2.5.3 Land use

(1) General points

Urban facilities are planned to be distributed according to the structural idea for urban division proposed in the Master Plan. Service centers and other facilities are to be located in each urban division. In locating these facilities, the population and capacity of each division are taken into consideration.

Tehran is planned to be divided into 22 districts, each of which has a population of 180 to 400 thousands. Each district consists of several areas, each of which has a population of about 30 to 70 thousands. Each area consists of several sections, each of which has a population of 10 to 20 thousands.

(2) Land use distribution

Table 2.5.3-1 shows the general idea for land use according to the Master Plan proposing that each classification of urban division has several utilizing ways for using land. The area of the land totals 613 km^2 with a population of 7.65 millions. As indicated in the table, the Master Plan proposes that residential buildings should be assigned to Sections, while warehouses and terminals should be assigned to Districts, the larger areas than Sections. In addition, the Plan proposes the other purposes for land use such as commercial facilities and educational facilities are managed by Districts, Areas and Sections.

The Master Plan also suggests that the land use project be treated in the district and zone levels. The dividing on a zone basis will be worked out in a few years. Table 2.5.3-2 and Table 2.5.3-3 show the idea of the land use project for the purposes mentioned above. In addition, the Master Plan shows concepts of such land use in Fig. 2.5.3-1.

Table 2.5.3-1 Land use for different urban divisions

Unit: [ha]

Land Use	Sectin	Area	District	Zone	City and Outer	Total
Residential	16.012	-	-	-	-	16.012
Comercial	92	107	176	161	321	857
Educational	1.148	23	161	8	8	1.346
Higher Education	-	-	27	34	796	857
Cultural	38	23	38	15	291	405
Religious	61	38	8	15	145	268
Services for Guests and Turists	23	15	12	10	92	152
Tratment	23	61	92	168	497	842
Cleaning	230	92	-	-	-	321
Official	-	61	45	55	467	628
Social	-	8	15	8	8	38
Leasure and Amusement	-	15	31	8	99	153
Sports	54	214	275	23	673	1.239
Green Space	1.301	536	956	574	3.611	6,977
Industrial	38	54	115	390	3.106	3.703
Urban Services and Equipments	-	15	360	1,282	203	1,860
Ware House	-	-	-	138	849	987
Terminal	-	-	77	115	2.180	2,372
Parking	153	153	77	115	115	612
Transportation	5.202	4.460	1.874	4.093	3.351	18.980
Total	24.374	5.875	4.338	7.211	19.504	61.301
Population Level	10,000 ～ 20. 000	30,000 ～ 70. 000	180,000 ～ 300. 000	1,200,000 ～ 1. 500. 000	≧6,000,000	7,650,000

Data Source: Ministry Housing and Urban Development, ATEK Consultant Engineering Co., 1992.6

Table 2.5.3-2 Land use for urban services in district level (Proposed by Master Plan)

Land Use \ Distlict No	1	2	3	4	5	6	7	8	9	10
Comercial	6.9	8.2	5.9	16.4	10.2	6.8	6.1	6.3	5.9	5.0
Educational	6.2	7.5	5.4	15.0	9.3	6.2	5.6	5.8	5.4	4.5
Higher Education	1.1	1.3	0.9	2.5	1.6	1.0	0.9	1.0	0.9	0.8
Cultural	1.5	1.8	1.3	3.6	2.2	1.5	1.3	1.4	1.3	1.1
Religious	0.3	0.4	0.3	0.7	0.4	0.3	0.3	0.3	0.3	0.2
Services for Guests and Turists	0.5	0.6	0.4	1.1	0.7	0.5	0.4	0.4	0.4	0.3
Treatment	3.6	4.3	3.1	8.6	5.3	3.5	3.2	3.3	3.1	2.6
Official	1.8	2.1	1.5	4.2	2.6	1.7	1.6	1.6	1.5	1.3
Social	0.6	0.7	0.5	1.4	0.9	0.6	0.5	0.6	0.5	0.4
Leasure	1.2	1.4	1.0	2.9	1.8	1.2	1.1	1.1	1.0	0.9
Sports	10.9	12.9	9.3	25.7	16.0	10.6	9.5	9.9	9.3	7.8
Green Space	37.7	44.7	32.3	89.2	55.4	36.9	33.1	34.4	32.2	27.0
Industrial	4.5	5.4	3.9	10.7	6.6	4.4	4.0	4.1	3.9	3.2
Urban Services and Equipments	14.2	16.8	12.2	33.5	20.8	13.9	12.4	12.9	12.1	10.1
Transportation	80.0	94.7	68.5	189.1	117.5	78.3	70.1	73.0	68.3	57.1
Total	171.2	202.7	146.7	404.5	251.3	167.6	149.9	156.2	146.2	122.3
Without Road	91.2	108.0	78.1	215.5	133.9	89.3	79.9	83.2	77.9	65.1
Population (Master Plan)	301.951	357.469	258.672	713.449	443.234	295.565	264.424	275.442	257.826	215.626

Unit: [ha]

Land Use \ Distlict No	11	12	13	14	15	16	17	18	19	20	21	22	Total
Comercial	4.8	5.8	4.3	8.2	11.7	6.5	5.8	9.5	4.8	7.6	13.7	15.5	175.9
Educational	4.4	5.3	3.9	7.5	10.7	5.9	5.3	8.6	4.4	6.9	12.5	14.2	160.7
Higher Education	0.7	0.9	0.7	1.2	1.8	1.0	0.9	1.4	0.7	1.2	2.1	2.4	26.8
Cultural	1.0	1.3	0.9	1.8	2.6	1.4	1.3	2.1	1.0	1.6	3.0	3.4	38.2
Religious	0.2	0.3	0.2	0.4	0.5	0.3	0.3	0.4	0.2	0.3	0.6	0.7	7.7
Services for Guests and Turists	0.3	0.4	0.3	0.6	0.8	0.5	0.4	0.7	0.3	0.5	1.0	1.1	12.2
Treatment	2.5	3.0	2.2	4.3	6.1	3.4	3.0	4.9	2.5	3.9	7.1	8.1	91.8
Official	1.2	1.5	1.1	2.1	3.0	1.7	1.5	2.4	1.2	1.9	3.5	4.0	45.1
Social	0.4	0.5	0.4	0.7	1.0	0.6	0.5	0.8	0.4	0.7	1.2	1.4	15.3
Leasure	0.8	1.0	0.7	1.4	2.0	1.1	1.0	1.6	0.8	1.3	2.4	2.7	30.6
Sports	7.5	9.0	6.7	12.8	18.4	10.1	9.0	14.8	7.5	11.8	21.4	24.3	275.4
Green Space	26.2	31.4	23.4	44.4	63.8	35.2	31.4	51.4	26.2	41.1	74.4	84.4	956.3
Industrial	3.1	3.8	2.8	5.3	7.7	4.2	3.8	6.2	3.1	4.9	8.9	10.1	114.8
Urban Services and Equipments	9.8	11.8	8.8	16.7	24.0	13.2	11.8	19.3	9.8	15.5	28.0	31.7	359.6
Transportation	55.5	66.5	49.5	94.2	135.3	74.6	66.5	109.1	55.5	87.2	157.8	178.8	2027.3
Total	118.8	142.2	106.0	201.5	289.5	159.6	142.4	233.4	118.8	186.6	337.6	382.6	4337.6
Without Road	63.3	75.7	56.5	107.3	154.2	85.0	75.8	124.3	63.3	99.4	179.8	203.8	2310.3
Population (Master Plan)	209.523	250.802	186.977	355.341	510.645	281.510	251.107	411.555	209.491	329.053	595.486	674.852	7.650.000

Data Source: Ministry Housing and Urban Development, ATEK Consultant Engineering Co., 1992.6

Table 2.5.3-3 Land use for urban services in zone level (Proposed by Master Plan)

Unit:[ha]

Land Use \ Zone	Central Zone	North Zone	East Zone	South Zone	West Zone	Total
Comercial	33.6	29.3	26.1	35.7	36.0	160.7
Educational	1.6	1.4	1.2	1.7	1.7	7.7
Higher Education	7.2	6.3	5.6	7.6	7.7	34.4
Cultural	3.2	2.8	2.5	3.4	3.4	15.3
Religious	3.2	2.8	2.5	3.4	3.4	15.3
Services for Guests and Turists	2.1	1.8	1.6	2.2	2.2	9.9
Treatment	35.2	30.7	27.4	37.4	37.7	168.3
Official	11.5	10.0	9.0	12.2	12.3	55.1
Social	1.6	1.4	1.2	1.7	1.7	7.7
Leasure	1.6	1.4	1.2	1.7	1.7	7.7
Sports	4.8	4.2	3.7	5.1	5.1	23.0
Green Space	120.0	104.5	93.3	127.4	128.5	573.8
Industrial	81.6	71.1	63.4	86.6	67.4	370.1
Urban Services and Equipments	268.1	233.6	208.5	284.7	287.2	1,282.1
Transportation	932.7	812.7	725.2	990.3	999.0	4,460.0
Total	1,508.1	1,313.9	1,172.5	1,601.1	1,615.2	7,210.9
Without Road	575.3	501.3	447.3	610.8	616.2	2,750.9
Population (Master Plan)	1,599,906	1,393,950	1,243,946	1,698,626	1,713,572	7,650,000

Data Source: Ministry Housing and Urban Development, 1992.6
ATEK Consultant Engineering Co.

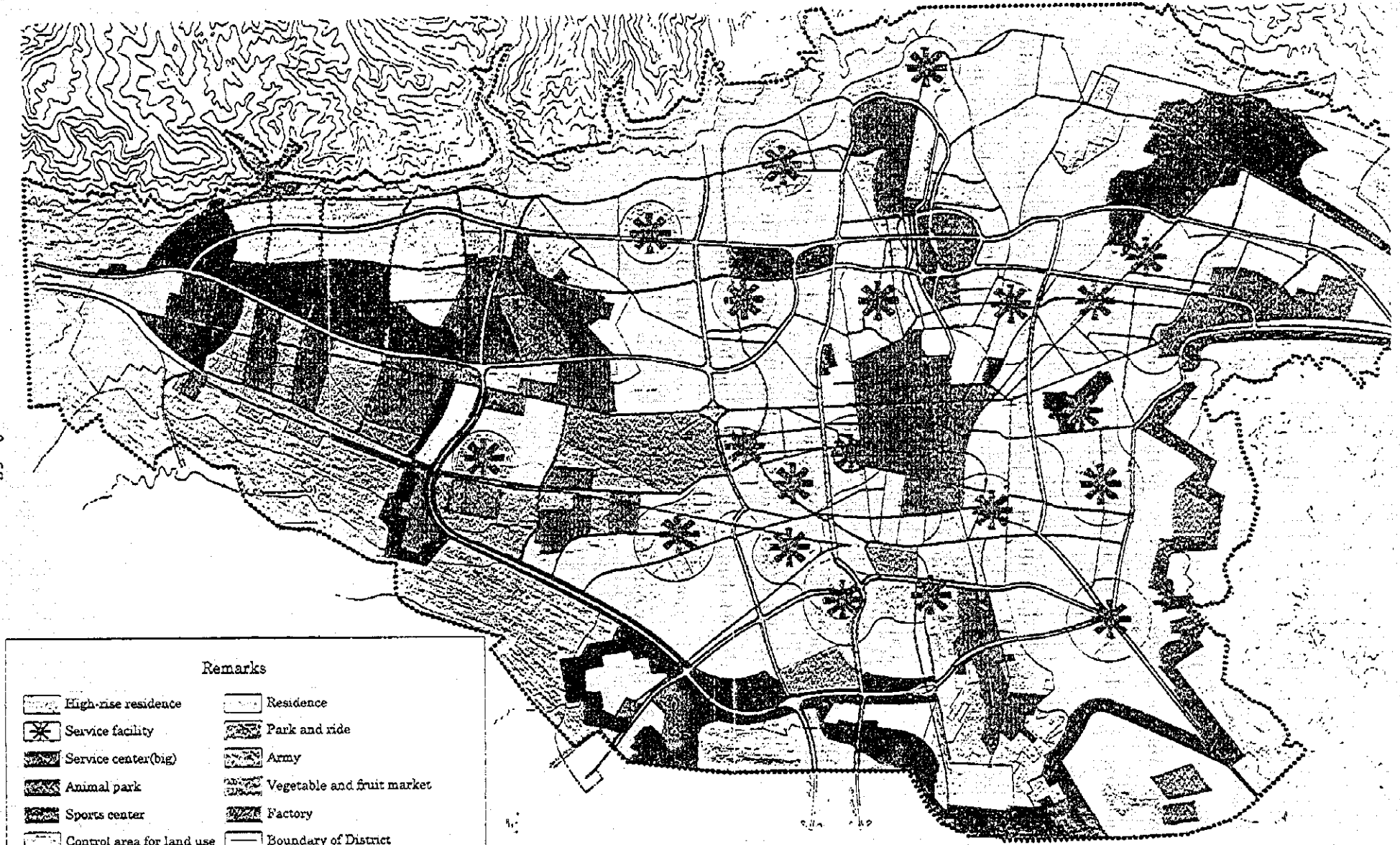


Fig.2.5.3-1 Land use plan (Proposed by Master Plan)

(3) The role of public transportation in the Master Plan

The Master Plan has given public transportation including subways, UBC buses and mini-buses a main role in Tehran's transportation system. The Plan proposes a system in which UBC buses and mini-buses make the most of the highways and the expressways; some of these highways and the expressways have already been completed, and some more are expected to be constructed.

Figure 2.5.3-2 (Plan-1) illustrates a plan to transport commuters to main subway stations via UBC buses and to transport commuters from suburban areas to Tehran's city center via mini-buses.
The mini-bus services around districts 21 and 22 are connected to a subway nearby.

Figure 2.5.3-3 (Plan-2) shows how the city can be divided into five zones, in each of which some Park-and-Rides or bus terminals will be set up as transportation bases. According to the plan, mini-buses transport the commuters from their residential areas to the bas stations, and UBC buses from their transport bases to the city center.

As for Tehran's subway system, the Master Plan expects the East-West Line and the South-North Line to work well. Moreover, a possible future plan involves the utilization of the Loop Line according to the Master Plan. It is not sufficiently clear how the subway system will connect to the bus network in Figure 2.5.3-3 (Plan-2). The subways seem to mainly serve residents on the subway lines and the commuters from the Karaj city.

Both plans 1 and 2 have been well elaborated with careful consideration of the city's transportation measures. It seems practical, however, to adopt plan2 taking into account Tehran's current state of road networks and geographical conditions (hills, rivers and so on). Even in this case, it is suggested that if the distance between a transportation base and the city center is beyond a particular

limit, the UBC bus route should be designed to connect with a subway station nearby instead of connecting directly with the city center. For example, the UBC bus line around the districts 21 and 22, which seem to have been designed to use the highways running around the neighborhood, should have a connection with a nearby subway station, because the transportation capacity of a subway system is much greater than that of a bus system and is much more time-efficient.

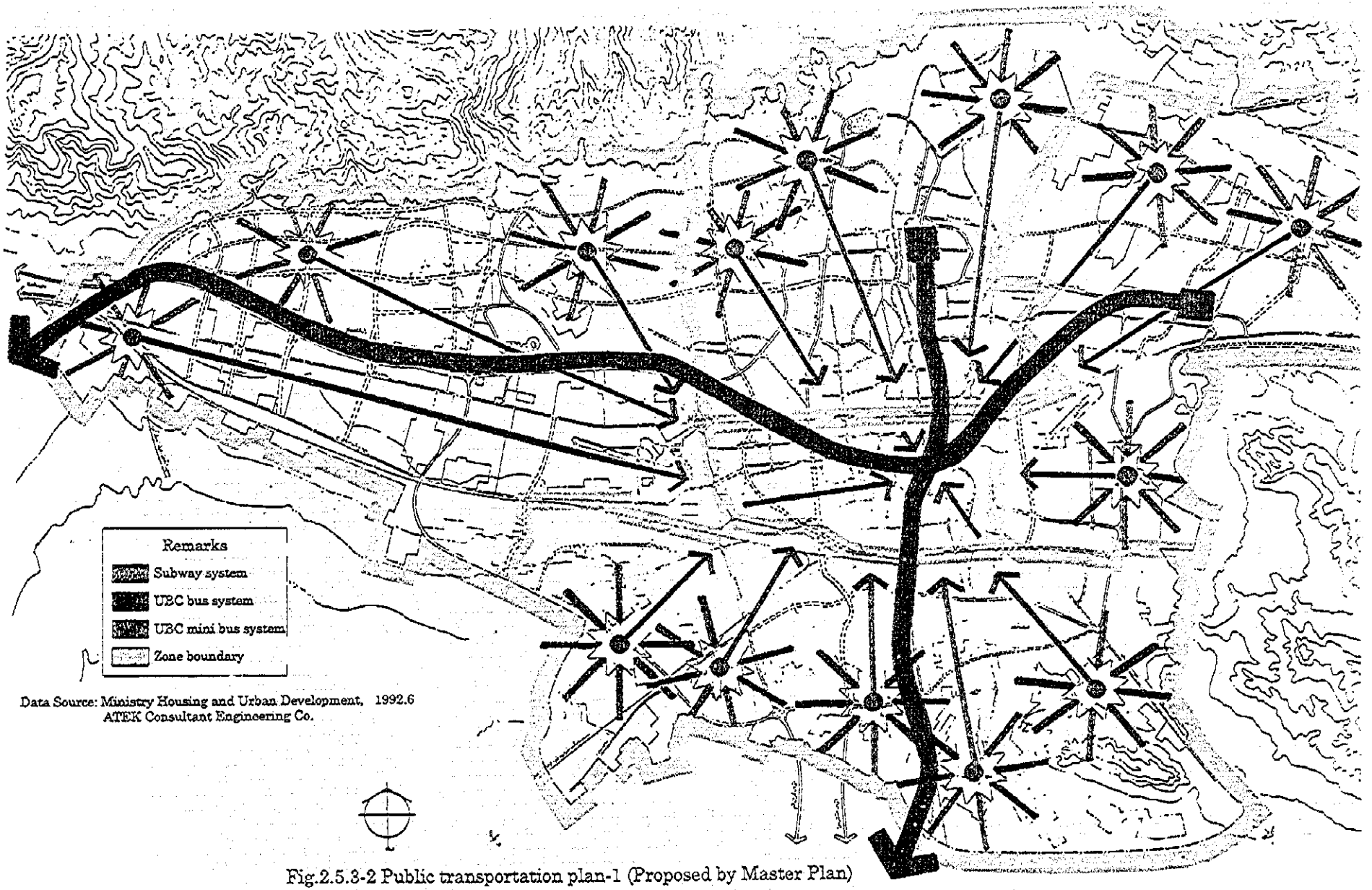


Fig.2.5.3-2 Public transportation plan-1 (Proposed by Master Plan)

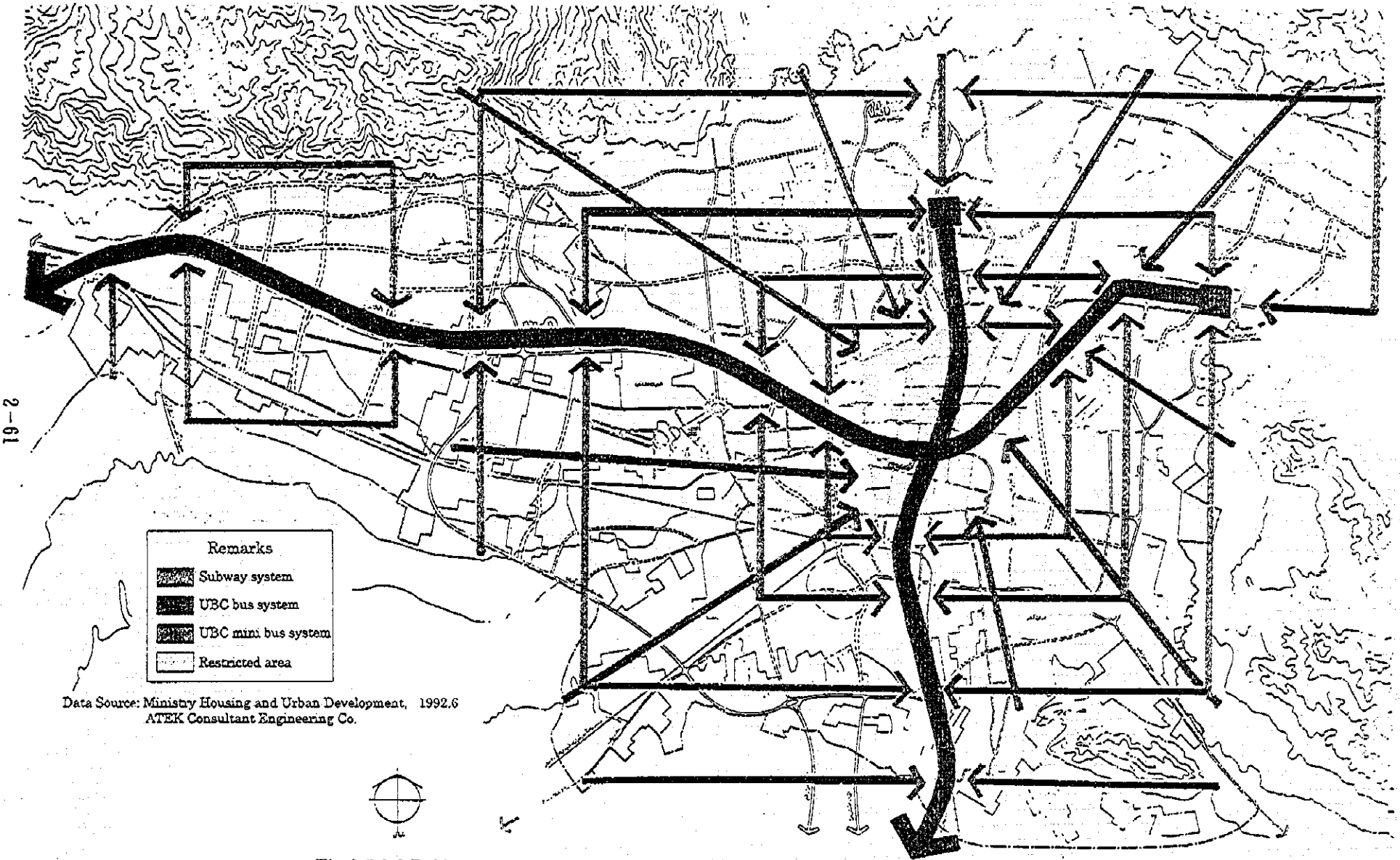


Fig.2.5.3-3 Public transportation plan-2 (Proposed by Master Plan)

Chapter 3

Present situation of air pollution in GTA

3. Present situation of air pollution in GTA

3.1 Overview

Based on the pollutant concentration data monitored at the stations located in a heavy traffic area (Fatemi) and a crowded commercial area (Bazar) in Tehran, the overview of air pollution is summarized below.

(1) SO_2

Annual variation of SO_2 is characterized by high concentration in winter, and comparatively low concentration in the warm seasons, because of more consumption of fossil fuel in winter. And concentration at Bazar is always higher than that at Fatemi. As for the diurnal variation, the peak is recorded around 9:00 through the year. In summer and autumn, the second peak is observed around 22:00. Holiday sink of concentration is recognized only in autumn. These variations depend on source activities and weather. The wind direction does not seem important for variations of the concentrations, but breezy or calm conditions contribute to the high concentration.

(2) NO

The NO concentration is high in autumn and winter, and low in spring and summer. In contrast to SO_2, the concentration at Fatemi is almost twice as high as that at Bazar in each month through the year, perhaps because of the difference in traffic volume. The diurnal variation shows a distinct half day cycle with two peaks, the first one appearing around 9:00 and the second around 22:00. The peak time may be determined by traffic activities and atmospheric stability. Holiday sink of concentration is seen in autumn at both stations, and also the values at Fatemi in August and November show typical drops. High concentration is observed under the conditions of northwesterlies and weak wind.

(3) NO_2

The NO_2 concentration is high in winter and low in early summer, but the annual range is narrow compared to NO. There is no particular difference among the stations in the

annual variation, except the concentration at Fatemi which has the second peak in April. Compared to NO, the diurnal range is not wide, and the half-day cycle is recognized only at Bazar. Notably the diurnal curve at Fatemi almost through the year shows the minimum concentration in the early morning and becomes flat in the afternoon. It is not easy to explain these features of the diurnal variation, because NO_2 is produced by oxidation of NO. The 7-day variation of each season is almost flat, while the day of the week does not have an important influence on the concentrations. The wind direction does not affect the concentrations, while the wind speed does. For example, calm or breezy conditions are conducive to high concentration.

(4) CO

While the annual concentration of CO is almost constant, the concentration in summer is slightly higher. The diurnal variation shows a half-day cycle through the year, especially summer and autumn curves are characterized by distinct two peaks in the morning and in the late evening. CO shows the most typical variation depending on the day of the week. Friday is distinguished from the other days by its distinct drop of concentration. Wind influence on the concentration is seen clearly at Fatemi, where the high concentration corresponds to northwesterlies or northeasterlies and weak wind.

(5) O_3

The O_3 concentration at Bazar is high in summer and low in winter. Diurnal change has one peak in the afternoon. Such variations are explained by the dependence of O_3 concentration on the intensity of solar radiation, because O_3 is produced by photochemical reaction. There are no distinct relationships between O_3 and the day of the week. On the other hand, southerlies and strong wind correspond to the high concentration. However, they are not considered the necessary conditions for high concentration and not related to photochemical reaction directly, but such winds are supposed to appear with strong solar radiation simultaneously.

(6) THC (Total Hydrocarbon)

The THC concentration is almost constant through the year except in late summer when it becomes somewhat higher. Similarly to CO, the diurnal variation shows a half-day cycle through the year, especially the summer and autumn curves are characterized by distinct two peaks in the morning and in the late evening. The 7-day variation in each season is almost negligible, but in summer and autumn, a drop on Friday is recognized. Concerning the wind influence, the high concentration corresponds to northwesterlies or northeasterlies and weak wind.

(7) PM10

The PM10 concentration is high in autumn and low in spring, and the concentrations at Bazar are higher than those at Fatemi almost through the year. The diurnal variation in each season shows a half-day cycle with two peaks in the morning and in the night, while the peak time is somewhat random especially at Bazar. The concentration clearly drops on Friday in summer and autumn. The wind direction is not related to the concentration. On the other hand, PM10 reduces with the increase of wind speed up to 4 - 5 m/s. When the wind is stronger than this level, the concentration increases in proportion to the wind speed. It is supposed that particles originated in natural sources such as soil will increase when the wind speed exceed 5 m/s.

3.2 Present activities for air pollution in the central government and MOT

3.2.1 Monitoring

It is not clearly stated which organization is responsible for ambient air quality monitoring pursuant to the Clean Air Act. Perhaps for this reason, many organizations are involved in ambient air monitoring activities. While DOE claims to be legally the only responsible body, the Municipality of Tehran is also involved in monitoring, referring to its responsibility for the well-being of citizens. These two organizations are equipped with real time monitoring stations, while other organizations like the Ministry of Health or Ministry of Oil have some discontinuous monitoring stations. Among these organizations, the Ministry of Health has the longest air quality record for TSP and SO_2. Table 3.2.1-1 lists ambient air monitoring stations in Tehran, while Fig.3.2.1-1 illustrates their locations in the Greater Tehran Area.

Table3.2.1-1 Air pollution monitoring station in Tehran(location and detail information)

Managing Organization	Location of the station	Measured pollutants	Year stating Meas.
AQCC	Fatemi St./Valleye-asr	NO_X, SO_2, CO, O_3, THC, PM10	Sep. 1995
AQCC	Bazar Square	NO_X, SO_2, CO, O_3, THC, PM10	Oct. 1995
AQCC	Nikoughhadam St.(AQCC Bldg.)	NO_X, SO_2, CO, O_3, THC, NMHC	Jul. 1997
AQCC	Mobile(movable station on truck)	NO_X, SO_2, CO, O_3, THC, PM10	Oct. 1995
DOE	Ostad Nejatollahee(DOE Bldg.)	NO_X,SO_2, CO, O_3,THC,NMHC, SPM	May 1993
DOE	Azadi Square	NO_X,SO_2, CO, O_3,THC,NMHC, SPM	Jun. 1993
DOE	Gholhak Area	NO_X,SO_2, CO, O_3,THC,NMHC, SPM	Jul. 1993
DOE	Tajrish area	NO_X,SO_2, CO, THC,NMHC, SPM	Nov. 1994
DOE	Farhang Saraye Bahman	NO_X,SO_2, CO, THC,NMHC, SPM	Dec. 1994
DOE	EmanKhomaini Mosque(Haram)	NO_X,SO_2, CO,THC,NMHC	(1995)
DOE	Piruzi Area	Intermittent SO_2, CO, Dust	1991
DOE	Narmak Area	Intermittent SO_2, CO, Dust	1991
DOE	Keshavars Boulevard	Intermittent SO_2, CO, Dust	1991
DOE	Emam Khomani Square	SO_2,	?
DOE	Enghelab square	NO_X,SO_2, CO	1991
MOH	Shariati Street	Intermittent SO_2,TSP, Smoke	1973
MOH	East Shoush street	Intermittent SO_2,TSP, Smoke	1976
MOH	Seyed Jamate/Asad Abadi street	Intermittent SO_2,TSP, Smoke	1976
RIPI	Tehran Refinery	NO_X,SO_2, CO, O_3, THC, Smoke	1969
NIOC(RIPI)	NIOC Bldg.Courtyard/Hafez St.	NO_X,SO_2, CO,THC, Smoke	1994

Abbreviations AQCC: Air Quality Control Company

DOE: Department of Environment

MOH: Ministry of Health

RIPI: Research Institute of Petroleum Industry

NIOC: National Iranian Oil Company

Notes: PM10 and SPM are mass concentration but based on different particle size separation.

For Dust and Smoke, relative concentration is listed.

Most of the available monitoring stations in Tehran are roadside stations. Therefore, their monitoring data may not be appropriate as the materials for assessment of the pollutants influence on environment and public health in Tehran. It is therefore necessary to select site carefully for development of the ambient air monitoring network. The most important monitoring stations in Tehran belong to DOE and AQCC.

Since the beginning of operation of these monitoring stations, AQCC has tried to make air quality data open to citizens and other institutions. On the contrary, DOE has

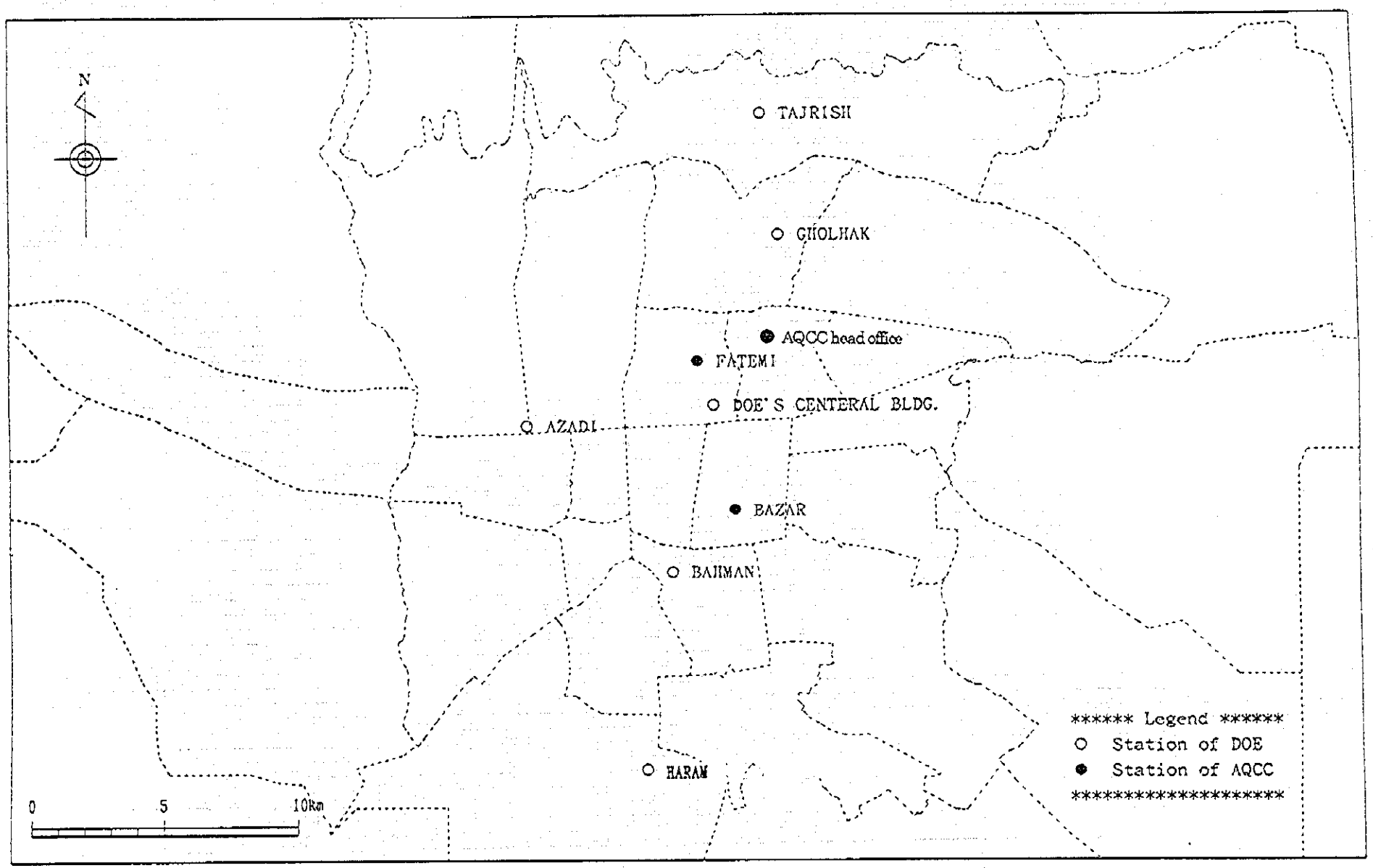


Fig. 3.2.1-1 Location of air pollution monitoring (continuous and real-time) station in Tehran (DOE and AQCC)

adopted a completely different strategy so that its data have been regarded strictly confidential. Since public awareness is one of the most important objectives of air quality monitoring, this policy of DOE certainly needs to be corrected in future. In addition, the inadequate number of stations in Tehran strongly necessitates exchange of data among interested bodies in order to take the best advantage of available resources.

It is difficult to evaluate the quality of data gathered at the ambient air monitoring stations in Tehran. Regardless of the organizations, difficulties in purchasing spare parts and calibration materials prevent them from getting high quality data. In addition, in some cases, shortage of well-trained service and maintenance staff make the task more difficult.

3.2.2 Meteorological observation

Data of surface and upper meteorological observation needed for the analysis of ambient air pollution in Tehran are routinely collected by the regularly scheduled observations and accumulated by IRIMO, DOE and AQCC. Among these, IRIMO and AQCC data were collected during the field survey by the JICA study team. Details of the routine observation by IRIMO and AQCC are reviewed.

Information of the observation network operated by IRIMO is summarized in Table 3.2.2-1. IRIMO has four kinds of meteorological observation stations, namely "Synoptic", "Upper Air", "Climatology" and "Rain gauge". The data of the Synoptic stations are useful in particular, because they are obtained hourly or every 3 hours and cover full items of observation. Details of these Synoptic stations are as follows:

There are four "Synoptic stations" in Tehran. The data obtained at these stations are indispensable for the analysis of air pollution mechanisms and for development of a simulation model. Among these, the 'Mehrabad Airport' (The headquarters of IRIMO) plays the central role in the observation network in Tehran. It is located in the western part of the city (the 9th district), whose facilities are established in an annex to the Tehran International (Mehrabad) Airport. Both the surface meteorological observation and the upper air observation are made routinely at this station. On the surface level, the hourly data of air pressure, wind direction and wind speed, temperature, relative humidity, precipitation and solar radiation are obtained, while the condition of clouds is observed hourly. The upper air observation using a radio sonde takes the data of air pressure, temperature, dew point, wind direction and wind speed twice a day (00UTC, 12UTC).

'Aghdasiyeh' (at 1548m) is located in the northeastern part of the city (the 1st district) at the foot of the Elburz mountains, while 'Dooshan Tappeh' (at 1209m) is annexed to the air force base in the southern part of the city. They are using the same menu of surface observation with the Mehrabad station, but at intervals of 3 or 6 hours.

'Geophysics' (at 1419m) is in the campus of the University of Tehran on the hilltop of Amir Abad in the 6th district close to the center of the city. This station is jointly operated by IRIMO, the University of Tehran and the Institute of Geophysics, whose observation is made only in the daytime (6:00~18:00) every 3 hours.

The data collected by these stations are entered in the computer and processed into statistics. The products are compiled together with the data collected at other observation points in the country, and made up into the "Yearbook".

On the other hand, AQCC is getting meteorological data as well as the ambient air quality at its monitoring stations. The data of wind direction and speed, temperature, relative humidity and solar radiation obtained every hour are stored temporarily in a personal computer of the monitoring station, and subsequently collected and stored in the data base.

In addition to these, DOE has one station for wind direction and wind speed.

Table 3.2.2-1 Details of the observation network operated by IRIMO

Type	Name of station	Latitude (N)	Longitude (E)	Altitude (m)	Start year of observation	Observation schedule	Observation item
Synoptic	Mehrabad Airport	35° 42'	51° 21'	1191	1942	Hourly	air pressure, precipitation wind direction and speed solar radiation, humidity temperature
	Aghdasiyeh	35° 47'	51° 37'	1548	1987	3 hourly	
	Dooshan Tappeh	35° 40'	51° 23'	1209	1971	3 hourly	
	Geophysics(Amir Abad)	35° 44'	51° 24'	1419		3 hourly (daytime)	
Upper Air	Mehrabad Airport	35° 42'	51° 21'	1191	1942	00, 12UTC	temperature, humidity, wind direction and speed
Climatology	Chitgar Area	35° 42'	51° 08'	1215	1990	03, 09, 15h	air pressure, temperature, dew point, precipitation, cloud amount wind direction and wind speed
	Amin Abad Area	35° 35'	51° 28'	1000	1963		
	Emam Khomini Airport	35° 27'	51° 06'	1004	1991		
Rain Gauge	East of Tehran	35° 43'	51° 24'	1244	1987	03, 15h	precipitation
	Northwest of Tehran	35° 45'	51° 16'	1548	1987		
	West of Tehran	35° 43'	51° 07'	1225	1987		
	Soologhan	35° 49'	51° 16'	1550	1989		
	South of Tehran	35° 34'	51° 23'	1124	1987		

3.2.3 Mobile sources

The central government of Iran and MOT have many organizations and companies dealing with mobile sources. Some of them carry out studies and plan reduction of air pollution by taking measures targeting at mobile sources and implementing these plans, while others are managing the public transportation, or in charge of production, development and improvement of vehicle engines and fuels. Activities of these organizations and companies are reviewed in this section.

(1) Air Quality Control Company (AQCC)

Being one of the organizations belonging to the city's Transportation and Traffic Affairs Bureau, AQCC was established in 1993. Its main tasks are to study countermeasures against air pollution in the city, to suggest and establish consensus among the affiliated organizations in the city. The organization has 40 staff members who work actively, and exchanges personnel with other affiliated organizations, universities and institutions. AQCC frequently accepts foreign research groups on anti-pollution measures and coordinates conferences and workshops. The organization also actively sends its personnel to foreign conferences or training centers.

AQCC is the main counterpart of the JICA study team of this project, serving not only as a good consultant of the study team but also as a member of the steering committee. AQCC took part in field surveys, measurements and inquiry activities planned by the study team, and greatly contributed to the team's fact-finding mission.

AQCC's field of study is extensive, emphasizing the study about countermeasures for vehicle emissions, and carries out many collaborative projects with affiliated organizations. It has also joined several studies of other organizations to be described later.

Some recent activities of AQCC are as follows:

- A study to examine effects of reducing air pollution by adjusting a vehicle engine.

This study proved effectiveness of adjustment of a vehicle engine for reducing air pollution with a quantitative analysis method. The results are likely to influence future plans for emission control of vehicles in the city.

- Campaigns to sensitize people in the city to the necessity of reducing air pollution.

It explains plainly the state of air pollution in the city through mass media such as a television. An animated character program illustrates a better way of driving and adjustment of vehicle engine operations to reduce air pollution.

- Monitoring air pollution and making databases.

AQCC has some stations for monitoring air pollution, and knowing current air quality in the city. It is now making databases based on the collected data. (See chapter 3 for details)

(2) Tehran Transportation and Traffic Organization (TTTO)

Established in 1968 for traffic management and engineering, TTTO is one of the organizations with the longest history in MOT, and its activities are manifold. The staff members are efficient. Main supervising tasks are as follows:

- Improvement of intersections and squares

TTTO undertakes field surveys of intersections and squares where traffic jams are noticeable and plans alleviation of the jams. It has all the information about the conditions of more than 650 intersections in the city, among which the organization has concluded 150 intersections and squares need prompt improvement. Plans for improvement have been proposed to MOT.

- Installation and maintenance of traffic signals

Installation and maintenance of traffic signals play a major role for promotion of

traffic safety and prevention of traffic accidents as well as alleviation of traffic jams. According to the statistics of MOH published in 1995, traffic accidents injured 5,721 and killed 1,645. Traffic accidents are the sixth largest cause of death in the city. TTTO installs and maintains traffic signals in the intersections and squares where these operations are considered effective for the purpose of mitigating traffic jams, promoting traffic safety and preventing traffic accidents.

TTTO collaborates with the signaling division of TTCC in installing traffic signals and adjusting the timing of signals.

- Planning of the city's road network.

TTTO plans ways to use most effectively freeways, expressways, trunk roads and local roads under the control of MOT.

- Positioning of bus stops.

Suggestions about the positioning of bus stops on the 300 routes of UBC buses were given to UBC by the TTTO. As a result of TTTO' s suggestions, several main bus routes have dedicated bus lanes.

- Introduction of one-way traffic system

TTTO plans to introduce a one-way traffic system on the basis of the field study and is implementing it, in order to improve the trunk roads where traffic jams are heavy.

- Specifying the restricted area where vehicles cannot enter

TTTO plays a major role in the process of establishing regulations limiting vehicles entering the center of the city. The current restricted area is 23 km² where restrictions are enforced from 6 a.m. to 5 p.m. on weekdays. The rule has been through alterations seven times.

- Various studies on transportation and traffic.

Plans for road networking, positioning of traffic signals and footbridges, and a one-way traffic system have been sent to TCTTS, a branch organization of the Transportation and Traffic Affairs Bureau of the city, whose merit is to be judged through feasibility studies and simulations. In making the above-mentioned plans, TTTO used the results obtained from the origin destination (O/D) studies and person trip (P/T) surveys. The last person trip survey was carried out in 1985, focusing on public officials, business persons and students.

While the JICA study team was implementing this project, TTTO made a great contribution to the operation by providing the team with pertinent information including the data on the MOT traffic system.

(3) Tehran Traffic Control Company (TTCC)

TTCC was established in 1991 with the purpose of improving the city transportation network and achieving the most effective use of the existing traffic facilities. TTCC consists of the following five divisions:

TV Surveillance Division

TV monitors have been set at the 50 main intersections in the city, so that the current state of traffic can be observed on 18 screens in the TTCC traffic control center. Remote control of these TV monitors makes it possible to turn the camera's direction or make them zoom in and out. The center has radio broadcasting facilities and airs traffic information every 15 minutes. Urgent information about traffic accidents and emergencies are reported via radio to the proper authorities, such as police and UBC.

Signaling Division

This division studies ways to automate the timing of traffic signals and to achieve the most suitable conditions of the system.

Geometric Design Division

This division works in cooperation with TTTO to improve traffic flows through intersections by using data obtained through field surveys and traffic volume research at busy intersections.

Research and Development Division

This division studies measures for preventing air pollution by improving traffic conditions using up-to-date technology. At the same time, it supports the Execution Division with scientific technology.

Execution Division

The Division installs traffic signals, detector loops, TV surveillance cameras and the like.

Of TTCC's many activities, the following studies are particularly notable.

_ Image analysis

Videotaped images are displayed on computer screens which can analyze data on traffic volume, the average speed of vehicles, traffic congestion, the number of parked vehicles, the number of running vehicles and others by scanning images and using image recognition application software. Selection of images can be specified by a mouse. This study will be carried out on several spots using video players provided by the JICA study team, and its further improvement and development are expected.

_ GIS system (Geometric Information System)

Data concerning 100 to 200 items, including road links, nodes and bus stations, are stored in the GIS system.

_ Measuring traffic volume and the AADT system

Measuring sensors have been installed at 16 spots to check traffic volume. The information provided by the sensors is used to control the timing of traffic signals. The

AADT (Annual Average Daily Traffic) systems, the sensors built on roads, are also able to measure traffic volume and record information. TTCC experienced in measuring traffic volume at some 20 to 25 spots at a time a few years ago. They made a great contribution to the project by supporting the JICA study team in measuring traffic volume.

(4) Tehran Comprehensive Transportation and Traffic Studies (TCTTS)

TCTTS was established in 1991 and is the only division in the Transportation and Traffic Affairs of MOT that makes transportation plans with a computerized simulation method. Among its variety of activities, the three engineering divisions simulate the plans made by affiliated organizations, predict the impact and effectiveness of these plans, and carry out feasibility studies of the plans.

The municipal authorities have great expectations of TCTTS, which is one of leading organizations to make MOT's master plan.

Activities of the three divisions are as follows:

Road Database Division

This division makes a database, dividing MOT into 20 districts and into 605 zones, arranging the information of road networks and road maps in each section and zone, with the assistance of the Trans CAD 2.1 software (Calper Corp. 1992).

In creating a road network database, the results obtained from the O/D study in 1992 and 1994 have been used. Images of the road network data (location, linkage, and information about roads and traffic) can be zoomed in and out freely on computer screens, and the roads can be displayed in different colors according to road specifications. The database made in this division is provided to the other three divisions and related organizations.

Road Traffic Simulation Division

This Division simulates to optimize the traffic volume, using the Canadian software EMME/2. By using this software, distribution of vehicles and traffic volume can be seen on screens. In addition, various conditions can be reproduced on screens so that influences on traffic volume can be studied. For example, when roads are expanded, more parking places are provided or linkages are changed.
The distribution of traffic volume and impacts on traffic can be judged by different colors for every change of traffic volume.

Also simulated are the contribution of individual factors to traffic volume and the conditions worked out by integrating the effectiveness of several factors, using a traffic volume sensitivity analysis called a "More choice model", so that the best traffic conditions can be designed on the basis of this analysis. The simulation projects designed to achieve the most suitable road conditions are being carried out on a five-year (short term) and a 20-year (long term) basis. When the analyzed results are judged to have positive effects on traffic volume, the plan is proposed to the Lord Mayor of Tehran.

Vehicle Emission Database Division

They make a database, collecting data on emission density of automobiles and motor cycles at the inspection and maintenance center belonging to TVTIB.
Substances covered by the emission database are CO, CO2, O2 and HC. The database stores data collected from some 200,000 vehicles.

(5) Tehran Vehicle Technical Inspection Bureau (TVTIB)

TVTIB supervises inspection and maintenance workshops and conducts public relations for advertising necessity of vehicle maintenance. TVTIB was established in 1990 and supervises 90 inspection and maintenance workshops of automobiles and 80 workshops of motorcycles in the city of Tehran under TVTIB's supervision. TVTIB also

manages the inspection and maintenance center of its own.

Automobile maintenance and inspection are obligatory every 12 months for passenger cars that need permission to move into the traffic restricted area and for vehicles subjected to change of ownership. In the event of a violation of this requirement, 10,000 rials fine is imposed. The enforcement, however, is not rigorous and the rate of compliance is said to be from 25 % to 40 %. Automobiles which went through inspection in 1995 numbered 350,000 and the motorcycles 90,000.

The inspection includes checking of a body, paint, wipers, windows, mirrors, a bumper, a clutch, a gear and so on, and varies by car types. According to the rule, the vehicle inspection costs 3,000 rials (fixed) plus 1,000 rials for each cylinder (unfixed), with additional cost for spare parts.

The inspection also includes measuring of exhaust gas emissions while an engine is idling. The regulated limit of emission concentration was 5 vol% for CO and 500 ppm for HC until last year, and has been revised to 6.5 vol% for CO and 700 ppm for HC respectively since this year. The proper standard value of emission concentration control was determined by TVTIB and AQCC based on their collaborative work and has a great effect on decision making for the present and future emissions control of the inspection system.

While working actively for the public relations about maintenance of vehicles. They use mass media for raising consciousness in addition to the following activities:

1) They distributed tuning up parts of an engine (spark plugs, contact breakers, air filter) for low prices at more than 80 inspection centers in Tehran in December, 1995. As they got approving reaction of the public, the project was prolonged until February in the following year.
2) Pamphlets were distributed, though irregularly, in Tehran to raise public awareness of necessity of car maintenance.
3) Tehran Blue Sky Fair were held in order to upgrade the public knowledge about

inspection and maintenance of their vehicles in 1994 and 1995.

(6) United Bus Company of Tehran (UBCT)

UBC, the largest public transportation company in MOT, was established in 1956. The company supervises operations of public buses, mini-buses and trolley buses. UBC has divided the city into six zones and supervises and runs their vehicles in each section. In addition, it plans new bus routes, adjustment of the bus system and introduction of new buses in each section. Table 3.2.3-1 shows the UBC bus and trolley bus operations in Tehran.

More than 85 % of the total number of buses in UBC are in working conditions, while 10 to 15 % are not in use going through maintenance or repair. Operating hours of the buses are from 6 a.m. to 10 p.m. when two drivers work in two shifts.
On articulated buses and double-deckers running during rush hours, a driver and an attendant work together.

The bus fares are set according to distance, the first fare stage being 50 or 100 rials for ordinary buses. Though there is no commuters ticket system or discount ticket system, UBC did issue a one-month discount ticket to commuters in the 1980's with two-thirds discount below the regular fare.

A Research Division of UBC is developing a new type vehicle, service system and reduction of air pollution respecting the following themes:

1) Engine and transmission
2) Spare parts
3) Future plans for bus systems
4) Plans for reducing emission
5) Study for introducing buses with LPG and CNG-burning engines
6) Plans for increased use of electric buses

The relating explanations about the activities of UBC will be made in Section 3.3.1.

Table 3.2.3-1 UBC bus (mini bus) and trolley bus operation in Tehran

Area	Number of Line	Number of Busses	Route Distance [km]	Number of Passengers	Daily Average	Daily Passengers of a Car	Operation District
1	43	619	381.4	16,095,236	555,008	1,312	1, 3, 4, 6, 7
2	38	578	304.8	15,779,040	544,105	1,286	8, 12, 13, 14
3	42	679	418.1	11,117,713	383,369	844	12, 15, 16, 20
4	26	573	224.8	15,687,411	540,945	1,252	11, 12, 16, 17, 19
5	22	388	276.9	6,035,219	208,111	691	9, 18
6	35	631	280.3	17,628,237	607,870	1,378	2, 5, 6, 9, 10, 11
Bus Total	206	3,468	1,886	82,342,856	2,839,408	6,763	
Mini Busses	110	4,026	915.7	2,990,000	1,150,000	286	All area of Municipality of Tehran (City and Suburbs)
Trolley Busses	3	29	20.6	1,810,226	62,422	2,312	Line-1,2: 7,8,13 Damavand St. Line-3 : 12,13,14 Hefdah-E-Shahrivar St.

Data Source: United Bus Company of Tehran(UBC), 1995 and Air Quality Control Company(AQCC)
Note : Line 3 of trolley bus will be in operation very soon

(7) Research Institute of Petroleum Industry (RIPI)

(A subsidiary of the Ministry of Oil and NIOC)

Established in 1969, RIPI conducts research and studies mainly in ways to improve petroleum-related technology, devise countermeasures against environmental pollution, and improve combustion technology of vehicles. In the fields of petroleum-related technology and counter-measures against environmental pollution, they are researching the effect of petroleum and gas on environment and methods of prediction of pollution. In the field of combustion technology of vehicles, RIPI has made many achievements.

For example, it has completed the C/D testing responding to the request of MOI, MOT and auto makers and is studying to improve combustion technology for domestic vehicles by conducting C/D tests. The C/D device was manufactured by British Scott Co. Ltd. and the gas analyzing device equipped with FTIR laser analyzing devices was REGA 7000, a newest instrument manufactured by USA Nicolet Co.Ltd.

It is also studying in the better quality of automobile fuels, and introduction of TEL, MTBE and methanol.

(8) Automotive Industries Research and Innovation Center (AIRIC)

AIRIC was established in 1993 as a private research company partly capitalized by the Ministry of Industry. The research targets automobiles for private use.
It tests performance of cars, designs cars, and simulates future conditions of vehicles.
It has a designing division and experiment division, and is staffed by 250 persons including 100 engineers.

1) Designing Division

This division works on new designs for vehicles, being entrusted by car manufacturers. To design vehicles, they simulate new forms of chassis and bodies using computer graphics, and finally define a new model getting feedback from manufacturing plants.

2) Experiment Division

The purpose of their entrusted experiments is to evaluate and improve performance of cars, and their main experiments involve Chassis Dynamometer Testing (C/D). The C/D testing device was manufactured by ZÖLLNER, used to test cars which are equipped with a gasoline or diesel engine, and weigh up to 2.5 tons.
It is equipped with a dilution tunnel, a constant volume sampling system (CVS).
The gas analyzing system was manufactured by USA FISHER ROSEMOUNT, and is used to determine the amount of NO, NO_2, NOx, CO, CO_2, O_2 and HC. Its measuring mode is based on the ECE15 standard mode, but EPA and Japanese standard modes can also be used. Their goal is to establish the standard mode of Iran in the future, although they are in the process of a trial and error to functionalize the measuring mode of C/D testing properly. Also they advise automobile manufacturers to reduce emissions on the basis of C/D testing.

The C/D test by 69 test modes has been done for 19 cars of five different types including Paykan, Peugeot and Renault by the JICA study team with a good deal of assistance by AIRIC.

(9) Iranian Research Organization for Science and Technology (IROST)

(A subsidiary of the Ministry of Culture and High Education)

Established 10 years ago, IROST cooperates with the Ministry of Culture and Higher Education. It has more than 10 laboratories and offices throughout the country as well as its head office in Tehran. IROST has 200 staff members and the following Institutes under its reporting line:

-The Mechanical Engineering Institute

Motors(Engines)

Material Designs

Fluid Mechanics

- The Chemical Engineering and Chemistry Institute

- The Agricultural and Natural Resources Institute
- The Electrical Engineering Computer Institute
- The Technological Research and Studies Institute

The Mechanical Engineering Institute has 60 staff members and studies to improve a diesel engine of IDEM Co. Ltd., and to provide measures to control emission from a gasoline engine manufactured by Iranian auto makers. Also it has conducted a running test (a distance of 600 Km from Tehran to Tabriz) of buses which burn gas instead of light oil, in cooperation with Shahab-Khodro and IDEM.

Recently it invented an engine supplement kit to reduce emissions of Paykan vehicles, with the assistance of the Iranian government and Municipality of Tehran (MOT). This device consists of some 30 parts and the purpose of the invention is to achieve the following objectives:

-Less fuel consumption
-Prevention of engine smoking and escapes of fuel vapor
-Easy and inexpensive maintenance
-Longer life of engine
-To facilitate more use of gas
-To enhance engine power for comfortable driving inside / outside the city

Only 15,000 Paykan automobiles have been equipped with this device, although 30 % reduction in fuel consumption (100 Km/h) as well as 70 % reduction in smoke has been achieved. However, due to the non-uniform positive effects on all Paykan fleet, the plan to broaden the application was given up in 1995.

(10) Material and Energy Research Center (MERC)

(A subsidiary of the Ministry of Culture and Higher Education)

Activities of MERC was started in 1974 in the fields of materials, energy, electronics and air pollution. For the time being, MERC is cooperating with universities and other research centers.

1) Energy Research Center

The activities of this center is in the fields of renewable energy resources and pollutants of environment. This center is studying utilization of solar and wind energy which are to replace fossil fuels, as well as pollution caused by fossil fuels.

There are 3 groups in this center: the solar energy group, energy conversion and storage group, environmental and energy group. Researchers of this center are able to identify the pollutant and conduct quantitative studies. Several educational activities have also been made since 1986.

Its main equipment are:

- Exhaust gas analyzers
- Different solarimeters
- Humidity meters, solar hours measurements, air suction equipment
- Air and water temperature, speed measurements
- Hot elements
- Atomic absorption
- Gas chromatography
- Spectra photometer (infrared, ultraviolet, visible)
- Aerosol generator
- Thin layer chromatography etc.

2) Research Center of Ceramics

This center is one of the most advanced research centers for ceramics in the country and provides services for other organizations. There are three groups in the

center: the primary material preparation group, silicate ceramics group, and engineering ceramics group.

3) Research Center of Semiconductors

This center has three groups working on crystal glass, part production and material identification. These groups work on several projects like quartz, silicon, glass, production of electronic elements such as solar cells, infrared detectors, analysis of the structure of materials, electrochemistry and composite materials.

(11) Iranian Diesel Engine Manufacturing Co. (IDEM)

IDEM was established in 1966. The Iranian government and German Mercedes Benz Co.Ltd. have funded 70 % and 30% of its share capital respectively.

At first IDEM imported parts from Germany and assembled them into a diesel engine. Now 90 % of the parts it uses are national products except for injectors, electric parts and O-rings. IDEM is the largest manufacturer of a diesel engine in Iran whose share of the production is 95 %. The capacity of production line is 24,000 sets of engines per year, producing 5,000 sets of engines as well as parts last year.

It provides Iran Khodro, Shahab Khodro and Khavar with the products to be used for engines of heavy and light trucks, and of mini buses. The table below shows specifications and production of the main products.

Engine Type	Power	Fuel Consumption	Exhaust Emission [g/l-Fuel]			Production Quantity		Kind of car equiped with this engine	
	[HP]	[l/100km]	HC	CO	Nox	Quantity	Ratio[%]	Company	For Use
OM-314	85	28	12	48	62	62,759/ 28 years 76,766/ 28 years	50.0	Khavar Iran Khodro	Light truck Mini bus
OM-352	130	42	12	49	63	32,210/ 28 years Engine Parts	12.5	Khavar	Middle truck
OM-360	170	57	12	50	65	36,360/ until now 1,549/ until now	12.5	Iran Khodro Shahab Khodro	Bus Bus
OM-355	240	77	13	53	68	46,408/ until now 15,995/ until now	25.0	Khavar Khavar	Heavy truck Special heavy truck

Data Source: IDEM, 1996

IDEM is working for improvement of an engine through its own research and development center collaborating with universities. The recent main achievements are:

- Testing mini-buses and light trucks equipped with engines which converted their fuel to LPG from diesel oil, with technical cooperation of Mercedes Benz (Collaborative work with AQCC).
- Testing a supercharger with a built-in intercooler, based on current mass-produced engines.

3.2.4 Stationary Emissions Sources

According to the report issued by the United Nations, Tehran is one of the worst cities in terms of environmental pollution, especially air pollution. According to our estimation, contribution to air pollution in GTA by stationary emission sources is about 29%, while contribution by mobile emission sources is 71%. Effective measures to reduce air pollution in GTA, therefore, is to give priority to reduction of pollutants emitted by mobile sources.

Energy consumption of stationary emission sources, however, is anticipated to increase in the future due to progressive urbanization and industrialization in GTA. Consequently, immediate measures for reduction of pollutants emitted by stationary sources is believed to be critical.

(1) Current status of stationary emission sources

Among various kinds of energy sources, electricity and natural gas are regarded clean although electricity is not always clean due to power generation through thermal combustion. The table below shows energy consumption patterns in GTA and whole Iran estimated by our team.

Table 3.2.4-1: Energy-wise & sector-wise energy consumption pattern in GTA and Iran

(%)

Energy wise			Sector wise		
Item	GTA	Total Iran	Item	GTA	Total Iran
Electricity	8.5	5.6	Manufacturing	46.6	23.7
Natural gas/LPG	40.8	36.7	Commercial & Household	32.6	26.7
Fuel oil	43.9	51.7	Transport	11.4	17.9
Others	6.8	6.1	Energy Conversion	9.4	21.3
			Others		10.4
(Total)	100.0	100.0	(Total)	100.0	100.0

(Note) Projected by Project Team

As GTA consumes about 20% of the total energy consumption in Iran in 1994, while its shares of occupied land area and population are around 0.1% and 12% respectively, GTA is

one of the worst air-polluted areas in the world. Nevertheless, according to Table 3.2.4-1, administrative efforts of MOT can be noticed because the shares of clean energy consumption is much higher in GTA than those in total Iran, since the most effective way of environmental control by MOT is to convert energy sources to electricity and natural gas.

(2) Current measures for stationary air pollution control

The major procedures which MOT has currently conducted for stationary air pollution control in GTA are as follows.

- Energy source replacement with natural gas and electricity
- Conversion to low sulfur content fuels
- Hazardous factories relocation

1) Energy source replacement with natural gas and electricity

The energy source conversion to the cleaner energy sources like natural gas and electricity has been actively promoted in GTA leading to remarkable reduction of pollutants, especially SOx and SPM. The project for expansion of natural gas supply grids is under way in GTA.

2) Replacement with low sulfur content fuels

Proportional reduction of SOx emission is expected by reduction of sulfur content in fuels. The government announced in the middle of 1996 that the hydrodesulfurization units (HDS) would be constructed to protect environment under the Second Five Year Plan. The total reduction of SOx emission is estimated at 80,700 tons/year, of which contribution of Tehran refinery is 5,200 tons/year as illustrated in Table 3.2.4-2.

Table 3.2.4-2: HDS construction project in Iran

Refinery	Product Treated	Capacity (bbl/day)	SOx Reduction (ton/y)	Investment (US$ million)
Tehran	Kerosene	31,200	5,215	40
Isfahan	Kerosene	45,500	7,605	50
Abadan	Kerosene	62,000	10,363	60
Abadan	Gas Oil	80,000	57,496	85
(Total)		218,700	80,679	235

(Note) Sulfur reduction ratio of 90% is assumed (Source) AQCC

3) Hazardous factories relocation program

(a) Factory relocation program of GTA

Two big projects are underway under the industrial relocation program of GTA. One of them being promoted by ORSUITO on behalf of MOT involves 4 industrial estates, the other being developed by MOI involving 8 industrial estates. The site preparation of which is now under progress and in the near future some relocated workshops are expected to start operation. The outline of these estates are tabulated in Table 3.2.4-3 and 3.2.4-4 respectively, and their locations are in Figure 3.2.4-1.

(b) Reduction of pollutants by the relocation projects

In order to evaluate reduction of pollutants to be achieved by relocation of factories, the average emission of pollutants per factory or per worker is used, although more sophisticated projection will be made when detailed data of relocated factories become available.
As shown in Table 3.2.4-3 & 3.2.4-4, projected total reduction of 5 major pollutants in GTA is roughly evaluated at around 42,000 ton/year for each project, i.e. 84,000 ton/year in total, approx. 18% of total stationary emission volume in GTA on the assumption that all the projects be fully implemented as planned and also all relocated factories come from GTA.

(c) City planning for factory relocation program

The key factors for success of the projects are full provision of infrastructures including residential units for workers. According to the site survey, the following points need to be thoroughly incorporated in the program.

① Air pollution control measures of relocated factories will be necessary, without which the industrial estates will become another emission center of pollutants.

② Waste water treatment facilities, wherever appropriate need to be a central facility, since only a few waste water facilities are located in small and medium size factories in GTA.

③ Residential areas for workers need to be carefully planned to avoid slum formation.

Table 3.2.4-3 : Industrial estates under MOT in GTA area

	Name	Location	Sector	Area (ha)	Total Planned Number of Units	Unit Emission of Pollutants (ton/unit)	Total Emission of Pollutants (ton/year)
1	Khavaran	Khavaran Highway	(1) Heavy Machinery	50	870		
			(2) Timber Deals	40	910		
			(3) Building Steelwares	30	570		
			(4) Machine Products	20	300		
			(5) Administrative Facilities	10			
			(Sub-total)	150	2,650		
2	Junub (South)	Saveh Highway	(1) Aluminum Works	n.a	620		
			(2) Building Steelwares	n.a	600		
			(3) Metal Products	n.a	600		
			(4) Wood Products	n.a	800		
			(5) Vacancy	n.a	80		
			(Sub-total)	250	2,700		
3	Malekabad	Saveh Highway	(1) Havey Machineries Sales Shops	250	n.a		
4	Sangshahr (Stone City)	Behesht Zahra	(1) Stone Cutting Works	60	150		
			(2) Chemical Products	300	2,450		
			(3) Metal Products	300	2,450		
			(4) Vacancy	1,640	150		
			(Sub-total)	2,300	5,200		
			(Total)	2,950	10,550	4.11	43,361

(Source) ORSUITO

Table 3.2.4-4 : Industrial estates under MOI in Tehran province area

	Name	Location	Sector	Area (ha)	Total Planned Number of Workers	Contracted Area (ha)	Contracted Number of Unit	Unit Emission of Pollutant (ton/worker)	Total Emission of Pollutant (ton/year)
1	Eshtehard	3km west from Estehard	Food, Textile, Chemical, Plastic, Metal, Non-metal, Minerals	3,480	9,700	224	547		
2	Charmshahr	25km southwest from Varamine	Leather, Soap, Chemical, Textile, Plastic, Cleaning	670	9,900	218	521		
3	Sepidar	25km from Tehran, along Saveh Highway	Metal, Chemical, Textile, Leather, Plastic	125	n.a.	n.a.	n.a.		
4	Salafchakan	3km North from from Salafchakan Cross Road	Textile, Paper, Non-metal, Metal, Chemicals, Tissue, Stone Cutting	294	200	6	10		
5	Shamsabad	50km from Tehran, along Qom Highway	House/Car, Ceramic, Glass, Moulding, Mosaic, Grinding, Stone Cutting, Wood, Brick	2,890	18,100	431	1,002		
6	Abbasabad	46km from Tehran, along Semnan Road	Rubber, Car, Metal, Plastic, Wood, Clothes, Food	1,020	4,200	102	380		
7	Aliabad	51km from Tehran, along Semnan Road	Crystal, Metal, Food, Electric Plating	360	8,800	208	938		
8	Lia	15km from Ghazuin Boieenzahra Road	Textile, Metal, Electronics, Food, Non-metal, Chemical	150	4,600	96	148		
			(Total)	8,989	55,500	1,285	3,546	0.75	41,625

(Source) MOI

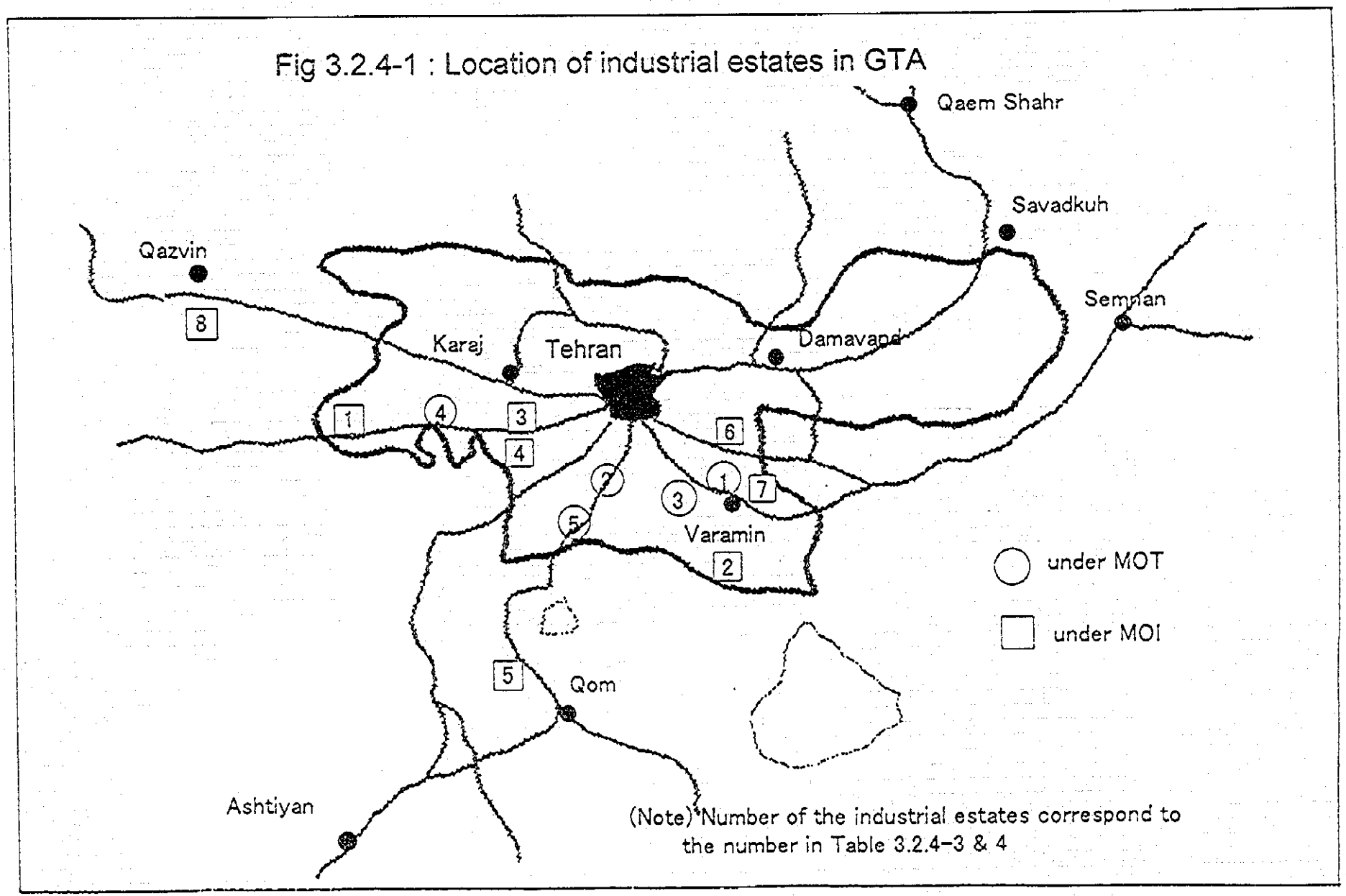


Fig 3.2.4-1 : Location of industrial estates in GTA
Qaem Shahr
Savadkuh
Qazvin
Semnan
Karaj
Tehran
Damavand
Varamin
Qom
Ashtiyan
under MOT
under MOI
(Note) Number of the industrial estates correspond to the number in Table 3.2.4-3 & 4

Table 3.2.4-5 : Data base for projection of pollutant emission by industrial estates

(ton/year)

Sector	Emission of Pollutants in GTA						No. of Unit of GTA	No. of Worker of GTA	per unit	per worker
	SOx	NOx	CO	HC	SPM	(Total)				
31	21,242	8,275	3,577	534	3,059	36,687	6927	42,399	5.30	0.87
32	8,118	2,921	4,516	278	888	16,721	24779	99,400	0.67	0.17
33	979	301	994	52	113	2,439	4099	9,920	0.60	0.25
34	3,627	1,473	1,823	80	424	7,427	2436	17,899	3.05	0.41
35	12,379	6,148	7,262	324	1,686	27,799	2951	42,311	9.42	0.66
36	83,776	15,430	6,688	774	5,461	112,129	1720	24,748	65.19	4.53
37	19,252	13,402	7,145	327	2,720	42,846	964	11,121	44.45	3.85
38	6,348	3,223	10,984	536	956	22,047	19162	120,490	1.15	0.18
39	12,553	5,367	4,549	42	1,595	24,106	7948	23,512	3.03	1.03
(Total)	167,923	56,541	47,533	2,948	16,966	291,916	70,986	391,800	4.11	0.75
per unit	2.37	0.80	0.67	0.04	0.24	4.11				
pet worker	0.43	0.14	0.12	0.01	0.04	0.75				

3.3 Present situation of sub-sector relating to the air pollution

3.3.1 Transportation and traffic

(1) The number of vehicles and the traffic volume

While some statistics of MOT' are available, the numbers of registered vehicles and in-use vehicles vary depending on a source of data. According to AQCC, the following numbers (Table 3.3.1-1 and Table 3.3.1-2) are most reliable.

Table. 3.3.1-1 Numbers of registered vehicles classified by car type and age

	Passenger Car	Van	Mini Bus	Bus	Mini Truck	Truck	Total
1967-1971	83,970	25,992	2,743	5,679	1,823	13,514	133,721
1972-1976	225,020	76,109	5,010	2,920	1,230	12,768	323,057
1977-1981	199,269	52,286	4,643	2,917	219	13,758	273,122
1982-1986	98,979	33,627	1,450	1,586	57	10,880	146,579
1987-1991	46,487	13,068	3,893	852	50	6,945	71,295
1991	4,375	-----	3,265	1,330	150	5,422	14,542
1992	230,398	15,056	3,786	1,331	552	32,704	283,827
1993	73,168	-----	-----	-----	-----	-----	73,168
1994	56,877	-----	-----	-----	-----	-----	56,877
Total	1,018,543	216,138	24,790	16,645	4,081	95,991	1,376,188

Source : The center for Computer Service, Municipality of Tehran

Though there is a slight difference in numbers between Table 3.3.1-1 and Table 3.3.1-2 because of different classification of vehicles, the total numbers of vehicles are almost equal.

Figure 3.3.1-1 shows the number of vehicles in each district in accordance with Table 3.3.1-2, illustrating that the districts 1 to 5 in the north part of the city, and the districts 14 and 15 in the southeast part of the city have a large number of vehicles, because these districts are heavily populated residential areas.

Table 3.3.1-3 shows the number of trips within each district, the average number of trips per head and the number of vehicles. Figure 3.3.1-2 illustrates the number of trips within each district. The number of trips in the districts, where the populations are large, is relatively high, as compared with the number of trips in

less populated.

The government offices of Tehran and places of business are concentrated in districts 10, 11 and 12. Fleets of vehicles heading for the center of the city, especially from the north and the southeast contribute to the increased volume of traffic.

Table 3.3.1-2 Distribution of vehicle fleet in Municipality of Teheran

Type / District	Bicycle	Motor Cycle	Passenger Car	Taxi *	Van	MiniBus	Bus	Mini Truck	Truck	Other	Total
1	9,063	6,098	52,465	1,676	3,428	1,012	459	177	339	1,073	75,790
2	15,537	9,933	72,215	2,720	4,957	763	595	235	894	1,038	108,887
3	13,066	5,670	58,698	946	3,001	495	421	61	162	669	83,189
4	15,401	19,331	66,479	3,558	9,526	2,080	1,978	707	1,510	1,660	122,230
5	11,372	10,031	52,304	2,424	5,911	1,680	1,431	365	1,269	1,858	88,645
6	9,619	6,338	49,394	951	2,644	203	356	226	429	738	70,898
7	8,482	12,060	34,416	2,332	2,871	555	1,066	294	495	1,032	63,603
8	8,405	14,834	38,641	2,605	5,099	782	574	106	681	1,528	73,255
9	7,728	9,971	23,763	2,079	3,690	928	1,103	270	1,139	1,086	51,757
10	5,461	15,274	21,222	2,007	3,409	671	673	114	543	509	49,883
11	5,620	13,091	19,724	2,051	2,445	367	726	345	315	312	44,996
12	6,986	18,671	17,420	1,646	3,666	463	753	286	556	1,039	51,486
13	5,764	10,730	21,753	1,177	1,794	329	1,249	200	185	446	43,627
14	9,948	30,885	34,314	4,105	5,714	747	1,632	404	844	1,195	89,788
15	10,092	34,335	30,330	3,040	9,905	2,606	1,554	746	1,689	1,667	95,964
16	5,908	16,247	15,849	1,300	4,597	1,110	520	172	778	821	47,302
17	5,424	16,522	16,263	1,812	4,337	889	546	205	675	1,225	47,898
18	6,909	14,194	16,015	1,259	5,844	1,050	612	629	872	636	48,020
19	3,467	10,927	12,016	847	4,048	371	388	220	679	1,360	34,323
20	11,163	16,505	19,549	2,514	6,023	1,073	854	438	2,005	714	60,838
Total	175,415	291,647	672,830	41,049	92,909	18,174	17,490	6,200	16,059	20,606	1,352,379

Data Source: AQCC, based on 1994
Note : Taxi includes Private and Agencies cars

Table 3.3.1-3 Distribution of trips and statistics in MOT

District No.	Number of Trips (Passenger Cars)	Number of Trips (All kind of Cars)
1	189,078	525,939
2	293,644	822,182
3	175,112	488,372
4	357,744	999,284
5	240,645	676,208
6	179,051	503,292
7	167,592	470,125
8	198,747	558,140
9	146,822	410,018
10	148,612	417,531
11	124,620	344,544
12	121,038	341,324
13	101,701	287,657
14	219,158	617,174
15	261,773	738,462
16	136,079	377,818
17	132,498	370,304
18	139,660	387,478
19	117,099	326,297
20	155,774	438,998
Total	3,606,446	10,101,145
Average	180,322	505,057

District No.	Number of Vehicle (All kind of Cars)	Population (Estimate of 1994)	Number of trips of each person	Population / Number of Cars
1	75,790	269,000	2.0	3.5
2	108,887	383,000	2.1	3.5
3	83,189	241,000	2.0	2.9
4	122,230	593,000	1.7	4.9
5	88,645	425,000	1.6	4.8
6	70,898	270,000	1.9	3.8
7	63,603	302,000	1.6	4.7
8	73,255	368,000	1.5	5.0
9	51,757	263,000	1.6	5.1
10	49,883	318,000	1.3	6.4
11	44,996	256,000	1.3	5.7
12	51,486	265,000	1.3	5.1
13	43,627	201,000	1.4	4.6
14	89,788	435,000	1.4	4.8
15	95,964	613,000	1.2	6.4
16	47,302	346,000	1.1	7.3
17	47,898	355,000	1.0	7.4
18	48,020	369,000	1.1	7.7
19	34,323	273,000	1.2	8.0
20	60,838	366,000	1.2	6.0
Total	1,352,379	6,912,000	-	-
Average	-	-	1.5	5.1

Data Source: AQCC, based on 1994

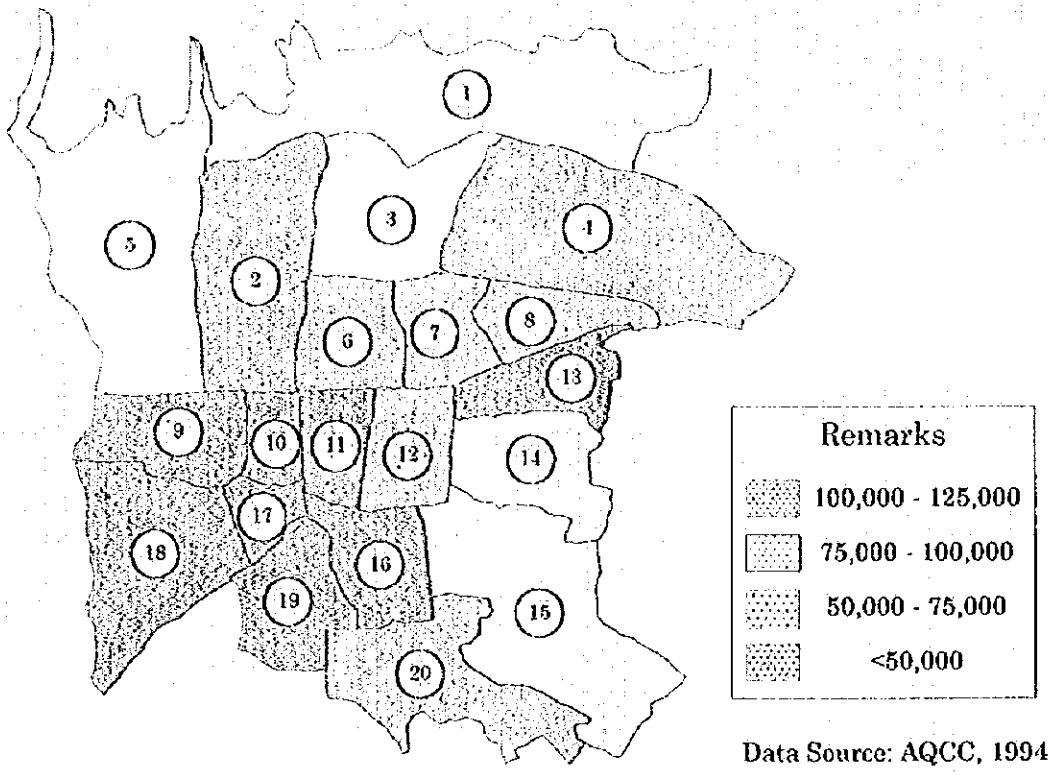


Fig. 3.3.1-1 Distribution of vehicle fleet in MOT

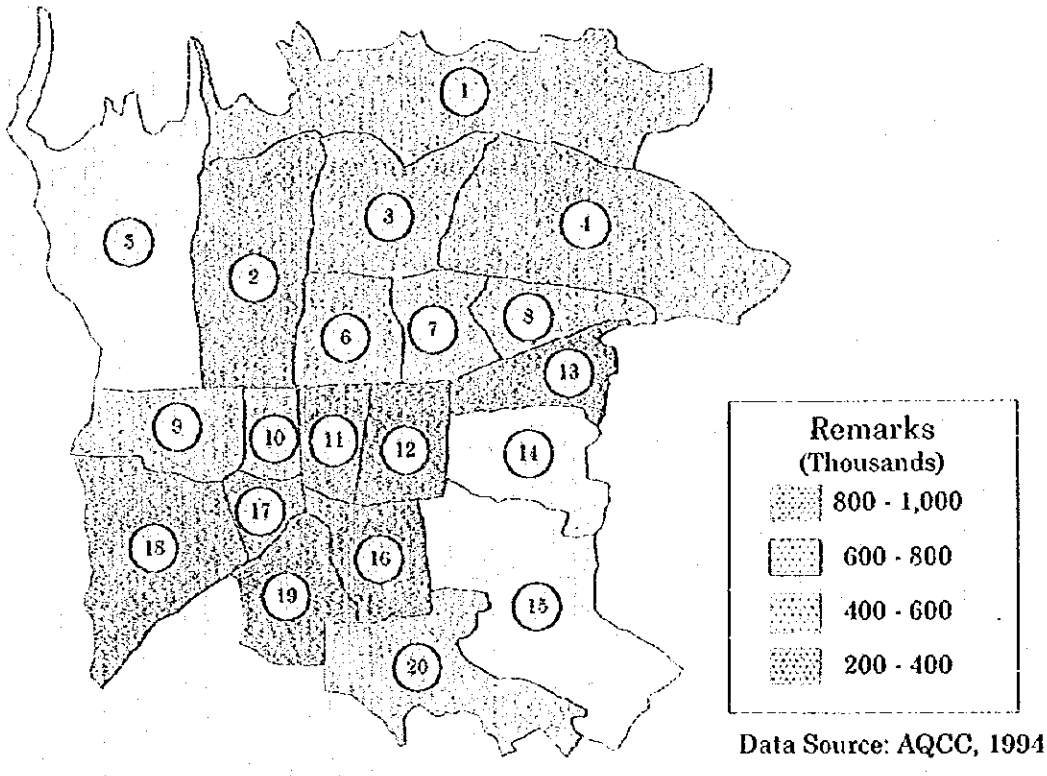
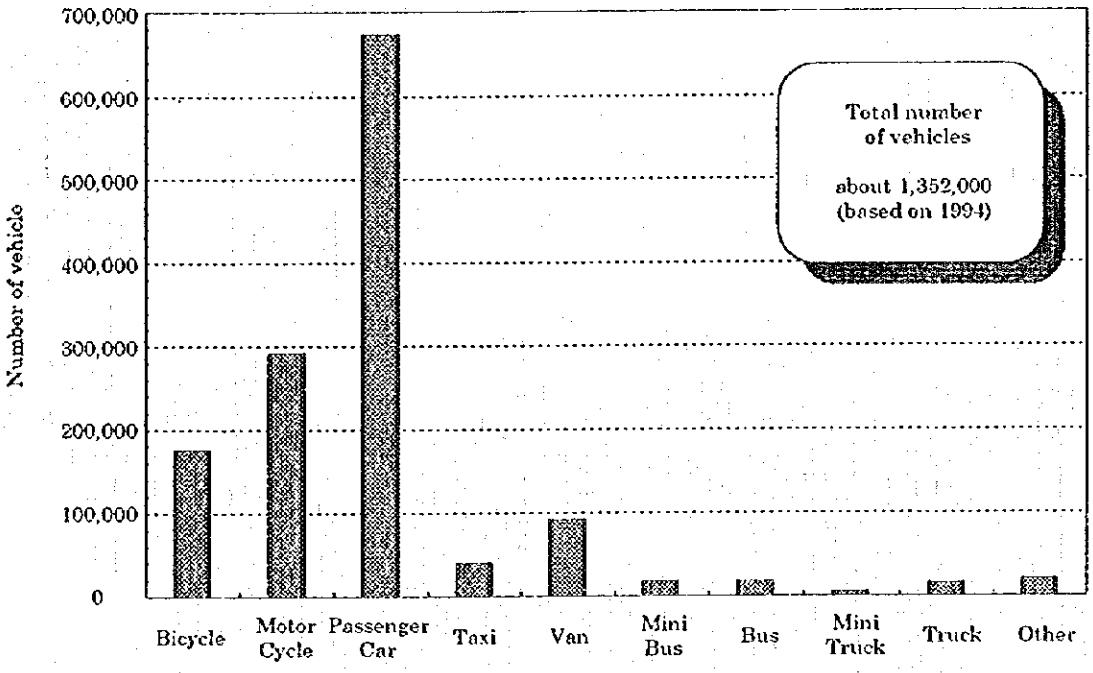


Fig. 3.3.1-2 Distribution of trips in MOT

Figure 3.3.1-3 shows the number of vehicles of each type. Passenger cars prominently number as many as 670,000 (50%) and motorcycles 300,000 (22%). The number of buses, mini-buses and taxis categorized as public transportation totaled 77,000 (5.6 %).



Note: Recent private passenger cars number goes up to 790,000 in 1997
Data Source : AQCC

Fig. 3.3.1-3 Distribution of vehicle classified by type

(2) Age of vehicle

Figure 3.3.1-4 shows the number of vehicles in MOT classified according to the age. Vehicles aged from 16 to 22 form a large part of the total and the average age is 15.9.

Paykan, the national cars, holds 50 % share, of which vehicles aged 10 years or more hold an average of more than 60 % share, and the vehicles aged less than 10 years drop to 35 %.

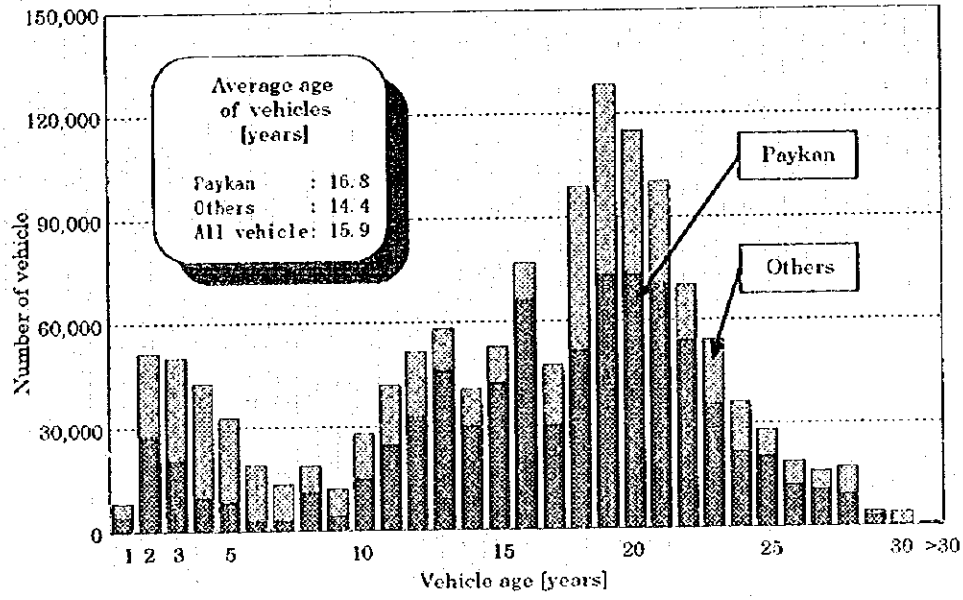


Fig. 3.3.1-4 Distribution of vehicle age

(3) Traffic control and surveillance center and traffic signal system

The Traffic Control and Surveillance Center controls the network of roads, setting TV cameras at 50 main intersections, monitoring 18 screens and remote-controlling them in the center (Figure 3.3.1-5). Traffic information is aired on the radio every 15 minutes by the center and urgent information like traffic accidents and other emergencies are reported through radio to the proper authorities, like police and UBC.

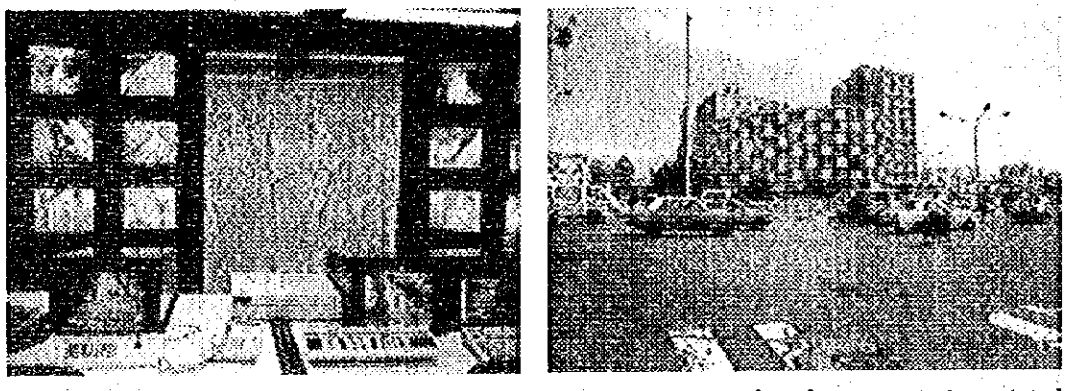


Fig. 3.3.1-5 TTCC operation room (left) and an example of camera sites (right)

Traffic signals can be controlled on the basis of collected information using traffic volume measuring sensors (16 spots) and built-in sensors on roads called AADT system. To meet heavy traffic conditions on streets and at intersections, however, police officers often control the lighting system of signals or control traffic directly. Currently, the TTCC Signal Division is studying to automate and optimize the lighting system of traffic signals. As TTTO also plans to improve facilities at intersections, the situations will hopefully be better in future.

(4) Intersections and squares

The traffic in Tehran is considerably heavy especially on trunk roads, during morning and evening commuting hours, and during night hours on holidays.
Traffic flow would never be smooth without police officers' control particularly at busy intersections and squares. As MOT mentions the congestion at intersections and squares as one of the causes of traffic jam, TTTO and TTCC are implementing reforming plans. According to their plans, 500 intersections and squares needing improvement were listed, among which 150 were selected as policy targets in accordance with field investigations. The two authorities are in the process of giving suggestion for improvement to the branch offices in each district in MOT.

(5) Traffic regulation

Traffics have been regulated by setting up a restricted area in the city, with seven-time alterations in the sphere and the duration. The current restricted area mainly consists of the Tehran Bazar site, the market of automobile parts and the site of the Ministry of Finance, covering 23 km^2, while the effective hours are from 6 a.m. to 5 p.m. during weekdays. The restricted zone is closed to vehicles except for vehicles for public use, colored taxis registered at the Taxi Organization and ambulances.

When vehicles enter into this area, they need to have the permission stickers. Within the zone, only pedestrians are permitted to enter into the area around the Central post office and the Foreign Ministry. Although there is no plan for expanding the current restricted area, expansion could be made in areas in northern and eastern parts of the current zone.

(6) Park and ride and terminal facilities

The municipal authorities are making efforts to control traffics entering into the city from the suburbs. One of the measures is to encourage accessing to the city via park and rides located at the circumference of the city. The City of Tehran has four big park and rides in the east, west, south and north parts, facilitating transits of public buses, taxies and private cars connecting the City and suburbs.
Consequently, the park and rides in the city provide terminal facilities and parking as well as traffic junctions. The buses of United Bus Company (UBC) transport passengers between the park and rides and terminal facilities and main places in the city including Enghelab Square, Imam Khomeini Square and Valiasr Junction.

1) South Park and Ride

It occupies 3 ha on the Besat Street, whose average number of users per day is 12,000. The most frequently used transportation are 35 lines of UBC and taxis between Tehran and Ghom. Next to the park and ride is the 17ha two storied South

terminal, which holds 1,500 vehicles and is used by 75,000 passengers per day. Its annual income amounts to 3.5 billion rials, of which 70 to 80 % is spent on maintenance of the facilities. The South terminal will be expanded to 23 ha in the future.

2) West Park and Ride

It occupies a 2.2 ha area on the Azadi Square, whose average number of users per day is 35,000 commuting from the Karaj city. Next to it is the 55ha West terminal, which has a lounge and a fuel station and is used by 22,000 passengers per day as the terminal station of 1,150 buses. Most of the monthly income of 220 million rials is spent on maintenance of the facilities.

3) East Terminal

It is located at the intersection where the Damavand Street and the Sorkhesar Street cross, covering the area of 3.2 ha. Although this is not a park and ride, the terminal holds 349 buses, 303 mini-buses and 227 other vehicles. MOT announced that the site would be expanded by 26.8 ha with a five storied building and a parking place of 4 ha within five years.

4) Beyhaghi Park and Ride

This park and ride is adjacent to the Arjantin Square located in the northern part of the city. It is mainly used by the UBC buses and mini buses and the average number of users reaches 15,000 per day. The parking fee is 500 rials for the first one-hour and 250 rials for every following hour. (1996)

(7) Parking

The City has a large number of public and private parking facilities, besides park and rides and terminals. Figure 3.3.1-6 shows where parking places are located in the main part of the city. According to the Parking and Parkometer Bureau belonging to TTTO, the number of parking places is 252 and the total area is 53ha, holding over 20,000 vehicles, so that 2 % of all the vehicles registered at the municipality can find parking places in the City.

The parking fees vary depending on types of vehicles or parking duration as shown in Table 3.3.1-4. Detailed data by TTTO related to parking spaces are referenced in Table 3.3.1,3.3.2 in a supporting report.

Table 3.3.1-4 Parking fee in different area

Parking fee in Restricted Area (No Roof)

Type	Entrance	Hourly Fee (6 a.m to 8 p.m)	Hourly Fee (8 p.m to 6 a.m)
Private, Van	500	250	100
Mini bus	600	250	100
Bus-Truck	1,000	300	150
Large truck	1,500	500	300
Motor Cycle	150	100	50

Parking fee out of Restricted Area (No Roof)

Type	Entrance	Hourly Fee (6 a.m to 8 p.m)	Hourly Fee (8 p.m to 6 a.m)
Private, Van	500	250	100
Mini bus	600	250	100
Bus-Truck and Large Truck	1,000	300	150
Motor Cycle	150	100	50

Parking fee out of Restricted Area (with Roof)

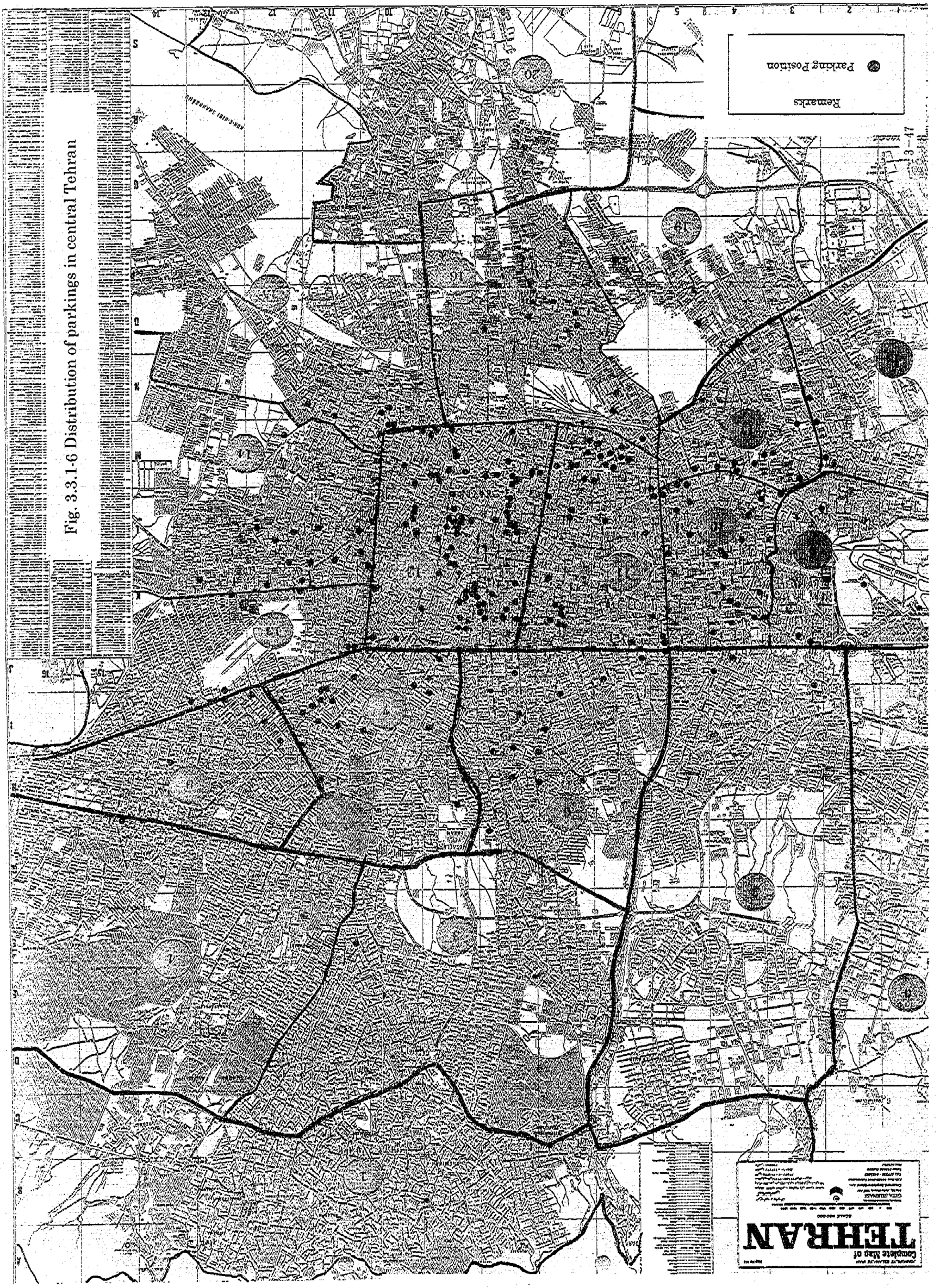
Type	Entrance	Hourly Fee (6 a.m to 8 p.m)	Hourly Fee (8 p.m to 6 a.m)
Private, Van	700	300	150
Motor Cycle	200	150	100

Parking fee in Restricted Area (with Roof)

Type	Entrance	Hourly Fee (6 a.m to 8 p.m)	Hourly Fee (8 p.m to 6 a.m)
Private, Van	700	300	150
Motor Cycle	200	150	100

Data Source: TTTO,1996

Fig. 3.3.1-6 Distribution of parkings in central Tehran



(8) Public bus

In Tehran buses and mini buses play a major role in public transportation, because only few railway networks are available. The United Bus Company of Tehran (UBC) supervises operations of public buses, mini-buses and trolley buses. The number of users of these buses is said to be more than 4 millions per day.

As for types of buses, the number of Benz302 is 2,000, the largest, and others are Benz305, Leyland (a double-decker), Ikarus280 (an articulated bus), Volvo, Skoda15-Tr (an articulated trolley bus) and so on. The number of buses in use is 4,000.

The average age of buses is about 11 years, while that of the Benz302 type buses, which are the largest in number, is 12.3 years. The record of the types of buses introduced in the last 3 years reveals increasing trend of Ikarus and Volvo.

UBC administrates and manages operations of about 4,000 public buses by dividing the city of Tehran into six sectors. Figure 3.3.1-7 shows how the bus system of the MOT works.

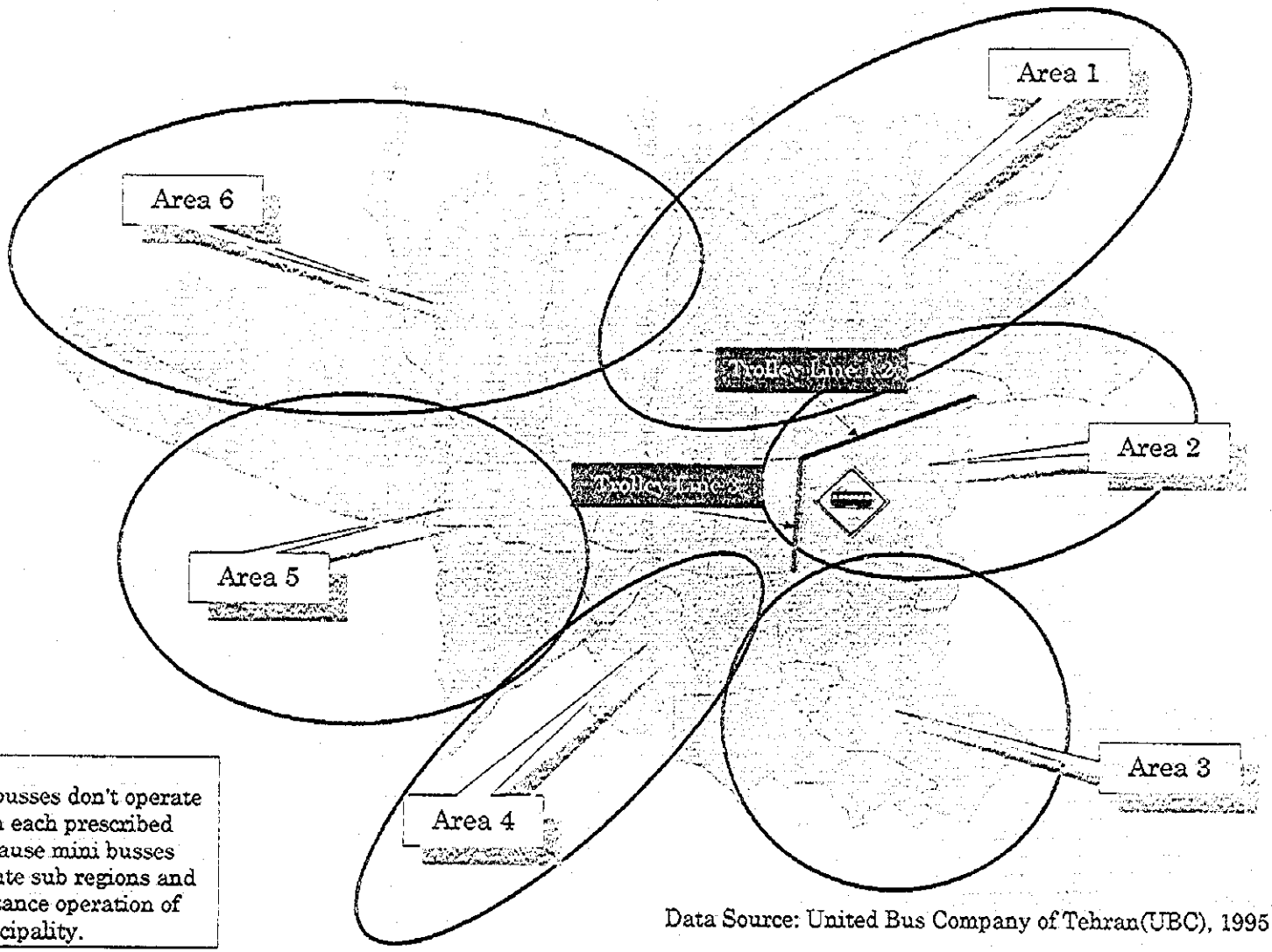
Mini buses run between bus terminals functioning as major junctions and rural/suburban regions within the Greater Tehran Area. The shares of the mini-buses running in the urban area of 20 districts in the City is 10 to 15 % of all the transportation, while 80 to 90 % of mini-buses are operated in suburban of the municipality.

The trolley buses (electric cars) run on the Damavand Street in the east of Tehran under the two systems called Line 1 and Line 2. The total distance of the route is 15 km. As for Line 3, MOT announced that the opening plan was in process of realization on 6km the Hefdan-E-Shahrivar Street. (And in operation since 1997)

The bus fares are set according to distance, and the first fare stage is 50 or 100 rials for ordinary buses, 200 rials for shuttle buses.

There is neither commuters' ticket system nor a discount ticket system.

Fig. 3.3.1-7 UBC bus(mini bus) and trolley bus operation area in Tehran



Note:
Mini busses don't operate always in each prescribed area, because mini busses can operate sub regions and long- distance operation of the Municipality.

Data Source: United Bus Company of Tehran(UBC), 1995

(9) Taxi

About 25,000 taxis run in the City of Tehran, registered at the Taxi Organization and classified into four types: orange-colored band taxis can go everywhere in the city; gray-colored band taxis named "telephone taxi" run in response to customers' telephone calls; green-colored band taxis called "airport taxi" service customers on the airport site; and blue-colored band taxis called "line service taxi" run along fixed routes.

In addition to the four types, there are a large number of unlicensed taxies operated privately, which also play a substantial role.

Orange-colored band taxis and owner-taxis have no limits on the area of operation, and can take one or more customers at a time, who can get on and off at any major intersections or buildings anytime, paying only for their own dues. Fares depend on the distance, and average about 300 rials. These taxis are mainly used by people who travel relatively short distance.

Because of the availability of private taxis in a large number, should they be used more often instead of passenger's own cars, the traffic volume in the city would be greatly reduced.

The capacity of taxis is 26% (by Taxi Organization, 1995) of all the transportation in the city. Of the taxis registered at the Taxi Organization, all Hyundai and Renault and part of Paykan and Peugeot are dual mode cars that can use both gasoline and LPG so that contribution to air pollution may be lowered. MOT announced that all new taxis would be of dual mode.

(10) Subway (Tehran Metro)

The plan of the Tehran subway system was made in 1986, since when the responsibility has been passed to the Tehran Urban and Suburban Railway Company. At present the plan is about to be executed. Figure 3.3.1-8 shows the contents of the plan including the planned routes of the Tehran subway.

The Master Plan of the MOT includes construction of four subway lines.
Now the construction of Line 1 and Line 2 are going ahead.
Line 1 will run from north to south between the Shahid Haghani Expressway and Behesht Zahra, a distance of 34.2 km, where 22 stations will be constructed and 22 trains will be operated.
Line 2 will run from east to west between Dardasht and Sadeghieh, a distance of 20.3 km with 21 stations and 11 trains. The trains of Line 2 will run on the ground from Sadeghieh situated in the west part of the city to Karaj, a satellite city of Tehran, and the total length of the line will be 41.5 km.
Construction of Line 3 and Line 4, is also planned but MOT Master Plan gives priority to constructing the Metro Ring which is to circulate the city.

The municipal authorities have released the information about the general characteristics of the capacity of subways as follows:

The transport capability of Tehran Metro

Capacity of each car	:	186	Persons
Number of cars in each train	:	7	
Capacity of each train	:	1,300	Persons
Headway between trains	:	4	Minutes

When the subway becomes operational, 1.5 to 3 million trips are likely to be diverted to the subway.

In addition to the current plan, the Tehran Metro plans another 8 lines,

aiming at making the subway major means of public transport in Tehran.
However, it is said that 8-subway construction is not likely to materialize all in the future.

(11) Railway

According to the operations report published by Islamic Iranian Republic Railways, the total length of the railway in Iran is about 5,400 km, but about 200 km, not counting the length of the subways in a Greater Tehran.

The total number of trains operated in Greater Tehran is about 100 per day. The share of each transport in the total transport system is as follows:

- Road : 87.5 %
- Railway : 12.4 %
- Plane : 0.1 %

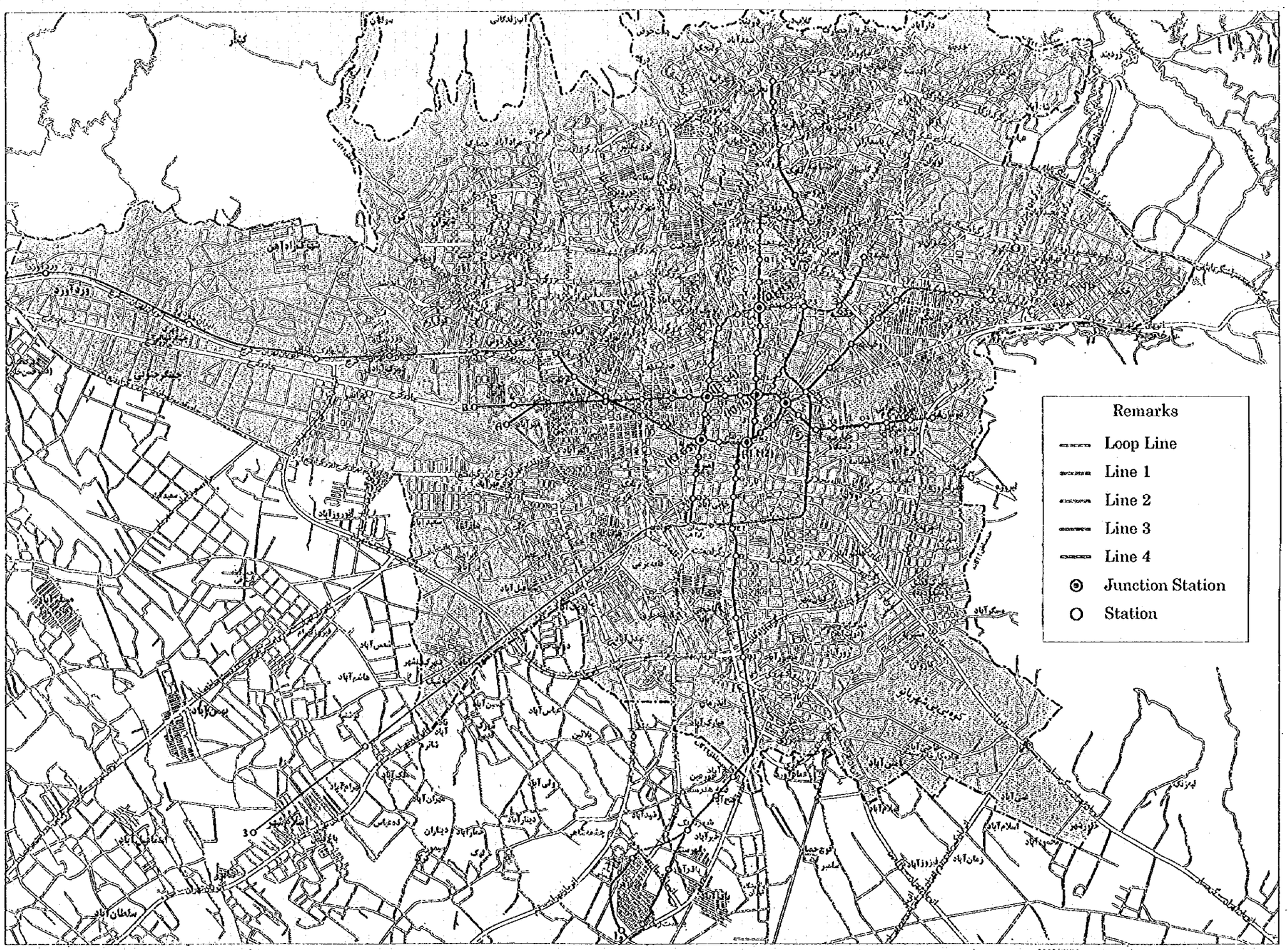


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Fig. 3.3.1-8 The route line of Tehran subway