3.4.5 Drainage (Appendix)

(1) Forward

This work was carried out in the preliminary design study. During this stage, rainfall ditches along the roads in the industrial estate and residential area were taken into consideration.

As agreed in the Minutes of Meeting on September 12, 1992, all the rainfall ditches were canceled. Rainfall run-offs will be collected together with wastewater by a combined system of drainage and sewerage. The combined system is requested by MODANC.

This subsection is described for a readers reference as an Appendix.

(2) Design Conditions

(a) Design Rainfall

a) Features of the Rainfall Data

Available and probable rainfall data are mentioned in the Progress Report. Features of rainfall at the project area are summarized:

- Storm rainfall occurs several times a year as revealed by the daily rainfall data of Suez City for a period of 10 years.

- The duration of the storm rainfall is almost less than 1.5 hours.

- The recorded maximum daily rainfall is 22.0mm/day on Jan. 26, 1990 which corresponds to a return period of about 25 year.

b) Design Rainfall

Design rainfall for the drainage in Ataqa I.E. and Adabiya I.F.Z. is selected 14.4 mm/day with 5 year return period due to the following reasons:

- It rains only a few days for the duration less than 1.5 hours in every year.

- According to the monthly maximum daily rainfall data of Suez City, the maximum rainfall recorded forty seven (47) times during the 10 year period, and rainfall more than 14.4 mm/day is only three (3) times for the same period. Based on the statistical data, the probability of the occurrence of the rainfall more than 14.4mm/day is considered less than 6.4%.

- Dimensions of the drainage ditch is to be minimized for economy.

- Storm water protection will be built around the Ataqa I.E. and Adabiya I.F.Z. to meet the 23.4 mm/day rainfall with a 30 year return period.

The duration of the design rainfall of the 14.4 mm/day for the drainage is estimated to be 90 minutes. Therefore, the design rainfall intensity becomes 9.6 mm/hr.

(b) Layout of the Drainage System

Open channel drainage along the road is proposed. The following studies are carried out:

- Estimated catchment areas are shown in Figure 3.4-5-1. Design discharge points are also indicated in this Figure.

- The drainage system is planned based on the estimated catchment areas and the road network plan as mentioned above. Layout plan of the drainage system is shown in Figure 3.4-5-2.

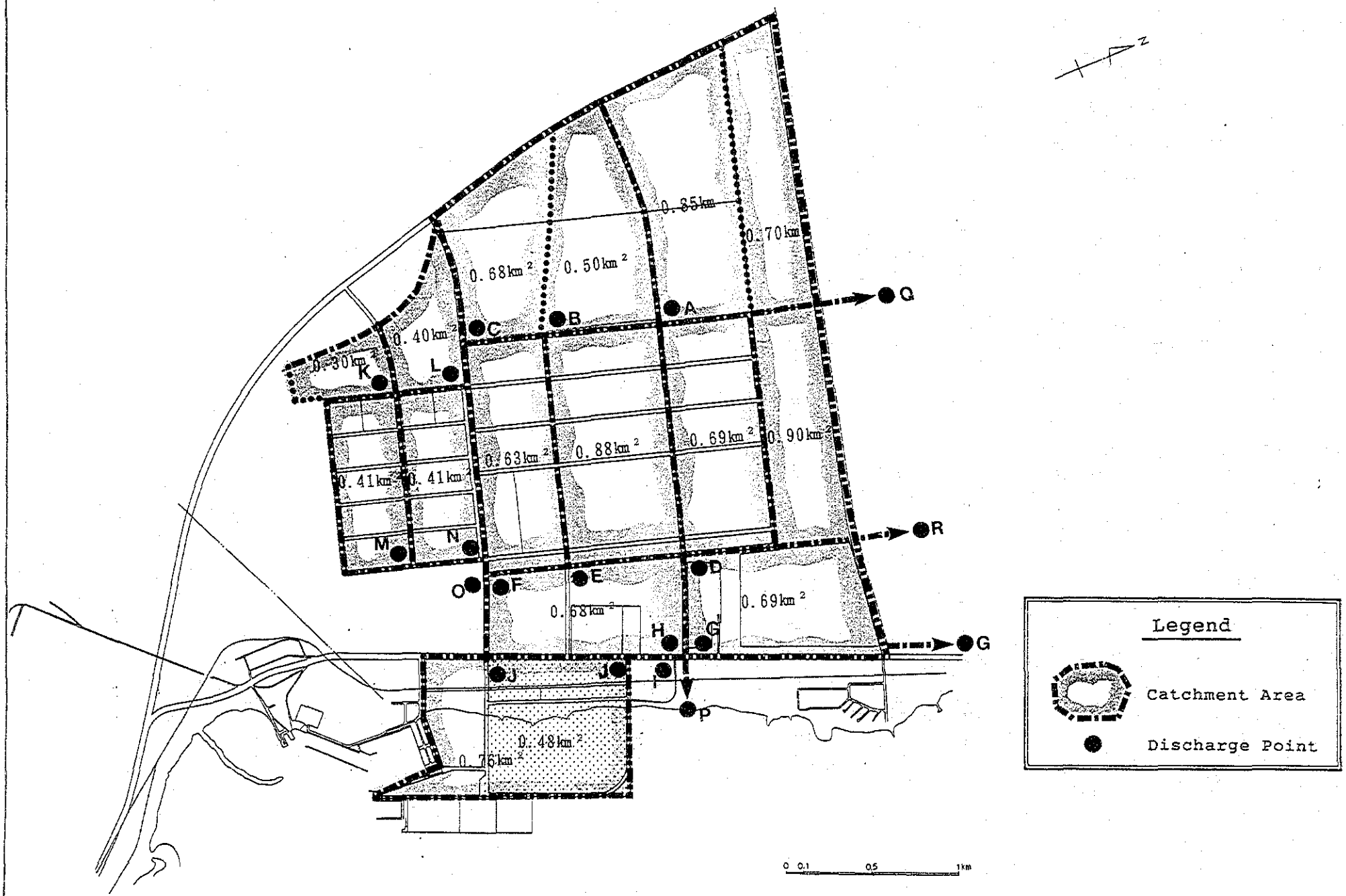


Figure 3.4-5-1 Estimated Catchment Area (Appendix)

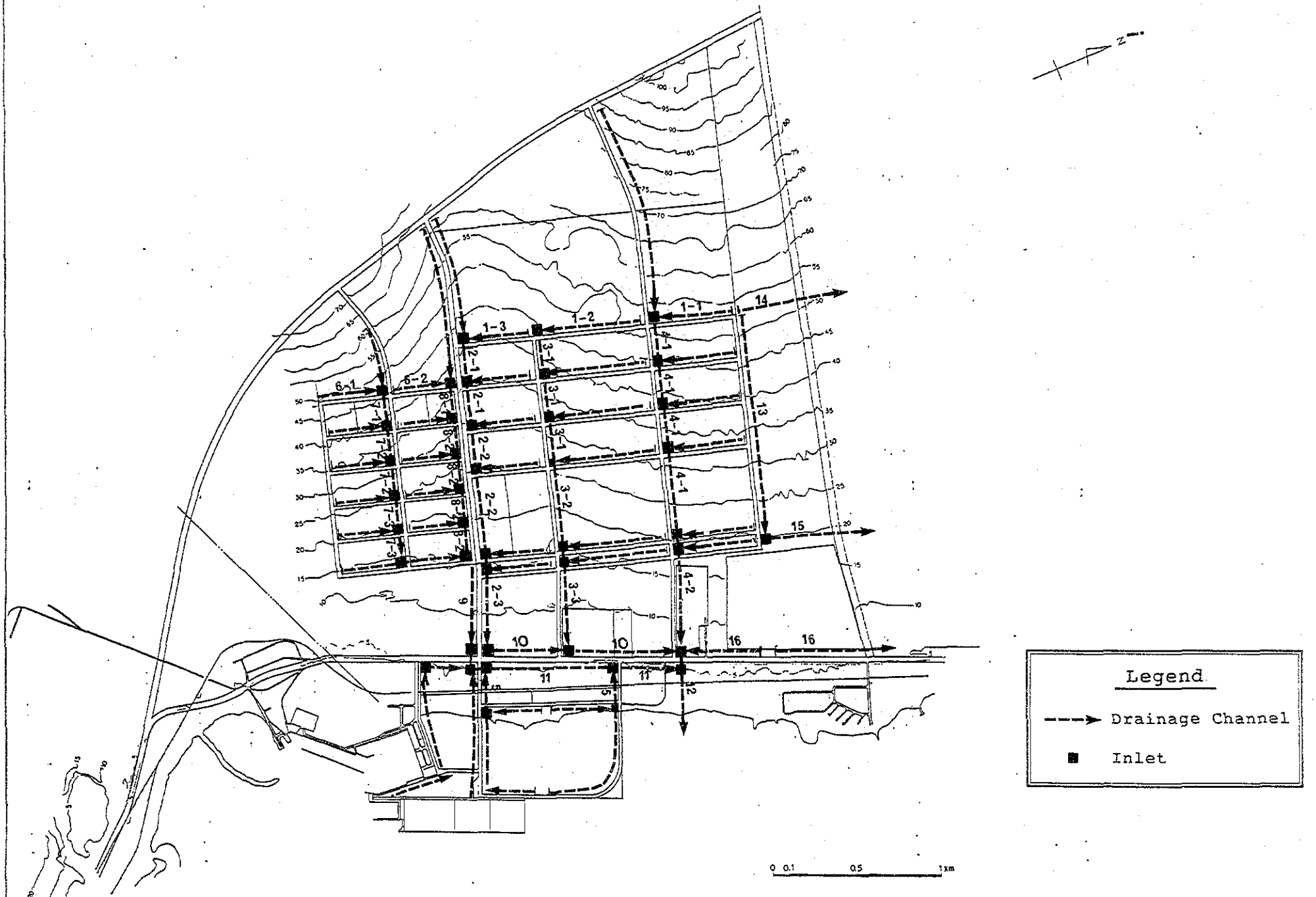


Figure 3.4-5-2 Layout Plan of the Drainage System (Appendix)

(3) Preliminary Design

(a) Design Discharge

The design discharge of each drainage channel is calculated by the following Rational Formula.

$Q = 1/3.6 \times C \times I \times A$

where;

Q: Peak discharge (m3/s)
C: Runoff coefficient (C=0.4)
I: Rainfall intensity (mm/hour, I=9.6)
A: Catchment area (km2)

In the above formula, the runoff coefficient is estimated 0.4 which is two (2) times higher than the coefficient for storm water drainage design. This is to meet the probable area covered by the factory lots in the future, such as factory buildings and pavement.

The design peak discharge is calculated by the above formula. The calculated points are indicated in Figure 3.4-5-1. The results are summarized in Table 3.4-5-1.

(b) Drainage Channel

A trapezoidal channel section is proposed same as storm water drainage. The side slope of channel is 1:0.5, and mortar riprapping is applied for protecting the slope.

The hydraulic studies were conducted to determine the most appropriate size and dimensions of the drainage channel by applying the following Manning's formula.

$Q = A \times V$

$V = 1/n \times R(2/3) \times I0.5$

where;

Q: Discharge (m3/s)
A: Flow area (m2)
V: Flow velocity (m/s)
n: Roughness coefficient
R: Hydraulic radius (m)
I: Gradient of channel

The results of the study is summarized in Table 3.4-5-2.According to the results, the proposed dimensions of each drainage channel are determined as shown in Figure 3.4-5-3.

Table 3.4-5-1 Calculated Peak Discharge (Appendix)

(1) Ataqa Industrial Estate

Basin and Point	Catchment Area (km2)	Rainfall Intensity (mm/hr)	Runoff Coeff.	Peak Discharge (m3/s)
Future Expansion Area and Green Zone				
A	0.85	9.6	0.4	0.91
B	0.50	9.6	0.4	0.53
C	0.68	9.6	0.4	0.73
Factory Area				
D	1.54	9.6	0.4	1.64
E	1.38	9.6	0.4	1.47
F	1.31	9.6	0.4	1.40
G	0.35	9.6	0.4	0.37
H	3.37	9.6	0.4	3.59
I	2.28	9.6	0.4	2.43
J	0.24	9.6	0.4	0.26

(2) Adabiya Industrial Free Zone

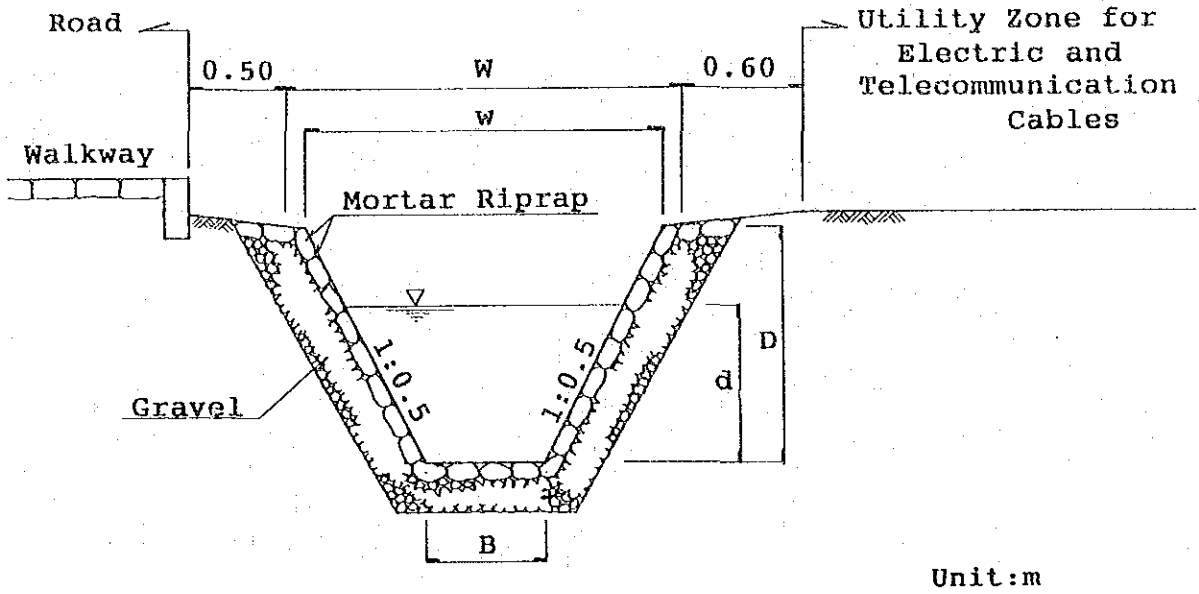
Basin and Point	Catchment Area (km2)	Rainfall Intensity (mm/hr)	Runoff Coeff.	Peak Discharge (m3/s)
Residential Area				
K	0.30	9.6	0.4	0.32
L	0.40	9.6	0.4	0.43
Factory Area				
M	0.71	9.6	0.4	0.76
N	0.81	9.6	0.4	0.86
O	1.52	9.6	0.4	1.62

(3) Others

Basin and Point	Catchment Area (km2)	Rainfall Intensity (mm/hr)	Runoff Coeff.	Peak Discharge (m3/s)
Out Put				
P	7.54	9.6	0.4	8.04
Green Belt				
Q	0.70	9.6	0.4	0.75
R	0.90	9.6	0.4	0.96

Table 3.4-5-2 Sizes and Dimensions of Drainage Channels (Appendix)

Drainage Channel	Design Discharge (m3/s)	Water Depth (m)	Base Width (m)	Slope (1:m)	Rough. Coeff.	Grad.	Flow Velocity (m/sec)	Froude Number
(1) Ataqa Industrial Estate								
1-1	0.91	0.80	0.60	1 :0.5	0.030	0.005	1.14	0.41
1-2	0.61	0.50	0.60	1 :0.5	0.030	0.012	1.44	0.65
1-3	0.80	0.95	0.60	1 :0.5	0.030	0.002	0.78	0.26
2-1	1.40	0.65	0.60	1 :0.5	0.030	0.025	2.33	0.92
2-2	1.42	0.70	0.60	1 :0.5	0.030	0.020	2.14	0.82
2-3	1.45	0.75	0.60	1 :0.5	0.030	0.016	1.98	0.73
3-1	1.60	0.70	0.60	1 :0.5	0.030	0.025	2.40	0.92
3-2	1.62	0.75	0.60	1 :0.5	0.030	0.020	2.21	0.82
3-3	1.62	0.80	0.60	1 :0.5	0.030	0.016	2.03	0.73
4-1	1.81	0.75	0.60	1 :0.5	0.030	0.025	2.47	0.91
4-2	1.82	0.80	0.60	1 :0.5	0.030	0.020	2.27	0.81
5	0.35	0.60	0.60	1 :0.5	0.030	0.002	0.64	0.26
(2) Adabiya Industrial Free Zone								
6-1	0.54	0.60	0.40	1 :0.5	0.030	0.010	1.29	0.53
6-2	0.51	0.45	0.40	1 :0.5	0.030	0.025	1.80	0.86
7-1	1.18	0.65	0.40	1 :0.5	0.030	0.035	2.51	0.99
7-2	0.80	0.55	0.40	1 :0.5	0.030	0.030	2.15	0.93
7-3	0.86	0.60	0.40	1 :0.5	0.030	0.025	2.04	0.84
8-1	0.86	0.60	0.40	1 :0.5	0.030	0.025	2.04	0.84
8-2	0.89	0.65	0.40	1 :0.5	0.030	0.020	1.89	0.75
9	1.82	0.85	0.60	1 :0.5	0.030	0.016	2.09	0.72
(3) Others								
10	3.71	1.45	1.50	1 :0.5	0.030	0.002	1.15	0.31
11	2.67	1.20	1.50	1 :0.5	0.030	0.002	1.06	0.31
12	8.28	1.60	1.80	1 :0.5	0.030	0.005	1.99	0.50
13	1.04	0.55	0.60	1 :0.5	0.030	0.025	2.16	0.93
14	0.77	0.60	0.60	1 :0.5	0.030	0.010	1.42	0.59
15	1.01	0.85	1.00	1 :0.5	0.030	0.002	0.83	0.29
16	0.39	0.70	0.50	1 :0.5	0.030	0.002	0.65	0.25



Dimensions of Drainage Channels

Unit: m

Area	No.	W	B	D	w	d
Ataqa Industrial Estate	1	2.0	0.6	1.2	1.8	0.50 ~0.95
	2	2.0	0.6	1.2	1.8	0.65 ~0.75
	3	2.0	0.6	1.2	1.8	0.70 ~0.80
	4	2.0	0.6	1.2	1.8	0.75 ~0.80
	5	1.6	0.6	0.8	1.4	0.60
Adabiya Industrial Free Zone	6	1.5	0.4	0.9	1.3	0.45 ~0.60
	7	1.5	0.4	0.9	1.3	0.55 ~0.65
	8	1.5	0.4	0.9	1.3	0.60 ~0.65
	9	2.0	0.6	1.2	1.8	0.85
Other Areas	10	3.5	1.5	1.8	3.3	1.45
	11	3.5	1.5	1.8	3.3	1.20
	12	4.0	1.8	2.0	3.8	1.60
	13	1.6	0.6	0.8	1.4	0.55
	14	1.6	0.6	0.8	1.4	0.60
	15	2.4	1.0	1.2	2.2	0.85
	16	1.6	0.5	0.9	1.4	0.70

Figure 3.4-5-3 Typical Cross Section of Drainage Channel (Appendix)

(4). Conclusions and Recommendations

a) The preliminary design study for the drainage is conducted by applying 14.4 mm/day rainfall which will take place with 5 year return period.

b) The open channel drainage network along the road as shown in Figure 3.4-5-2 is proposed.

c) The trapezoidal channel section with 1:0.5 side slope of mortar riprapping applied for the slope protection is proposed.

d) Proposed dimensions of the channel determined by the hydraulic studies are as shown in Figure 3.4-5-3.

3.5 RAILWAY

3.5.1 Purpose of Proposed Railway

The purpose of the proposed railway is to transport imported wheat and other grain products from the proposed Ataqa Port to the inland areas. The grain products will be loaded into the wagons through the hopper bin to be constructed in the bonded area of the port, and the loaded train will be dispatched to the existing main line after shunting in the proposed yard. The railway to be constructed in this project includes loading lines, a shunting yard, a branch station from the existing main line and a connecting line between the loading lines and the shunting yard.

3.5.2 Design Items

The design items to be included in the detailed design are as follows:

Permanent way

- Plan and profile of track
- Alignment of shunting yard, loading yard and branch station
- Earthwork and drainage
- Construction gauge
- Cross section of track
- Track accessories
- Turnout details
- Office building, storage and workshop for railway

Railway signaling system

- Signaling system
- Interlocking device
- Signal device
- Safety device at railway crossing
- Telecommunication network
- Telecommunication cables

3.5.3 Design Conditions

(a) Role of proposed railway

The role of the proposed railway is to receive the empty trains from the main line, to break down trains in the yard, to load wheat or other grain products on the loading line in the proposed bonded area of the Ataqa Port, to build up trains in the yard and to dispatch the loaded trains to the main line. To achieve this objective, a branch station, a shunting yard, loading lines and their connecting line shall be constructed.

(b) Traffic volume forecast

The traffic volume of wheat and other grain is forecasted as follows:

Traffic Volume Forecast

Year	2000	2010
Total volume (thousand ton/year)	1,300	1,800
Volume transported by rail (thousand ton/year) (70% of total)	910	1,260

No other commodities are assumed to be transported by the proposed railway from the Ataqa I.E. and Port. However, the area along the proposed loading line where an unloading facility of agricultural products may be constructed in future. This is taken into consideration for the design work.

(c) Train composition

The composition of the trains to be operated on the proposed line is estimated as follows:

1) Dimensions of wagons and locomotives

The major dimensions of the wagons and the locomotives to be operated on the railway are assumed as follows in accordance with the standards of Egyptian National Railways:

Wagon

Type:	2-axle bogie hopper wagon
Loading capacity:	65 ton
Overall length:	16,000 mm
Max. width:	3,000 mm
Max. height:	4,319 mm

Locomotive

Maximum length:

main line locomotive	21,630 mm
shunting locomotive	19,000 mm

2) Train composition

The train to transport grain products will normally consist of a locomotive and maximum 25 wagons on the main line. The length of the train will be about 422 meters and the loading capacity of the train will be 1,625 tons.

The train will be divided into two portions in the shunting yard and each portion will be operated to the loading area one by one, because the effective length of the loading track will be too short to accommodate the whole trainset due to lack of Right-of-Way. The number of wagons forming each portion shall be 13 or less.

(d) Number of trains to be operated on main line

The number of trains to be operated on the main line to transport the forecasted traffic volume of grain products is computed as follows on the assumption that the annual working days are 295 days and the fluctuation ratio of the daily traffic volume is 30 %.

Year 2000: $910{,}000 / 295 \times 1.3 / (65 \times 25) = 2.5 \fallingdotseq 3$

Year 2010: $1{,}260{,}000 / 295 \times 1.3 / (65 \times 25) = 3.4 \fallingdotseq 4$

3.5.4 Design Criteria

(1) Structure gauge and loading gauge

The structure gauge and the loading gauge to be adopted to the proposed railway are shown on the Drawing A7-7.1-1-6.

(2) Track

1) Track alignment

The design criteria for track alignment in station yards are stipulated by ENR as follows:

Minimum radius of curve:	200 meters
Maximum gradient:	
as far as possible	0 %
if necessary	0.2 %

2) Track structure

Basically, a ballasted track will be adopted for the proposed railway. Only for the loading line and crossing with road, a paved track will be constructed. The proposed roadway diagram of the ballast track is based on the standard diagram of ENR.

(3) Signaling and telecommunication system

The signaling and telecommunication system shall be designed based on the train operation system so as to be conformed to the train operating regulations of ENR. The system shall be composed of almost same system as already installed on the existing Suez-Adabiya Line.

3.5.5 Design Concept

(1) Location of railway network

The horizontal alignment of the proposed railway network is shown on the Drawing A7-7.1-1-1 and A7-7.1-1-4 and the vertical alignment is shown on the Drawing A7-7.1-1-2 and A7-7.1-1-3.

(a) Loading line

The loading line will be constructed so as to be stretched passing through the center point of the hopper bin of the loading facility. A weighing scale will be equipped at the track under the hopper bin on the loading line. It shall be located within the custom fence. The location of the loading line is to be decided taking into consideration the following conditions:

- to simplify train movements on the loading line
- to simplify train operation between the loading line and the yard
- to be located as close as possible to the proposed grain berth in order to reduce the distance to transport grain products from the berth to the loading facility

However, the study reveals that, even if it is located outside the port, the train must be divided into two portions to avoid the interference with road traffic to and from the port; it is due to the minimum requirement of radius of curve of track and the restricted area between the port premises and the existing railway main line along the Suez-Adabiya Coastal Road. Therefore, the loading line will be located as shown on the Drawing A7-7.1-1-1, though the location has a disadvantage that the normal train composition to be loaded on the loading line needs to be divided into two portions to enter the loading line because of short length of the proposed loading line.

(b) Shunting yard

A shunting yard will be constructed to receive empty trains from the main line, to break down and make up trains, to dispatch/receive trainset to/from the loading line, and to dispatch loaded trains to the main line. The yard will be located along the branch station, which is to be constructed at the connecting point of the proposed railway with the existing main line.

A single line will be constructed to connect the proposed loading line with the shunting yard.

(2) Signaling system

(a) Block and signaling system related to the main line

New signal block will be constructed at the branch point on the existing main line as mentioned above. The staff block system, which is being used on the main line at present, is adopted to the new signal block.

The existing block section, in which new signal block is to be located, will be divided into two block sections. The staff instrument and mechanical signaling system with signal cabins shall be equipped in the new signal block to control line clearance. In the signaling system, departure signals, receiving signals and precaution signals shall be equipped at the signal block. The signals and turnouts shall be handled from the proposed signal cabin by signalmen using a centralized mechanical control system with interlocking devices.

(b) Shunting yard

The signaling system of the shunting yard shall be equipped in accordance with the system mentioned above. The signals and turnouts on the dispatch lines, receiving lines and locomotive running line shall be interlocked with the signals and turnouts mentioned in the preceding subsection. The turnouts on the stabling lines will be handled with key lock at site.

(c) Loading line and connecting line

The train operation on the loading line and on the connecting line between the shunting yard and the loading line will be controlled manually. No block system will be equipped on the loading line and the connecting line. Only shunting signals shall be equipped to control the train operation outgoing from the yard and incoming to the yard. The trains shall be operated at the speed less than 8 km/h.

(3) Telecommunications

The telecommunication system will consist of the following devices.

(a) Railway system

The railway telephone, which is composed of the ordinary telephone will be equipped for general use at the station office, signal cabins and other offices related to the railway.

(b) Line block telephone system

The exclusive line block telephone system will be equipped between the new signal cabin and the same of the adjacent stations.

(c) Train despatching telephone

A slave telephone of the centralized train control system will be equipped at the new signal cabin to dispatch the train operation on the main line from the train control center.

(d) Wireless telephone

Wireless telephones will be provided on the shunting locomotive, at the signal cabin and the station office to control the train operation and shunting in the proposed I.E. and Port area.

3.5.6 Detailed Design

(1) Alignment of railway

The alignment of the railway is shown on the Drawing No. A7-7.1-1-1 and A7-7.1-1-4.

(a) Loading line

1) Length of a train to be loaded

Loading will be carried out onto the trainset divided into two portions as mentioned above. Each portion comprises maximum 13 wagons and a locomotive. Accordingly, the effective length required to accommodate the portion is computed as follows.

16m x 13	+	19m x 1	+ 25m	= 252m
(wagon)		(shunting loco)	(contingency)	

2) Track alignment

The track alignment of the loading line is planned as shown on the Drawing A7-7.1-1-4. The dotted line in the figure is to be constructed in future when the train operation becomes busy. Smooth train operation and reduction of obstruction on road traffic at the level crossing have been considered for the design.

3) Train operation on loading line

The trains will be operated on the loading line as mentioned below:

- An empty train enters from the shunting yard;
- The train is moved by the locomotive so that each wagon stops under the center of the hopper bin one by one;
- The wagons are loaded and weighed at the point of the center of the hopper bin;
- The train is drawn out after loading and weighing are finished;
- The loaded train departs the loading line towards the yard.

(b) Shunting Yard

The track alignment of the proposed shunting yard is shown on the Drawing A7-7.1-1-4.

1) Despatching and receiving line

The number of despatching line and receiving line has been estimated as follows:

The average time interval between the grain trains will be about eight hours in the year 2000 and six hours in the year 2010 according to the forecasted number of the trains (refer to Subsection 3.5.3 (4)). On the other hand, the total time required for shunting and loading a train is estimated at maximum five hours. Fluctuation of train operation and possible delay of trains on the main line as well as loading and shunting work on the proposed railway are taken into consideration, and two receiving lines and two despatching lines are necessary and enough to handle the proposed grain trains. A locomotive running line shall be constructed in addition to these lines. Accordingly, the following lines will be constructed:

Despatching line	2 lines
Receiving line	2 lines
Locomotive running line	1 line

The necessary effective length of each dispatching line and receiving line has been computed as follows:

16m x 25	+ 22m x 2	+ 35m	= 479m ≒ 500m	
(wagon)	(shunting loco)	(contingency)		

2) Stabling line

The trainset shall be broken down into two portions to be operated to the loading line as mentioned above. The stabling lines are required for shunting work to break down and build up trains. The effective length of each stabling line is calculated as follows:

16m x 13	+ 19m x 1	+ 35m	= 247m ≒ 250m
(wagon)	(shunting loco)	(contingency)	

3) Draw up line

A draw up line is required to carry out shunting work. Its effective length is estimated at 250 meters by the same calculation as above.

4) Other lines

Three lines with each effective length of 150 meters will be constructed to accommodate inspection trolleys and other vehicles for maintenance.

5) Illumination of yard

In the area including the dispatch and receiving tracks, locomotive running track, stabling tracks and inspection tracks, a lighting system of minimum illumination of one lux shall be provided by means of lighting towers with height of approximate 20 meters equipped with sodium vapor lamps.

(c) Connecting line

A line connecting the loading line with the yard will be constructed. The line will be located on the outside along the east and south boundary of the industrial zone. The line will be of single track, because only one train will be operated to the loading line beyond this lime at the same time.

(2) Track

(a) Track structure

The track structure shall be designed in conformity with the following requirements:

Gauge:	1,435 mm
Track profile:	shown on the Drawing A7-7.1-1-7 for shunting yard and shown on the Drawing A7-7.3-1-1 for loading line
Track spacing:	4.7 meters in shunting yard and 5 meters in loading area
Sleeper type:	Wooden sleepers
Sleeper spacing:	600 mm

Rail fastening:	K-type fastening shown on the Drawing A7-7.1-1-9
Rail:	UIC 54 or equivalent
Ballast:	Ballast thickness shall not be less than 250 mm measured below the base of the sleeper.
Cant:	No cant is provided.

(b) Track accessories

1) Sleeper

The sleeper size will be 250 mm x 150 mm x 2,600 mm for ordinary track and 250 mm x 150 mm x length as shown on the Drawing No. A7-7.1-1-8.

2) Ballast

The ballast will be of crushed stone of an accepted quality, which shall consist of clean angular fragments made of hard rock.

3) Fishplate

The dimensions of the fishplates are shown on the Drawing A7-7.1-1-9. The fishplates shall be fixed to rails with fishbolts and nuts.

(c) Turnout

The turnouts connecting to the main line will be 1 in 10 turnouts and the other turnouts will be 1 in 8 turnouts. The standard drawings of the turnouts are shown on the Drawing A7-7.1-1-8.

(d) Embankment

1) Earthwork

Embankment shall be built up evenly over the full width unless otherwise indicated on the drawings, and shall be maintained with a sufficient camber and a surface sufficiently even to enable surface water to drain readily from them.

(3) Signaling system

(a) Block system

The staff block system will be applied to the main line, as mentioned in Subsection 3.5.5 (2) (a). Two signal cabins, namely the first signal cabin and the second signal cabin shall be constructed in the proposed signal block area. A staff instrument shall be equipped in the first cabin.

(b) Interlocking machine

The kind of the interlocking machine is basically of the English type. The interlocking machine consists of lever parts and lock parts. In the lock parts, adequate dogs and cross bars shall be arranged to secure interlocking between the levers.

The proposed interlocking chart of the device is shown on the Drawing A7-7.1-2-1.

(c) Signal cabin

Two signal cabins, first and second cabin, will be constructed as mentioned above. Almost signal and point levers are installed in the first and second signal cabins, and the staff instrument and block telephone are installed only in the first cabin.

(d) Semaphore signal

The semaphore signal system is adopted for the signals related to the main line. In the day time, signal aspects are indicated with position, figure and color of the arm, while, at night, aspects are indicated with color light. The number of aspects of the semaphore signal is two; horizontal and downward 45 degree. The figures of the semaphore signal are shown on the Drawing A7-7.1-2-2.

(e) Shunting signal

The shunting signals shall be erected in front of the turnouts on the arrival and dispatch tracks, locomotive running track, inspection tracks and the connecting line in

the proposed shunting yard to control the shunting of cars and locomotives. The figures of the shunting signals are shown on the Drawing A7-7.1-2-2.

(f) Transmission of movements

The devices to transmit the motion of the point and signal levers in the signal cabin to the points and signals consist of the following parts.

1) Point operation

Rod:	used for the transmission of the point lever movement to the points.
Rod roller:	useful to support the rods, to reduce fractional resistance and to enable smooth movement.
Crank:	used for changing direction of movement of the rods. Some kind of cranks such as radial, right angle, straight and adjust are used according to the site conditions. The figures of the cranks are shown on the Drawing A7-7.2-2-3.
Compensator:	used for automatic adjustment against expansion and contraction caused by variation of temperature.

2) Signal operation

Wire:	used for transmission of the signal lever movement to the signals. The wire is twisted wire composed of seven single wires.
Wire carrier:	provided for supporting of wire (shown on the Drawing A7-7.1-2-3).
Wheel:	used for changing of the direction of the wire path (shown on the Drawing A7-7.1-2-3)

Balance weight: Single wire handling system is proposed to control the signals. In this system, when a signal is restored to normal, balance weight will descend by its weight. Then, the signal arm will return to the horizontal position. In case that the wire is broken, the signal arm will return automatically to the horizontal position.

(g) Switching and locking device

A switching and locking devices are to switch the point to the normal or reverse position. When the point is switched, the locking device locks the point at the normal or reverse position to prevent it from being moved by an external force.

(h) Detector bar

The function of the detector bar is to prevent mishandling of points when a train is running. The detector bar is simultaneously operated by the locking lever which is handled before switching the point. In case that only one point lever is equipped, the detector bar is operated by the point lever at the same time.

(i) Single handed lever

The single handed lever is a switching lever of points installed at site. This lever is operated by manpower and locked by a key. A point indicator is mounted on the top of switching device, by which normal and reverse position can be recognized both in day and night.

(j) Spring point

The spring point is the operated with a spring attached to the tongue rail. When a train automatically passes through the point from the trailing direction, the tongue of the point is split against the spring force. When they pass through from the facing direction, the tongue is maintained at the fixed position by the spring force.

(k) Stop position sign for trains

The stop position signs for trains will be erected to indicate the stop point to the drivers. The signs will be erected along the connecting line in front of the yard and at both side of the level crossing mentioned in the following subsection.

(l) Safety device at level crossing with road

The safety device will be installed at the level crossing with the main road to/from the port shown on the Drawing A7-7.1-1-1. The safety device will include the following parts:

1) Barrier

The total width of the level crossing designed to be 31.5 meters, and the proposed barrier shall cover the full width for each direction of the road. The barrier is to be operated manually by means of winch with less labor power by watchmen. The feature is shown on the Drawing A7-7.1-2-4.

2) Warning device

The warning system will consist of the flashing red signals and the audible warnings by either a bell or a simulated tone from a speaker controlled manually.

(4) Telecommunications

(a) Telecommunication facilities connecting to the existing ENR network

1) Telephone system for general use

A number of ordinary telephone sets will be installed at strategic points, such as station office and signal cabin, as extension lines at nearby existing ENR railway telephone switching system.

2) Blocking telephone circuits

Necessary facilities and circuits will be established between the proposed signal block and its adjoining signal blocks for the purpose of train block operations on the ENR main line.

3) Telecommunication aerial cable

SS (self-suspended) cable of 10 pair conductors will be installed on the existing poles between the proposed signal block area and Suez Station to accommodate railway telephone circuits and train blocking telephone circuits.

The blocking telephone circuits in the direction towards Adabiya Station will be accommodated in the unused pair of the existing SS cable.

4) Train despatching telephone

A telephone circuit necessary for control of train operation will be established between the signal block and the ENR regional control center. This despatching telephone shall be covered by the existing ENR train despatching radio system by installing additional radio equipment, antenna, etc. for this purpose.

(b) Telecommunication facilities for the proposed yard, loading line and connecting line

1) Station premises telephone system

A dedicated telephone system to enable communication between the administration office, signal cabin, shunting yard, loading yard and level crossing will be installed. To accommodate telephone circuits of this telephone system, 10-pair SS cables and supporting structure will be newly installed between the loading yard and the shunting yard area where the administration office and signal cabins are located.

2) Radio system for operation and maintenance

A radio system to enable communications necessary for operation and maintenance will be installed.

The transceivers for shunting operations will be installed on the switching locomotives and at the signal cabins and also carried by the flag men and the switching point operators. The transceivers for maintenance purposes will be carried by the maintenance staff when they are engaged in the maintenance of railway facilities and cars.

(5) Building

(a) Scope

An office building and a workshop and storage building for railway operation will be constructed adjacent to the proposed shunting yard. The location of the buildings is shown on the Drawing A7-7.1-1-4.

(b) Requirement of buildings

The structure of the buildings shall be of the ordinary reinforced concrete type. The building works shall include lighting, sanitary fixtures, pipe and accessories for water supply and plumbing, electrical fixtures, and wiring and accessories for electrical supply.

3.5.7 Recommendations of Improvement of the Ataqa-Suez-Cairo Line

(1) Objectives of the Study

The grain products will be transported by rail from Ataqa area to Cairo area through the Ataqa-Suez-Ismailia -Zagazig-Benha-Qalyub-Cairo line or the Ataqa-Suez-Ismailia-Zagazig-Shibin-Qalyub-Cairo line when the Project is completed. The freight traffic volume including the grain products and other commodities transported on the above routes is expected to increase to a large extent. In this study, the track capacity of the railway for the transportation, possibility of increase of the train speed and possibility of introduction of efficient operation system will be examined. The following main items have been studied:

-- Train operation system
-- Track alignment
-- Track structure and its maintenance
-- Signaling system
-- Telecommunication network
-- Type and characteristic performance of locomotives and cars
-- Maintenance system of rolling stock

(2) Present Conditions of Objected Railway

(a) Proposed Transportation Route

Wheat and other grain products imported at the proposed Ataqa Port are planned to transport by railway to the flour mills located at Shubra, Imbaba, etc., in the suburb of Cairo. The possible railway route from the Ataqa Port to the destinations has been recommended as follows by Egyptian National Railways at the meeting held on September 9th 1992 at MODANC (refer to Fig 3.5.7-1):

Ataqa-Suez-Ismailia (Nifisha South)-Zagazig-Qalyub-the fial destinations.

There are two alternative routes on the section between Zagazig and Qalyub. One is the route via Benha and the other is via Shibin El Qanater.

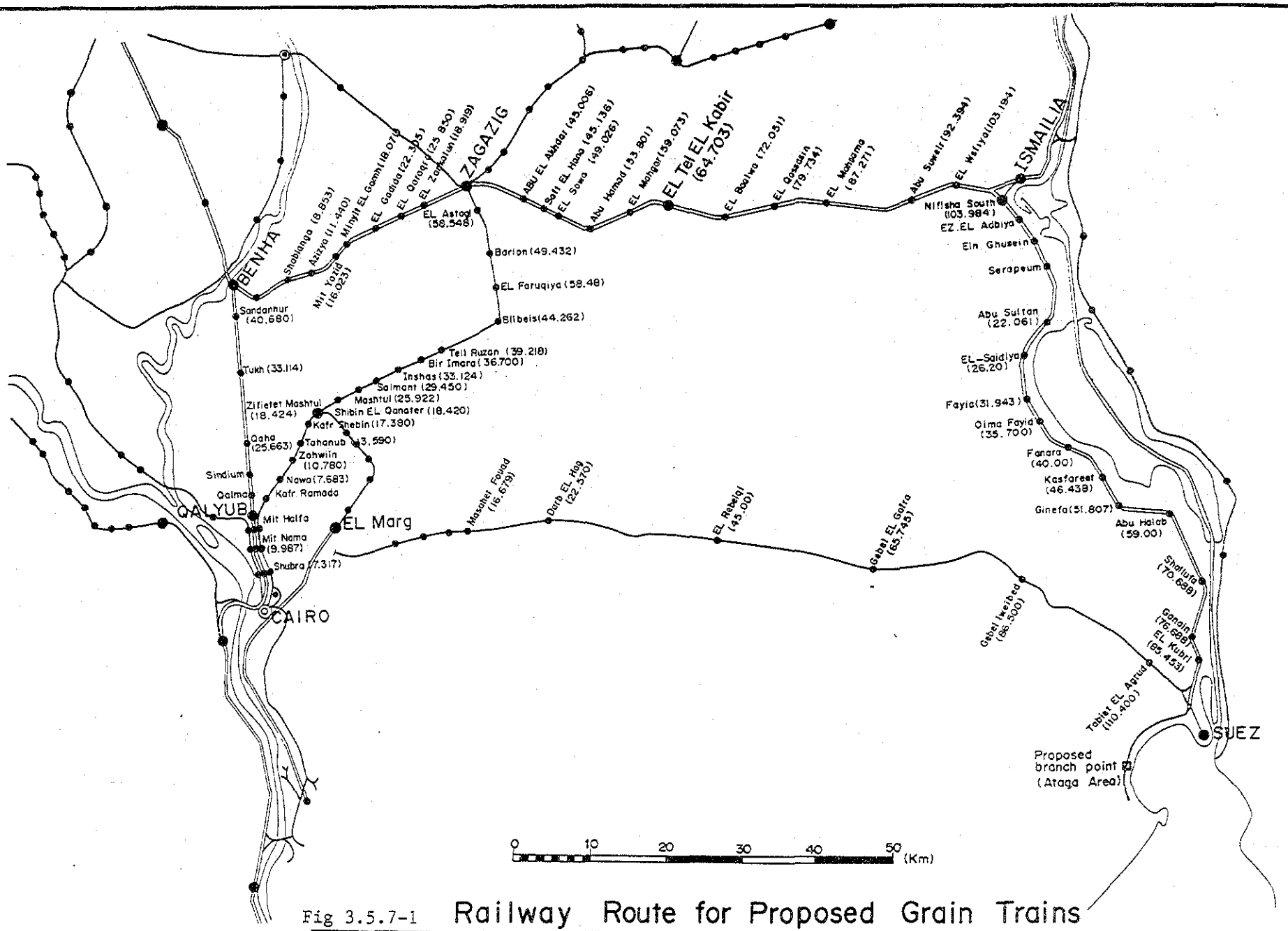


Fig 3.5.7-1 Railway Route for Proposed Grain Trains

There was a shorter route between Suez and Cairo, which was stretched from Suez to Cairo directly towards the west via El Rabelqi. However, the line has been cut out at Ain Shams in order to divert the line beyond Ain Shams to the newly constructed commuter railway line between El Marg and Helwan. Therefore, the line is isolated from other lines except connecting at the Suez Station.

The proposed transportation line between Suez and Cairo is of a double track, except the line of a single track between Zagazig and Qalyub via Shibin El Qanater. The route length of the line is about 8.5 kilometers from Ataqa to Suez and about 240 kilometers from Suez to Cairo via Benha and about 225 kilometers via Shibin El Qanater.

(b) Train Operation

1) Train composition

The maximum load transported by the freight train and the maximum number of passenger cars consisting of the passenger train on the lines between Ataqa and Cairo are as follows:

Table 3.5.7.-1 Hauling Capacity

Line	Max. load of freight trains (tons)	Max. composition of passenger trains (cars)
Ataqa - Suez	1,500	-
Suez - Ismailia	1,500	8
Ismailia - Zagazig	1,500	12
Zagazig - Benha	1,500	12
Benha - Qalyub	1,500	12
Qalyub - Cairo	1,500	12
Zagazig - Shebin	1,500	12
Shebin - Qalyub	1,500	12

The predominant type of locomotives hauling the trains are Henschel locos with the gross power of 2475 HP for the freight trains and GM locos with gross power of 1650 HP for the passenger trains.

2) Maximum train speed

The maximum train speed stipulated for the lines are tabulated in the following:

Table 3.5.7.-2 Train Speed

Line	Max. speed (km/h)	ENR Class of line
Ataqa - Suez	30	III
Suez - Ismailia	70	II
Ismailia - Zagazig	105	I
Zagazig - Benha	105	I
Benha - Qalyub	140	I
Qalyub - Cairo	140	I
Zagazig - Shebin	70	III
Shebin - Qalyub	70	III

The speeds mentioned above are assessed on the basis of the class and conditions of the track on the lines. The classes of the lines are shown in table above.

3) Number of trains and line capacity

The current number of trains operated and the line capacity on the lines are tabulated as follows:

Table 3.5.7.-3 Number of Trains Operated

Line	No. of freight trains	No. of passenger trains	Total of trains	Line capacity
Ataqa - Suez	18	0	18	20
Suez - Ismailia	16	18	34	84
Ismailia - Zagazig	16	50	66	86
Zagazig - Benha	21	44	65	86
Benha - Qalyub	29	115	144	320
Qalyub - Cairo	29	188	217	400
Zagazig - Shebin	2	25	27	39
Shebin - Qalyub	2	36	38	56

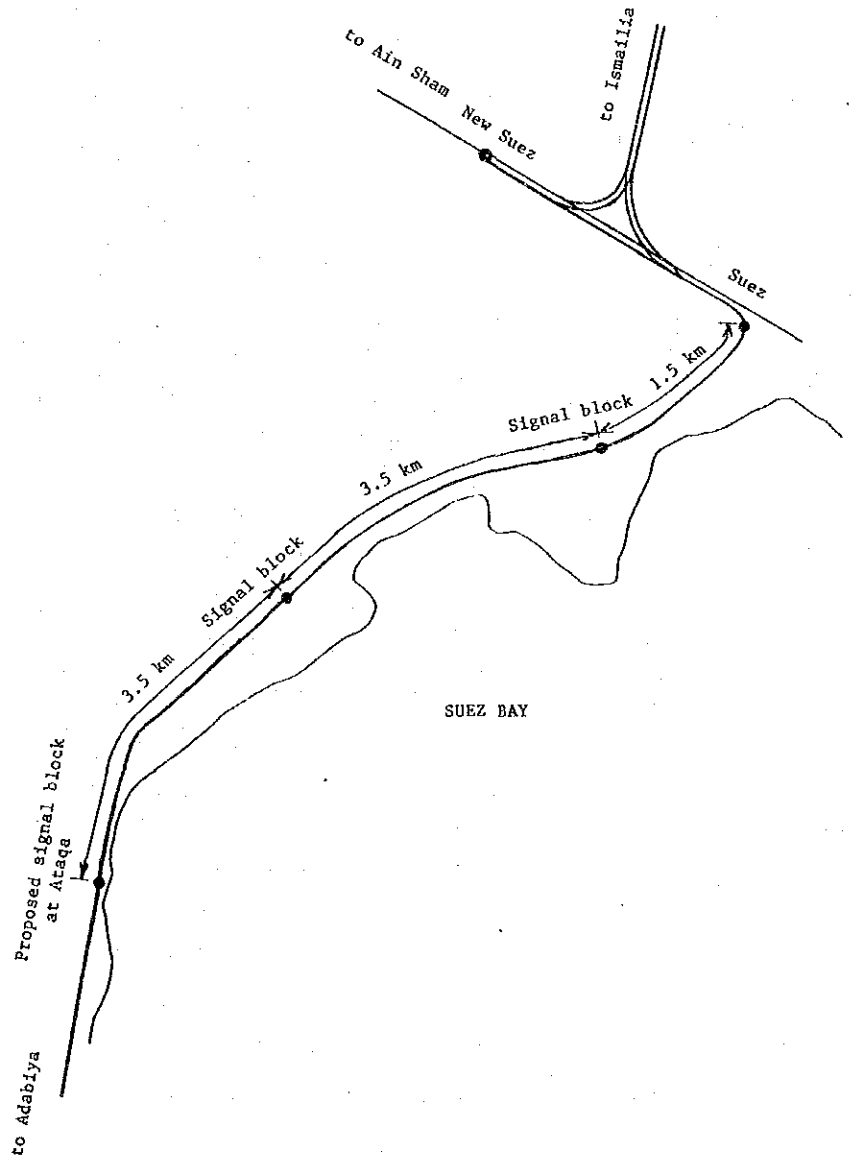
There are much rooms to increase the number of trains on the double track line from Suez to Cairo via Ismailia, Zagazig, Benha and Qalyub, and some rooms on the single track line between Zagazig and Qalyub via Shebin. There is scarcely a room on the single track line between Ataqa and Suez.

(c) Station

The conditions of the principal stations on the route are as mentioned below. (refer to Fig 3.5.7.-1)

a) Ataqa - Suez

The line is a single track line. There are two signal blocks between Suez and the proposed signal block at the Ataqa area as shown on the route map below. The distances of the lines between adjacent signal blocks are 3.5 km, 3.5 km and 1.5 km as shown on the following map.



b) Suez - Ismailia

The line is a double track line with route length of about 90 km. There are 14 en-route stations on the line.

c) Ismailia - Benha

The line is a double track line with route length of about 105 km. The big stations on the line are Ismailia, Zagazig and Benha, and there are 19 en-route stations on the line. The trains operated between the Suez - Ismailia line and the Ismailia - Benha line can be operated on the bypass line without entering Ismailia station.

d) Benha - Cairo

The line is a part of the main line connecting Alexandria with Cairo, which length is about 50 km. The big stations are Benha, Shubra and Cairo and there are eight en-route stations. Farz freight yard is located adjacent to the Cairo station.

e) Zagazig - Shibin - Qalyub

The line is a branch line with single track to connect Zagazig to Qalyub via Shibin. The route length of the line is shorter than that of the route via Benha. There are 16 stations, where trains can cross each other.

(d) Track

1) Track Structure

The track gauge of the objected lines is 1,435 mm. The tracks are constructed on the ground level except at some crossing with roads. The track structure of the lines are mentioned below.

a) Ataqa - Suez Line

Class:	III
Rail:	Indian rails 75 pound or 47 kg
Fastening:	screw spike with tie plate
Sleeper:	wooden sleeper or iron sleeper
Ballast:	crushed stone

b) Suez - Ismailia Line

Class:	II
Rail:	UIC 54
Fastening:	K-type(refer to the Drawing A7-7.1-1-9)
Sleeper:	steel sleeper and some concrete sleeper
Ballast:	crushed stone

c) Ismailia - Zagazig - Benha Line

Class:	I
Rail:	UIC 54
Fastening:	K-type
Sleeper:	steel sleeper or concrete sleeper
Ballast:	crushed stone

d) Benha - Cairo Line

Class:	I
Rail:	UIC 54
Fastening:	K-type
Sleeper:	concrete sleeper
Ballast:	crushed stone

e) Zagazig - Shebin - Qalyub

Class:	III
Rail:	46 kg
Fastening:	screw spike with tie plate
Sleeper:	iron sleeper
	wooden sleeper (in stations)
Ballast:	crushed stone

2) Track Maintenance

a) Ataqa - Suez Line

The maintenance of the track is manual. No mechanical maintenance system is introduced into this line. The condition of the track is not good. It has defects in the following respects.

a) The roadbed has not regular formation in some sections.
b) The ballast is quite inadequate to form the standard road diagram.
c) Some fastenings are not well fixed, because of looseness of the screw spikes.
d) Some fish plates are not well fixed. Some bolts of the fish plates are lost. Some expansion space at the rail joints are too large.
e) Track irregularity is excessive almost over the line.

b) Suez - Ismailia

The mechanical maintenance system has been introduced into this line in addition to the manual maintenance. The conditions of the track is much better than that of the Ataqa - Suez Line. Furthermore, rehabilitation of the track is now in progress. The condition of the track is being further improved.

c) Ismailia - Zagazig - Benha

The mechanical maintenance system has been introduced into this line in addition to the manual maintenance. The track is well maintained.

d) Benha - Cairo

The mechanical maintenance system has been introduced into this line. The conditions of the line is maintained at high level to operate some passenger trains at maximum speed of 140 km/h or 120 km/h.

e) Zagazig - Shibin - Qalyub

The maintenance of the track is manual. The conditions of the track is not so good as mentioned below.

1) The ballast is insufficient to form the standard road diagram.
2) Some fastenings are not well fixed, because of looseness of the screw spikes.
3) The track irregularity is excessive almost over the line.

(e) Signal and Telecommunications

1) Signaling System

The existing main signaling system on the route is as mentioned below.

a) Ataqa - Suez

i) Blocksystem

The staff instrument block system is adopted to this section. The staff exclusively used for the section is carried by the engine driver as the key for passing the block section. Only one of the staff effective for the section can be taken out from the instrument at either station after mutual arrangement of both stations is fixed.

ii) Signal

The semaphore signals are used on the main line of the section.

iii) Interlocking

Almost all signal and point levers are concentrated on the signal cabin(s). In some stations, signal levers are set together at one or more places, while point levers are set at the side of each turnout. The interlocking devices among signals and points are a mechanical interlocking system both in cabins and field.

b) Suez - Ismailia - Benha

i) Block system

Tyre's instruments block system is adopted to this section. A train can be despatched when the section becomes clear for the train by handling the instrument under the mutual agreement of the both stations.

ii) Signal

The type of the signals on the main line is same as that of the section between Ataqa and Suez. There are two types of shunting signals . One is semaphore type and the other is disc type.

iii) Interlocking

The interlocking device among signals and points is same as that of the line between Ataqa and Suez.

c) Benha - Cairo

i) Block system

A double line automatic block system is adopted at this section. The continuous track circuit is equipped with the section. The trains are operated under automatic blocking and signaling.

ii) Signal

Multiple type colour light signals are installed on the main line and electric position light signals are installed for shunting in the station yards.

iii) Interlocking

The interlocking devices applied to this section mainly consist of illuminated track models, console tables, electric magnetic relays, rectifiers and wiring terminals, from which the cables are drawn individually to the field locations and equipment.

2) Telecommunications

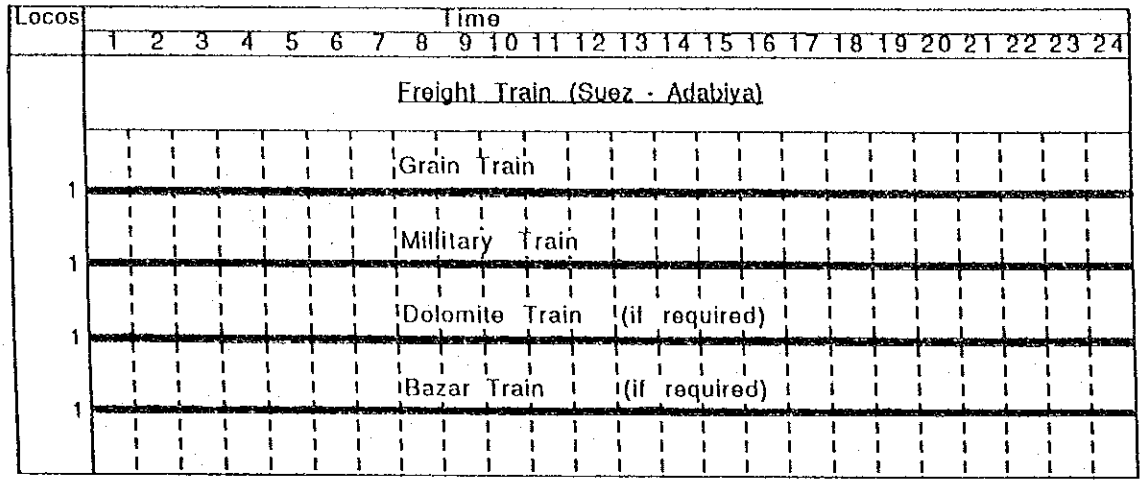
The telecommunication facilities on the related lines form a part of the whole ENR telecommunication system. The facilities include the ordinary telephone devices, the line block telephone devices and the train despatching telephone devices. The wireless telephone system is widely installed for the train operation.

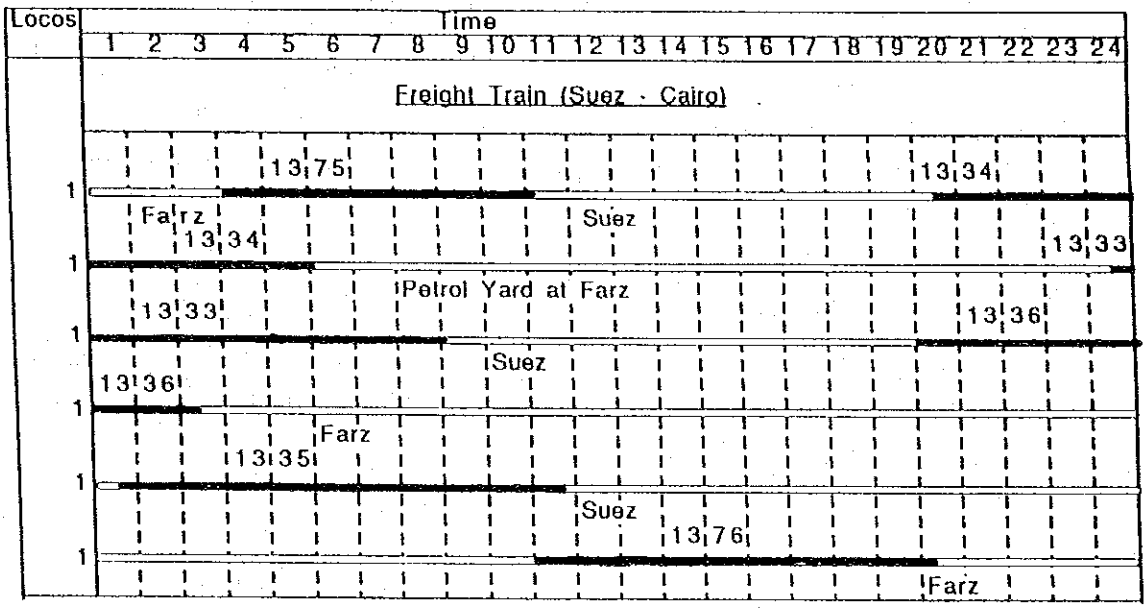
(f) Locomotives and Cars

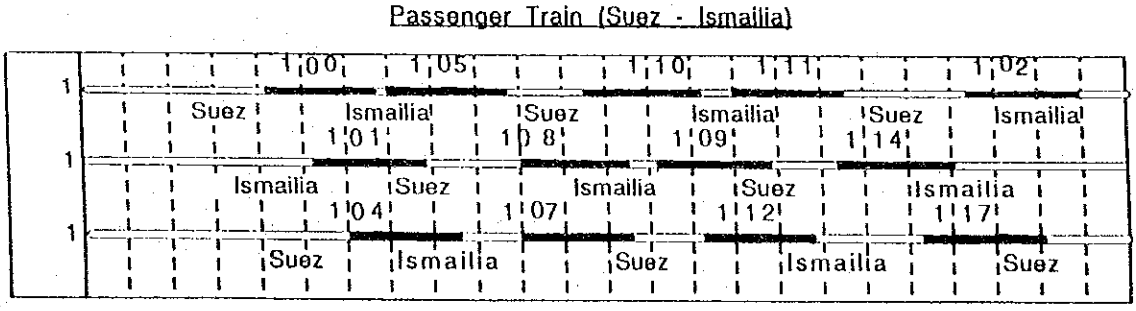
1) Locomotive

a) Operation of locomotive

The locomotive operation diagrams for the freight trains on the lines between Suez and Adabiya and on the line between Suez and Cairo and for the passenger trains between Suez and Ismailia are shown in Fig 3.5.7-2. The numbers of locomotives operated based on the diagram mentioned above are as follows:







Note: The numbers above the bars indicate train numbers.
The name of stations under the bars indicate the stations where the locomotives are stabling.

Fig 3.5.7-2 Locomotive Operation Diagram

Freight train

Suez - Cairo	6
Suez - Adabiya	2
	4 (if required)

Passenger train

Suez - Ismailia	3

b) Type of locomotive

The types of the locomotives hauling the trains mentioned above are as follows.

	Type	Horse Power	Manufacturer
Freight train:	AA2T	2475 HP	Henschel (Germany)
Passenger train:	G22	1650 HP	G.M. (Canada)

The numbers of the locomotives on book of ENR as of September 1992 are shown in the following:

Type	2450 HP Henschel, G.M.	1650 HP G.M.	Old type G.M.	East European
Numbers	300	257	169	97

c) Maintenance of locomotive

The maintenance schedule of the locomotives of ENR is as follows:

Daily inspection

Before trip

Periodical examination

Two weekly,

Six monthly, and

Yearly

Overhaul

Light overhaul (after three years),
Intermediate overhaul 1 (after six years),
Intermediate overhaul 2 (after nine years),
General overhaul (after twelve years),
and repeated again

The daily inspection is carried out at Farz Depot in Cairo and at the depot located in Suez. The current average work load for the daily inspection of the depot in Suez is 210 locos/month.

The periodical examination is carried out at Farz Depot in Cairo and at Zagazig Workshop, and the overhauls are carried out at Farz Workshop in Cairo.

The ratio of the number of the main line locomotives in operation to the numbers on book was about 80 % in September 1992.

2) Wagon and Coach

a) Grain wagon

The dimensions of the existing ordinary grain wagons are two-axle bogie wagons and their principal dimensions are as follows:

Overall length	16,000 mm
Overall width	3,000 mm
Height	4,319 mm
Maximum load	65 ton

b) Coach

No passenger trains are operated on the line between Suez and Adabiya. Only local passenger trains are operated on the line between Suez and Ismailia. The train consists of maximum eight coaches of third class only.

c) Maintenance

The maintenance schedule of the wagons and coaches of ENR is as follows:

i) Wagon

Daily inspection

Before trip

Periodical examination

Three monthly

Overhaul

General overhaul

Grain wagon: every two years

Flat wagon: every three years

The daily inspection is carried out at the starting station. The periodical examination in Suez area is carried out at Suez Farz. The average work load for one month is 120 wagons/month. The overhauls are carried out at main workshop at Gabal EL Zaton.

ii) Coach

Daily inspection

Before trip

Periodical examination

Three monthly

Overhaul

General overhaul (every 18 month)

The daily inspection is carried out at the starting station. The periodical examination is carried out at Suez Farz. The average work load for one month is 6 coaches. The overhaul is carried out at main workshop at Kom Aboradi.

(g) Administration

The railway network of ENR is managed by dividing it into seven regions. They are Central Region(Administration office is located in Cairo), East Delta Region(Zagazig), North Delta Region(Mansoura), Mid Delta Region(Tanta), West Delta Region(Alexandria), Mid Region(El Minya) and South Region(Aswan). The names in parentheses show the places where the administration office of each region is located.

The Adabiya-Suez-Ismailia-Zagazig line is included in the East Delta Region. The train operation on the line is under the control of the train despatching center at Zagazig. The Zagazig-Cairo line is included in the Central Region. The locomotives of Henschel type to haul the freight trains operated on the objected lines are assigned to the Farz Depot in Cairo.

(3) Future Traffic

(a) Traffic Volume

1) Transportation of the Grain Products

The forecast traffic volume of the grain products from the proposed Ataqa Port to the silos in Cairo area is estimated as follows. (refer to the Subsection 3.5.3 (b))

Traffic Volume Forecast of Grains

unit: thousand ton/year

Year	2000	2010
Total volume	1,300	1,800
Volume transported by rail	910	1,260

Namely, 910 thousand tons of grains will be transported by rail from Ataqa to Cairo area via Suez, Zagazig and Qalyub in the year 2000, and 1,260 thousand tons be transported in 2010. The number of freight trains required to transport the grains will be three in the year 2000 and four in 2010.

2) Other transportation volume

The following data has been issued from ENR.

Passenger and Cargo Traffic Volume

(Adabiya/Suez Line, Suez/Ain Sham Line)

Unit: 1,000 ton or 1,000 passenger

Year	Petroleum materials	Adabiya/Suez Cargo	Suez/Ain Sham	
			Passengers	Cargo
Actual-:				
1989	151	301	1,457	77
1990	89	311	1,500	81
1991	74	501	1,671	93
Estimated-:				
1992	78	551	1,790	102
1993	82	606	1,917	113
1994	86	666	2,053	124
1995	90	734	2,199	136
1996	85	807	2,355	150

The traffic volumes of cargo mentioned above are shown in the following graphic form of Fig 3.5-7-3.

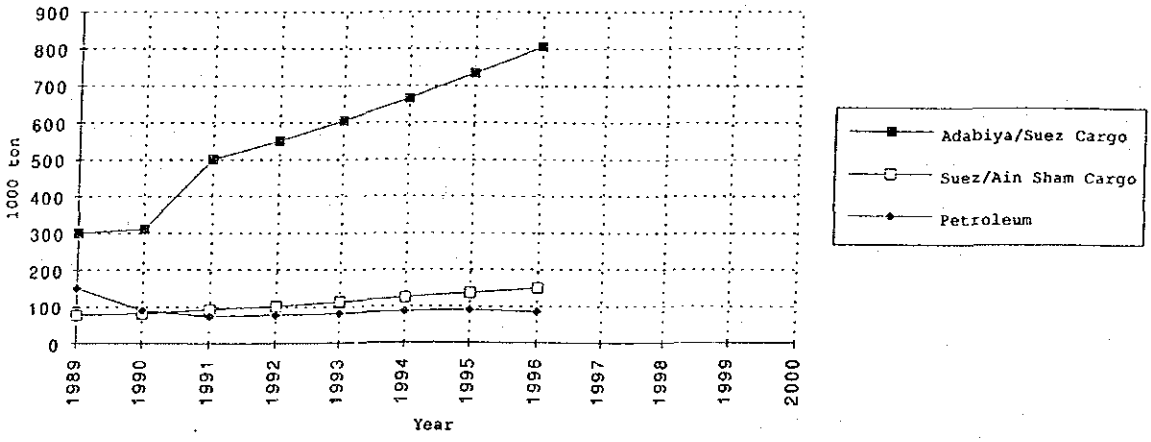


Figure 3.5-7-3 Traffic Volume Forecast

The future traffic volume of cargo on the Adabiya-Suez Line has been estimated as above on the assumption that the traffic volume will increase year by year with average ratio of 1.0998 per year.

If the traffic volume on the line increases at the same ratio as above, the traffic volume in the year 2000 is estimated at 1,181 thousand tons.

(b) Train Operation

1) Trains to transport grain products

The number of trains to be operated on the line to transport the forecast traffic volume in the year 2000 is computed as follows:

Assuming that

-- annual working days are 295 days,
-- loading capacity of a wagon is 65 tons,
-- the maximum number of wagons consisting a trains 25, and
-- the fluctuation ratio of the daily traffic volume is 30 %,

therefore,

$$910{,}000 / 295 \times 1.3 / (65 \times 25) = 2.5 \fallingdotseq 3$$

2) Trains to transport other commodities

The additional number of trains required to transport the traffic volume increased from the year 1991 to 2000, is computed as follows on the assumption below. The number of trains to transport petroleum is not considered to increase upto 2000, because the traffic volume of petroleum is forecasted almost same from 1991 to 1996.

In case that traffic volume is assumed to increase from 1996 at the same ratio as that in the previous years:

Assuming that

-- annual working days are 295 days,
-- loading capacity of a train is 1,500 tons,
-- loading efficiency is 70 %, and
-- fluctuation ratio of daily traffic volume is 30 %,

therefore,

$$(1,181,000 - 501,000) / 295 \times 1.3 / (1,500 \times 0.7) = 2.9 \fallingdotseq 3$$

(4) Items to be Studied

The study will be made on the following items for the transportation program in the year 2000.

(a) Line Capacity

a) Ataqa-Suez Line

The line capacity of the Ataqa-Suez Line is now 20 as mentioned in the Subsection 53.5.7 (2) (b) 3). On the other hand, the number of trains to be operated on both directions in 2000 will be estimated as follows:

Number of trains at this time	18
Number of the proposed grain trains	6
Number of trains to transport other commodities	6
Total	30

Accordingly, the line capacity will be insufficient to accommodate the trains to be operated in the year 2000.

b) Suez - Ismailia - Zagazig - Qalyub - Cairo

Study has been carried out on the assumption that all additional twelve trains mentioned in the previous subsection would be operated into the Suez - Ismailia - Zagazig - Qalyub - Cairo line. On the other hand, the current number of trains and the line capacity of the lines is mentioned in Subsection 3.5.7 (2) (b) 3). They are shown below.

Line	Current No.of trains	Line capacity
Suez - Ismailia	34	84
Ismailia - Zagazig	66	86
Zagazig - Benha	65	86
Benhaa - Qalyub	144	320
Qalyub - Cairo	217	400
Zagazig - Shebin	27	39
Shebin - Qalyub	38	56

As shown in the table, the line capacity of each line is enough to operate the increased number of trains mentioned above, except that the capacity will be filled up on the line between Zagazig and Shebin if all the increased number of trains are operated on the line.

b) Train Speed

The maximum speeds stipulated for the lines are as follows (refer to Subsection 3.5.7 (2) (b) 2):

Line	Max. speed (km/h)
Ataqa - Suez	30
Suez - Ismailia	70
Ismailia - Zagazig	105
Zagazig - Benha	105
Benha - Qalyub	140
Qalyub - Cairo	140
Zagazig - Shebin	70
Shebin - Qalyub	70

As shown above, the maximum speed on the Ismailia - Zagazig - Benha - Qalyub - Cairo line is high enough to operate the proposed trains mentioned above. The maximum speed on the Ataqa - Suez line is too low to operate the proposed trains, which can be operated at the maximum speed of 85 km/h,

(c) Locomotive fleet

In 2000, the additional number of freight trains operated on the Ataqa - Suez - Ismailia - Zagazig - Qalyub - Cairo line can be foreseen to be twelve as mentioned above. If the running kilometers per day of locomotives is same as that of the estimated from the locomotive operation diagram shown in Fig 3.5.7-2, the additional number of locomotives are estimated twelve.

(5) Improvement Required

(a) Kind of Improvements Required

As mentioned in the previous subsection, the following problems will take place to operate the proposed trains.

1) The line capacity on the Ataqa - Suez line is short.

Line capacity is controlled by distance between adjacent signal block, average train speed and signal and block system.

2) The maximum train speed on the Ataqa - Suez line is extremely low.

The maximum speed on the section is controlled by track conditions of the line and performance of locomotives and hauling tonnage of trains operated on the line.

Furthermore, procurement of twelve additional locomotives mentioned above is necessary.

(b) Improvement to Increase Line Capacity on Ataqa - Suez Line

(a) Signal and block system

A Tyre's staff block system and a semaphore signaling system with a mechanical interlocking device are now being adopted to the Adabiya - Suez line. It takes about five or more minutes to set up block of a section. However, no problem will occur to operate the forecasted number of trains, because the forecasted number of trains on the

line is not so high. No improvement program of the block system on the related lines are planned by ENR.

The reduction of the time required to set up block on a section is effective to increase track capacity. When the improvement of the existing block system on the Ataqa - Suez line is planned, it is proposed to introduce new block system called Electronic token system, which is used widely in Europe and Asia. It can be introduced to other lines including Suez - Ismailia - Benha line. The system can make it possible to reduce train operation cost and to enhance reliability and safety of the block system.

In this system, tokens for blocking are not handled by the station master but the engine driver. It allows signal block to be unmanned. A train carries a token transmitter which consists of a simple radio set transmitting a memorized number, that is "token". Each station has a local equipment comprising a line telecommunication device attached with microprocessor, a radio set to communicate with trains and a safety controller with two fail-safe mode microprocessor. Signals and track circuits should be installed if necessary.

(c) Improvement to increase Maximum Train Speed on Ataqa - Suez Line

1) Locomotive and Train formation

In the Central Region of ENR including the proposed Suez-Cairo line, the freight trains are hauled by the 2,450 HP Henschel type locomotives. The additional locomotives, which will be used to haul the increased number of trains, will be the same horsepower, because there is no program to change the operation system of freight trains drastically. Also the formation of freight trains will not be changed. Accordingly, an ordinary freight train will be composed of the maximum 25 wagons with transportation capacity of 1,500 tons hauled by a 2,450 HP locomotive. It is capable to run at the speed of maximum 85 km/h on level track. No improvements of the performance of locomotives and wagons will be necessary to operate the proposed trains on the proposed line.

2) Track

a) Existing conditions

The track of the Adabiya - Ataqa - Suez Line is very old consisting of the following materials:

Rail:	Indian rails, 75 pound or 47 kg
Fastening:	screw spike with tie plate
Sleeper:	wooden sleeper or iron sleeper
Ballast:	crushed stone

The maintenance of the tracks is carried out manually without large size track machines. The condition of the tracks is not good shape. The kind of the defects is mentioned in Subsection 3.5.7 (2) (d) 2). The maximum speed on the line is restricted to 30 km/h. However, the trains are operated with much lower speed on some sections due to bad conditions of the track.

b) Improvement of track structure

The track structure shall be changed so as to be in conformity with the following requirements, which are being adopted to the track of the Suez - Ismailia line, because the passing tonnage per single track will be almost same each other (refer to the table shown in Subsection 3.5.7 (4) (a).

Rail:	UIC 54
Fastening:	K-type
Sleeper:	concrete sleeper
Ballast:	crushed stone

The standard roadway diagram is shown on the Drawing A7-7.1-1-7.

The maximum train speed will be 70 km/h, which is same as that of the existing Suez - Ismailia line.

c) Maintenance of track

The improved track mentioned above shall be maintained so as to keep sufficient conditions to be able to operate trains at the stipulated speed. The budget shall be secured to procure spare parts enough to maintain the track, and training of the maintenance staff is necessary. It is desirable to introduce a mechanical maintenance system, which is already applied to other lines.

(d) Procurement of Locomotive

1) Type of locomotive

The type of the locomotives to haul the proposed freight trains will be 2,450 HP Henschel type, which is now being used predominantly to haul the freight trains on the ENR lines.

2) Number of locomotives required

The additional number of the trains to be operated to transport the proposed grain products and other commodities would be total six trains as mentioned in Subsection 3.5.7 (3) (b). The total running kilometers of the trains per day is roughly computed as follows:

253 km x 6 x 2 = 3,036 km

On the other hand, average running kilometers of the locomotives being operated on the line between Suez and Farz in Cairo is roughly computed based on the values taken from Fig 3.5.7-2.

Where,

number of trains operated per day:	6 (both direction)
number of locomotives operated per day	6
running kilometers of a train	245 km

Therefore,

average running kilometers:	245 km

The average running kilometers may be increased in future, according to reduction of time for stabling, loading and unloading, because the times shown in Fig.3.5.7-2 are considered to be too long. The number of locomotives to be operated in 2000 is estimated at ten, if average running kilometers in 2000 is assumed to be 300 km.

3) Procurement of locomotives

The number of locomotives to be operated to haul the proposed trains has been estimated at ten as mentioned above. While, the number of the main line locomotives on book in the Central Region at this time is as follows:

Type	2,475 HP Henschel or G.M.		1,650 HP G.M.	
	Freight	Passenger	Freight	Passenger
Number	138	133	---	94

The ratio of the number of the locomotives in operation to the number on book is about 80 % as mentioned in Subsection 2.6.1 (3). Accordingly, the number of the locomotives of Henschel type for the freight trains in operation is estimated at about 110. However, the ratio of 80 % mentioned above is too low. Such conditions will be improved in future. The number of the locomotives in operation will be 117, if the ratio is increased to 85 %. Namely, seven locomotives will be added to the number of the locomotives in operation at the current rate of operation. It means that seven locomotives will be supplied without purchasing new locomotives.

4) Improvement of maintenance system

Daily inspection and periodical inspection of the locomotives to haul the freight trains operated on the proposed line are carried out at Farz Depot in Cairo and the overhaul is carried out at Shubra Workshop. Farz Depot has eight daily inspection lines and three periodical inspection lines, and Shubra Workshop has three dismantling and assembling lines. The overhaul work of one locomotive requires about one month at this time.

As mentioned above, the current ratio of operation is low. It may have been resulted from lack of spare parts and superannuation of facilities of the depot and workshop.

The following measures are recommended to be taken to improve the maintenance conditions.

- Rearrangement and rehabilitation of inefficient and superannuated facilities and machinery
- Comprehensive computerization of inventory adjustment of spare parts
- Arrangement of budget large enough to procure necessary spare parts

(6) Conclusion

The facilities including track arrangement, track structures, signaling system and telecommunications on the Suez - Ismailia - Zagazig - Benha - Cairo are well maintained and will be capable to transport the forecast traffic volume from Ataqa to Cairo. However, the facilities on the Ataqa - Suez line and the Zagazig - Shebin - Qalyub line will be insufficient to transport the forecast volume. Meanwhile, the number of locomotives will become short to operate the required number of trains. Accordingly, the following improvements and procurement are required.

(a) Improvement of track structure

The track structure of the Ataqa - Suez line shall be improved in conformity with the following requirements.

Rail:	UIC 54
Fastening;	K-type
Sleeper:	steel or concrete sleeper
Ballast:	crushed stone

(b) Procurement of locomotives

The number of locomotives required to haul the additional trains in 2000 is estimated seven.

(c) Improvement of maintenance system of locomotives

The facilities and management of the workshop and depot shall be improved as follows:

- Rearrangement and rehabilitation of inefficient and superannuated facilities and machinery

- Comprehensive computerization of inventory adjustment of spare parts

- Arrangement of budget large enough to procure necessary spare parts

(d) Introduction of new block system

Introduction of new block system called Electronic token system is recommended in order to reduce train operation cost and to enhance reliability and safety of the block system.

3.6 Buildings

3.6.1 Introduction

(1) Background

The initial site investigation and planning study were conducted from early April, 1992 and completed in July, 1992 together with lists of facilities and their floor area requirements with principal approvals by the relevant authorities.

The preliminary design was carried out based on the established planning guides and basic deign concepts, and completed at the end of September, 1992.

The detailed design was initiated at early December, 1992 and the whole design and drawings was reviewed and revised taking into consideration the comments indicated on the Minutes of Meeting dated 12th September, 1992, which was accepted by all of the Steering Committee, MODANC and JICA Study Team, during the month of December, 1992.

The revised design and drawings of the facilities were given basic approvals by the following authorities.

- General Organization for Industries (GOFI) : Facilities in Centers A and B;
- General Authority for Investment (GAFI) : Facilities in Center C;
- Red Sea Port Authority (RSPA) and Customs: Facilities in Ataqa Port Area;
- General Company for Silo and Storage : Facilities in Ataqa Port Area;
- Ministry of Development & New Communities(MODANC) : Overall approval.

(2) Scope of services

The scope of services of the detailed design included the design of the public service facility buildings in the following areas:

- Ataqa Industrial Estate (Center A);
- Ataqa Industrial Estate (Center B);
- Adabiya Industrial Free Zone (Center C);
- Ataqa Port Bulk Cargo Terminal;
- Ataqa Port Grain Terminal.

The detailed design were carried out based on the following findings.

- Expected numbers of employees: 12,000 in the Free Zone and 20,800 in the Industrial Estates;
- Results of preliminary design;
- Report (I);
- Research of applicable national and local codes, standards and conditions;
- Results of meeting with owners, users and administrators of the proposed buildings;
- Findings from investigation of similar projects;
- Study of the architectural, structural, electrical, mechanical, civil and landscape materials and equipment that are available and commonly used in the project area, in addition to those generally used in Egypt.

The design works of the buildings in the areas specified above included the architectural, structural, electrical, HVAC and plumbing designs.
The site planning design included the landscape, internal roads and streets and utility works.

The detailed design products and the related back up information and data were compiled into Interim Report (II), the Design Drawing Package and the Calculation Sheets Package and submitted for comments and approvals.

(3) Content of the Interim Report (II)

The Interim Report (II), the Design Drawing Package and the Calculation Sheets Package contained the following main items:

(a) Interim Report (II)

- Codes and standards;
- Design conditions and criteria;
- Design concept;
- System descriptions;
- Main materials used;
- Site plans and main building floor plans.

The above items were compiled for the following fields of works.

- Architectural work;
- Structural work;
- Electrical work;

- HVAC work;
- Plumbing work;
- Landscaping work.

(b) Design Drawing Package

The Design Drawing Package included the following:

1) Architectural drawings

- General drawings including lists of drawings, general notes and symbols, abbreviations, materials and various schedules;
- Site plans, floor plans, sections and elevations, and reflected ceiling plans;
- Enlarged plans, and typical and special details.

2) Structural drawing

- General drawings including lists of drawings and general notes;
- Schedules and plans of axes, columns and foundations;
- Floor slab plans;
- Details and schedules of reinforcement.

3) Electrical, HVAC and plumbing drawings

- General drawings including lists of drawings, site plans, and general notes and symbols;
- Plans and diagrams;
- General details, system diagrams and miscellaneous details.

4) Landscaping drawings

- Grading plans and materials;
- Planting plans;
- Details.

(c) Calculation Sheets Package

Analysis and calculation were made for the whole buildings listed. However, to represent the typical calculations, the following buildings were selected as representatives to avoid repetitious and lengthy presentation of the similar calculations.

- Administration Building of Center A;
- Administration Building of the Port Authority.

The Calculation Sheets Package included the following items of calculation:

1) Structural calculations

- Slab and beam calculation;
- Column calculation;
- Foundation calculation;
- Staircase calculation.

2) Electrical calculations

- Electrical demand load calculation;
- Lighting calculation;
- Cable sizing calculation;
- Short circuit current calculation.

3) HVAC calculations

- Heat loss and gain calculation;
- Natural and mechanical ventilation calculation;
- HVAC unit sizing calculation.

4) Plumbing calculations

- Calculation of fixture units;
- Calculation of pipe size.

5) Landscaping calculations

- Irrigation water demand calculation.

(4) Summary of floor area of the buildings

Floor areas of the buildings proposed were as shown on the followings pages.

Summary of Floor Areas of the Buildings

(1) Center Zone	No. of Stories	Type of Structure	Floor Area (m^2)
(a) Center A (Ataqa Industrial Estate)			
1) Administration Building	1	RC	728
2) Police and Fire Station	1	"	276
3) Mosque	2	"	650
4) Dispensary (Clinic)	1	"	103
5) Restaurant	1	"	378
6) Power Substation	1	"	187
Sub Total			2,322
(b) Center B (Ataqa Industrial Estate)			
1) Administration Building	2	RC	1,477
2) Police and Fire Station	2	"	921
3) Mosque	2	"	2,073
4) Dispensary	1	"	1,544
5) Restaurant	1	"	440
6) Power Substation	1	"	187
7) Social Club	1	"	907
8) Post Office	1	"	207
Sub Total			7,756
(c) Center C (Adabiya Industrial Free Zone)			
1) Administration Building	2	RC	1,935
2) Police and Fire Station	1	"	444
3) Mosque	2	"	650
4) Dispensary	1	"	104
5) Restaurant	1	"	516
6) Power Substation	1	"	187
7) Field Custom Office	1	"	203
8) Control Gate (2 buildings)	1	"	112
Sub Total			4,151
Center Zone Total			14,229

(2) Ataqa Port Area	No. of Stories	Type of Structure	Floor Area (m^2)
(a) Bulk-Cargo Terminal			
1) Administration Building	2	RC	2,070
2) Power Substation	1	"	187
3) Field Custom Office	1	"	204
4) Control Gate	1	"	25
5) Viewing Tower	35m h.	"	99
6) Incinerator Station	1	"	14
Sub Total			2,599
(b) Grain Terminal			
1) Administration Building	2	RC	1,375
2) Service Building	1	"	184
3) Grease and Oil Storage	1	"	104
4) Grain Sacks Storage	1	STL	415
5) Grain Sacks Bagging	1	RC	400
6) Maintenance shop/Spare Parts Store	1	"	894
Sub Total			3,372
Ataqa Port Area Total			5,971
(3) Center Zone + Ataqa Port Area			20,200

3.6.2 Detailed Architectural Design

(1) Design conditions and criteria

The following design conditions and criteria were established for the detailed architectural design.

(a) Building codes and standards

Any authorized national or local codes and standards in Egypt are applied to the design of the buildings. However, the comparable, internationally recognized codes, standards and practices such as British Standards (BS), German Building Codes, Japanese Architectural Codes, Uniform Building Codes (U.B.C.) are referenced where appropriate for securing safety of the buildings and users.

(b) Site planning criteria

The given site areas of the center zones seem sufficient enough to arrange the facilities without any grouping or combining, however, it is necessary to take an approach of minimizing the number of the buildings by grouping and/or combining of the facilities taking their functions into account, without sacrificing the integrity of each building, in order for reduction of the construction costs as well as for easy operation and maintenance. Accordingly, the following site planning criteria were established.

The facilities for which an individual building is required, for their special functions;

- Custom and quarantine field office
- Mosque
- Control gate
- Fire and police station

The facilities which may be either in an individual building or in a combined building;

- Exhibition hall
- Restaurant
- Dispensary
- Social club
- Spare parts, grease/oil and other storage

The facilities which are better to be in a combined building (complex building);

- Branch office of Ministry
- Custom and quarantine home office
- Post and telecommunication
- Trading offices
- Branch offices of banks
- Administration

(c) Other conditions and criteria established

Additional design conditions and criteria as follows were established for the architectural designs;

- The project budget shall be respected and reviewed during the design period, while the service and functional criteria established for the industrial estates are strictly observed.

- Professional judgments on the local requirements, such as walking distance, corridor width, room size, lobby and entrance locations and their sizes, for smooth operation and effective use of the facilities shall be made as the self-governing criteria for the design.

- Architectural style and form of the buildings shall be responsive to the local climate, culture and social needs.

- Building materials and equipment to be selected shall be locally available, and the equipment shall be easy to operate and maintain.

- The buildings shall have flexibility for future modifications of the office layouts.

(2) Design concepts

The design concept established were as follows:

(a) Site planning concept

1) Overall site planning concept

Center B are planned to have the following facilities so that the Center functions as a

center of the industrial communities in the project area;

- A dispensary as an emergency treatment center with sophisticated medical equipment for various types of emergency examination and treatment activities. The dispensaries in Centers B and C are designed for only the services normally undertaken by small clinics;

- Mosque, administration building, police and fire station, etc. bigger in size and better-equipped in comparison with the same facilities in other Centers.

Center A is planned to serve for only the nearby industry community and the port area.

Center C is to serve for the specifically designated area of Adabiya Industrial Free Zone including the security and customs.

2) Site planning concept for Center C

Center C must have such specific functions for serving for Adabiya Industrial Free Zone as inspecting and examining quality and qualities of dutiable items. As studied in the preliminary design, a clear and simple separation between the primary security zone and the secondary security zone is required for smooth operation of customs and quarantine service in accordance with the regulations. The following basic concepts of the site planning were derived from this policy;

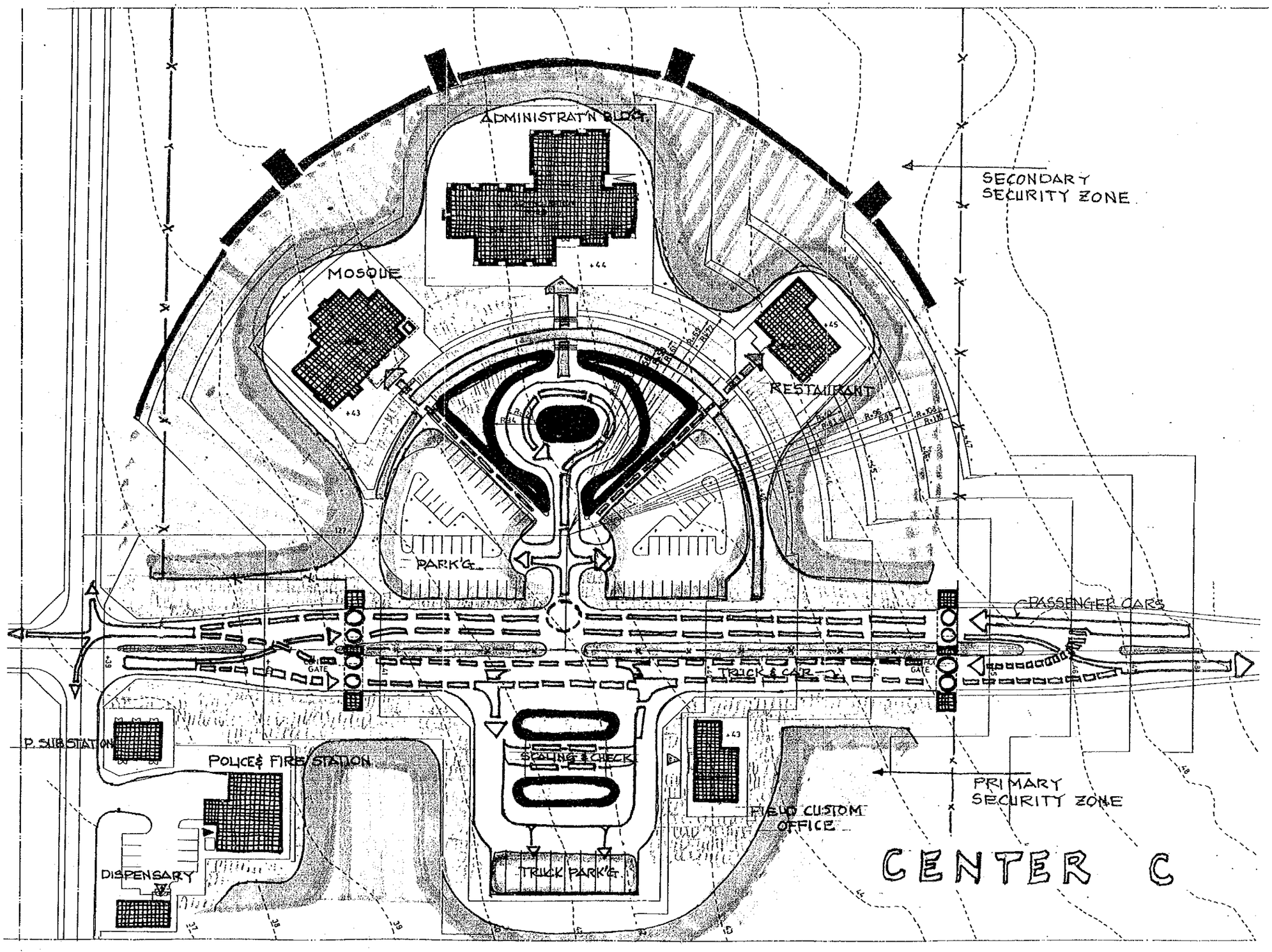
- To provide an integrated complex for services for the free industrial zone

  Instead of locating the buildings randomly in the site, the buildings for various functions should be located along the circular pedestrian walkways, so that overall activities in the Center will be more integrated into a so called "complex", thus providing better services for the industrial free zone as well as a comfortable site environment.

- To provide a pleasant and attractive site environment

  Buildings and facilities are situated along the circular pedestrian promenade axis. This axis will connect the various buildings and integrate the activities in the Center, and provide a pleasant pedestrian circulation.

  The administration building complex should be located at the central location in such a way that the main building will be noticed first and the parking area


ADMINISTRAT'N BLDG.
MOSQUE
RESTAURANT
SECONDARY SECURITY ZONE
PARK'G.
PASSENGER CARS
GATE
TRUCK & CAR
GATE
P. SUBSTATION
POLICE & FIRE STATION
SCALING & CHECK
FIELD CUSTOM OFFICE
PRIMARY SECURITY ZONE
DISPENSARY
TRUCK PARK'G.
CENTER C

subsequently as visitor cars approach to the complex from the entrance gate.

The restaurant is located at the area having a direct access from both the parking area and the main access road.

The mosque and exhibition hall should be located in an open area.

The parking areas are provided in an area fairly close to every building, considering the local climatic conditions. A clustered central parking is adopted for parking efficiency and flexibility.

- Security control

For smooth operation of security control, Center C is divided into a primary security zone and a secondary security zone. Customs and quarantine field offices, fire and police station, and small dispensary building are situated in the primary security zone, while other buildings are located in the secondary security zone. Two gates are provided; one for the primary check and the other for the secondary check as shown.

- Functional circulation

Circulation for vehicles which need customs and quarantine checks are completely separated from other circulation which require general security check. The entrance gates are also separated.

- Future expansion

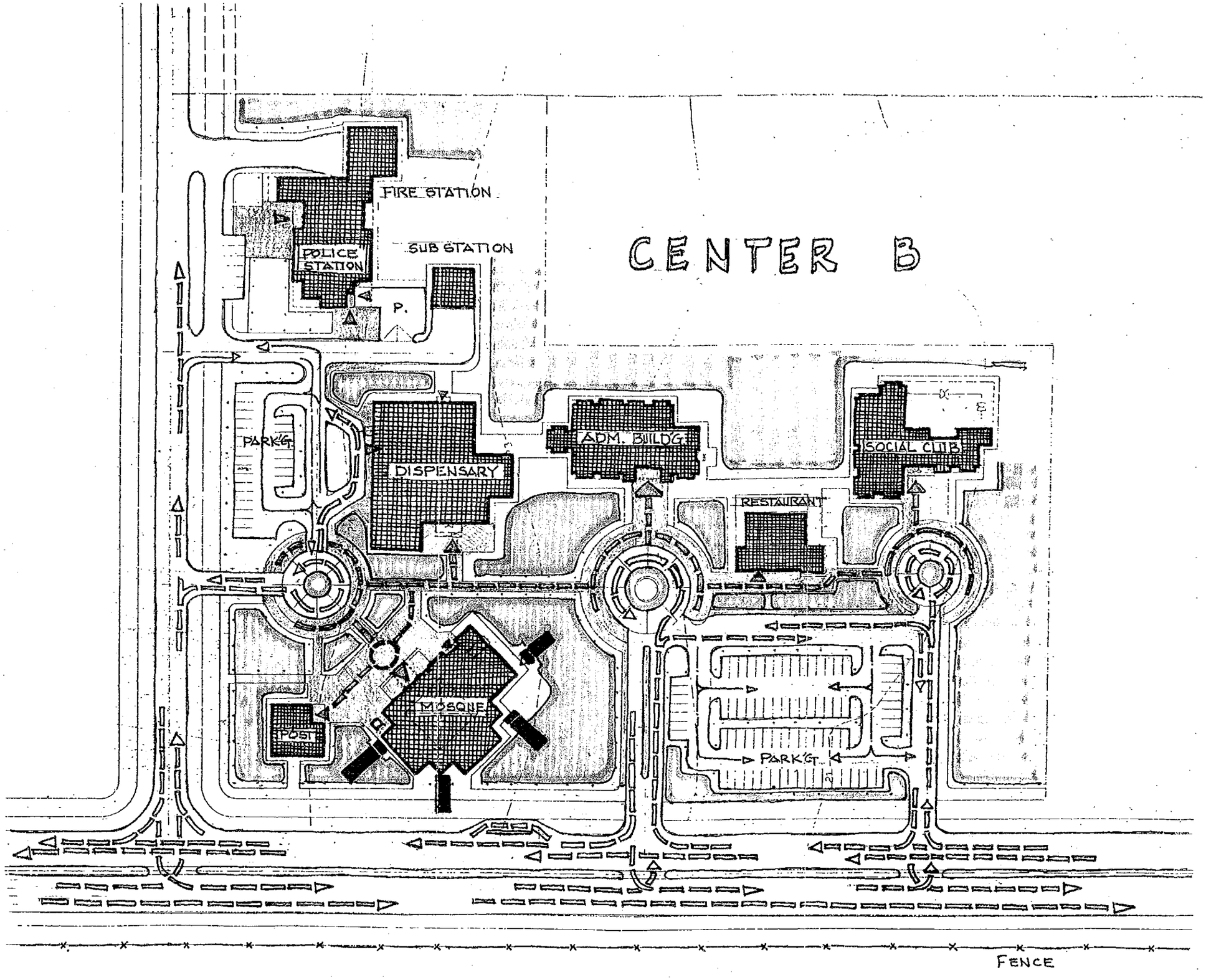
Areas for future expansion of the buildings and facilities, together with necessary access roads and open spaces, are reserved in the areas behind the developed areas.

3) Site planning concept for Centers A and B

Center B is a zone which does not require specific security control, provides normal services to Ataqa Industrial Estates, and functions as a center for whole Ataqa industrial development communities.

Center A is a satellite center for services to the surrounding industrial estate and the port area.

Basically, the site planning concepts for Center C are applicable to Centers A and B.


CENTER B
FIRE STATION
POLICE STATION
SUB STATION
P.
PARK'G
DISPENSARY
ADM. BUILDG
SOCIAL CLUB
RESTAURANT
MOSQUE
POST
PARK'G
FENCE

The main concepts are as follows:

- To provide an integrated complex

- To provide a pleasant and attractive site environment with the following;

  Landscaped courts;
  Buildings located along the landscaped promenade;
  Parking located close to the building entrances and flexible in use;
  Mosque located and oriented to act as one of focal points in the Center.

- To provide direct accesses to the police and fire station building

- To provide ample future expansion areas

(b) Building design concept

1) Overall building design concept

The overall concepts for the building design were as follows:

- Functionally and aesthetically satisfactory

  The buildings are to be so designed that satisfy both of the design conditions and criteria and the design philosophy.

- Image

  Image of each building is to be a self expression of its function, an artistic interpretation by the designer of the organization, spaces and mass of the facility. Style of the building should be attractive as well as responsive to the local climatic, cultural and social needs, while satisfying the budgetary constraints.

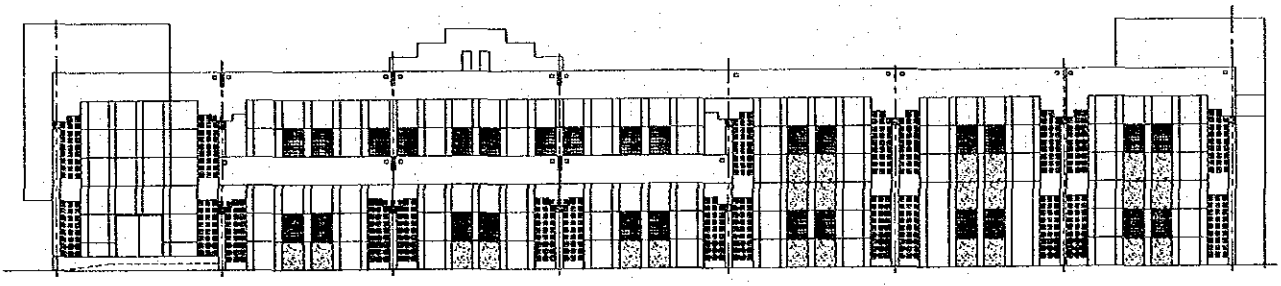
The main concepts regarding the aesthetic expression of buildings, building and facility environment, circulation pattern and climatic control are described and illustrated below.

2) Aesthetical expression of buildings

- Post modern Egyptian architecture

The proposed overall expression and image of the buildings are modern Egyptian architecture utilizing traditional architectural vocabularies including Egyptian pattern, texture, form and shape, color, etc. based on interpretation of these elements by modern perception of the designers.

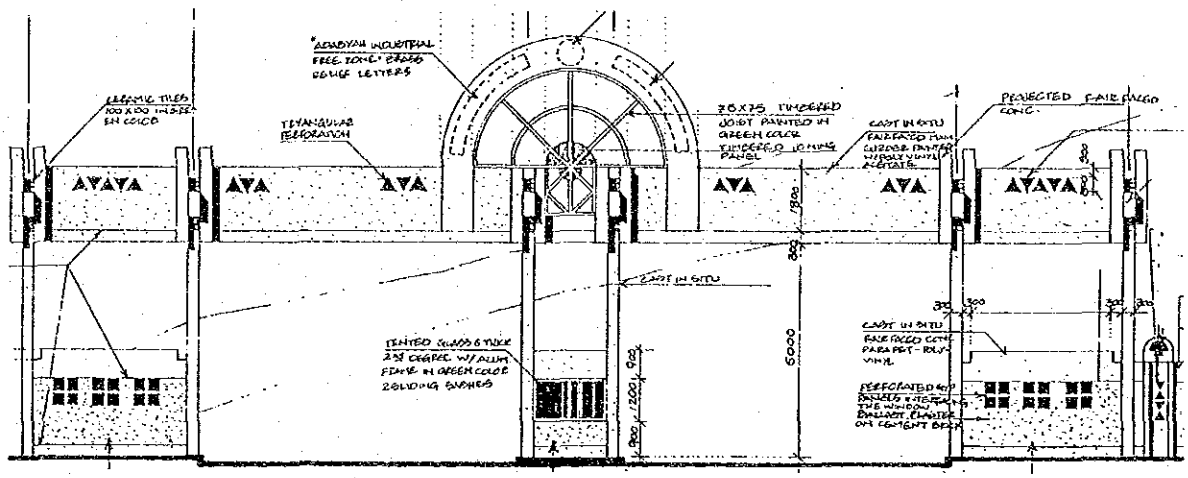
The proposed image as illustrated in elevation below will also represent the image of activeness of the modern industrial estate.



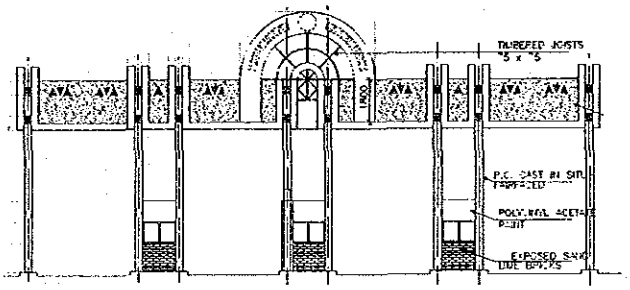
- Land mark expression

It is a concept that each zone or area should establish its own image which suit its own identity within the project. Along with this concept, the building appearance proposed for each zone or area was so determined to represent its identity, thus the building becomes a landmark as targeted. Image of the entrances proposed are as illustrated below.

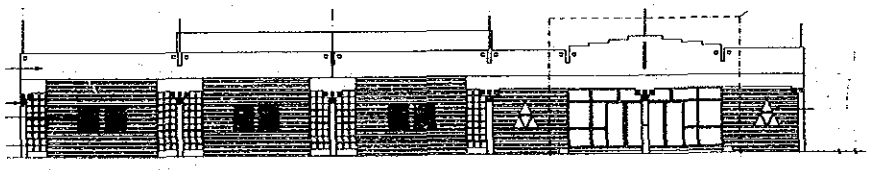
Entrance at Center C



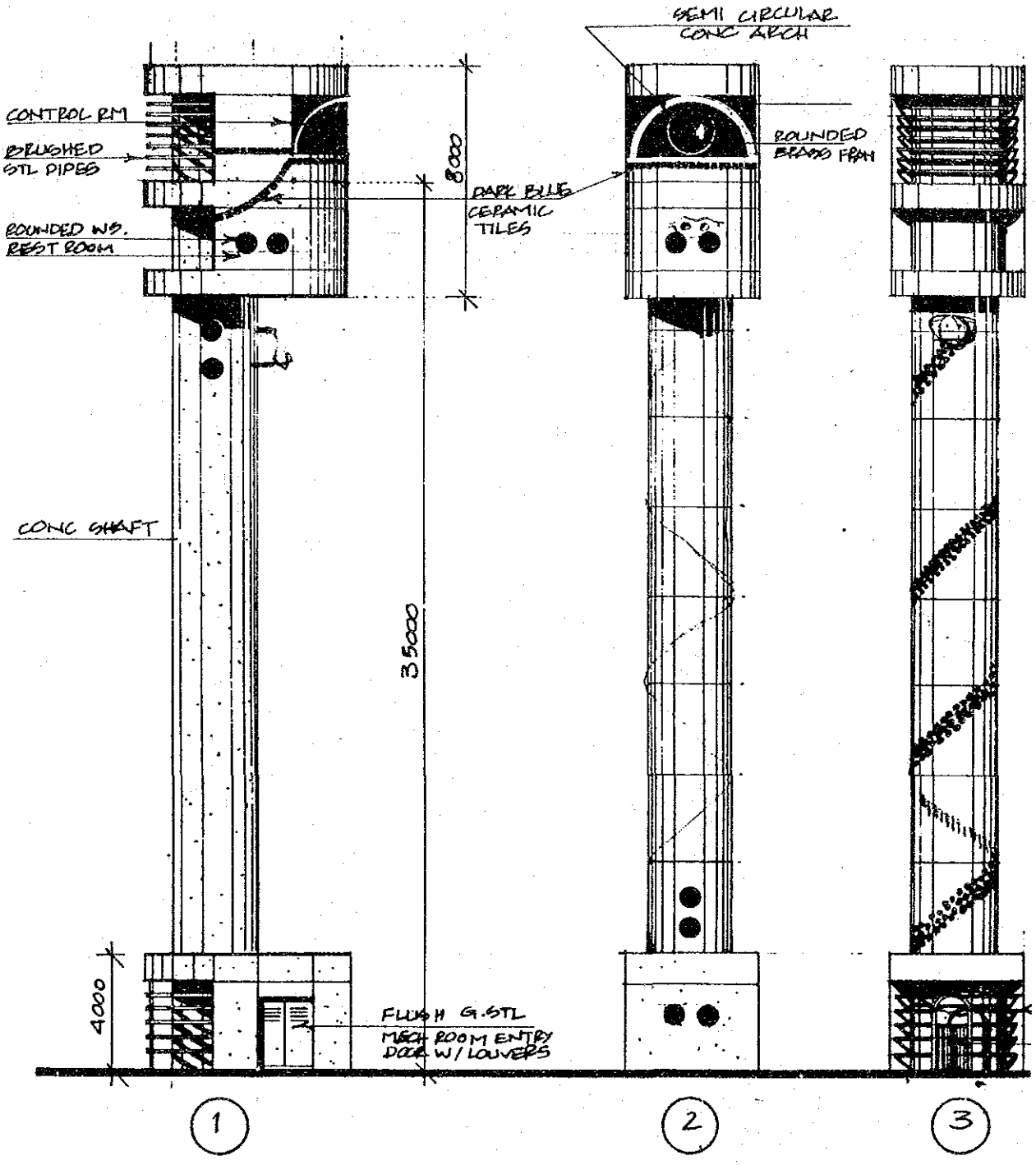
Entrance Gate at Port Area



Entrance at Center A



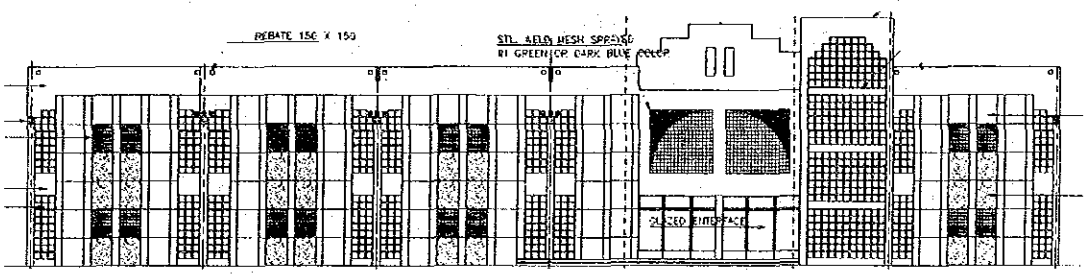
Port Entrance View from the Sea



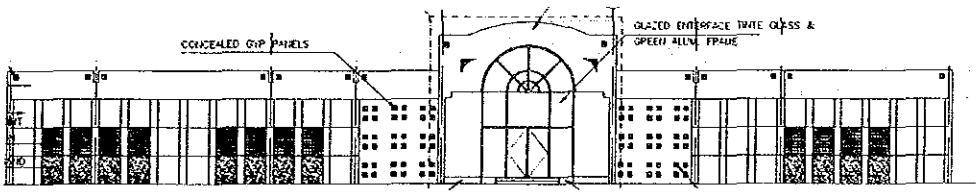
3) Functional expression of each zone

Administration Building in Center A

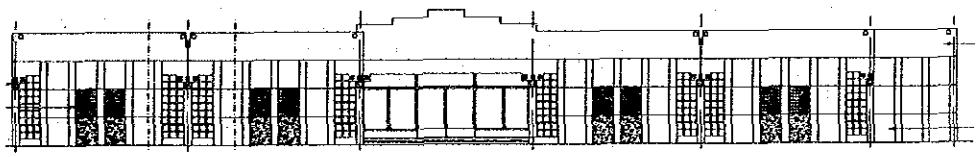
Administration Building in Center B



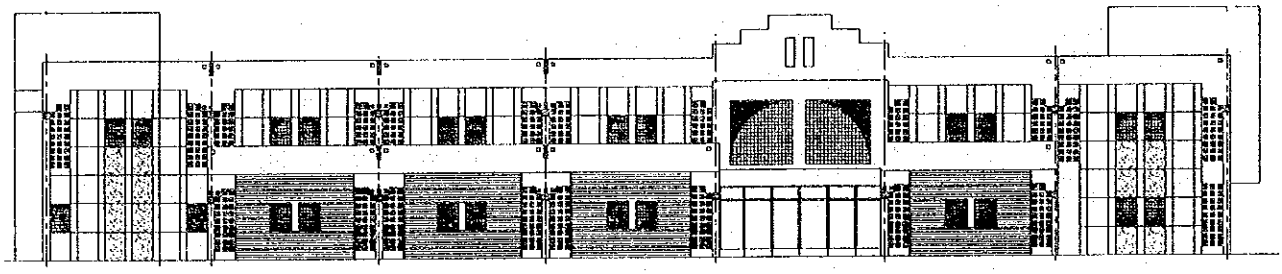
Dispensary in Center B



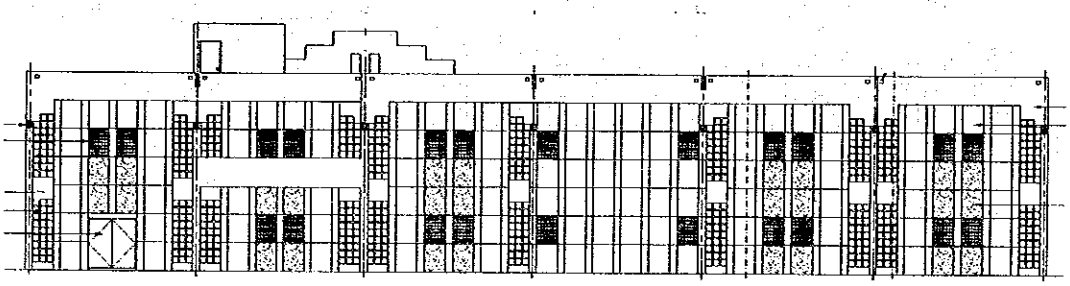
Social Club in Center B



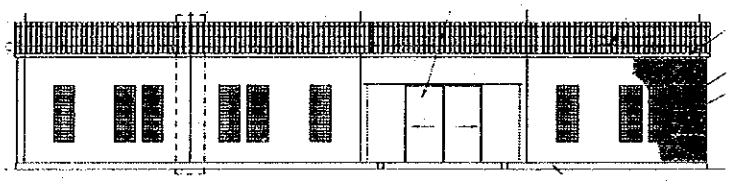
Administration Building in Center C



Administration Building in Port Area

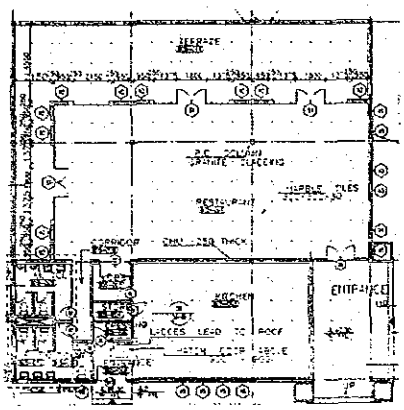


Grain Sacks Storage in Grain Terminal

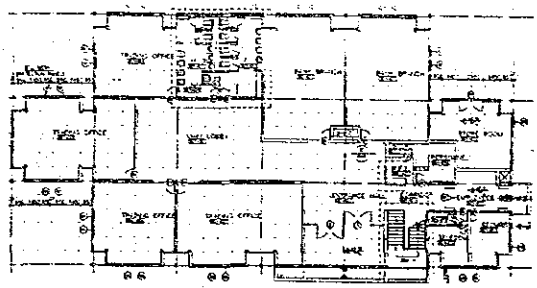


4) Environment in the building

To provide comfortable and efficient working environment for the workers in the building, the concept of "Inward looking" or "Internal completeness", which does not require particular external environment for the workers to feel comfortable, is adopted. Based on the concept, terraces and partially recessed walls are employed as shown below.



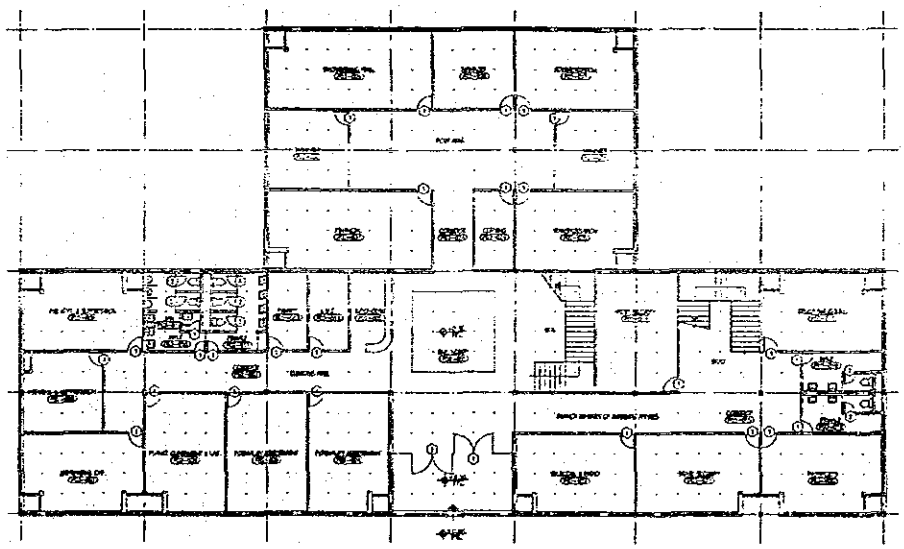
Restaurant



Administration Building

The building interior is zoned based on the functional needs so that the facilities in the zones function properly and efficiently as needed. As an example, a first floor plan of the port administration building, which indicates three zones; namely, port administration, customs and security, and the Ministry of Internal Affairs' branch office zones, is shown below.

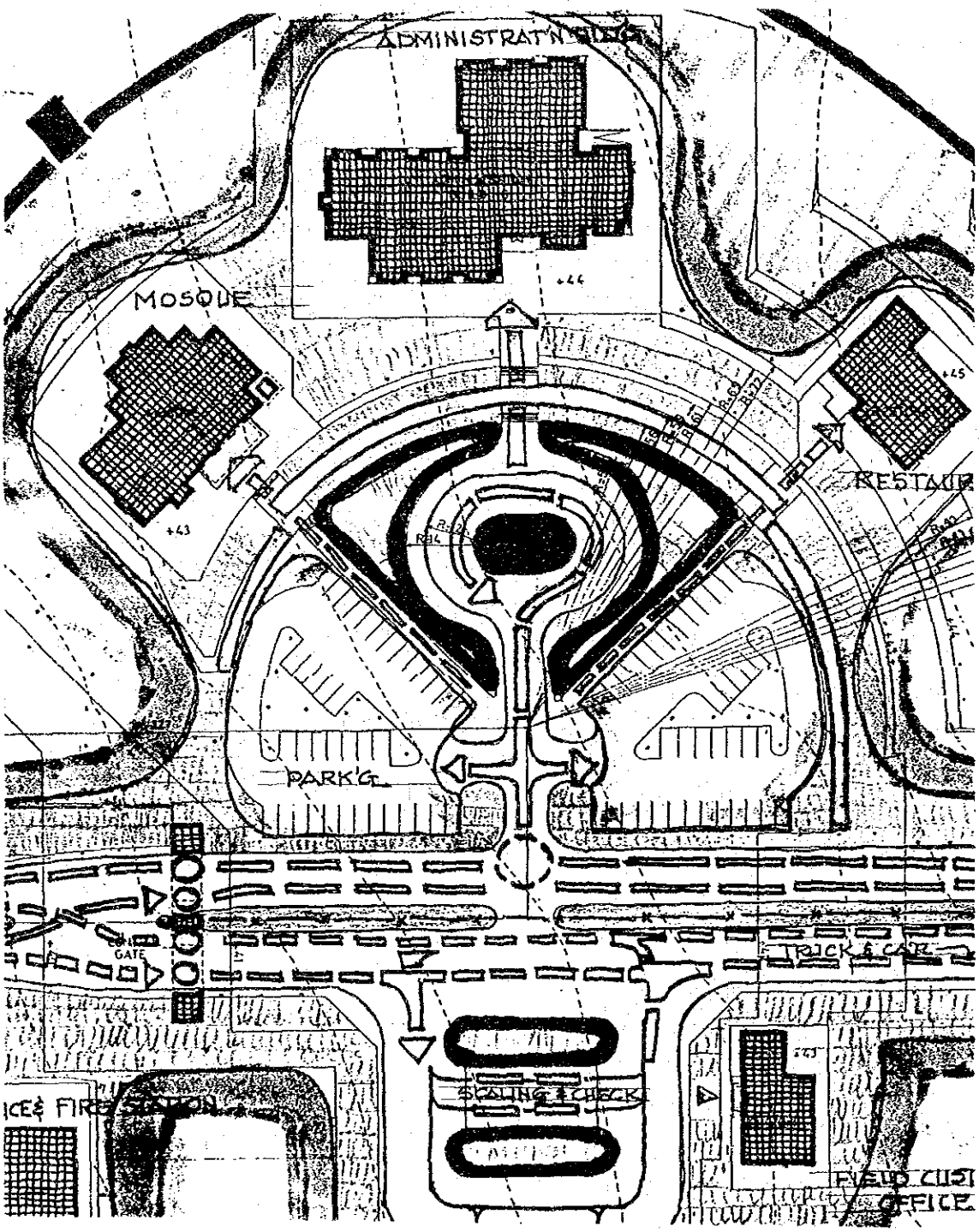
Port Administration Building



5) Circulation patterns

Circular and hierarchical spatial arrangement is proposed for comfortable approach from the entrance of the zone to the destination building. Sit plan of Center C is given below as an example.

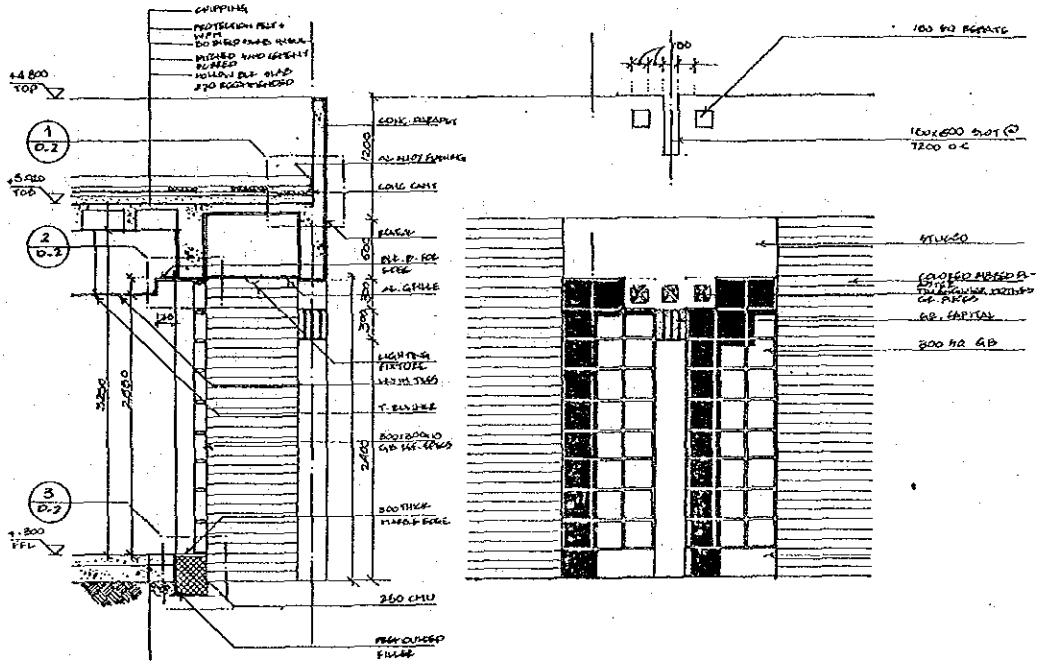
Site Plan of Center C

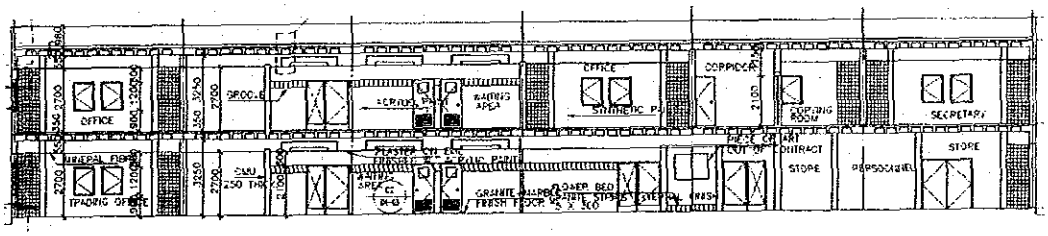


5) Climatic control

Though major office areas are proposed for mechanical air-conditioning, natural climatic control measures over the local hot and humid climate during summers are taken into consideration in the design of the buildings. Main items considered are as follows;

- Projected overhangs or in/out wall formation to shade windows;
- Building orientation in a way to reduce direct sunlight entering the building;
- Building openings orientation perpendicular to the dominant wind direction;
- Landscaping around the building.





(c) Building material selection concept

The building materials are selected based in general on the concepts described below.

- Maximum use of locally supplied materials;
- Adequacy for the architectural forms proposed;
- Adequacy for the local environmental conditions;
- Adequacy of physical characteristics of materials;
- Adequacy for visual impact envisioned;
- Construction economy.

Each of the concepts is described into detail below.

1) Maximum use of locally available materials

It is one of the main determinants for material selection that the materials are locally available. It is a fact that selecting suitable, locally available materials to a maximum extent possible will result in high efficiency in construction and maintenance and excellence in achieving the Egyptian architecture with a reasonable cost. Granites, Hasana marbles, Surnage tiles (terra-cotta), vinyl sheets, emulsions, acrylic and synthetic wall and ceiling components, mineral fibers, aluminum strips, gypsum ceiling boards, etc. are locally available and proposed for the buildings.

2) Adequacy for the architectural form proposed

The proposed architectural form of the buildings is to expose the features of the Egyptian and Arabic architecture through contemporary architectural treatments. The materials used are selected to emphasize this point. Following are the examples of the materials adequate for the proposed architectural forms.

In the administration buildings, the exposed columns in the facades are used to emphasize its relationship with the beams. The crowns of the columns are ornamented with granite in old Egyptian architectural features. Glazed blocks are used in a form of moldings behind the columns, intersected by structural beams in a way that emphasizes all construction elements and provides the facade with a consistent rhythm.
Steel welded mesh panels are also used in a form of contemporary Arabic in front of the windows, which act together with the glazed blocks and the groves in an uniform rhythm (300 - 900 mm) or the ribbed plaster to enhance the architectural form while keeping it as one consistent unit.

For the mosque, the Arabic and Islamic architectural elements are used in a contemporary form, together with colored steel panels or gypsum panels in front of the windows, while covering the ceiling of the "SAHN" and the end of the minaret with aluminum sheets colored in a new and attractive way.

As a part of the architectural form, rhythm and harmony of the buildings are also considered in selecting the materials. The following examples illustrate clearly the effects of the materials selected:

- Windows

  Window dimensions are selected to be in compatible with the envisioned rhythm. Therefore, most of them have a width of 900 mm, while their heights vary between 900, 1,200, 1,800, 2,100 and 2,400 mm.

- Floors

  Granite and marble squares are used in patterns of 1,200, 600 and 300 mm.

3) Adequacy for the local environmental conditions

As mentioned previously, the building materials are selected carefully to suit their required functions. It is also important to mention here that the materials are selected very carefully to suit the local physical environment such as temperature, moisture, dust and brightness.

For example, the polyvinyl acetate paint used for the external facades is highly resistant against local climate. In addition, colors selected are light colors such as white and peach with a smooth outer surface which helps reflecting the heat.

External walls consist of concrete hollow blocks to insulate the extreme exterior heat so that the room temperature will be reduced. Also, tinted glass panes are used for the windows to reduce penetration of sun rays into the buildings, and, in order to minimize the heat penetration through the openings, the openings are reduced in size and number to an extent practical.

4) Adequacy of physical characteristics of materials

Materials are carefully selected considering their physical characteristics. Following are the examples how the materials are selected.

Granite is selected for floors and columns at entrances for its solidity and durability.

For its easiness in cleaning, vinyl flooring sheets are used in office areas and the areas designated for health care such as dispensary buildings.

Polyvinyl acetate paints are used for external facades, not only because of its high performance against climate, but also its wash ability after formation of a hard homogeneous film.

Acrylic emulsion paints are proposed for entrance areas because of its durability against rough usage, color change and fading, as well as its readiness in wash-cleaning.

Terrazzo tiles are used in toilet and kitchen floors because of its durability and high resistance against friction, while ceramic tiles are proposed for walls of the said spaces because of its wash ability and attractive colors.

Concrete slabs with hardener finish are employed for the floors of the workshops for its durability against friction.

5) Adequacy for visual impacts envisioned

It is one of the main design objectives that the materials play an important role in emphasizing homogeneity, contrast and appearance as envisioned in the design. Materials are selected with utmost care for achieving the said objectives effectively and efficiently.

6) Construction economy

Construction economy is the most important factor in implementing the project, therefore, the materials are selected taking the following factors into consideration.

- Quality of building expected versus material cost;
- Constructability in the site;
- Material made to the order, or mass production material.

3.6.3 Detailed Structural Design

(1) Design conditions and criteria

The following design conditions and criteria were established for the detailed structural design.

(a) Codes and standards

The structural designs are carried out in principle in accordance with the Egyptian Code of Practice E.S.S.(1989).

(b) Design method

The structural design method shall be "Ultimate Strength Design Method", and the ultimate load "U" should be taken as follows:

- Dead load (D.L.) and Live load (L.L.)
  U = 1.4 D.L. + 1.6 L.L.

- Dead load (D.L.) and Wind load (W)
  U = 0.9 D.L. + 1.3 W

- Dead load (D.L.) and Live load (L.L.) plus Wind load (W)
  U = 0.8(1.4 D.L + 1.6 L.L. + 1.6 W)

- Dead Load (D.L.) and Live load (L.L.) with Earthquakes load (E.L.)
  U = 0.8(1.4 D.L. + 1.6 L.L. + 1.6 E.L.) or
  U = 0.9(D.L. + 1.3 E.L.)

- Dead load (D.L.) and Live load (L.L.) with Earth pressure (H.L.)
  U = 1.4 D.L. + 1.6 L.L. + 1.6 H.L. or
  U = 0.9(D.L. + 1.6 H.L.)

- Dead load (D.L.) and Live load (L.L.) with Differential settlement, Creep, Shrinkage or Temperature change (T)
  U = 0.8(1.4 D.L. + 1.4 T + 1.6 L.L.) or
  U = 1.4(D.L. + T)

(c) Design loads

The design loads used shall be as follows:

1) Dead loads (D.L.)

The dead loads shall include the deadweight of the structural member itself plus superimposed loads such as deadweights of walls, partitions, flooring, ceiling, roofing, mechanical equipment bases, services and all other permanent construction. Dead loads must be calculated from the actual weights of the materials used. The following are the typical unit weight of the materials.

- Reinforced concrete	: 2,500 kg/cu. m
- Steel	: 7,850 kg/cu. m
- Concrete finish topping	: 2,200 kg/cu. m
- Suspended ceiling	: 75 kg/sq. m
- Hollow block	: 1,150 kg/cu. m
- Solid block	: 1,900 kg/cu. m
- Mortar	: 2,100 kg/cu. m
- Marble	: 2,700 kg/cu. m

2) Live loads (L.L.)

The following are the typical uniform live loads applicable to the structural members.

Roofs:

Varies according to the roof type (for accessible roof: 200 kg/sq. m, for inaccessible roof: 100 kg/sq. m).

Floors:

- Laboratory	: 400 kg/sq. m
- Office area	: 300 kg/sq. m
- Storage area	: 1,000 kg/sq. m
- Corridor	: 400 kg/sq. m
- Staircase	: 500 kg/sq. m
- Lecture hall with fixed seats	: 500 kg/sq. m
- Mechanical room	: Variable according to type of equipment (dynamic effect and vibration applies)
- Toilet room	: 300 kg/sq. m

- Gymnasium, art gallery, etc. : 300 kg/sq. m
- Dormitories (residential) : 200 kg/sq. m

3) Wind load (W)

Wind shall be assumed to come from any horizontal direction.

- Basic wind speed: The design basic wind speed shall be v = 145 km/hr.

- Exposure: An exposure coefficient shall be assigned at each site.

- Design wind pressure: The design wind pressure shall be determined in accordance with the following formula:

$W = C.K_S.\ W_d$

where,

W = Design wind pressure (kg/sq. m)

C = Coefficient determined based on the height, horizontal dimensions and inclination

K_S = Pressure coefficient depends on the location of the site

= 1.0 for normal locations, 1.3 for locations heavily exposed to wind

W_d = The equivalent static pressure for the building height above the design wind pressure grade in meters (kg/sq. m)

height (m)	Wd (kg/sq. m)
00 to 10	50
10 to 20	60
20 to 30	65
30 to 40	75
40 to 60	80

Coefficient C in upward, outward, or inward direction is determined as follows:

- Windward side
  C = 1.3 sin Ø - 0.4 where ratio of height/width > 2.5
  C = 1.2 sin Ø - 0.4 for other ratios
- Leeward side C = - 0.4

4) Seismic loads

All building zones in Egypt are determined in accordance with E.S.S. to be in the Seismic Zone 1 or Zone 2 as follows:

- Zone 1 for all locations in Egypt, except the areas in Zone 2;
- Zone 2 for Red Sea shores, Sinai and Aswan areas.

According to E.S.S., the structures, or any part thereof, located in the Zone 2 must be designed in such a way that they can resist a total horizontal static force "V" of not less than 2 % of the relevant vertical load "W" of the structure, and the V shall not be less than the value given below:

- For structures of regular shape, the total horizontal static force "V" is to be taken as follows :

  $V = 0.3\ K\ C\ I\ W$

  where,

  K = Coefficient depending on the ductility of structure

  = 2/3 for structural systems composed of space frames

  = 4/3 for structural systems composed of R.C. walls

  = 1.0 for structural systems composed of both space frames and R.C. walls.

  $C = 1/(15\ T^{0.5})$

  T = Period of basic vibration (in seconds)

  $T = 0.09H/B^{0.5}$

  where,

  H = Total height of the building (m)

  B = Width of the building in the direction of the force (m)

  I = Importance coefficient

  = 1.5 for buildings with special importance such as hospitals, police station, etc.

  = 1.0 for other buildings

  W = Total equivalent vertical force of the building

  = Dead load only (in case of line load < 500 kg/sq. m)

  = (D.L. + 1/2 L.L. (in case of line load > 500 kg/sq. m)

- The total horizontal force is distributed along the building according to the following formula:

  $$V = f_t + \sum_{i=1}^{n} f_i$$

  where,

  f_t = Concentrated force at top level of roof $\leq 0.25\ V$

  = 0.0 for T < 0.7 sec.

$$f_X = [\,(V - f_t)\, w_X\, h_X] \,/\, \sum_{i=1}^{n} W_i\, h_i$$

where,

W_X, W_i = The equivalent vertical load for the floor at height h_X, h_i (measured from the foundation level)

n = Number of floors above foundation

f_X = Lateral force applied to level x

5) Accidental and other loads

- Dynamic loads :
  The structure shall be designed and constructed to resist the effects of dynamic load of equipment and machinery such as rotating and/or vibrating machines.
  The use of factored imposed static load equivalent to the dynamic effects as specified by the manufacturer is adequate.

- Horizontal loads on parapets:
  The parapets shall be designed to resist minimum horizontal loads equal to 100 kg/m acting at the top.

- Impact load:
  An impact load equal to 2 tons acting at height of 1.2m above pavement level shall be taken into consideration in the design of structures in parking areas.

(2) Design concept

The concept of the structural design is to provide the structural systems which ensure not only safety and economy of the proposed buildings and structures, but also are compatible with the proposed architectural scheme and the mechanical and electrical systems. The structural design includes the design of all the superstructures and substructures, slabs, beams, columns, bracing and foundations.

(3) Structural materials

The following is a summary of the materials of construction proposed for use in the structures. All materials described below conforms to the applicable standards listed in E.S.S.

(a) Cast in- place concrete

- Reinforced concrete for foundations, slabs on grade, slabs on metal deck, topping: f_{cu} = 250 kg/sq. cm
- Reinforced concrete for grade beams, columns, wall beams, slabs: f_{cu} = 300 kg/sq. cm
- All other reinforced concrete: f_{cu} = 300 kg/sq. cm
- Plain concrete: f_{cu} = 200 kg/sq. cm

(b) Reinforcing steel

- Normal mild steel 24/35: f_y = 2,400 kg/sq. cm
- High grade steel 36/52: f_y = 3,600 kg/sq. cm

(c) Aggregates

Concrete aggregates shall conform to E.S.S (1989).

(d) Cement

Cement shall conform to E.S.S. (1989). Sulfate resistant cement (SRC) shall be used in all concrete structures in contact with soil. Ordinary Portland cement (OPC) shall be used in all other concrete structures.

(e) Water

Water used in mixing concrete shall be clean and free from injurious amounts of soils, acids, alkalis, salts, organic materials or other substances that may be deleterious to concrete and/or reinforcement.

(4) Design solutions

(a) Foundation system

The soil investigation results showed the presence of the swelling clay layers in Center A area, while a sand/clay mixture soil stratum is indicated in other areas. Therefore, continuous strip footing (inverted T shape) foundations are proposed for the Center A structure foundations, to avoid any differential settlements due to the swelling clay layers. It is considered not necessary to use pile foundations for the buildings of 1 or 2-story.

Foundation level : -1.50 m from G.L.

Soil replacement layer	: 1.50 m thick
Bottom level of excavation	: -3.00 m from G.L.
Bearing capacity	: 1.25 kg/sq. cm

For all other Centers and terminals, isolated reinforced concrete footings connected with each other by grade beams are proposed for the foundation system.

Foundation level	: -1.50 m from G.L.
Soil replacement	: 1.50 m thick
Bottom level of excavation	: -3.00
Bearing capacity	: 1.25 kg/sq. cm

(b) Superstructure system

Either one of the following systems is proposed as the superstructure system for each building.

- Hollow concrete slab of total thickness of 27 cm (7 cm solid thickness) without the secondary beams, where the span not exceeding 7.20 m, to obtain the required clear ceiling height and to eliminate any conflicts with the air-conditioning ducts and electric cables beneath the slabs.

- For other buildings where dynamic or highly concentrated loads exist, solid reinforced concrete slabs with the secondary beams (traditional beam and slab system) are recommended.