

## 2-3 Survey of Leakage

The public water supply service in Sharqiya Governorate is divided into three systems, that is, a) City-Owned, b) Housing Department's and c) Abbasa Regional Water Supply System. The three systems are controlled and managed separately at present and, following the above order, the leakage survey will be reported for each.

### 2-3-1 City-Owned Systems

The city-owned systems vary in size differ in composition in two ways: one is composed of surface and/or groundwater source, treatment (only for surface water) and distribution/service facilities and another is of only distribution/service facility. The latter cities are supplied treated water from Abbasa Regional Water Supply System.

Zagazig City's system, belonging to the former category, was selected for the leakage survey as it represents the city-owned systems in the following manner:

- a) It is the oldest one in the area, developed in the pre-war days,
- b) It was the prototype, more or less taken after by the other systems,
- c) Data necessitated for the survey are better prepared

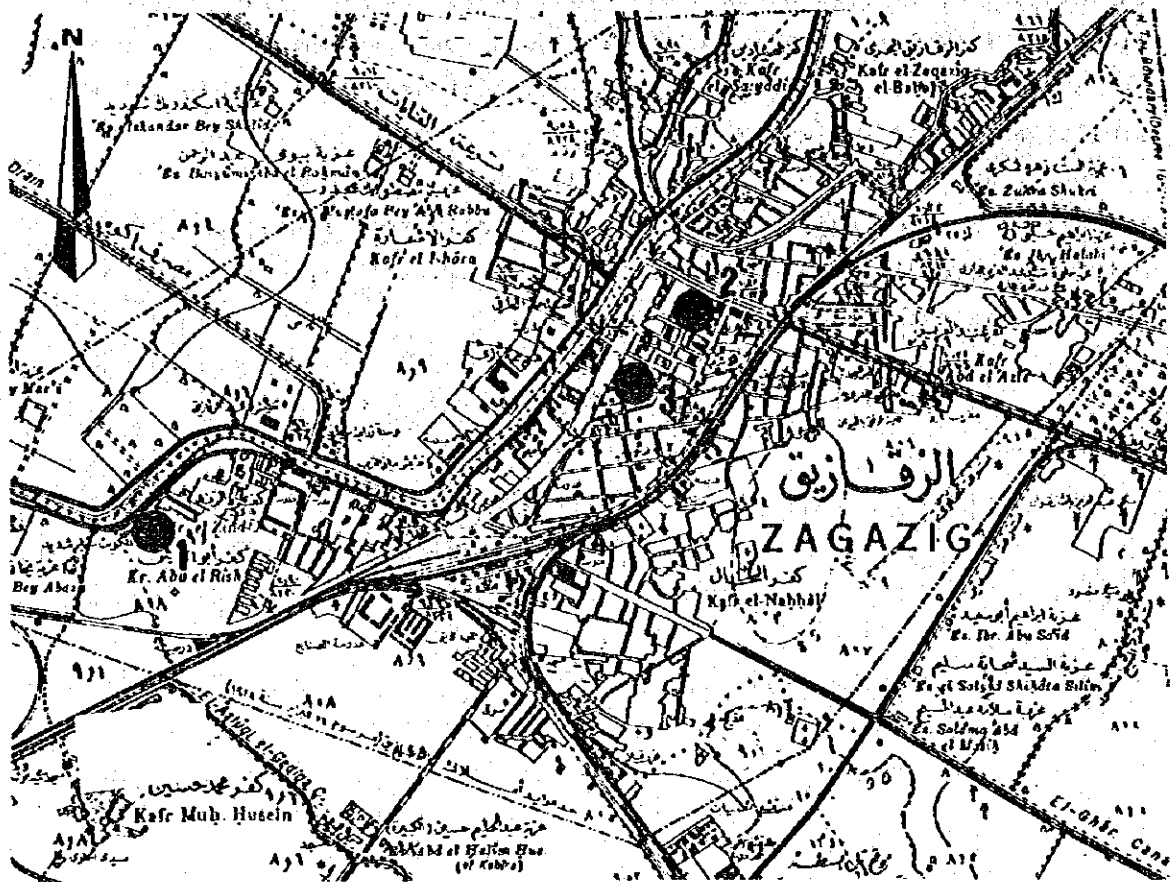
#### 1) Selection of Survey Sites

A meeting for selecting the survey sites for the city was held on June 2 (Sat) at Zagazig Municipal Office, attended by the city's engineers and Study Team staff members. At first, two area, Kafr El-eshara and Midan Montaza, were selected and later El-Falaha was added to the two.

Kafr El-Eshara, a typical residential area closely located to the central part of the city, has been supplied water since the days of system's foundation, about 50 years ago.

Midan Montaza is an area in the commercial center of the city and all buildings are, like in other commercial areas, used dually, the ground floor for retail shops and the other floors for residences. As the area is more prosperous, the buildings are comparatively bigger than in other similar areas.

El-Falaha, located adjacent to Midan Montaza in the fringe part of the city's commercial center, is also oriented commercially. The size of buildings is rather smaller, however.



Scale 1:25,000

ZAGAZIG CITY OWNED SYSTEM  
**1: KAFR EL ESHARA**

ZAGAZIG CITY OWNED SYSTEM  
**2: MIDAN MONTAZA**

ZAGAZIG CITY OWNED SYSTEM  
**3: EL FARAKHA STREET**

Fig-5 LOCATION OF SURVEY SITES

2) Survey at Kafr El-Eshara

About 70 % of the area is occupied by old, reinforced concrete-made, about 5 stories high, residential buildings, while the rest, 30 % of it, by newly constructed apartment houses by the municipality, and a public school.

Regarding the living standards, the old buildings' dwellers seems to be in a better position generally than the new buildings' dwellers. The old buildings are usually equipped with 5 to 10 water (Fig-6) taps and the new ones with about 4 taps. All households are supplied individually as mentioned before and the whole area has one fire hydrant and no standpipe. The features are:

No. of connections : 273, steel pipe of 10 to 13 mm diameter  
No. of buildings : 43  
Public pipeline : 100 mm dia. cast iron pipe of 160 m long and 75 to 100 mm dia. asbestos cement pipe of 260 m long

Survey Schedule

The schedule was drafted and amended taking into account advice of the municipal engineers before being finalized as shown below:

5 June (Thu.) Preparation of drawing of survey site,  
6 June (Fri.) Adjustment and correction of the drawing at the site,  
9 June (Sun.) Excavation of valves, saddles and meter pit,  
10 June (Mon.) - do -  
11 June (Tue.) Preliminary leakage survey in the midnight,  
12 June (Wed.) Water flow observation from 11 a.m. to 11 a.m. the next day (24 hours), and  
13 June (Thu.) Water flow observation under all taps closed condition

### Preparation and Correction of Drawings

The survey site's pipeline maps were supposed to be made from the ledger of the water supply system at the beginning. However, it was found that almost all records were missing and maintenance works were being carried out, mostly depending on the memories of personnel concerned. The leakage survey maps were eventually made using the maps of Cable Installation Works of Telecommunication System which was undertaken last year.

Corrections were made on the prepared maps under cooperation of the municipal engineers and they were checked of accuracy of the pipes location, material and size and other features at the survey site. For the work several observation pits were dug along the pipelines. Necessary corrections were made on the spots.

### Preliminary Leakage Survey

Several pits were excavated for observing the present conditions of branching house connections from the mains, using saddles. No leakage was found and it proved a good workmanship.

Stethoscopes, leak detectors (by sound) and box locators (by magnetic field) were used, prior to the preliminary survey, to locate the pipelines, valve boxes, points of branch connections and detectable leakage spots.

The preliminary survey started at midnight on June 11. Stethoscopes and leak detectors operated by the municipal personnel caught a remarkable sound at two spots, but the exact location and the cause of sound, leakage or strong current of normal flow, was not identified.

### Water Flow Observation

A pit was dug along the main for installing the flow meter and the municipal engineers prepared an electricity line for the meter and illumination.

The water flow was measured from 11 a.m. on June 12 to 11 a.m. next day for 24 hours as scheduled, under cooperation of the municipal engineer and staff. The meter pit and three water pressure observation points were located as shown in Fig-7. Fig-8 shows the survey results.

As the end of this survey, a trial of complete water uses stop was conducted from 11 a.m. to 11:30 a.m. on June 13. For the trial, the loudspeaker announcement and the municipal personnels' checking of every household were employed. The flow started to decrease gradually until it levelled off around 11:30 a.m.

The lessons learnt in such operation were:

- a) Despite the warning, the people seemed to use water during the designated hours and the complete control was found to be very difficult, and
- b) The only possible means of checking it was by detecting sounds of water flow.

To improve the situation, the following steps were taken:

- a) To ensure the water uses stoppage, the loudspeakers of nearby mosques were used for broad casting the warning,
- b) Leaflets were distributed to the consumers,
- c) The municipal personnel were sent to the households for inspection,
- d) The survey area was reduced in size, to make the personnel's inspection easy and assured

After the levelling off, the flow was still substantial and unidentified leakage was suspected. The JICA study members, remembering that sound had been detected during the preliminary survey, tracked the route and found a leakage at a corner of the school's playground. A 2 inch steel pipe, rising above ground and supplying water to the gymnasium of school, was leaking heavily at the downstream valve of water meter. The leaking water was scouring the ground and spilling widely over the playground. Without doubt, it caused the sound detected previously.

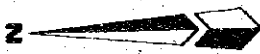
As there was another valve installed on the upstream side of the leaking spot, it was immediately closed and the flow meter responded, showing reduction of flow. Opening and closing the valve, the leakage could be measured.

Fig-8 shows the result of 24 hours' flow measurement, the flow including the above mentioned leakage. Contrary to the anticipation, the supply pressure increases together with the flow rate for some part of the day and the possible reasons was that the number of pumps in operation was increased to catch up the demand and this area, located close to the pumping station, was affected by its directly.





Fig-9 shows the response of the flow rate on open and closing of the valve upstreams of the leakage point. The leakage, caused by a broken valve installed downstreams of a water meter, amounted to about 2.0 liters/sec. as calculated from it.







Scale 1:1,000

- LEGEND**
-  : Point where pressure was measured
  -  : Mosque
  -  : Distribution pipeline and pipe diameter
  -  : Building

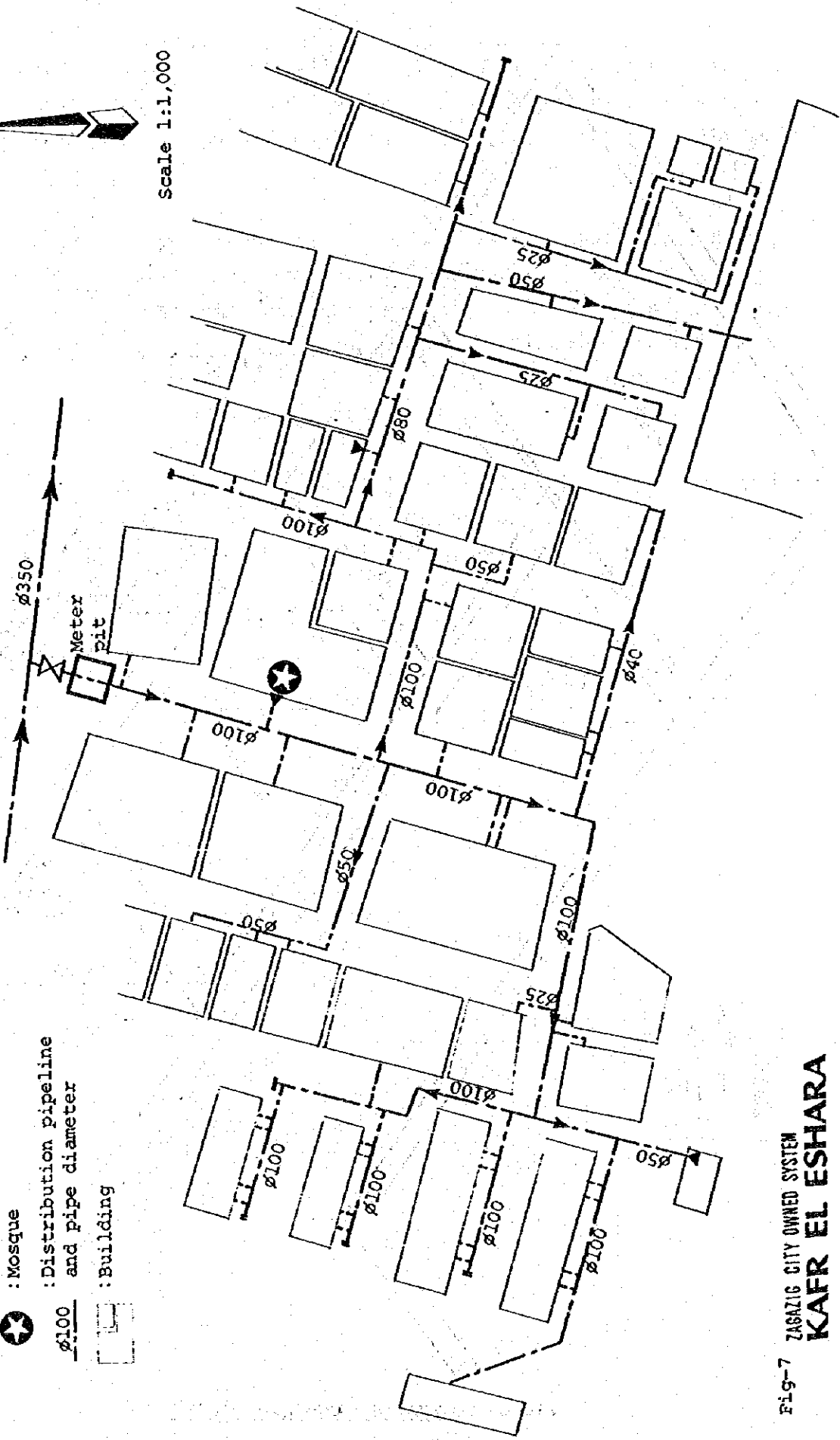


Fig-7 ZAGAZIG CITY OWNED SYSTEM  
**KAFR EL ESHARA**

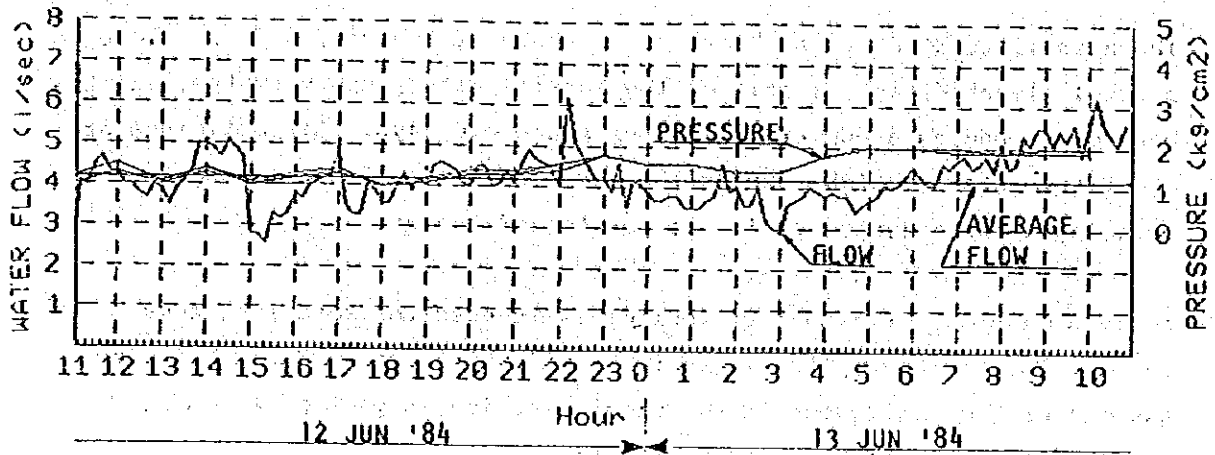
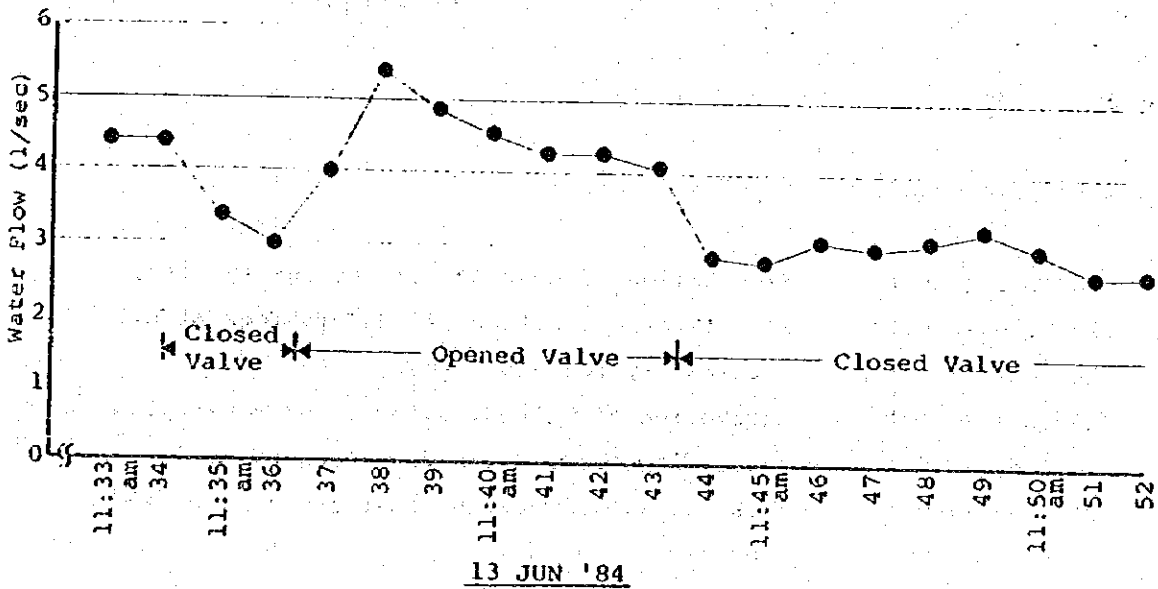


Fig-8 WATER FLOW AND PRESSURE

Fig-9 WATER FLOW UNDER CLOSED TAPS



3) Survey at Midan Montaza Area

The area is located at the heart of downtown of the city. It is close to a steel elevated tank, a part of the initial water supply system, and has been developed as a commercial center since old days. All buildings are about five stories high, except the three storied police headquarter building which occupies a sizable portion of the area.

The ground floor of almost all buildings is used for retailing some commodities and the upper floors for residential uses. Every building has one or two staircases in the middle section, a part of which is retained for the wellhole mentioned before.

All households in the area are supplied by individual connections with water meters, although they are mostly failing to register correctly. The area is provided with two fire hydrants and no standpipe. The features are:

No. of connections : 133, steel pipe of 10 to 13 mm dia.  
No. of buildings : 10  
Pipeline : 400 mm dia. asbestos cement pipe of 200 m length  
and 250 mm dia. asbestos cement pipe of 30 m length

Survey Schedule

The survey was conducted as stated below:

16 June (Sat.)	Preparation of drawings of the survey site,
17 June (Sun.)	Adjustment/correction of the drawings at sit,
18 June (Mon.)	Preliminary leakage survey,
19 June (Tue.)	Excavation of valves, saddles and meter pie,
20 June (Wed.)	Water flow observation for 24 hours, and
21 June (Thu.)	Water flow observation under all taps closed condition

### Preparation and Correction of Drawings

The work was made in a similar manner to the previous case of Kafr El-Eshara.

### Preliminary Leakage Survey

From 2 a.m. of 18 June, the preliminary leakage survey using leakage detectors started. Although flow sound was detected at a supply branch of 50 mm dia. steel pipe to the police headquarters, it could not be confirmed whether the sound was originating from actual leakage, as it was dark and inspecting the premises was impossible. Other flow sound was not noticeable along the pipeline and service pipes, except the mentioned one. Moreover, no wet or muddy spots were observed on the surface along the routes.

Next day, the premises of the headwater was inspected and leakage at a branch was found in the backyard. The outflowing water collected into a temporary drain gutter and led to a sewerage manhole. Besides several ball-valves of cistern in the toilet were malfunctioning, causing overflow of water from the cistern.

Three saddles were dug experimentally and no leakage was found at all of them. Almost all pipings inside buildings were exposed and bracketed on the wall, and even aged pipes showed little leakage. However, water was dripping from joints and water meters, almost all of them malfunctioning, making the wellhole very damp.

### Abandonment of Survey

The survey was abandoned halfway due to difficulty of dewatering the meter pit to keep the ultrasonic sensor dry from soaking. High groundwater table at the spot seems to be caused by an irrigation pipeline running along St. Abd el Lateed Hasaneen. The pit was supposedly located 30 m apart from the pipeline.

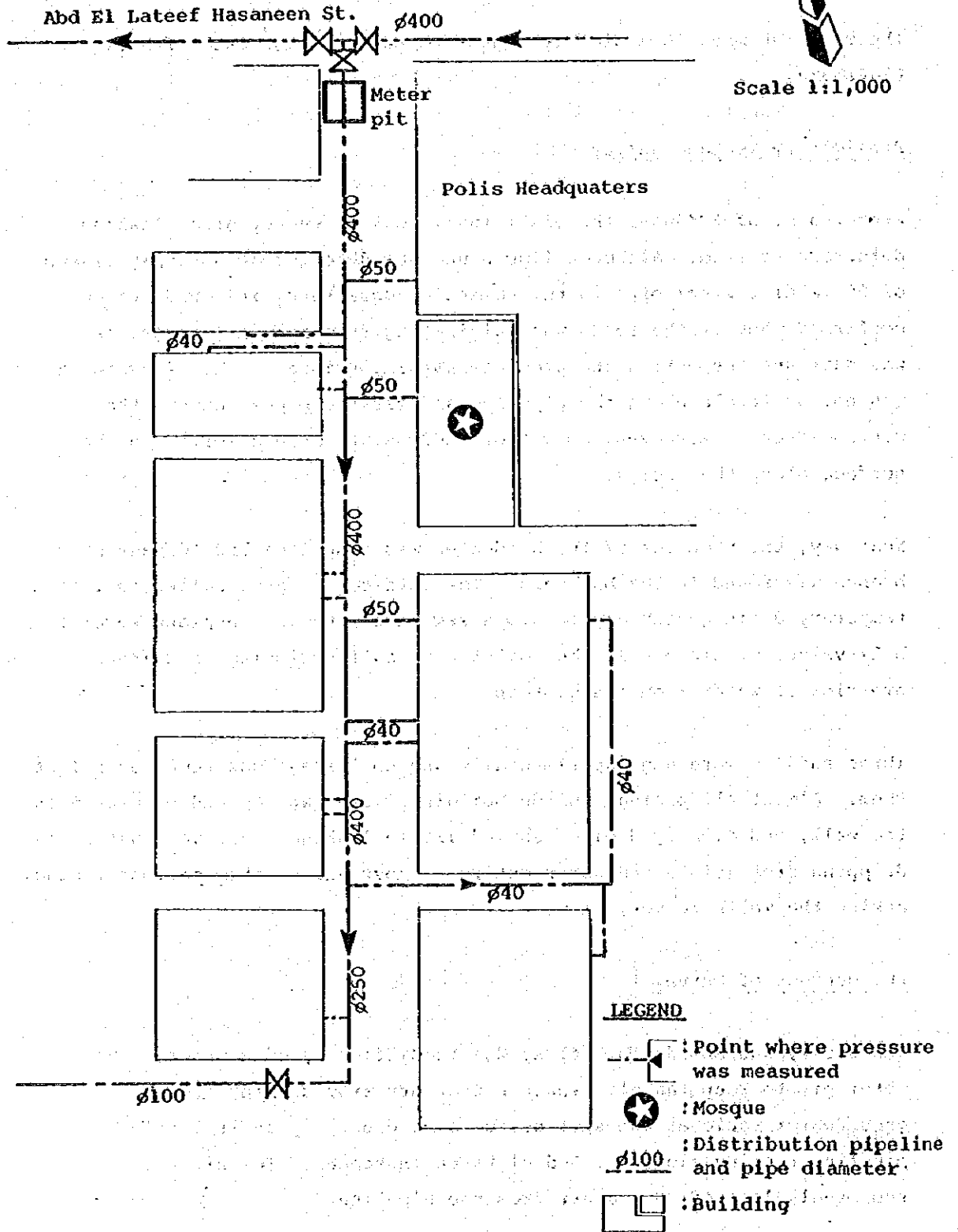


Fig-10 ZAGAZIG CITY OWNED SYSTEM  
**MIDAN MONTAZA**

4) Survey at St. El-Falaha

Outline of Area

St. El-Falaha is a fringe area of Midan Montaza, the commercial center of the city, and is also on the most prosperous commercial areas. The buildings in the survey area are rather small in size, when compared with Midan Montaza's and they are 4 to 5 stories high, made of brick mostly. About 30 % of buildings are used exclusively for residence while 70 % for retail business on the ground floor and for residence on the upper floors.

The middle section of all buildings are used for staircases and a vertical shaft called wellhole. In a unit apartment house, 4 to 5 taps including a shower tap in the bathroom are usually equipped. Each unit is supplied by a half inch steel pipe with a water meter. For toilet, a cistern is widely used instead of a flush valve, due to the pipe size smallness and low supply pressure. Though the regulation forbids it, nearly every apartment house uses a booster pump with a small air tank to increase pressure.

No. of connections : 125  
No. of buildings : 34  
Pipeline : 100 mm dia. asbestos cement pipe of 180 m length

Survey Schedule

The survey was conducted as stated below:

20 June (Wed) Field survey  
21 June (Thu) Field survey and test digging  
24 June (sun) Preliminary leakage survey and excavation for valves  
25 June (Mon) Water flow observation for 24 hours  
26 June (Tue) Water Flow observation under all taps closed condition

### Preparation and Correction of Drawings

The survey map of the area was made as it was done previously. In this area also, no unregistered connection was found.

Several saddles and pipe joints randomly selected at the survey site were dug for inspection. Their present condition was satisfactory as each around them was not damp. No wet or muddy spots were found on the surface along the pipe routes, as far as visually observed.

### Preliminary Leakage Survey

No flow sound indicating leakage could be caught along the pipelines and exposed service pipes.

### Water Flow Observation

The location of the tap where pressure was measured is shown in Fig-11, and the survey results of the flow and pressure are shown in Fig-12.

The observed minimum flow was below the sensitivity of the meter, as shown in Fig-12, consequently. And it verifies that leakage in the area is almost non-existent.

Looked from the point of water consumption pattern, El-Falaha can be regarded as a typical residential area. Although active commercially, the shops do not use water substantially for their business, except for very few cases. There are no standpipes, official buildings, and schools in the survey area which tend to use water extravagantly, because they are not charged for water.

The Ramadan (Islamic fast season) was from 1 to 29 June this year. The observed pattern of water consumption, Fig-12, can be considered as showing domestic usage during the Ramadan period. A slight rise of the flow at very early morning will mean possibly the consumption for the first meal and washing prior to praying at mosques.

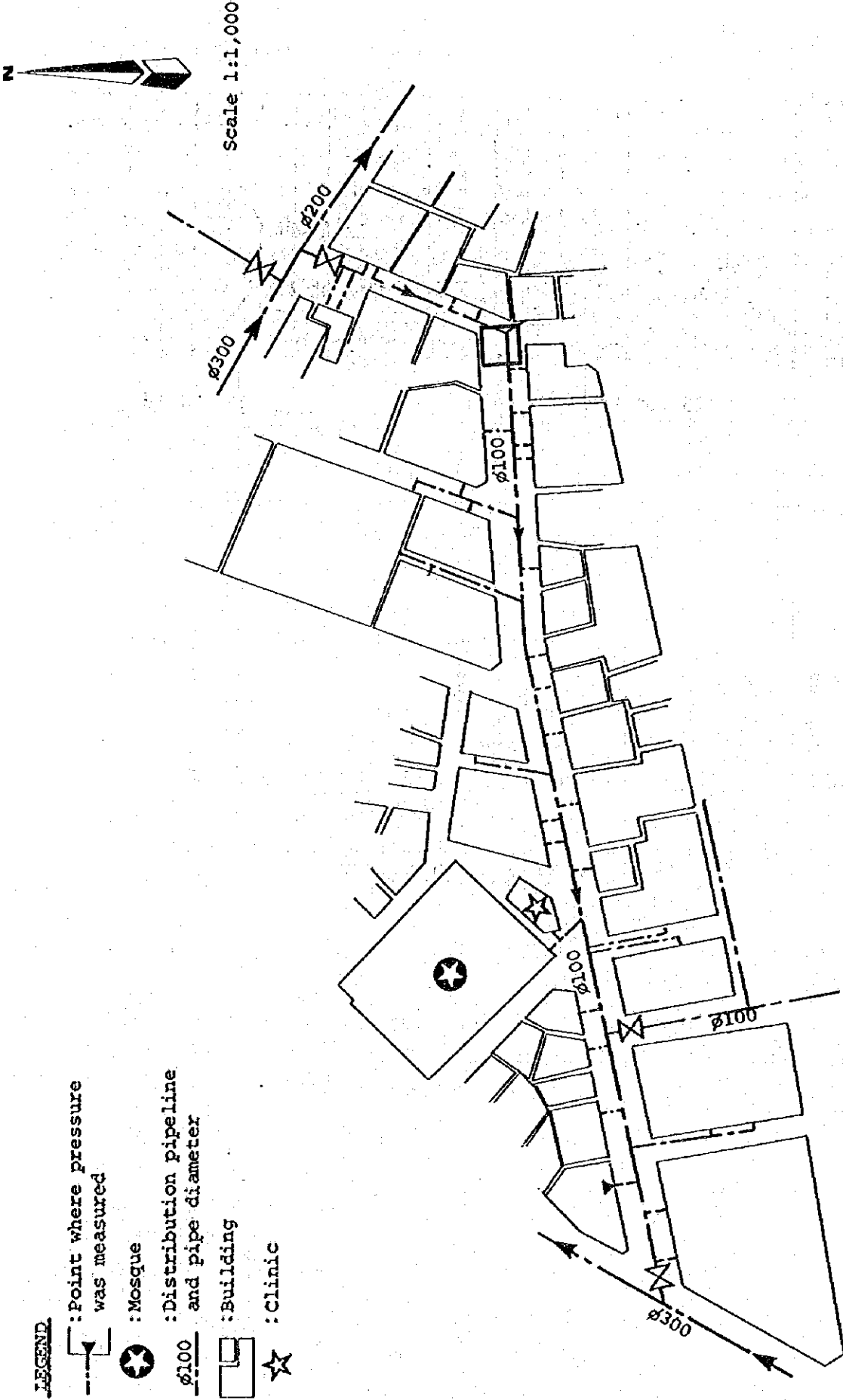


FIG-11 ZAGAZIG CITY OWNED SYSTEM  
**EL FARAKHA STREET**



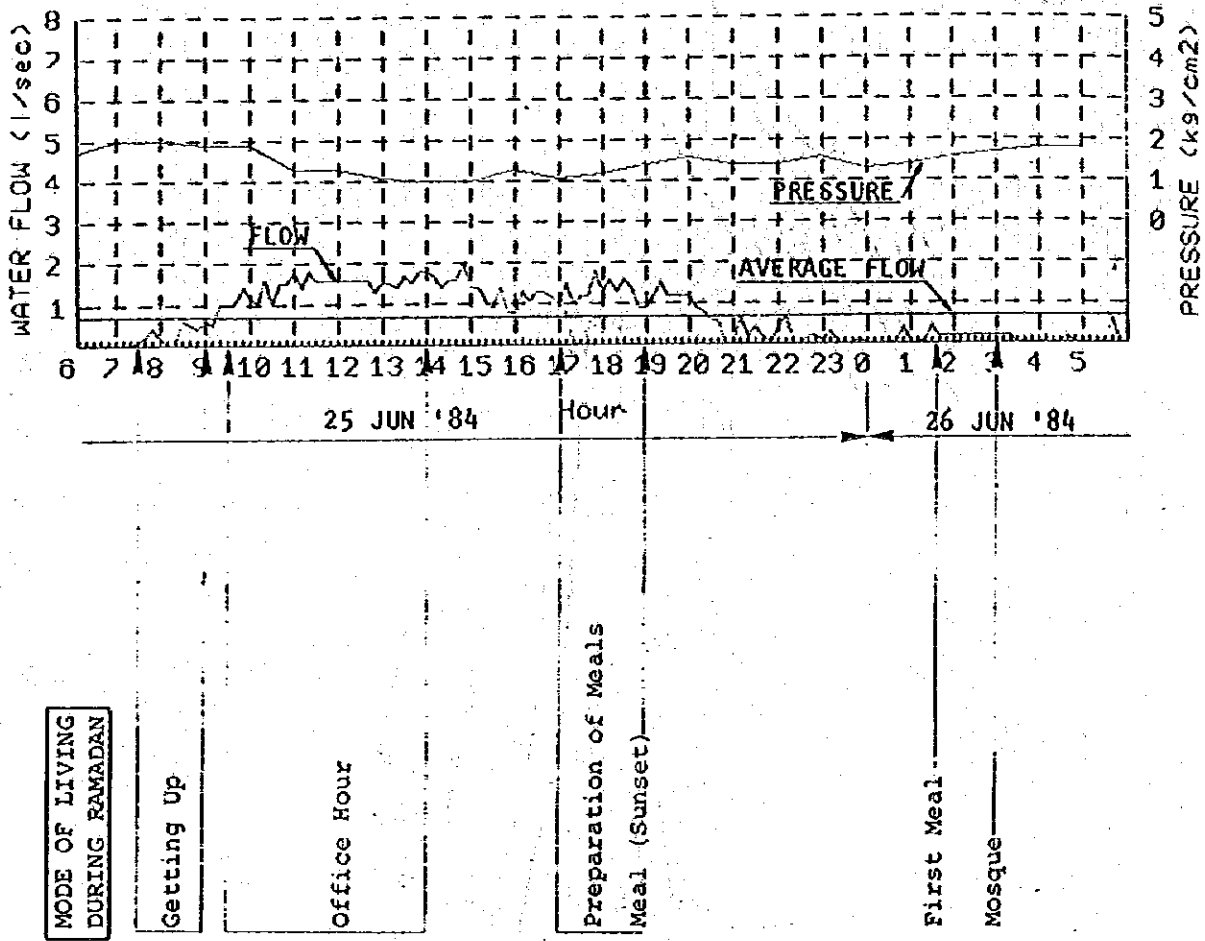


Fig-12 WATER FLOW AND PRESSURE

## 2-3-2 Housing Department's Systems

Housing Department's water supply systems were planned to supply safe, potable water to the local villages where groundwater of shallow wells and nearby canals' water had been used for domestic purposes. The villages are located in isolated areas and they are apart from each other. Presently the number is 82, but the government is promoting a policy of increasing the number and size of the systems.

### 1) Selection of Survey Sites

Every village is almost similar to others both in size and character. Most of the village people are farmers and the rest work in the shops like grocery, blacksmith and offices of clinic, etc. The supply capacity differs on the number of village under the system mostly.

In selecting the systems for leakage survey, the following consideration, together with the above conditions, were taken into account:

- a) The electricity can be supplied upon prior request, (Not all villages are supplied in the daytime)
- b) To ensure the all taps closed condition for the designated hours, the village people shall be cooperative in inclination,
- c) The pipeline maps/sketches are to be prepared owing to the peoples cooperation and the geographical reasons

The following sites were selected eventually:

Bany Koresh Village : a farming village, 30 km from Zagazig to west  
El-Asloug Village : A village, 3 km from Zagazig to east. There is a dairy factory,

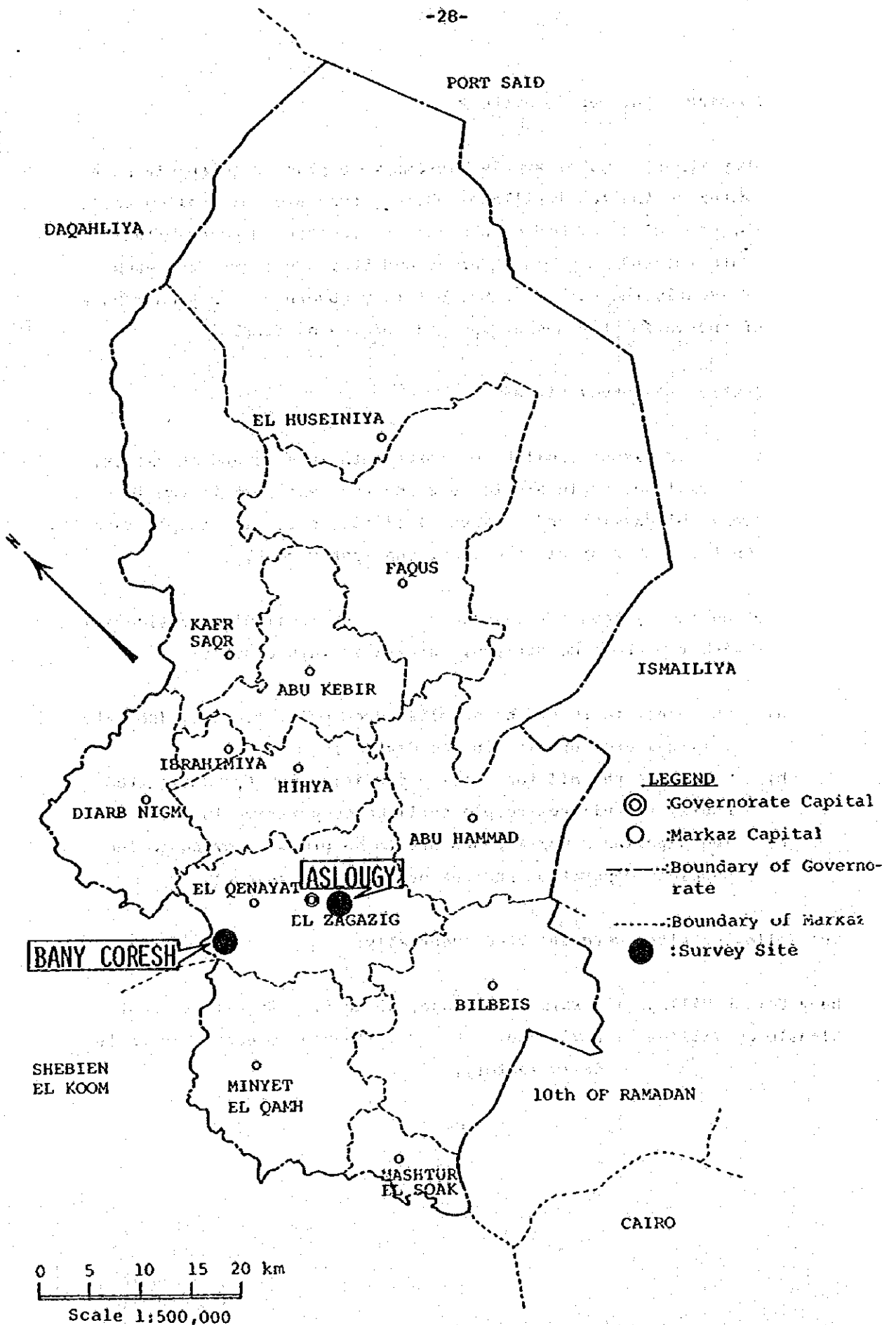


Fig-13 SELECTED SYSTEMS FOR LEAKAGE SURVEY

2) Survey at Bany Koresh Village

Outline of Area

The area is typical farming village in Zagazig Markaz, located at about 30 km to the west of Zagazig city. The village's whole population is about 3,100 as of 1983 and that within the service area is estimated as about 56,250 m<sup>2</sup>. The area is provided with two governorate schools, four mosques and one clinic. For the convenience of villages, four sets of standpipe put together with fire hydrant are facilitated. The groundwater station with two concrete elevated tanks is at Shelebaratel Moymonah and supplies to six villages including Bany Koresh.

Due to insufficiency of the electric power supply, the system is not operated continuously, in other systems under Housing Department. On an average, the groundwater station is run for nine hours a day.

The village's pipeline was installed in the middle of 1950s at first and extended, in 1980, under U.S.AID program. The pipe materials were granted by AID and the installation works were financed by the local budget. To save the cost, the village people did the most of earthwork voluntarily. Such a voluntary work has been employed widely in the rural area until nowadays.

The features of the area are:

No. of connections : 51 (including stand-pipe)  
Pipelines : 125 mm dia. asbestos cement pipe of 390 mm length,  
100 " " " " " " 590 m "  
75 " " " " " " 130 m "

### Survey Schedule

The survey was conducted as stated below:

23 June (Sat) Field survey  
28 " (Thu) Preliminary leakage survey  
5 July (Thu) Field survey and test digging  
7 " (Sat) Water flow observation for 24 hours  
8 " (Sun) Water flow observation under all taps closed condition

### Preparation and Correction of Drawings

Because useful records were missing in Housing Department, a drawing was prepared and the actual location of pipelines and branches were checked at the survey site on 23 June. The villagers' memory on their voluntary service helped the work virtually.

Several saddles and joints were dug for confirmation of the pipe size and inspection of the present condition which was found to be satisfactory. No wet and muddy spots were located on the surface along the pipeline routes, by visual inspection.

### Preliminary Leakage Survey

In the midnight of 25 June, the flow sound detection was tried with the leak detectors and stethoscopes. No flow sound indicated possible leakage was caught along the pipeline and exposed service pipes.

### Meter Flow Observation

During the flow observation, the pressure was measured at two taps hourly. The taps location is shown in Fig-14 and the survey results are in Fig-15. At the end of the 24 hours flow observation, all taps closed condition was brought on for 1 hour from 11 a.m. on a July As it was anticipated, the flow rate fell down to nearly zero.

From the previous experience, closing all taps could not be guaranteed, even though every conceivable means were mobilized. One certain way was to decrease the size of survey area and consequently the number of house connections, so that checking the desired condition could be confirmed by the limited number of team's staff, while a reasonable length of the distribution mains was surveyed.

For the case, the survey area was under the following condition:

Table-2 DETAIL OF CONNECTIONS.

No.	Item	No. of Connection	Dia. of Tap	Tap (mm)	Remarks
1.	Private	40	100*	13	
2.	Mosque	4	24	13	
3.	School	2	10	13	
4.	Clinic	1	5	13	
5.	Standpipe	4	12	13	Under Operation : 9
Total		51	151		

(Note) \* : Estimated (40 x @ 2.5\* = 100)

Technicians and workers of Housing Department were sent to every house, under instruction of the team's engineer, to close the valve installed upstreams of water meter of both private and public buildings. Where a valve was found defective and closed incompletely, it was repaired immediately.

Measurement of the flow was carried out under such a condition and the result, as shown in Figs. 14 - 16, indicates that no leakage was existent in the pipelines and service pipes. As the figure shows also, the nearly zero flow continued even after the closed valves had been responded by the

technicians and workers. Prior to the flow observation, the team inspected the water taps of individual connections and found them kept in a good condition which was verified by the result. The fact that the taps and service pipes are maintained well in the farmers' houses can be understandable, as the houses are built of sun-baked bricks leaking taps and pipes will cause damaging effect on the buildings.

On the other hand, almost all leakage and wastage occurs in the public taps where water is free of charge and which are neglected of care, exclusively due to insufficient maintenance budget and lack of spare parts. Most taps of such public connections are faulty. In case of the standpipes, 3 taps of while 12 were plugged and out of use and a tap of the 3 was plugged by a piece of wood which was wasting water noticeably.

All standpipes in use are faulty, leaking even when closed. When they are opened for use, they tend to be opened fully and usage cannot be distinguished from wastage. Economizing water shall rely on the users' manner and consciousness. The discharge of a standpipe, both when in and out of use, was measured as shown below:

Leakage from closed standpipe : about 30 liters/hour

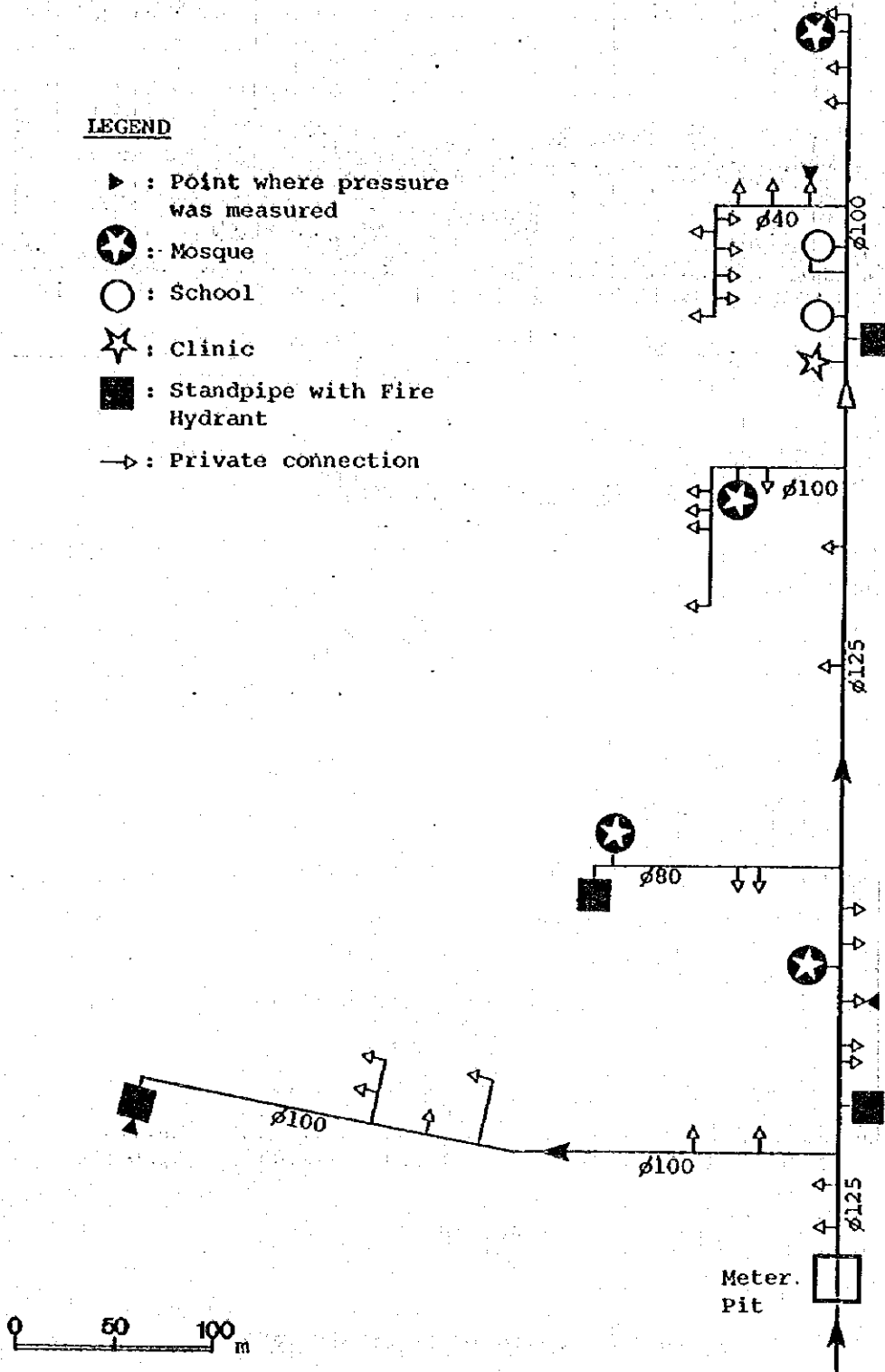
Discharge from opened standpipe: 7.5 to 8.0 liters/ min

The both measurements were taken under 0.1 kg/cm<sup>2</sup> pressure.



**LEGEND**

- ▶ : Point where pressure was measured
- ⊛ : Mosque
- : School
- ☆ : Clinic
- : Standpipe with Fire Hydrant
- : Private connection



HOUSING DEP. SYSTEM  
**Fig-14 BANY CORESH**



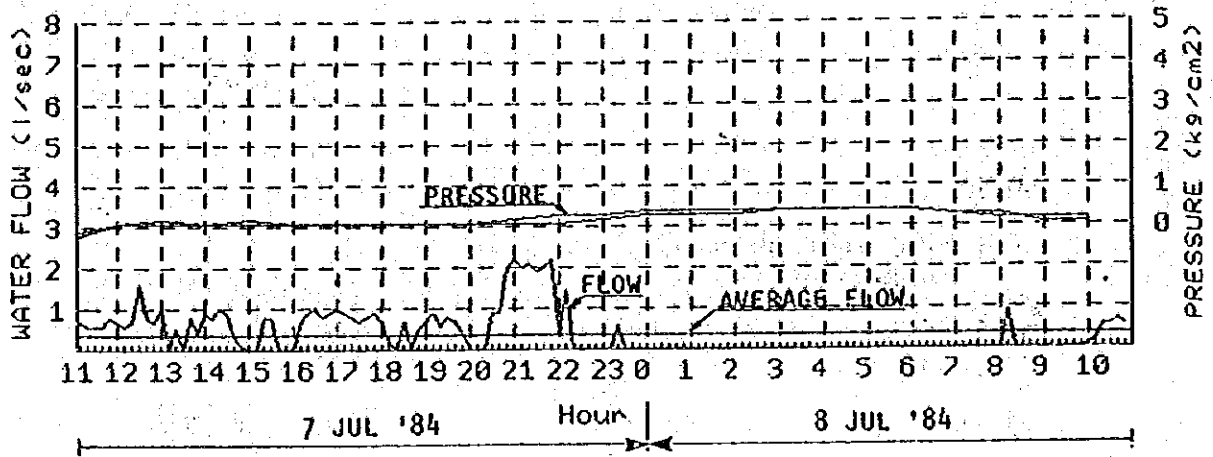


Fig-15 WATER FLOW AND PRESSURE

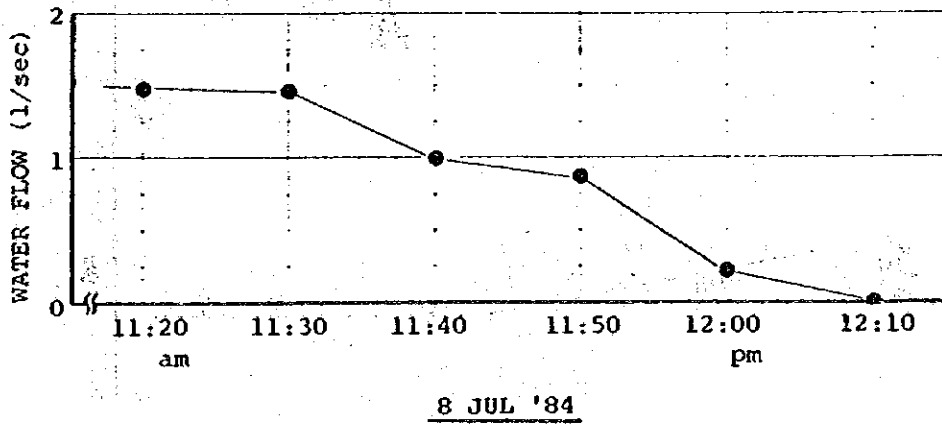


Fig-16 WATER FLOW UNDER CLOSED TAPS

### 3) Survey at El-Asloug Village

#### Outline of Area

The village is rather large in size in Zagazig Markaz and located about 3 km to the south of Zagazig city. The whole population in 1983 was about 9,900. Although the village is surrounded by farmland, farmers are only about 20 % population-wise and 80 %, the rest, is supposedly commuting to Zagazig city to work there.

As for the public facilities, one governorate school, one local branch office of Governorate, one clinic and five mosques are in the survey area. One factory is under operation using the material from the surrounding area's dairy farmers.

The groundwater station with a concrete elevated tank (Vol. 60 m<sup>3</sup> by Height 15 m ) and two wells is located close to the survey area. Presently an additional groundwater station is under construction to strengthen the existing capacity. Although 4 standpipes were installed originally, all of them, except 2 fire hydrants, are not in use any longer now, because they lack proper drainage facilities, instead rather easy accessibility of groundwater.

At present, due to mechanical problems the existing facility is operated for only about 2.5 hours a day, supplying water intermittently and the villagers are using hand pumps for their domestic use, in spite of questionable water quality of shallow wells.

The features of survey area are:

Not. of connections : 90

Pipelines : 100 mm dia, cast iron pipe of 200 m length,  
100 m asbestos cement pipe of 1,000 m length

### Survey Schedule

The survey was made on the following schedule:

- 27 July (Wed) Field survey
- 28 " (Sat) Preliminary leakage survey,
- 30 " (Mon) Field survey and test digging,
- 31 " (Tue) Water flow observation for 24 hours, and
- 1 Aug (Wed) Water flow observation under all taps closed condition

### Preparation and Correction of Drawings

Drainages were prepared and corrected by local staffs and team engineers during the field survey prior to the preliminary leakage survey.

During this field survey, leakage was found, adjacent to a branch valve, showing muddy ground and it was left unrepaired for the flow measurement.

### Preliminary Leakage Survey

The leaking valve stated above was confirmed by the detector. Moreover, two spots were found to be causing remarkable flow sound, as caught by the detector. One of them seemed to come from a joint. These two were also left unrepaired.

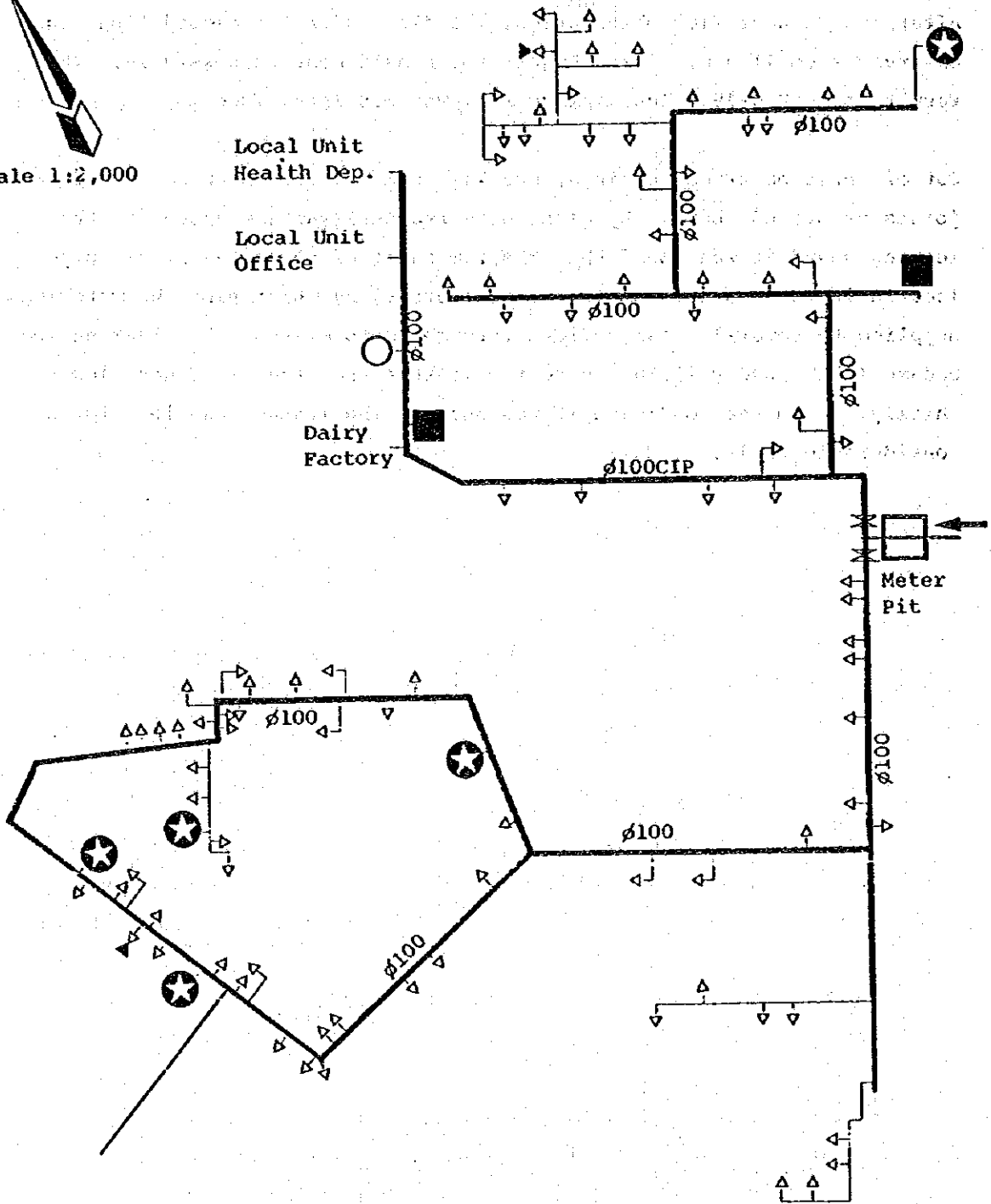
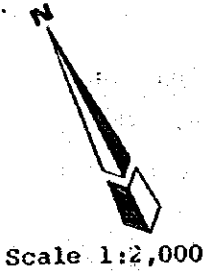
### Water Flow Observation

The observed flow diagram is shown in Fig-18 with a pressure curve. In the figure the flow suddenly dropped to 2.8 liters.sec at 1:50 a.m., and rose twice between 3 a.m. and 4 a.m.

An operator of the groundwater station reported that the level of the elevated tank decreased remarkably at 1:50 a.m. due to a trouble of pumps although recovered soon, and an additional pump was operated during 3 a.m. to 4 a.m. It is assumed that the above-named sudden changing of the flow occurred from such countermeasure of the station.

After the 24 hour flow observation, the flow under the closed taps was observed from 11 a.m. of 1st August for a half hour successively. The result is as Fig-19. The minimum flow was 3.8 liters/sec.

Out of three observed leakings, one was from a Valve and other two from joints as stated above. By means of a reconnaissance adjacent to the leaking sound it was found that the remaining of three was from a pipe located in the premises of the dairy factory, by which pipe the water was supplied to several local offices through the premises. The leaking spot became like a paddy field due to the leakage and water-weed was growing thickly. From the condition it was assumed the leakage was left for a considerable while.



LEGEND

- : Point where pressure was measured
- : Mosque
- : School
- : Standpipe with fire hydrant
- : Private connection

Fig-17

HOUSING DEP. SYSTEM  
**ASLOUGY**

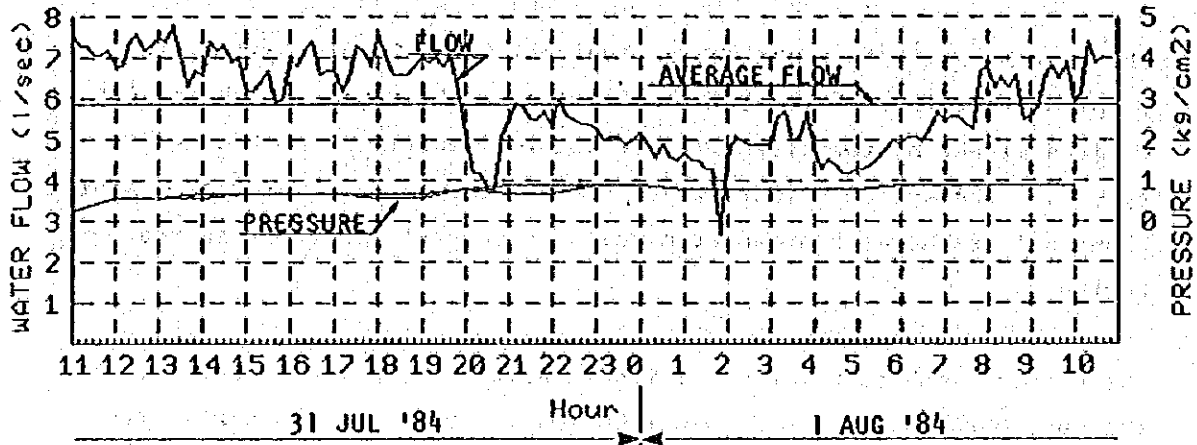


Fig-18 WATER FLOW AND PRESSURE

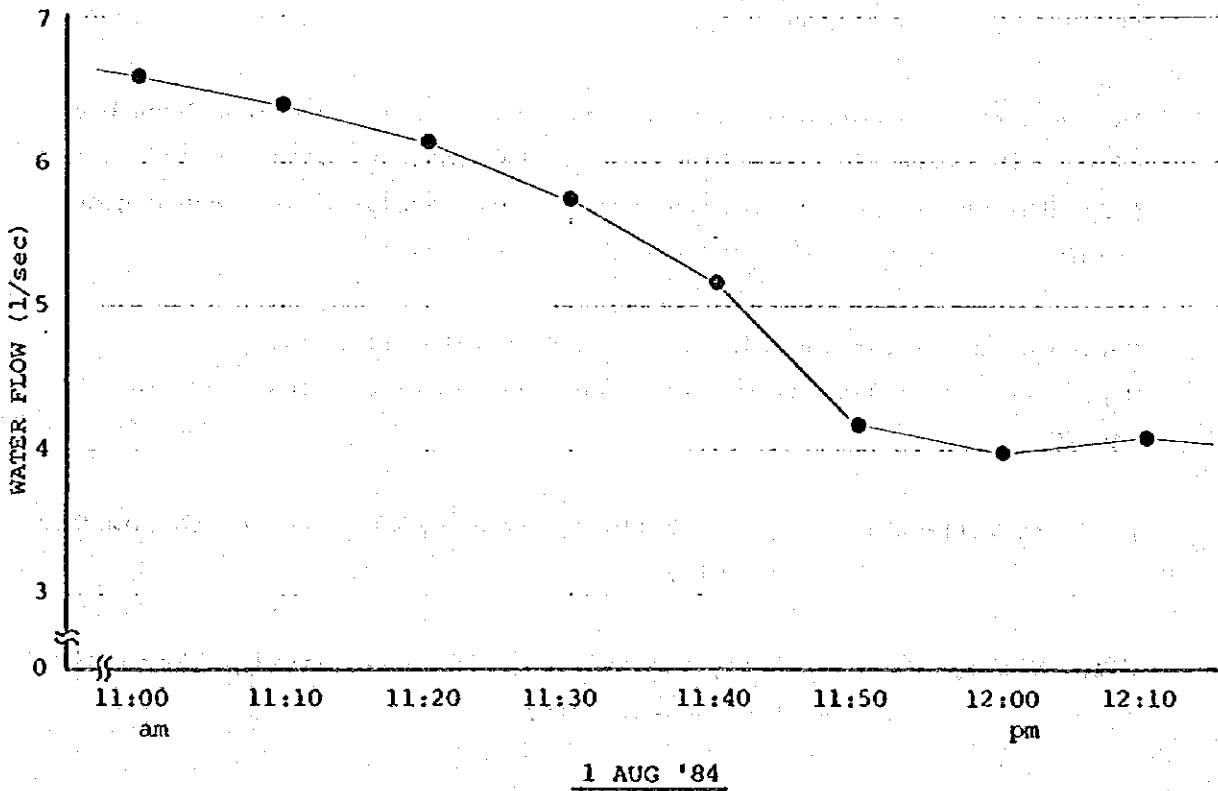


Fig-19 WATER FLOW UNDER CLOSED TAPS

### 2-3-3 Abbasa System

The system, as it is named Abbasa Regional Water Supply System, is complementary in that it serves the areas in the region which are not covered either by the city-owned or Housing Department-controlled systems. The system's sources are the treated surface water from Abbasa Plant and groundwater drawn from wells at several locations in the region.

The system supplies water to cities in bulk and the cities deliver it to the consumers through their distribution network. In the rural areas however, water is distributed through the transmission and distribution pipelines belonging to the system.

As far as the leakage survey is concerned, the survey area is urban or rural characteristically and the survey work resemble that in the city-owned system or in the Housing Department-controlled systems described previously.

#### 1) Selection of Survey Sites

As the system is comparatively new, the construction drawings have been kept in the file of Abbasa Plant and as for the pipelines, every inspector who is responsible for managing the assigned area had a good memory on them, including the history of extension.

Survey areas were selected, as it was done with the Housing Department-controlled system and, the selected areas were shown in Fig-20.

**Kattawia Village :** A farming village, about 10 km to the north from Abu Hammad City.

**Ellem Village :** A village spread in a wide area, about 20 km to the east of Zagazig City.

**Elaragy Village** : A village contiguous to Abu Hammad City with a comparatively high supply pressure.

**Kafr Aiyad Area** : An area consisting 18 villages neighboring Abu Hammad City with long distribution mains and high supply pressure.



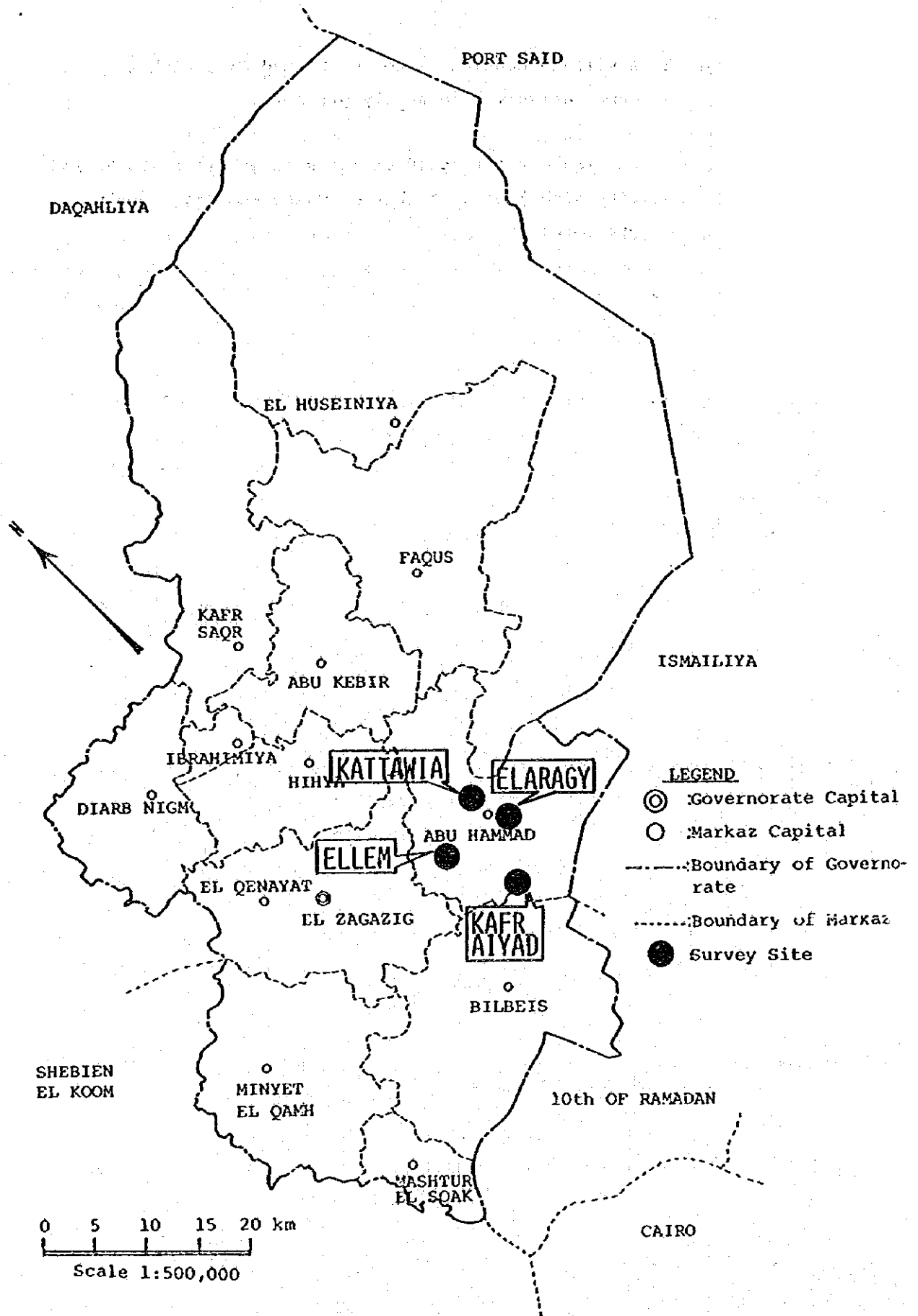


Fig-20 SELECTED SYSTEMS FOR LEAKAGE SURVEY

## 2) Survey at Kattawia Village

### Outline of Area

The survey area was limited to the southern half of the village where water was supplied by 100 mm dia. asbestos cement pipeline installed in 1959 and coming by way of Abu Hammad city. The population in the survey area is about 2,200 and most houses are supplied water by the individual connection. Originally 2 standpipes with fire hydrants attached were installed, but as the peoples' living level has been raised the standpipes were put out of use and presently some fire hydrants are still in use.

Although it has not been confirmed by the 1976 census, almost all villagers, probably 90 % population-wise, are farmers. The appearance of the village is quite similar to the villages under Housing Department's service.

As the supply capacity is obviously short of the demand, vessels to receive and store water are placed under the most taps. To make up the shortage, private shallow wells are used for various uses like washing and cleaning, in spite of questionable water quality of some wells. Although a reinforcement plan was put forth to meet the increasing demand, it has not been realized due to the budgetary reasons.

The features of the survey area are:

No. of connections : 381

No. of buildings : 420

Pipeline : 100 mm dia. asbestos cement pipe of 978 m length

### Survey Schedule

The survey was conducted in accordance with the following schedule:

- 14 July (Sat) Field Survey
- 15 " (Sun) Preliminary leakage survey.
- 16 " (Mon) Field survey and test digging
- 17 " (Tue) Water flow observation for 24 hours
- 18 " (Wed) " " " " under all taps closed condition

### Preparation and Correction of Drawings

The construction drawings were kept filed in a ledger. Necessary sketches were prepared with additional fill-in of the recently laid pipes.

Digging inspection was done on several saddles and joints same as other sites. It was found satisfactory.

### Water Flow Observation

Three locations of the pressure measured taps is shown in Fig-21, and the survey results of the flow and pressure are shown in Fig-22.

After the 24 hours observation, the water flow measurement under all taps closed condition was conducted, starting at 11 a.m. on 18 July. Every means of instructing the people was employed, but it was not effective as the result, shown in Fig-23, tells. The observed minimum flow was about 1.4 liters/sec. When all valves/cocks of the service pipes and public branches were closed by technicians and workers from 10 a.m. on the next day, 19 July, the water flow fell as low as below the sensitivity of the flow meter. (Fig-24)

From the result, leakage from the pipelines and service connections is scarce obviously, however, considerable amount of water discharged from the free taps of mosques, schools and such like is used very ineffectively. Remarkable is the fact that most these taps are faulty and leaking.

Contrarily the private taps are maintained fairly well. Almost all of them, however, are kept open and meager, intermittent discharge is received and stored in the vessels placed beneath.

As shown in Fig-22, therefore, the width of fluctuation of the measured flow is narrower than in the results of other surveys, standing between 2 and 4 liters/sec. Considering such a suppressed condition, this minimum flow, registered at 2 liters/sec at midnight, should not be interpreted as leakage and/or wastage.

When the suppression is removed by increased supply pressure however, wastage may occur at the standpipes, as witnessed in Bany Korish Village under Housing Department's supply even when the pressure was low.

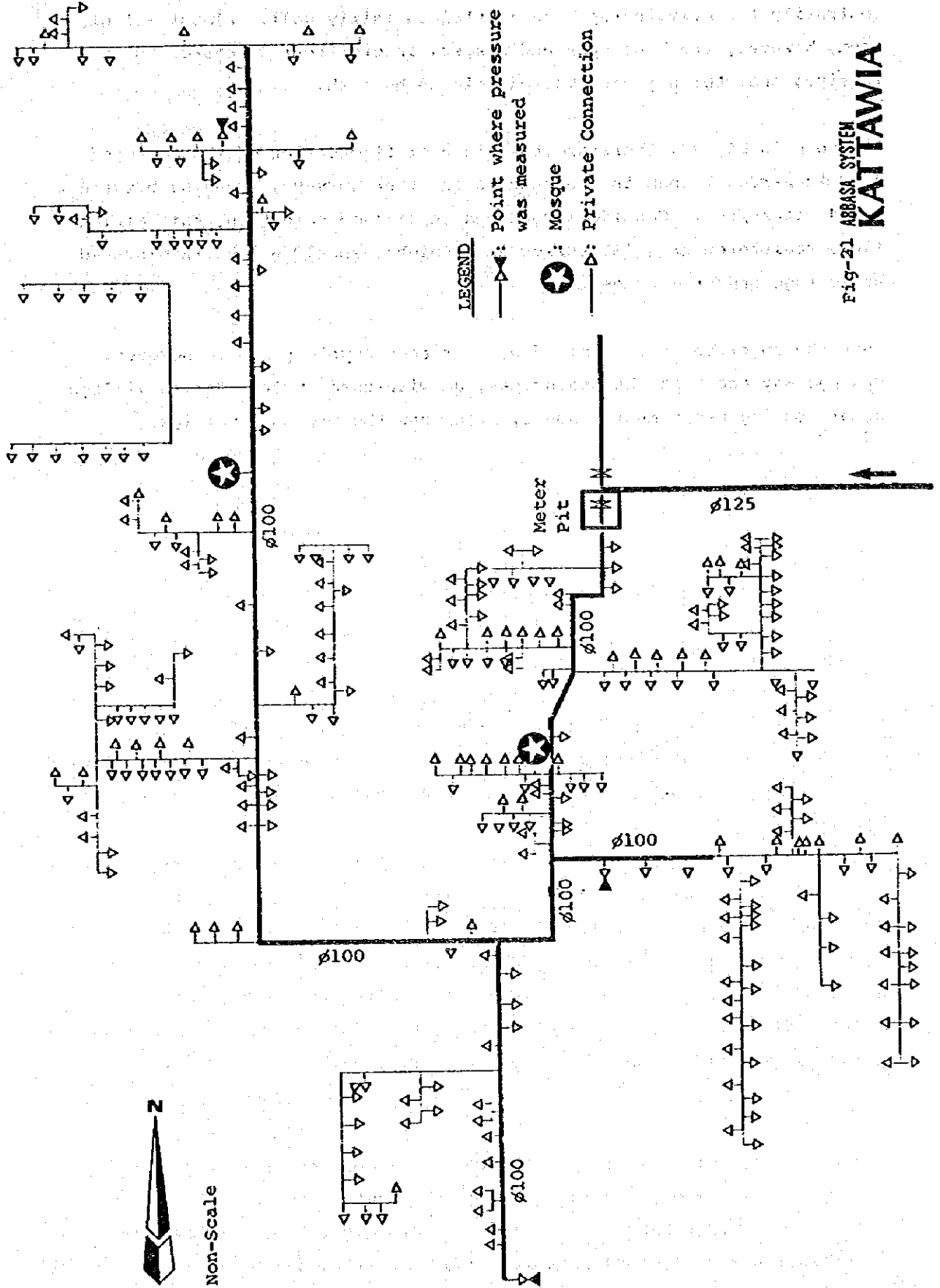


Fig-21 ABBASA SYSTEM  
**KATTAWIA**

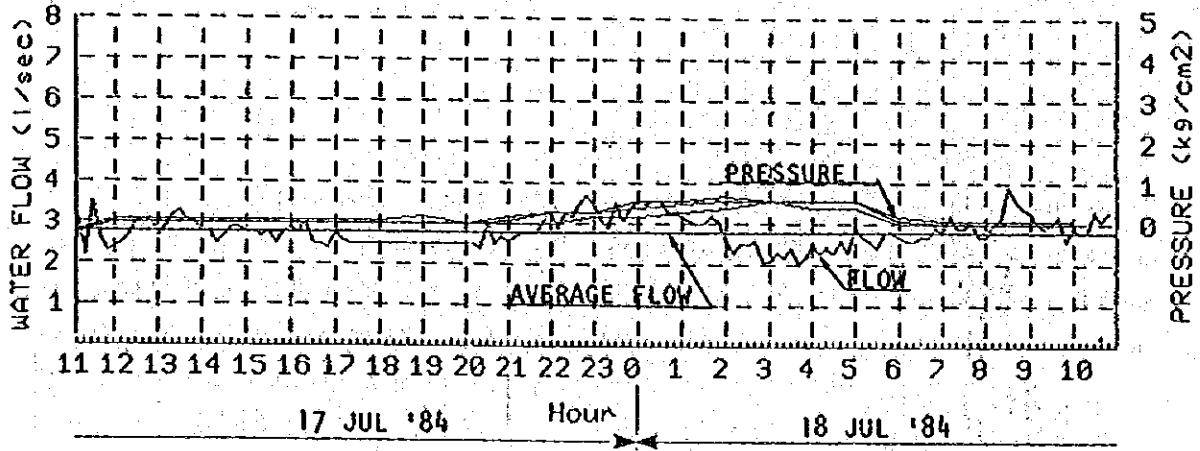


Fig-22 WATER FLOW AND PRESSURE

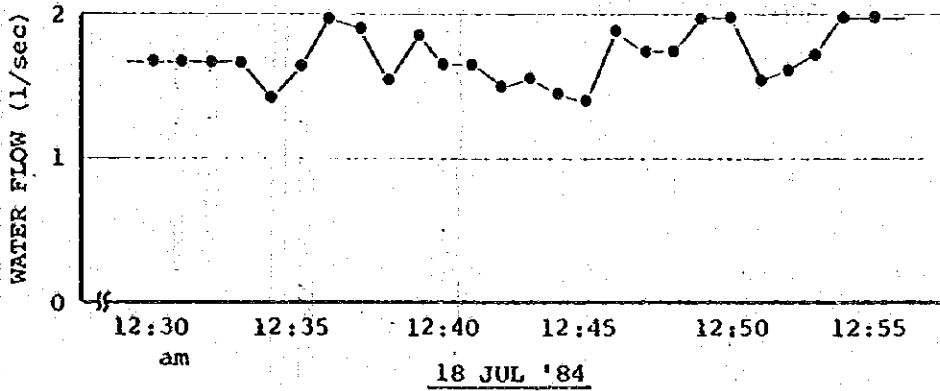


Fig-23 WATER FLOW UNDER CLOSED TAPS

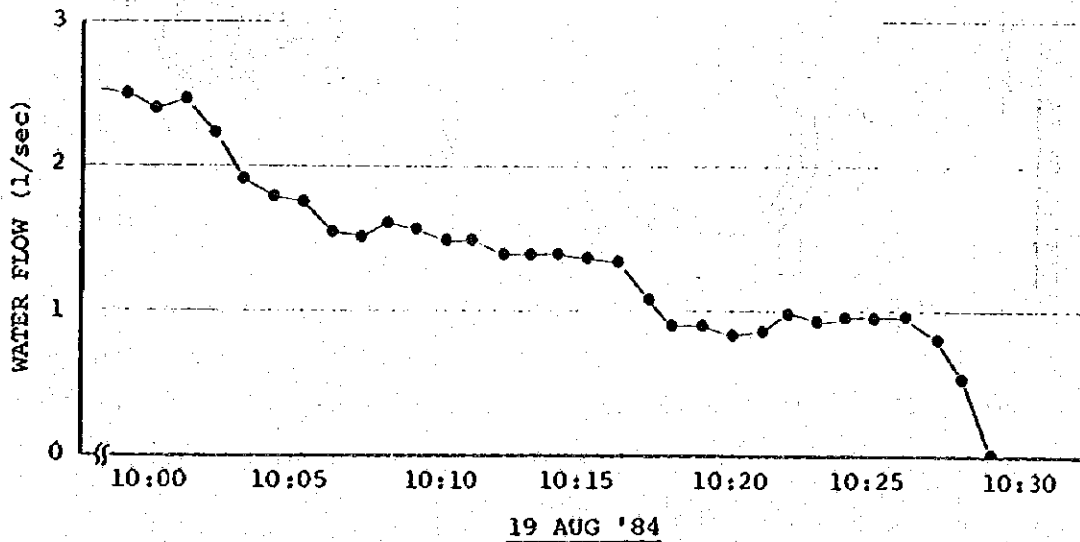


Fig-24 WATER FLOW UNDER CLOSED TAPS

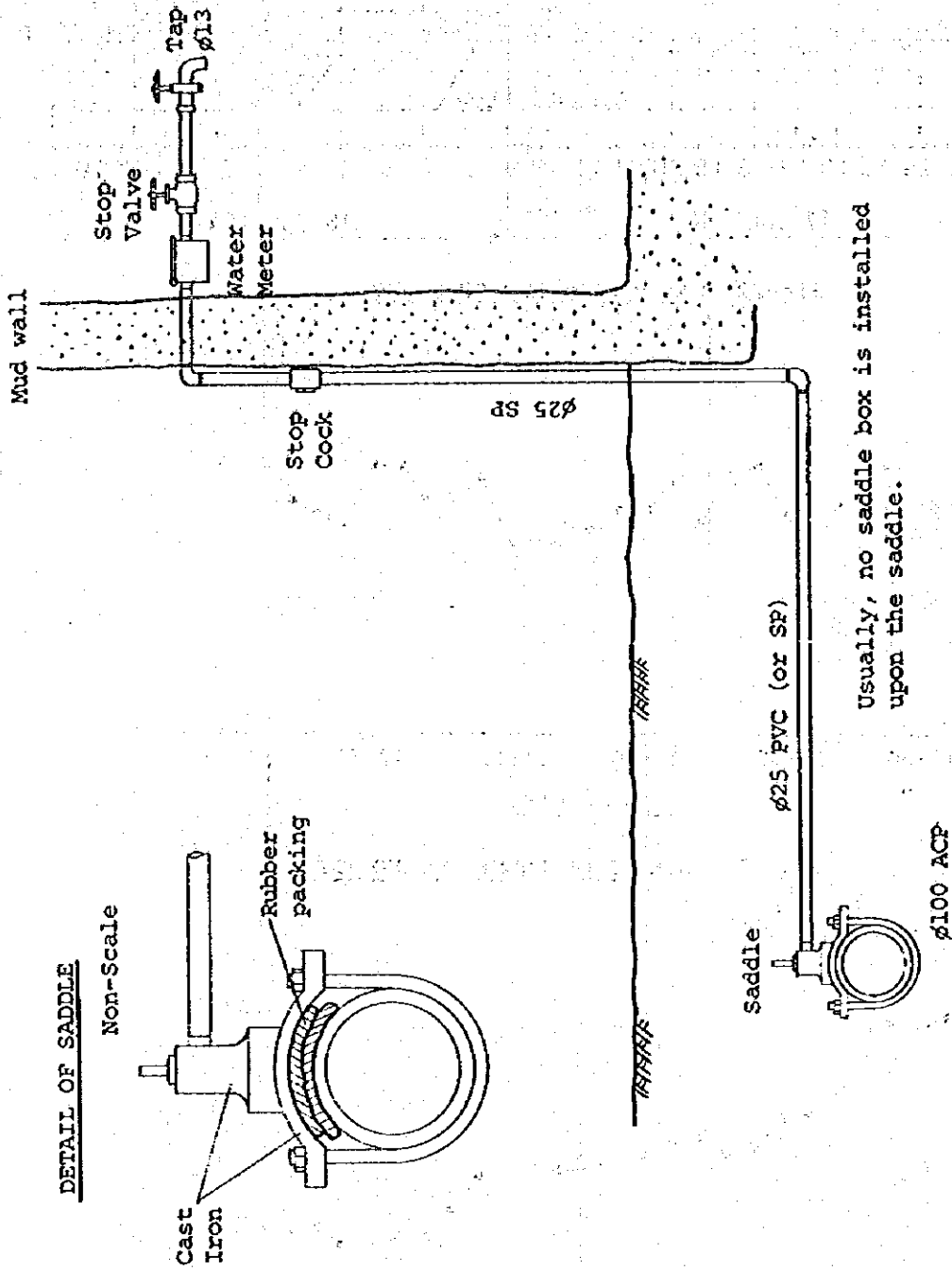


FIG-25 TYPICAL PRIVATE SERVICE CONNECTION OF RURAL AREA

### 3) Survey at Ellem Village

#### Outline of Area

The village is located at about 15 km southeast of Zagazig city, by the main road leading to Ismailiya. The population is about 3,550 in total. The village receives water through 125 mm and 100 mm dia. asbestos cement pipelines which are branched from 500 mm dia. cast iron pipeline between Abu Hammad and Zagazig cities. These 125 mm and 100 mm lines running along the rows of village houses were installed in 1959 when the Abbasa System was founded.

The population in the area consists of not less than 90 % farmers and workers in various fields. There are one mosque and a clinic for the public service in the area. Within and adjacent to the village there is no factory.

Most houses are facilitated with the individual connections branched from 100 mm dia. asbestos cement pipe. Although 2 standpipes are installed for the people's convenience, under improving living conditions, preference of the house connection to the standpipe is showing apparently.

Though it is not regularized in written forms yet, the house connection is standardized generally, for convenience of the material supply and maintenance works possibly. Most of the house connections are sized as 13 mm (1/2 in.), 25 mm (1 in.) and 36 mm (1 - 1/2 in.). The sizes are widely used in connecting the service pipes with the small mains laid along the public roads.

The features are:

No. of connections	:	200
No. of buildings	:	220
Pipelines	:	100 mm dia. asbestos cement pipe of 462 m length



### Survey Schedule

The survey was conducted according to the following schedule:

- 11 July (Wed) Field survey
- 23 " (Mon) Preliminary leakage survey
- 24 " (Tue) Field survey and test digging for confirmation of pipes' location and size
- 25 July (Wed) Water flow observation
- 26 " (Thu) Water flow observation under all taps closed condition

### Preparation and Correction of Drawings

The same procedures were taken as former sites. Leakage and seepage were not found as long as observed by the test digging.

### Preliminary Leakage Survey

Flow sound which is indicating leakage could not be caught along the pipelines and exposed service pipes.

### Water Flow Observation

The survey results obtained from the 24 hours observation showed a fluctuating flow of between about 2 and 6 liters/sec, as seen in Fig-27. The minimum flow of 2 liters/sec or less occurred from 2 to 5 a.m.

Almost all the villagers are farmers and most of them were taking rest during the time, as the local assistants patrolling the area witnessed.

Another flow observation made under all taps closed condition showed that the flow was zero and it was deduced that the leakage was negligibly small.



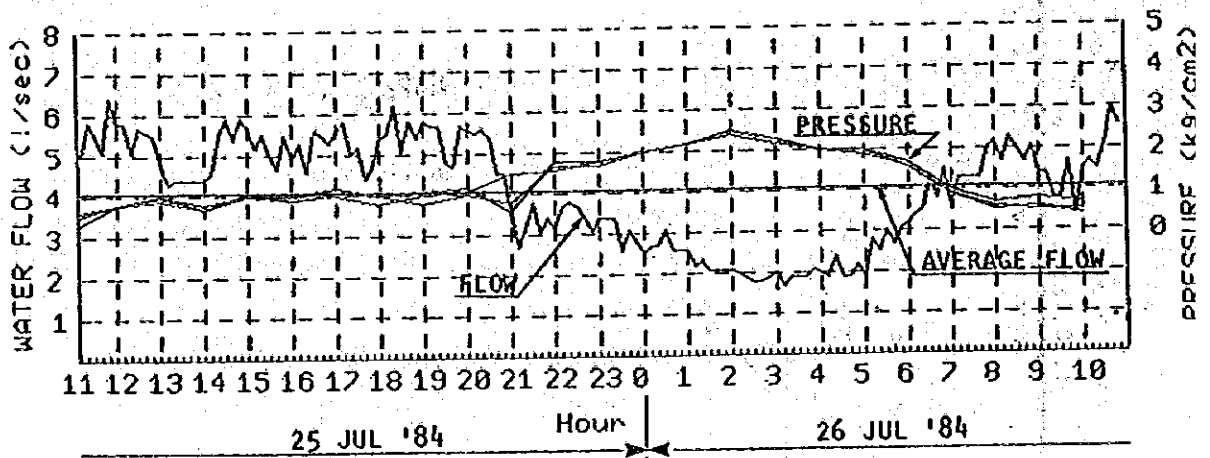


Fig-27 WATER FLOW AND PRESSURE

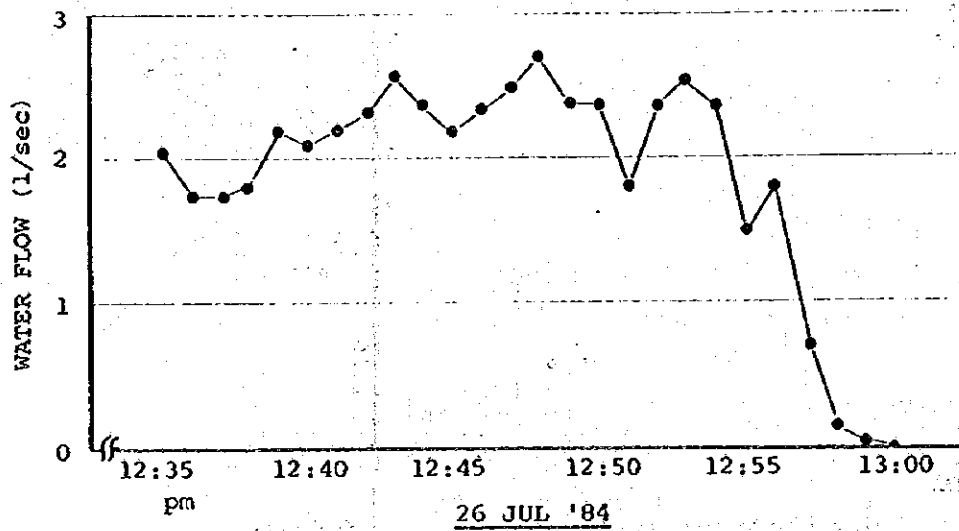


Fig-28 WATER FLOW UNDER CLOSED TAPS

#### 4) Survey at Elaragy Village

As the result that the survey sites were selected from the standpoints of availability of electric supply, cooperation of local people and others which are described in the preceding section, the supply pressure in the sites resulted in comparative lowness. For the selection of the sites, the condition of high pressure area was added to the conditions stated above, and Elaragy village supplied Abbasa system was adopted as additional survey sites.

#### Outline of Area

The village is located at about 1 km east of Abu Hammad city and on a slightly elevated area surrounded with field and paddy. As it is comparatively near from the Abbasa plant (about 2 km), the supply pressure is rather high comparing the prior survey sites. The pressure usually shows about 2.5 to 3.0 kg/cm<sup>2</sup> in the daytime.

Almost villagers are farmers and only several are groceries. 5 mosques and one primary school are scattered among 380 farmers' houses. About 70 % of farmers have their private connections to get water from the public system, and the remainings are utilizing standpipes which are set with simple drain systems at convenient places of the village.

The village is exclusively supplied by ACP  $\phi$  100 mm branched from CIP  $\phi$  500 mm along the main road to Abu Hammad city. There are one fire hydrant and 2 standpipes in which one of them are set with fire hydrant. Almost public taps like mosques and standpipes are damaged and water are dripping from the taps.

The features of the survey area are :

No. of connections : 250

No. of buildings : 380

Pipelines : 100 mm dia. asbestos cement pipe of 1,980 m

### Survey Schedule

The survey was made on the following schedule :

- 7 Aug (Tue) Field survey,
- 8 Aug (Wed) Preliminary leakage survey,
- 11 Aug (Sat) Field survey and test digging,
- 13 Aug (Mon) Water flow observation for 24 hours, and
- 14 Aug (Tue) Water flow observation under all taps closed condition.

### Preparation and Correction of Drawings

Preparation and correction of drawings were done by the same manner as former sites.

Recently several leakings were repaired which occurred on the pipeline beside and along a small canal between the branch of CIP  $\phi$  500 mm and the village hillock. The earth covering/depth of the pipeline was observed as about 0.4 to 0.5 m.

### Preliminary Leakage Survey

No remarkable flow sound which indicated leakage could be caught along the pipelines are exposed service pipes as long as utilized equipments employed.

### Water Flow Observation

At the last survey experience the electric power supply had been cut without any notice due to the maintenance, although the time was not so long. Especially such cuttings frequently occurred in rural area. Prior to the survey, therefore, it was strongly requested to the electric company through a local staff to supply the electric power continuously.

The water flow observation was commenced for 24 hours from 11 a.m. on 13 August with the flow meter installed on the pipeline. At the same time supply pressure of water was measured every one hour at 3 points which locations are shown in Fig-29.

The observed maximum flow 5.7 liters/sec occurred at around 8 a.m. when villagers would come back from their field and be released from their daily jobs, and minimum flow 1.5 liters/sec arose between 1 to 3 a.m. as expected from their living mode. The detailed survey result is as in Fig-30.

Succeedingly the water flow measurement under all taps closed condition was conducted from 11 a.m. on 14 August. The closed condition was made by closing stop cocks which were set between saddle and meter of every house connection.

Essentially stop cocks are set for replacement of meters and they have never been operated after their installation. At this time the stop cocks were turned to create the closed condition. As the result deteriorated packings of the cocks were damaged and water dripped out from about two thirds of the cocks despite keeping them watertight. The survey result under taps closed condition is shown in Fig-31.



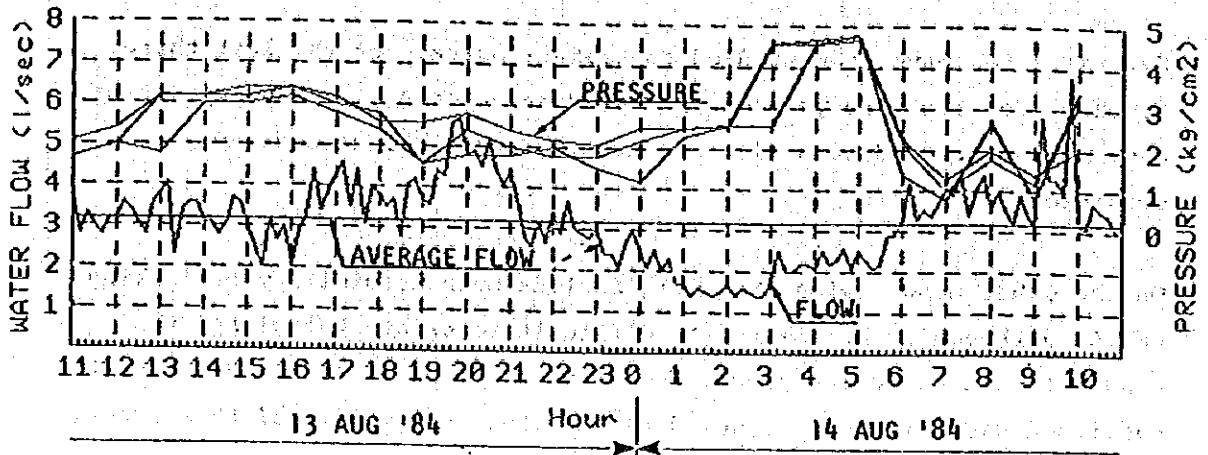


Fig-30 WATER FLOW AND PRESSURE

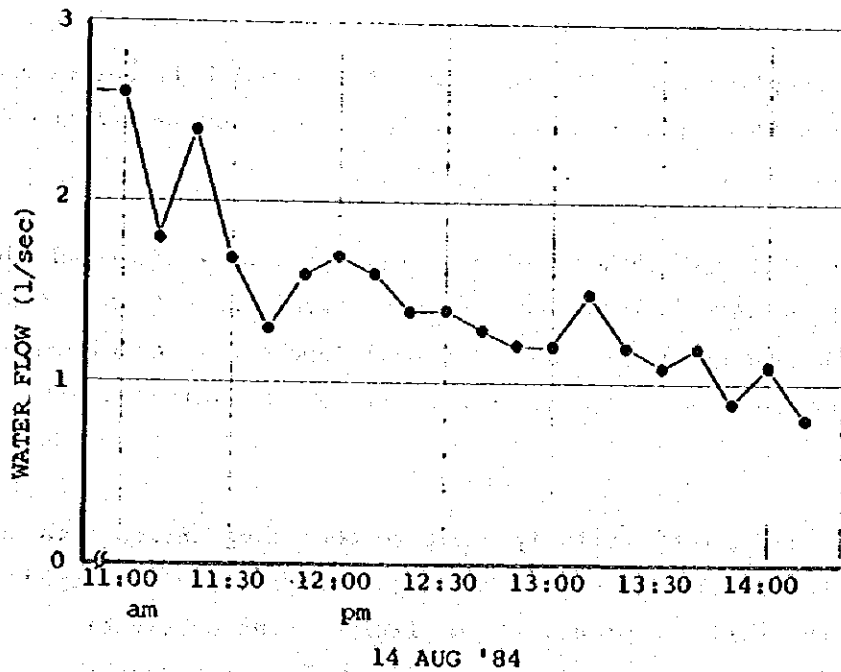


Fig-31 WATER FLOW UNDER CLOSED TAPS



#### 5) Survey at Kafr Aiyad Village and Its Vicinities

Several sites have been studied on Leakage Survey for the last three months. For the surveys areas had been selected from the viewpoint of easy manage to conduct a flow measurement under all closed taps condition.

On the other hand a wide area will include much possibility of leaking cases, although it becomes quite difficult to create the closed tap condition stated in the preceeding section. From such consideration the captioned wide area was selected as the last survey site of this stage.

#### Outline of Area

The area is between Hermiya and Saadat where are located at about 19 km east from Zagazig city in the southern area of the site spreading over the left bank of Ismailiya canal. This area consists of 18 villages and hamlets (called as "ezba" in Arabic) including Kafr Aiyad village, the biggest and representative one supported with rice, cotton and fruit cultivations.

The area is supplied water through CIP  $\phi$  300 mm which is one of main pipes for Bilbeis city and is branched from CIP  $\phi$  500 mm heading for Zagazig city.

All these 18 villages and ezba of the area are supplied through three lines of ACP  $\phi$  150 mm -  $\phi$  100 mm rebranched from the said CIP  $\phi$  300 mm. There are 24 mosques, 9 governorate schools and 6 clinics within the area. In addition two large-scale poultry farm buildings are in operation.

By reason of being comparatively close to consuming cities such as Zagazig, Bilbeis and Abu Hammad, the area has recently developed remarkably in fields of plantation of fruiter tree cultivation, poultry breeding and fish farming. In connection with yearly developments the utilization of sizable agricultural machinery like tractor and harvester has become popular among the proprietors of such agribusiness.

The features of the survey area are :

No. of connections	:	500
Pipeline	:	CIP $\phi$ 300 x 1,300 m
		SP $\phi$ 150 x 500 m
		ACP $\phi$ 150 x 5,100 m
		ACP $\phi$ 125 x 900 m
		ACP $\phi$ 215 x 4,200 m
		PVC $\phi$ 100 x 1,500 m
<hr/>		
Total		24,500 m

#### Survey Schedule

The survey was conducted in accordance with the following schedule:

15 Aug (Wed)	Field survey and preliminary leakage survey
16 Aug (Thu)	- do -
18 Aug (Sat)	- do -
19 Aug (Sun)	Water flow observation for 24 hours, and
20 Aug (Mon)	Confirmation and observation of pipelines and taps.

#### Preparation of Drawings and Preliminary Leakage Survey

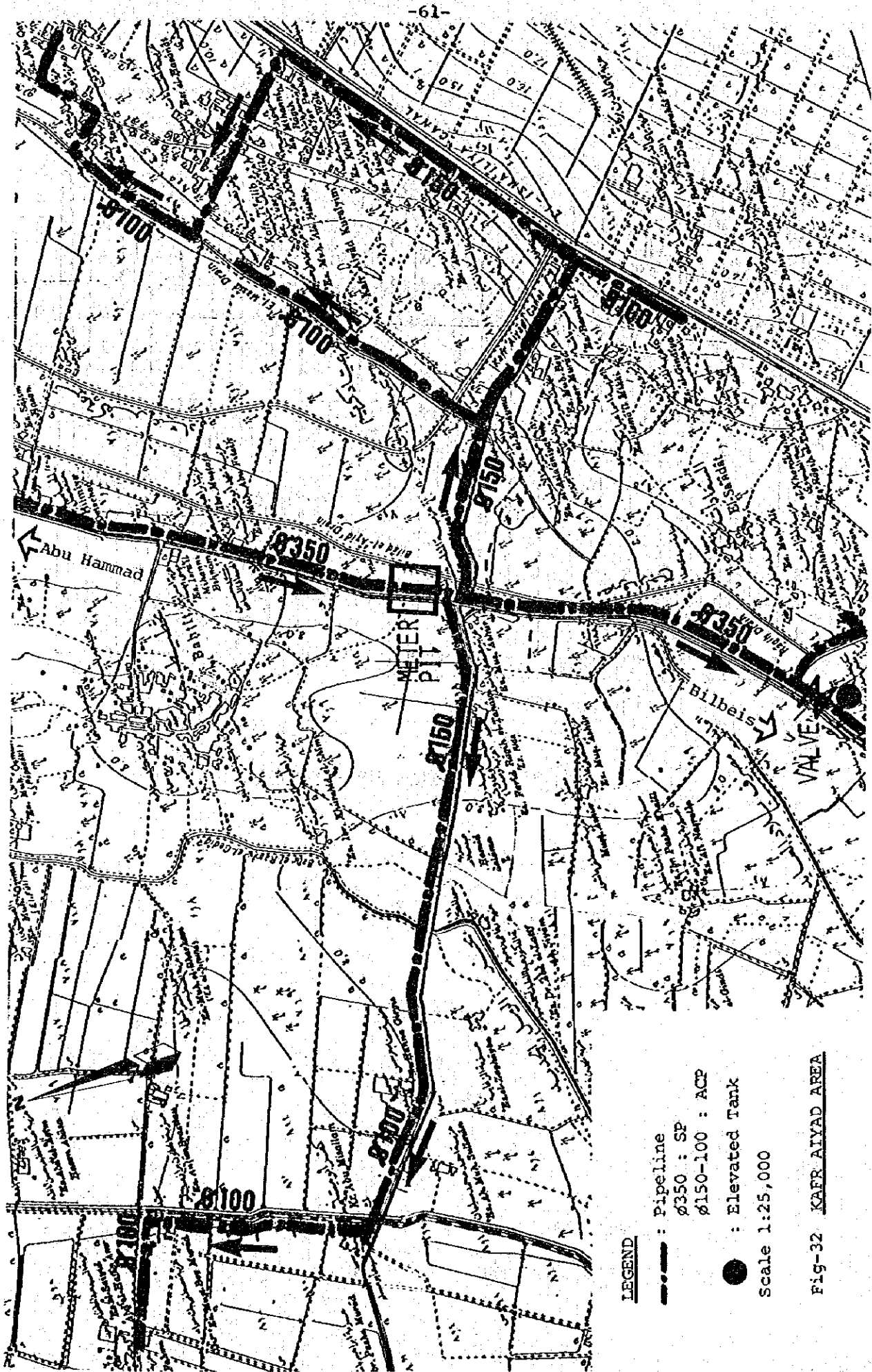
To make up the necessary sketches, several staffs assisted the Study Team member with some villagers concerned, since there were no reliable drawings in this area as well.

When the sketches were prepared, five leaking sites were found along the pipelines  $\phi$  300 mm and  $\phi$  100 mm. Within them 2 sites were repaired prior to the leakage survey. Three of these five leakage seemed to be occurred by shock load such as heavy truck. The other leakage points were from saddles.

Several saddles and joints were dug for checking the pipe sizes and their conditions as employed at every survey site. Their condition was satisfactory as long as inspected visually.

Water Flow Observation

The water flow and supply pressure were observed for two days of 19 and 20 August as scheduled. The obtained result is shown in Fig-33.



**LEGEND**

- : Pipeline
- Ø350 : SP
- Ø150-100 : ACP
- : Elevated Tank
- Scale 1:25,000

Fig-32 KAFR AIYAD AREA

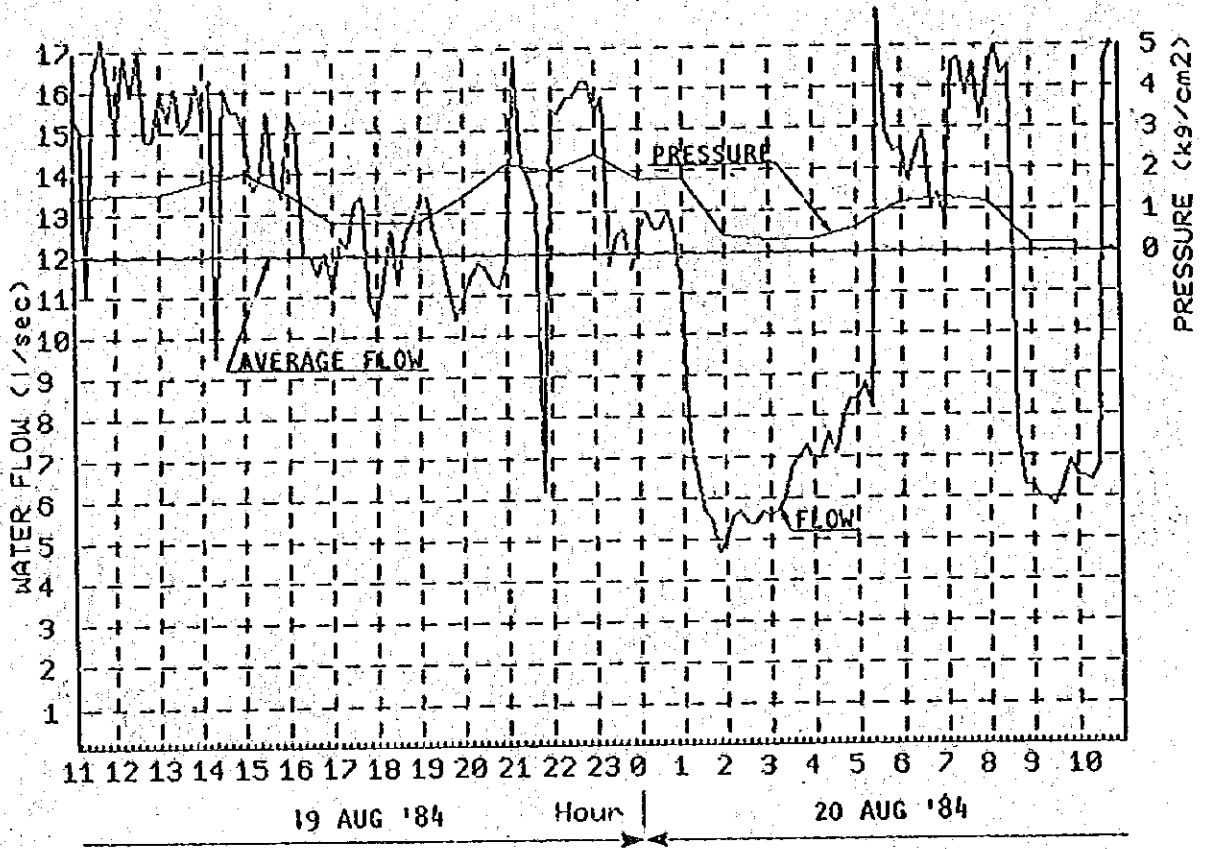


Fig-33 WATER FLOW AND PRESSURE

### III. CONSIDERATION FOR SURVEY RESULTS

#### 3.1 Summary of Survey

The field surveys were carried out from May to August 1984 at 9 sites consisting of 3 at Zagazig city, 2 at Housing Department System and 4 at Abbasa Regional Water Supply System, respectively. The flow observation of Midam Montaza at Zagazig city could not be surveyed due to a high water table.

Generally leakage from pipelines looks comparatively low in the Governorate. However, much wastage was observed everywhere, especially at public taps like standpipes and faucets of mosques.

### 3.2 Classification of Water Use and Definition of Terms

Regarding the use of water supplied by the public services, the common sense questions will be if the water is used effectively and if the used water is bearing revenue for the supply services.

Using the term "accounted for" which means "revenue bearing", a rough classification of the water use will be as follows:

- a) effective and accounted for,
- b) effective and unaccounted for,
- c) ineffective and accounted for and
- d) ineffective and unaccounted for

a) is the most and normal use of water, unnecessary for further explanation, while d) is mostly the leakage from the publicly owned pipelines.

b) is usually understood as used for the public installations like fountains, standpipes, fire-hydrants and it also includes the use in mosques, in the Egyptian cases. c) is a use, even though it is paid for, which is not effective: for instance the water being discharged from faulty taps and taps left open by negligence.

Findings in Sharqiya Governorate surveys indicates that a substantial water is being wasted in the uses of b) and c). Calling it "wastage" as a whole, the leakage of d) and the wastage as defined will be quoted in the later description.

### 3.3 General Situation

Prior to the leakage survey, it was anticipated that there would be a considerable leakage along the pipelines in Sharqiya Governorate, as it was described in the Beheira study report made in 1979 which had resulted from the first and sole leakage survey conducted systematically in the country. Contrary to the anticipation formed by the study results in which the leakage ratio was estimated at about 60 %, the leakage of pipelines in the Governorate was not so high as foreseen. Instead however, much wastage was observed everywhere, especially at the public taps like standpipes and faucets of the mosques.

Generally the leakage from pipelines is comparably low in the Governorate. The reasons seem to be as follows:

- a) At present the supply pressure is low as a whole,
- b) The shocks of heavy traffic load are not inflicted on the pipes and joints,
- c) The service pipes are usually installed by the water supply agencies own personnel,
- d) excavation works for the underground installations like gas pipes, telephone, etc. have not been made along or across the water pipelines, and
- e) Most soil in the Governorate generally consists of silt, clay or their mixture originating from alluvium of the Nile. Therefore, a leakage is easily detectable on the ground surface, as water tends to seep upwards due to the low permeability of underground soil.

The present low leakage maintained under the above described conditions will be increased when the conditions changes, and such changes may occur as the area are subjected to a rapid development.

To save the limited budget, the villages' voluntary labor has been widely employed for the pipelaying works in the rural areas. Where the groundwater table is high, they are compelled to lay the pipes in a shallow depth, because the dewatering pumps are not available usually. It causes leakage in many cases, as found at Elaragy, Karr Aiyad and Souwa, where the depth are only about 20 to 30 cm at some places.



And also, in recent years, as many big/heavy agricultural tractor has been introduced to farmers, many pipe-breaking accidents have been occurred.

Observation during the leakage survey disclosed several facts as described below:

#### Pipelines

Except some cases, the public pipelines are laid at a depth which can well stand the traffic load impacts and other disturbances. When the covering earth was excavated for installation of the flow measuring sensor, the pipelines were visually inspected and it was found that they had not been corroded both inside and outside and that few joints were leaking.

#### Water Meters

While a high portion of the water meters are found faulty or damaged in the urban areas, such cases are seen far less in the rural areas of the Governorate. Some of the damages to have been inflicted even intentionally.

#### Service Pipes

The service pipes installed indoors are mostly exposed and rarely seen leaking, possibly owing to the consumers' good care. However in some cases, the preceeding part installed outdoors are found dripping.

#### Faucets

Noticable is the finding that many publicly used faucets like in the mosques and outdoor standpipes are in the worst conditions. In an extreme case, a wooden piece plugs the pipe probably after the faucet has been removed.

### 3.4 Survey Results

Survey results are tabulated in table - 3.

From a 24 hours' continuous measurement, the maximum and minimum flow rates of a distribution pipeline can be recorded and by processing the data the average flow rate can be calculated. Table 4 lists those flow rates and the ratios between the maximum, average and minimum, respectively abbreviated as Max., Av., and Min.

#### a) Max./Min. Ratio

The Max./Min. ratios of Asloug and Kattawia are comparatively lower than those of other areas. Referring Table 3, it is found to be resulted from the considerably low pipeline pressure possibly. In Asloug village where leakage has been detected at several spots, a construction work is ongoing for improvement.

#### b) Max./Ave. Ratio

In the table the ratio ranges from 1.3 to 5.5, averaging 2.2. The two locations of El-Falaha and Bany Coresh show rather high figures, while both of the above mentioned Asloug and Kattawia show low figures. Where the supply pressure is high and the leakage/wastage ratio is low, the Max./Ave. ratio tends to run high as seen in Table 3 and 4.

This ratio is usually termed and used, in designing a supply system, as a "peak factor".

#### c) Min./Ave. Ratio

The percentage ratio, varying from 34 to 71, is the ratio including both leakage and wastage. El-Falaha and Bany Coresh, showing zero value, are exceptionally good.

d) Tap Close

To check the wastage occurring in the household uses, the taps leading to the inhouse installations, as many as possible practically, were closed by the supply services personnel during the measurement. Except at Kafr El-Eshara, four cases showed a decrease of the flow rate, further down from the minimum. The substantial decrease itself may be interpreted as the wastage and the "tap close" as the leakage of the public pipelines.

About the 60 % quoted as an approximate leakage ratio in the Beheira report, it is not far from the result of the Sharqiya survey and seems realistic, if the figure includes both leakage and wastage as defined previously.

Table 3 SUMMARY OF SURVEY RESULTS

Item	Zagazig City		Housing Dept.		Abbasa Regional Water Supply				
	Kafr El-Eshara	Midean Montaza	El-Falaha	Bany Coresh	Aslougy	Kattawia	Ellen	Eleragy	Kafr Aiyed
Survey Site	Ø100-75 420	Ø400-250 230	Ø100 180	Ø125-75 1,095	Ø100 2,000	Ø100 980	Ø100 462	Ø100 1,980	Ø300-100 13,500
Pipe Size (mm)	2,000*	1,050*	650*	56,250	96,163	2,940*	1,540*	32,300	675,000
Length (m)	21,500	10,350	8,100	50,000	50,000	50,000	23,500	32,300	675,000
Population	2,000*	1,050*	650*	56,250	96,163	2,940*	1,540*	32,300	675,000
Area (m2)	21,500	10,350	8,100	56,250	96,163	50,000	23,500	32,300	675,000
Private Con. No.	273	133	125	40	95	380	200	250	500
Public Con. No.	1	1	1	7	9	1	1	6	39
Building No.	43	30	34			430*	230*		
Household No.	286*	150*	130*			420*	220*		
Standpipe No.	0	0	0	4	0	2	0	2	45
Total Consumption (m3/day)	364	-	62	33	509	242	352	275	1,036
Av. Flow (l/s)	4.2	-	0.7	0.4	5.9	2.8	4.1	3.2	11.9
Max. Flow (l/s)	6.1	-	2.0	2.2	7.2	3.7	6.4	7.9	17.9
Min. Flow (l/s)	2.6	-	0	0	4.1	2.0	1.7	1.5	4.1
Tap Close (l/s)	2.8	-	0	0	3.9	0	0	0.8	-
Consumption/Con. (l/Con.)	1,328	-	492	702	4,894	635	1,751	1,066	1,786
Per Capita Consumption (l/cd)	182*	-	95*	82*					
Max. Pressure (kg/cm2)	2.0	-	2.0	0.4	0.9	0.7	2.5	4.8	2.4
Min. Pressure (kg/cm2)	1.0	-	1.0	0	0.6	0	0.5	1.0	0.3

(Note) "Con" means an abbreviation of "Connection" employed in the table  
 " Tap Close" denotes a water flow observed under closed taps by operating stop cocks.  
 The water flow could not be observed at Midean Montaza, and Tap Close was not carried out at Kafr Aiyed.  
 \* denotes "estimated".

Table 4 FLOW RATIO

Item	Zagazig City			Housing Dept.			Abbasa Regional		
	Kafr El-Eshara	El-Falaha	Bny Coresh	Aslougny	Kattawia	Ellem	Eleragy	Kafr Alyad	
Av. Flow (l/s)	4.2	0.7	0.4	5.9	2.8	4.1	3.2	11.9	
Max. Flow (l/s)	6.1	2.0	2.2	7.2	3.7	6.4	7.0	17.9	
Min. Flow (l/s)	2.6	0	0	4.1	2.0	1.7	1.5	4.1	
Tap Close (l/s)	2.8	0	0	3.9	0	0	0.8	-	
Max./Av.	1.5	2.9	5.5	1.2	1.3	1.6	2.2	1.5	
Max./Min.	2.4	*	*	1.8	1.9	3.8	4.7	4.4	
Min./Av. (%)	62	0	0	69	71	41	47	34	
Min/Tap Close	**			1.1			1.9		

(Note) \* : Mathematic infinity  
 \*\* : No measing. Because almost taps were not closed and the obtained figure 2.8 is unreliable.

### 3.5 Reducing Leakage

The leakage of pipelines, when detected, shall be immediately repaired and stopped. Not only it saves the loss of water but also it makes the undetected leakage detectable, as the decreased leakage will cause more leakage on the other spots. Moreover, in detecting other leakage the soil condition as described before will affect favourably. Patient repetition of such works will eventually result in a certain low level of the leakage ration.

For a systematic detection and repair works, the following will be needed essentially:

- Keeping well classified and documented records of pipelines and valves,
- managing all pipe materials and valves in stock in an orderly manner,
- preparing the repair works team for an immediate action,
- replacing the missing caps and covers of valves and chamber for easy finding of their locations.

### 3.6 Reducing Wastage

Repairing a leaking faucet is an easy work once the know-how is learned and practiced a few times. Neglected wastage comes from the consumers incapability of repairing and/or inattention of wastage.

Related to the wastage problem, maintaining the water meters in accurately-working conditions is indispensable. The responsibility is on both the supply service and consumers. When the water meters conditions are changed for improvement, the water tariff shall be raised to a reasonable and realistic level so that the consumers may realize the value of water and water supply service.

The following steps will be effective in reducing the wastage:

- immediate response to the consumers' request on repairing leaking faucets and teaching them how to do-it-themselves,
- systematic inspection, repair and replacement of the water meters,
- establishment of the realistic water tariff and its structure

### 3.7 Organizational Consideration

A leakage occurs unexpectedly and needs immediate repair, as it may cause damages on the roads and surroundings, not to mentioning the inconveniences on the traffic. In order to reduce the leakage, a preventive maintenance work shall be practiced.

Equipped with the leakage detection tools/devices and repair machines, and staffed with engineers, technicians, skilled and common workers, a special party shall be organized in the public water supply services. While repairing the leakage of pipelines occasionally, the party is engaged in the detection/repair as a daily maintenance work. By its nature it belongs to a technical/engineering department/division responsible for the distribution system.

The wastage from private and public faucets shall be repaired immediately upon the consumers' request and the supply service shall teach them the know-how of repairing by themselves on such occasions. The wastage prevention works are to be considered a service to the consumers, as it intends to save the inconvenience and expense for their sake.

The wastage prevention works, like regarding meter, billing and collecting the water tariff and installing the service facilities, shall belong to the public service department/division, because all the said works are similar in that they need the cooperation of the consumers. All the works shall be coordinated and integrated by the management of the department/division.



APPENDIX

Photographs of Survey Sites

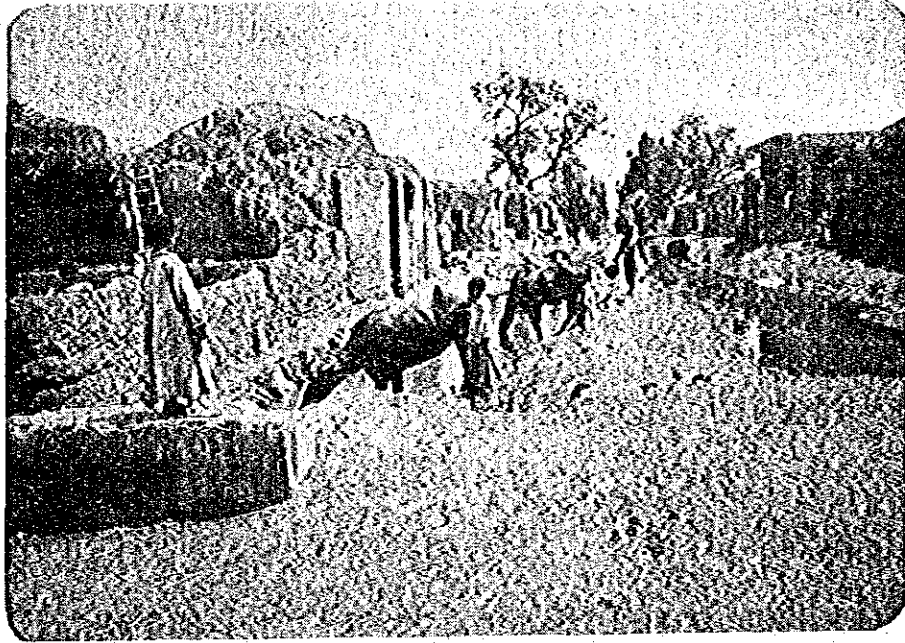
* Meter pit at Kafr El-Eshara area of Zagazig city .....	75
* Survey site, El-Aslough village of Housing Department's system .....	75
* Survey site, Elaragy village of Abbasa system .....	76
* Pressure observation by a local staff at Elaragy village .....	76
* Flow observation at Bany Karish village of Housing Department's system .....	77
* Leak detection with a local staff at Kafr El-Eshara area of Zagazig city .....	77
* Dripping tap and damaged tap covered with rags of a standpipe .....	78
* Installed private booster pumps .....	78



Meter pit at Kafr El-Eshara area of Zagazig city



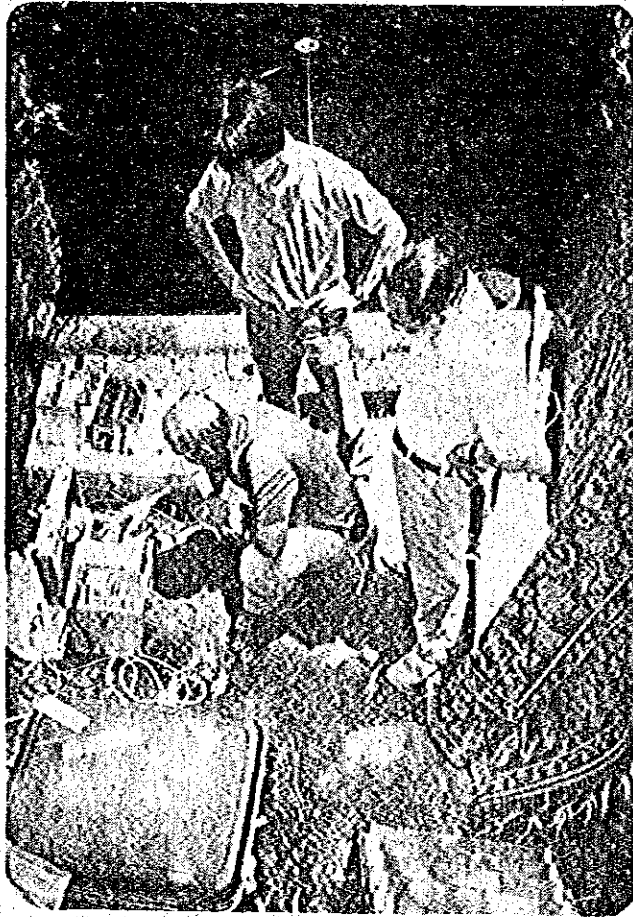
Survey site, El-Aslough village of Housing  
Department's system



Survey site, Elaragy village of Abbasa system



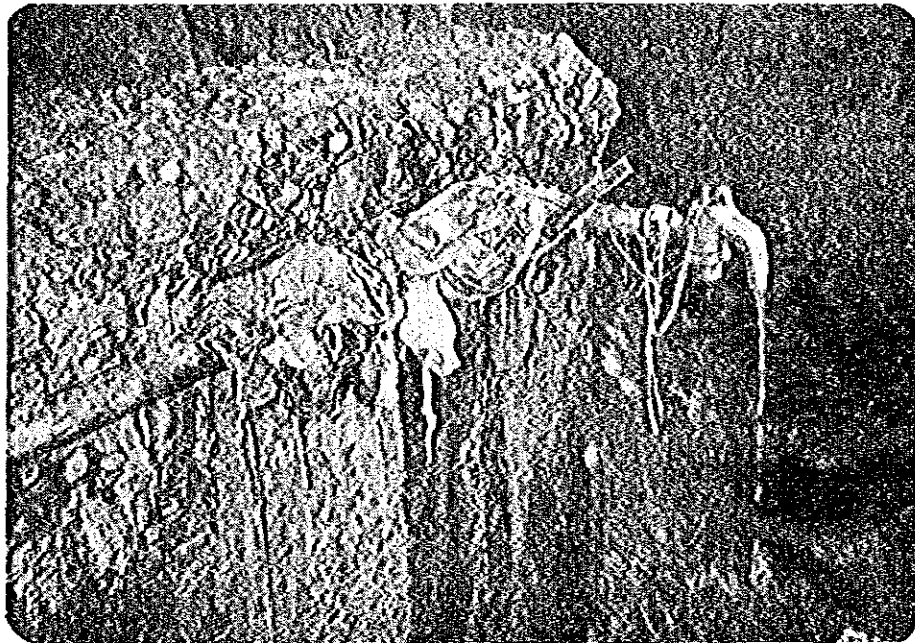
Pressure observation by a local staff at  
Elaragy village



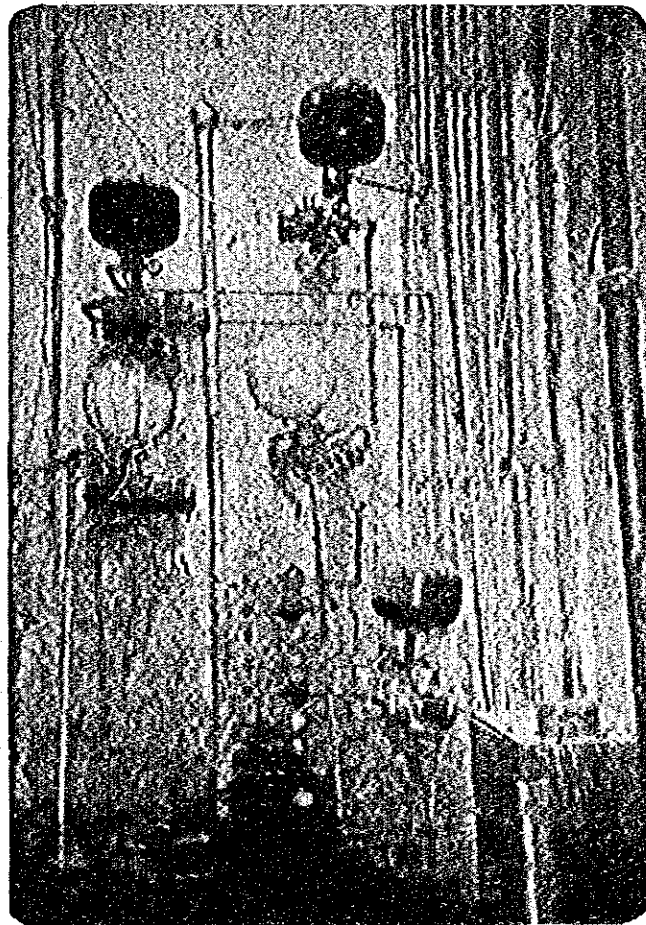
Flow observation at Bany Korish village of Housing Department's system



Leak detection at Kafr El-Eshara area of Zagazig city



Dripping tap and damaged tap covered with rags of  
a standpipe



Installed private booster pumps









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