE BUSINESSES

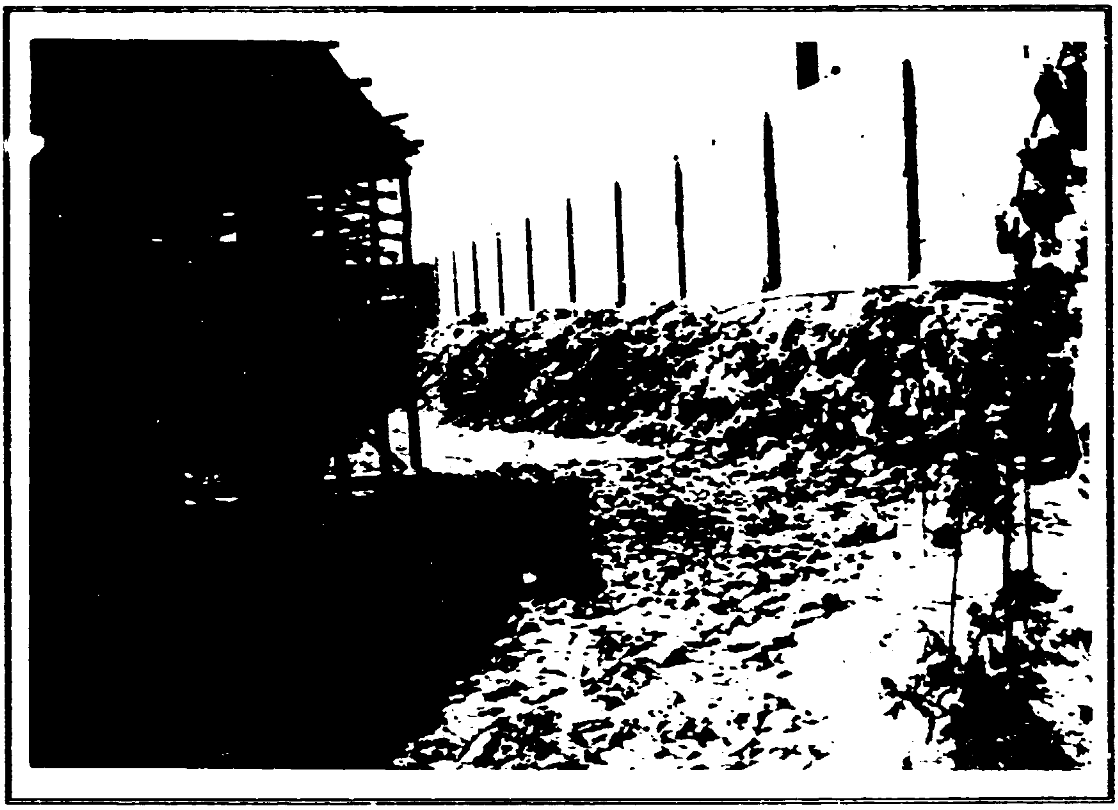
AIN TERMA TANNERIES

TANNERY CLUSTER: MANUAL PAINTING

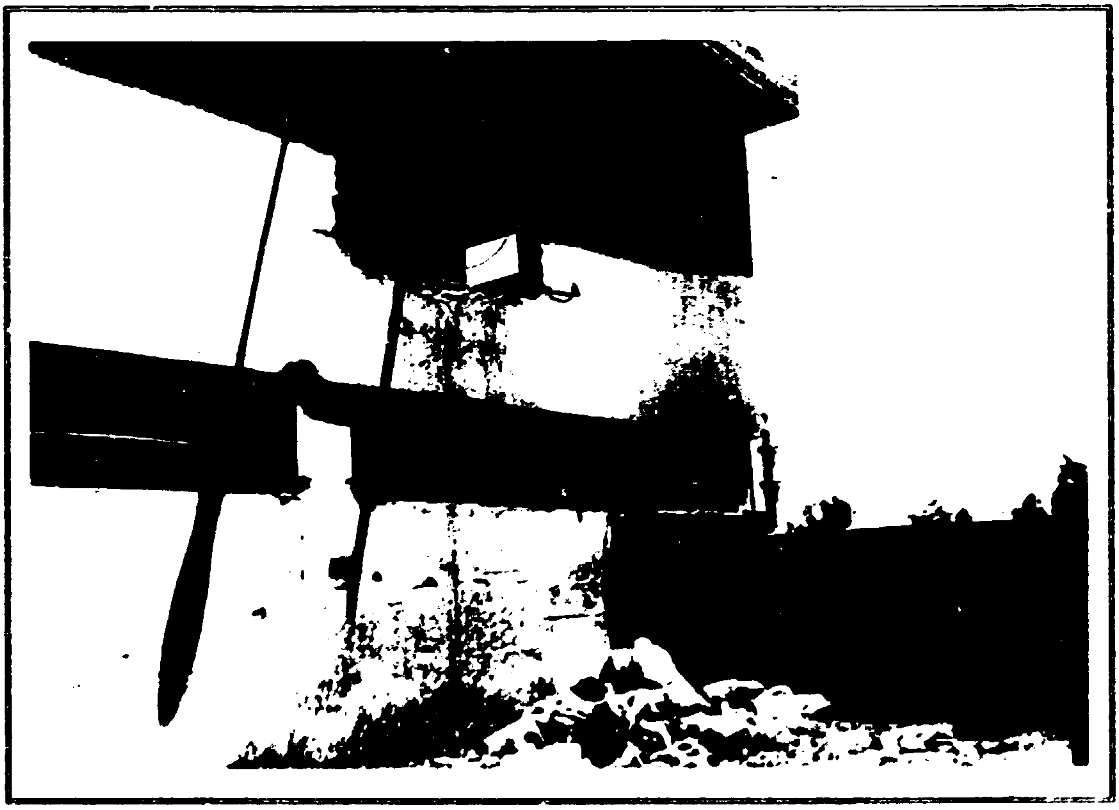


PUBLIC SHEEP SLAUGHTER HOUSE-PRETREATMENT PLANT OUT OF ORDER

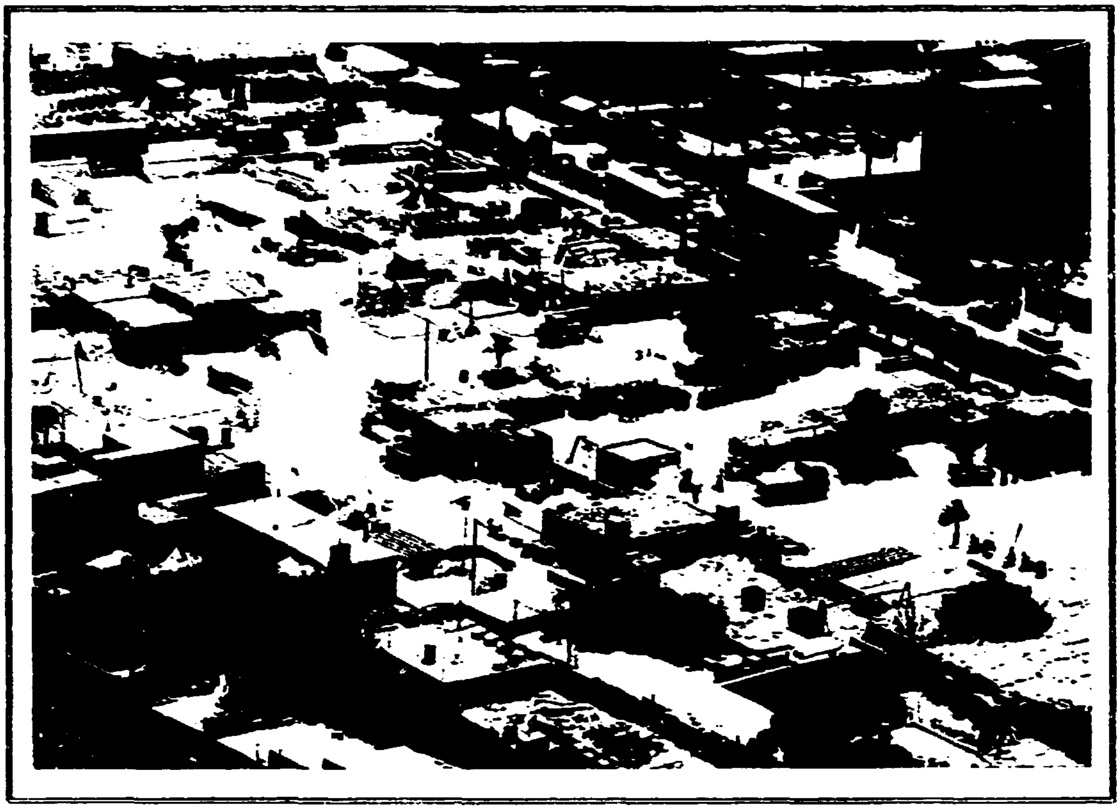
PRIVATE POULTRY SLAUGHTER HOUSE: POULTRY BREEDING ZONE



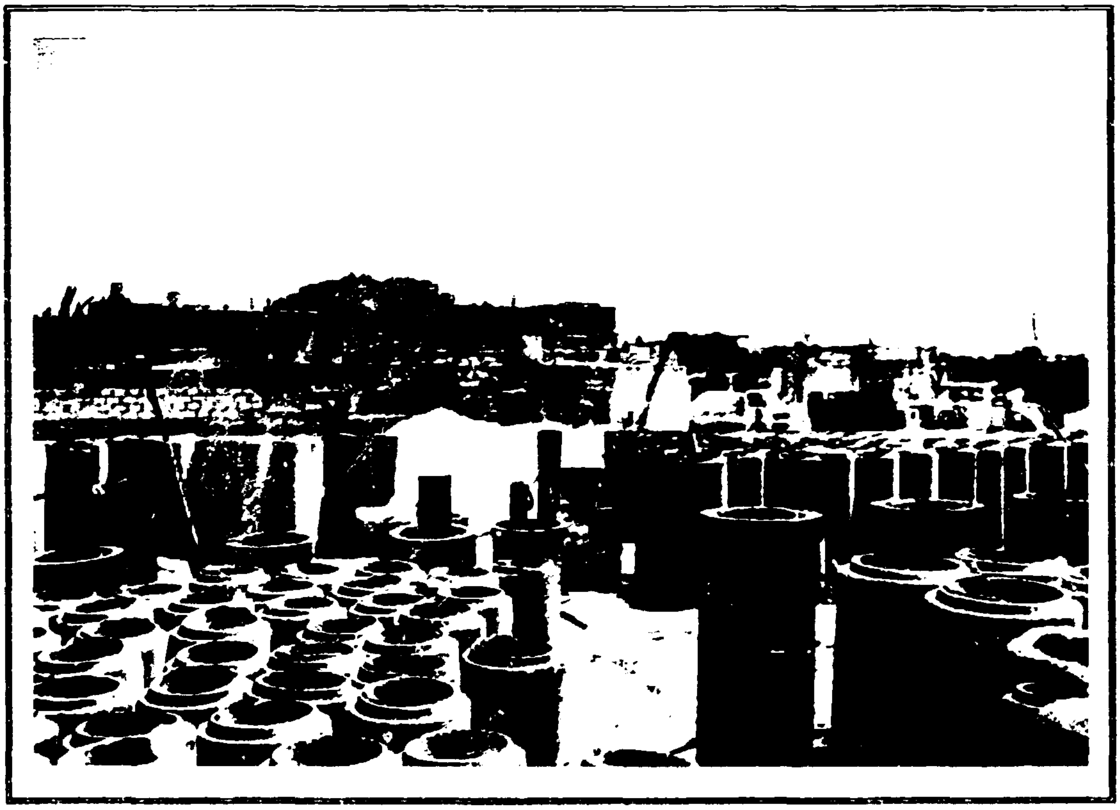
BY-PRODUCTS PROCESSING: GLUE FACTORY



BY PRODUCTS PROCESSING: LIFE-STOCK FEED FACTORY



CONCRETE BRICK AND SEWERS MOULDING: TOP WIEW



CONCRETE BRICK AND SEWERS MOULDING: PRODUCT STORAGE AREA

LIMESTONE CUTTING

LIMESTONE POLISHING

CAR REPAIR AND MAINTENANCE: TOP WIEW

CAR REPAIR AND MAINTENANCE: DETAIL

LAND IMPACT: SCRAPS IRON DUMPING

LAND IMPACT: OOPEN MARKET AND SLAUGHTER HOUSE

ROAD TO AIN TERMA: MISCELLANEA

ROAD TO AIN TERMA: MISCELLANEA

CLEAN ACTIVITIES: FACTORIES UNDER CONSTRUCTION

BUILDINGS UNDER CONSTRUCTIONS

ANNEX D

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