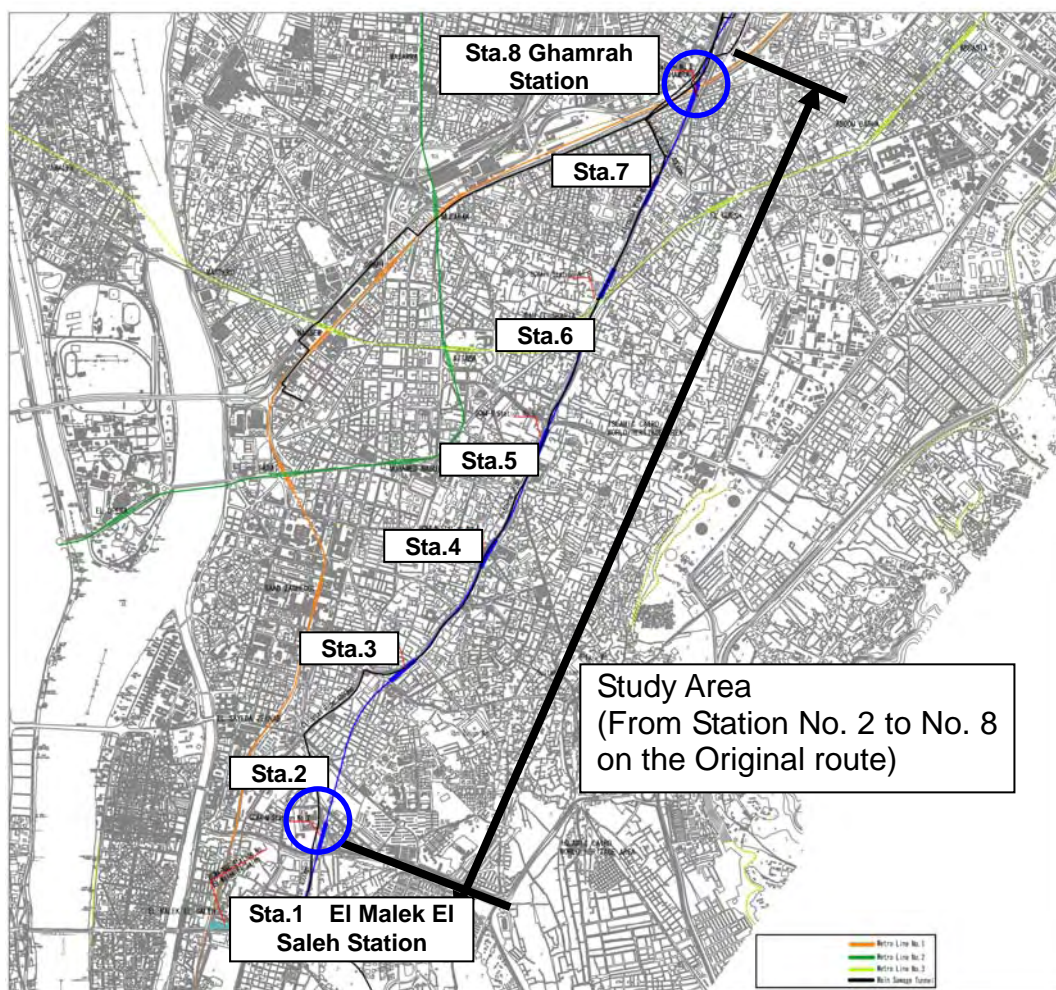


## 5.7 Preliminary Alternative Route Study for Phase 2 Section

### 5.7.1 General

Metro Line 4 Phase 2 study on the Northern Route is presented in Chapter 5.1 (hereinafter “Original Route”), which is planned to run under/above Port Said Street, where there is the existing Spine Waste Water Tunnel (SWWT).

In order to find out the possibility of an alternative alignment route which avoids the SWWT, the JICA Study Team has carried out alternative route study on the section between M4N Sta. No. 2 and Sta. No. 8. Figure 5-43 shows the location of the study area.



Source: JICA Study Team, 2009

Figure 5-43 Study Area

In general, the basic principle of the metro alignment is to situate along/under the street which has wide road-width and large traffic volume. The reasons are as follows:

- 1) The demand of the metro is related to the accessibility and convenience from the main line of the road, taking into consideration the inflow traffic at the connection point.
- 2) In order to minimize the land acquisition or interference to private land, which affect not only the project cost but also construction time, the underground of the road, which is public territory, should be utilized as much as possible.
- 3) In order to minimize the environmental impact on local residence during the metro operation such as vibration and noise, the alignment should keep some distance from the local residential district.

Based on the above basic principles, it was attempted to seek the alternate road where the metro alignment could be located instead of Port Said Street between El Malek El Saleh Station to Ghamrah Station. Consequently, however, the alternate road for the metro alignment did not exist in the vicinity of the northern route area except along Port Said Street.

Therefore, three alternative routes were chosen and studied based on the alignment along Port Said Street taking into account the distance to the SWWT.

The requirements for the study are as follows:

- Each station is assumed to have the dimension of L: 190 m × W: 25 m for the route study.
- The route is considered to connect with Metro Line 3 at Bab El Shaaria Station and with Metro Line 1 at Ghamrah Station considering the convenience of metro users.

### **5.7.2 Alternative Route Setting**

Three alternative routes were considered and compared in this study based on the following general concepts.

**1) Alternative Route 1 (AR1):** In principle, the alignment of AR 1 is located within close vicinity of Port Said Street to reduce the area of land acquisition as much as possible taking into consideration the distance to the SWWT. The stations are located at intervals of approximately 1.0 km. Since high-rise buildings are located along Port Said Street, the Metro Line 4 therefore passes under these high-rise buildings.

**2) Alternative Route 2 (AR2):** The alignment is shifted to avoid the high-rise building area. The location of stations is arranged and two of them are omitted in consideration of the effect of land acquisition.

**3) Alternative Route 3 (AR3):** The location of station is arranged in consideration of the effect of land acquisition. Two stations are omitted from the original route. The alignment is decided to satisfy the relation of each station location. This alignment can keep longer distance from SWWT at around Azhar Tunnel by passing under Muhammad Ali Street.

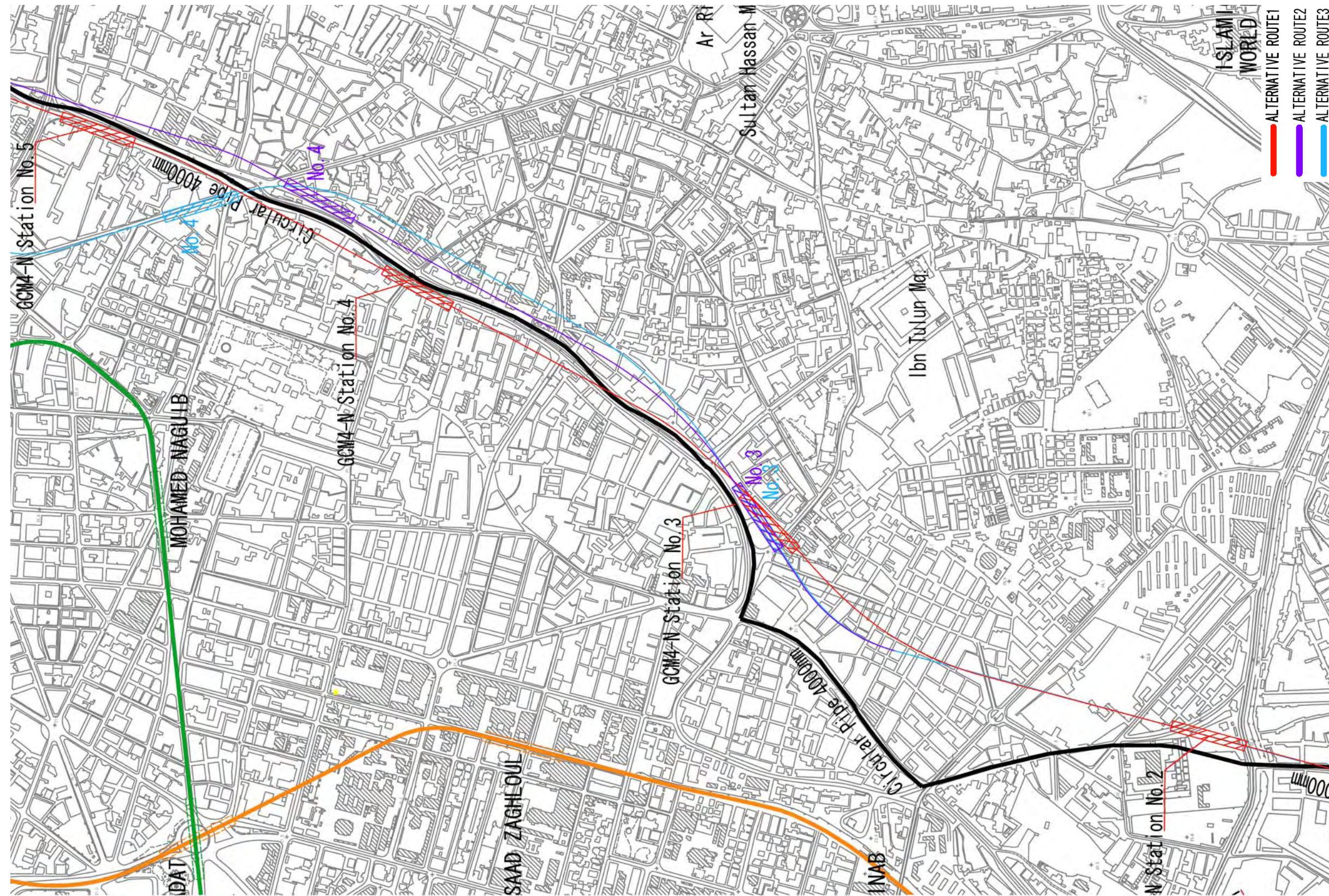
Table 5-12 shows the number of stations, station intervals, total length and average intervals for each alternative. The alternative routes are indicated in Figure 5-44 to Figure 5-46.

**Table 5-12 Number of Stations and Intervals**

Alternative Route No.		AR1	AR2	AR3
Number of stations (From Sta. 2 to the Sta. 8 )		7	5	5
Station intervals (km)	Sta. 2 - Sta. 3	1.3	1.3	1.3
	Sta. 3 - Sta. 4	1.0	1.4	1.7
	Sta. 4 - Sta. 5	0.8	1.3	1.3
	Sta. 5 - Sta. 6	1.1	1.8	1.8
	Sta. 6 - Sta. 7	0.8	-	-
	Sta. 7 - Sta. 8	0.7	-	-
Total length (km)		5.7	5.8	6.1
Average of intervals (km)		1.0	1.5	1.5

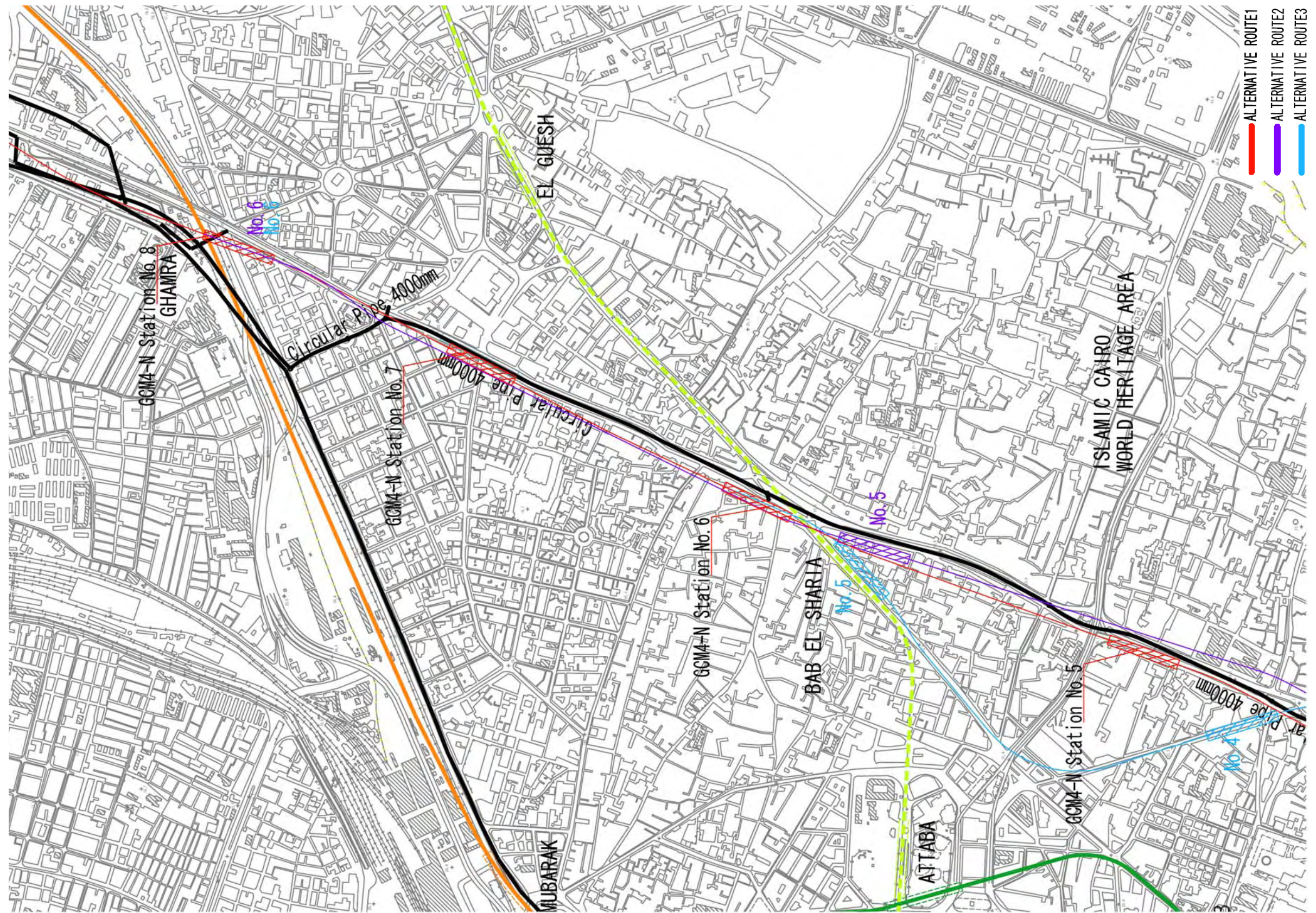
Source: JICA Study Team





Source: JICA Study Team

Figure 5-45 Route Map (1 of 2)



Source: JICA Study Team

Figure 5-46 Route Map (2 of 2)

### 5.7.3 The Condition of Station Locations

The condition of station locations for each alternative route is described as follows. Location list is attached as Figure 5.7.6.

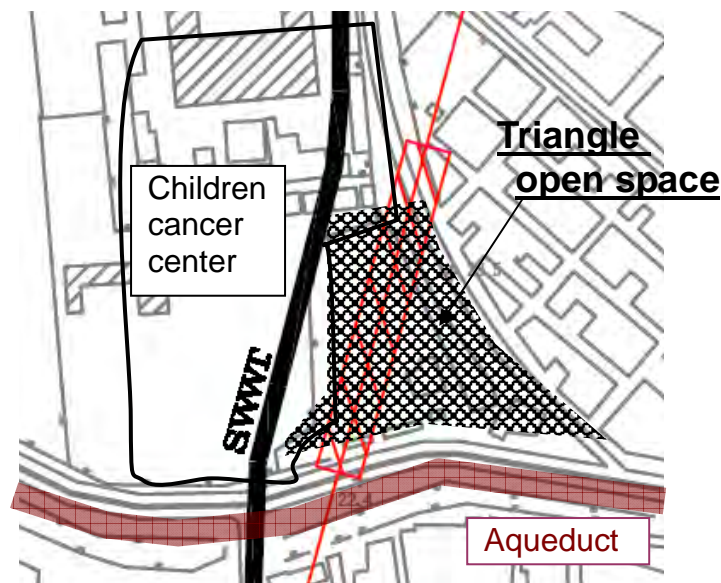
#### (1) For Alternative Route (AR) 1

##### 1) M4N Station No. 2 (AR1)

The triangular open space on the road in close proximity to the Children Cancer Center should be utilized for situating the station. The position of the station is determined according to the following reasons:

- To avoid the affecting the aqueduct
- To minimize the effect on the land acquisition

The adequate distance to the SWWT is ensured and the same location of the station is applied to all alternatives.

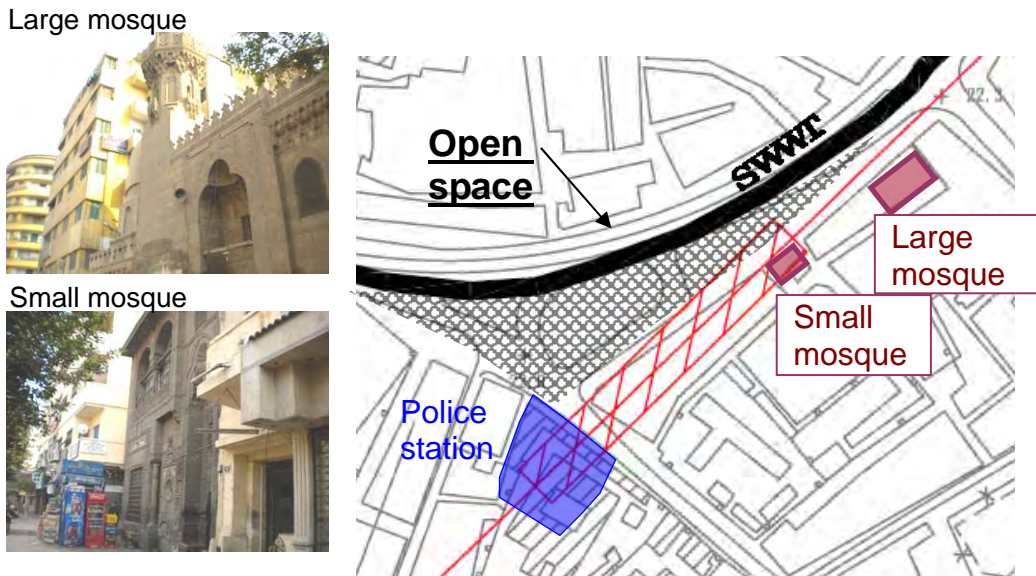


Source: JICA Study Team

**Figure 5-47 M4N Station No. 2 (AR1)**

##### 2) M4N Station No. 3 (AR1)

There is wide open space on Port Said Street in front of the police station. It should be utilized as much as possible.. However, in order to keep the appropriate distance from the SWWT, the land acquisition for low building can not be avoided. There are two different mosques shown in Figure 5-48. The demolition of the large mosque seems to be difficult because of its elegant appearance and assumed amount of prayers. On the other hand, there is higher possibility that the small mosque can be demolished. In addition, the police station land would be utilized because land acquisition seems easier than with private land.



Source: JICA Study Team

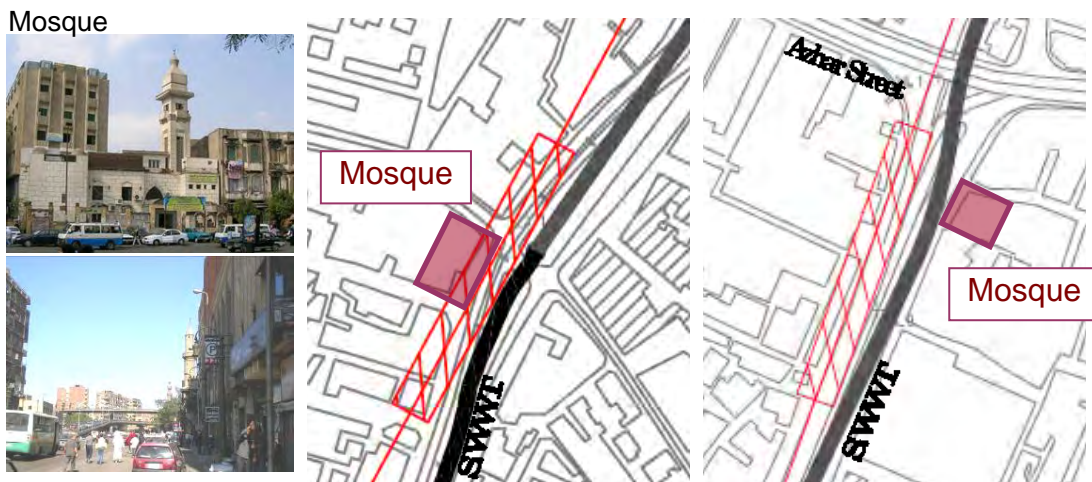
**Figure 5-48 M4N Station No. 3 (AR1)**

3) M4N Station No. 4 (AR1)

There is wide road-width area in front of the mosque (Figure 5-49), and it is within appropriate interval (1.0 km) from M4N Station No. 3 (AR1). Although the road side of the wide road-width is utilized, the space is not enough for the station due to the existing SWWT. It means that large number of high-rise buildings including the mosque is required to be removed.

4) M4N Station No. 5 (AR1)

There is the crossing with Azhar Street at a distance of 0.8 km from M4N Station No. 4 (AR1). The station is located in quite important place where the higher demand from the Azhar district is expected, though it is in front of the mosque. In addition, large numbers of high-rise building exist along Port Said Street at the area. Therefore, it is difficult to avoid large area of and acquisition.



Source: JICA Study Team

**Figure 5-49 M4N Station No. 4 and M4N Station No. 5 (AR1)**



5) M4N Station No. 6 (AR1)

The Metro Line 4 should connect with Metro Line 3 in consideration of the convenience for Metro users and expansion of the demand. The location in the north of the existing Bab El Shaaria Station is recommended in order to have suitable interval (1.1 km) from M4N Station No. 5 (AR1). Although there is wide open space at the centre of Port Said Street, the station cannot be planned there due to the existence of SWWT. Therefore, large number of high-rise building is required to be demolished.

6) M4N Station No. 7 (AR1)

There is a connection point with Metro Line 1 (Ghamrah Station) which is positioned at a distance of 1.5 km from M4N Station No. 6 (AR1), though the southern area of the station is occupied by high-rise building along Port Said Street and tranquil residential area. In view of station intervals, it is recommended to locate a station between Ghamrah Station and M4N Station No. 6 although large number of land acquisition cannot be avoided.



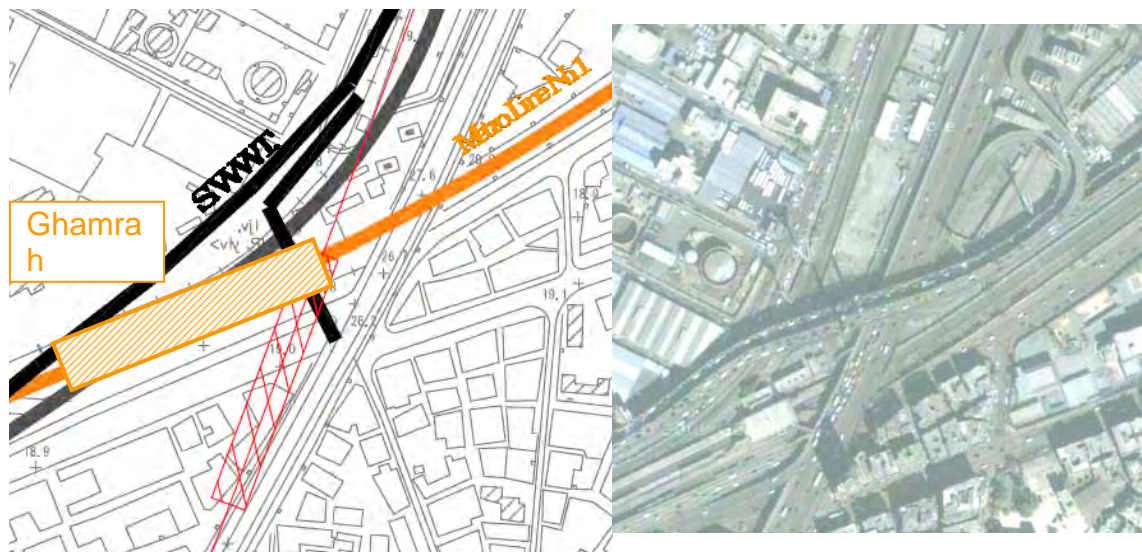
Source: JICA Study Team

**Figure 5-50 M4N Station No. 6 and M4N Station No. 7 (AR1)**

7) M4N Station No. 8 (AR1)

The location of M4N Station No. 8 (AR1) is shown in Figure 5-51. The location should be limited at the west side of Port Said Street due to the existence of 6<sup>th</sup> October Bridge ramp at the east side as shown in Figure 5-51.

The detailed location study is presented in Figure 5.7.4, considering that the location has a lot of construction difficulties.



Source: JICA Study Team

**Figure 5-51 M4N Station No. 8 (AR1)**

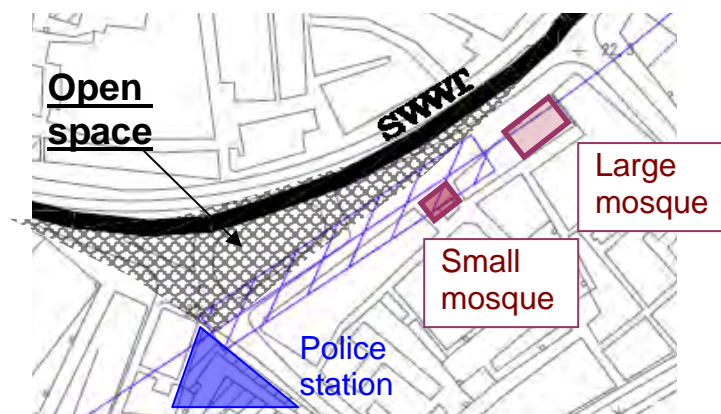
**(2) For AR2**

**1) M4N Station No. 2 (AR2)**

As mentioned in Section 5.7.3(1)1), the suggested location of M4N Station No. 2 in AR1 may not give any effect on SWWT. Therefore, the same location of M4N Station No. 2 for all alternatives can be suggested.

**2) M4N Station No. 3 (AR2)**

As mentioned in Section 5.7.3(1)2), land acquisition and demolition are required for the low buildings and small mosque. The difference from AR1 is the alignment direction.

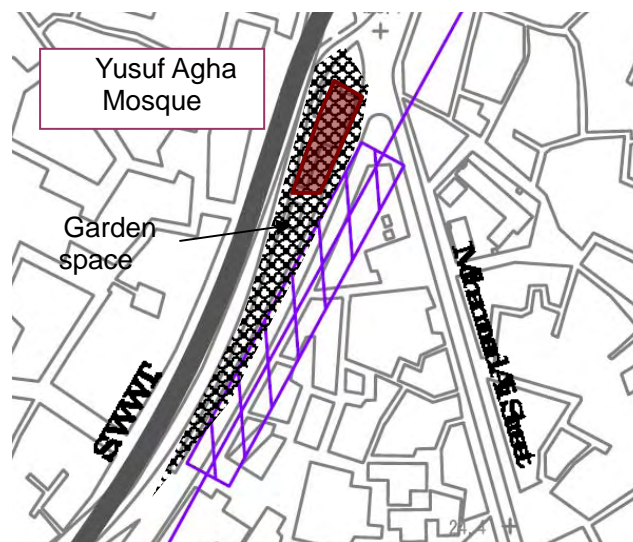


Source: JICA Study Team

**Figure 5-52 M4N Station No. 3 (AR2)**

### 3) M4N Station No. 4 (AR2)

From M4N Station No. 3 (AR2) to the northern area, high-rise buildings are densely situated along Port Said Street. In front of the connection with Mohammed Ali Street, there is Yusuf Agha Mosque with the garden in the centre of Port Said Street. It is recommended to locate the station in the vicinity of the garden taking into consideration the traffic demand from Mohammed Ali Street and the possibility of partial utilization of the garden space. However, the removal of the mosque seems to be difficult due to its elegant appearance and the assumed frequency of prayer time and devotees.

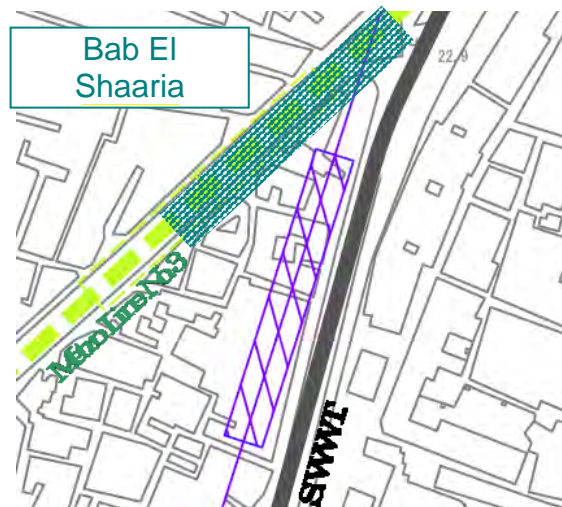


Source: JICA Study Team

**Figure 5-53 M4N Station No. 4 (AR2)**

### 4) M4N Station No. 5 (AR2)

The Metro Line 4 should connect with Metro Line 3 in consideration of the convenience for Metro users and expansion of the demand. In order to minimize the volume of land acquisition, the southeast area from Bab El Shaaria Station (Metro Line 3) is the recommended position which is mostly occupied by low rise buildings.



Source: JICA Study Team

**Figure 5-54 M4N Station No. 5 (AR2)**

5) M4N Station No. 6 (AR2)

From M4N Station No. 5 (AR2) to the northern area, the high-rise buildings are densely situated along Port Said Street. In order to minimize the volume of land acquisition, the area should be omitted. However, the station is essential at the connection with Metro Line 1 for the convenience of Metro users. Consequently, the interval between M4N Station No. 5 and M4N Station No. 6 becomes comparably large (1.8 km) for the minimization of land acquisition. The idea of the location is similar to AR1, as mentioned Section 5.7.3(1) 5).

**(3) For AR3**

1) M4N Station No. 2 (AR3)

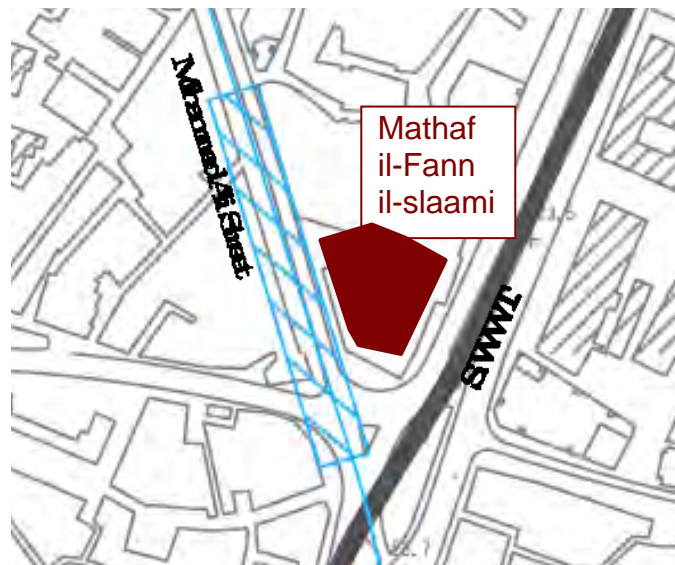
As mentioned in Section 5.7.3(1)1), the suggested location of M4N Station No. 2 in AR1 may not give any effect on SWWT. Therefore the same location of M4N Station No. 2 for all alternatives can be suggested.

2) M4N Station No. 3 (AR3)

As mentioned in Section 5.7.3(1)2), the requirement in the location is land acquisition for low buildings and the removal of small mosque. The difference from AR1 is the alignment direction.

3) M4N Station No. 4 (AR3)

There is a road crossing with Muhammad Ali Street, which is 1.7 km from M4N Station No. 3 (AR3). Although it is positioned diagonally against Port Said Street, it can be used because of the comparably wide road-width (approximately 20 m) in the street. The potential on the demand might be high because of the existence of the museum (Mathaf il-Fann il-slaami) and road traffic from the southern area.



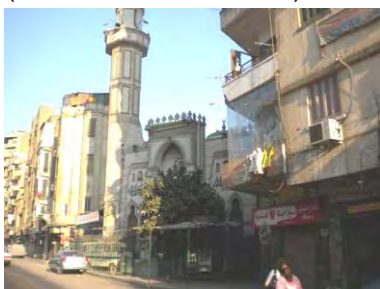
Source: JICA Study Team

**Figure 5-55 M4N Station No. 4 (AR3)**

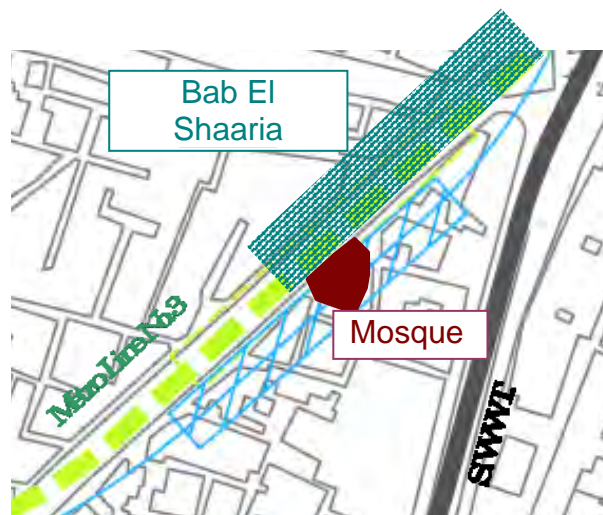
4) M4N Station No. 5 (AR3)

In order to connect with Metro Line 3, the alignment needs to have a right-hand curve and the station should be settled at the southern position which is parallel to Bab El Shaaria Station. Although the position is valuable in terms of the convenience for the connection with Metro Line 3, large number of land acquisition of not only high-rise buildings but also large mosque (Shams al-Din al-Ramli) cannot be avoided.

Mosque  
(Shams al-Din al-Ramli)



Source: JICA Study Team



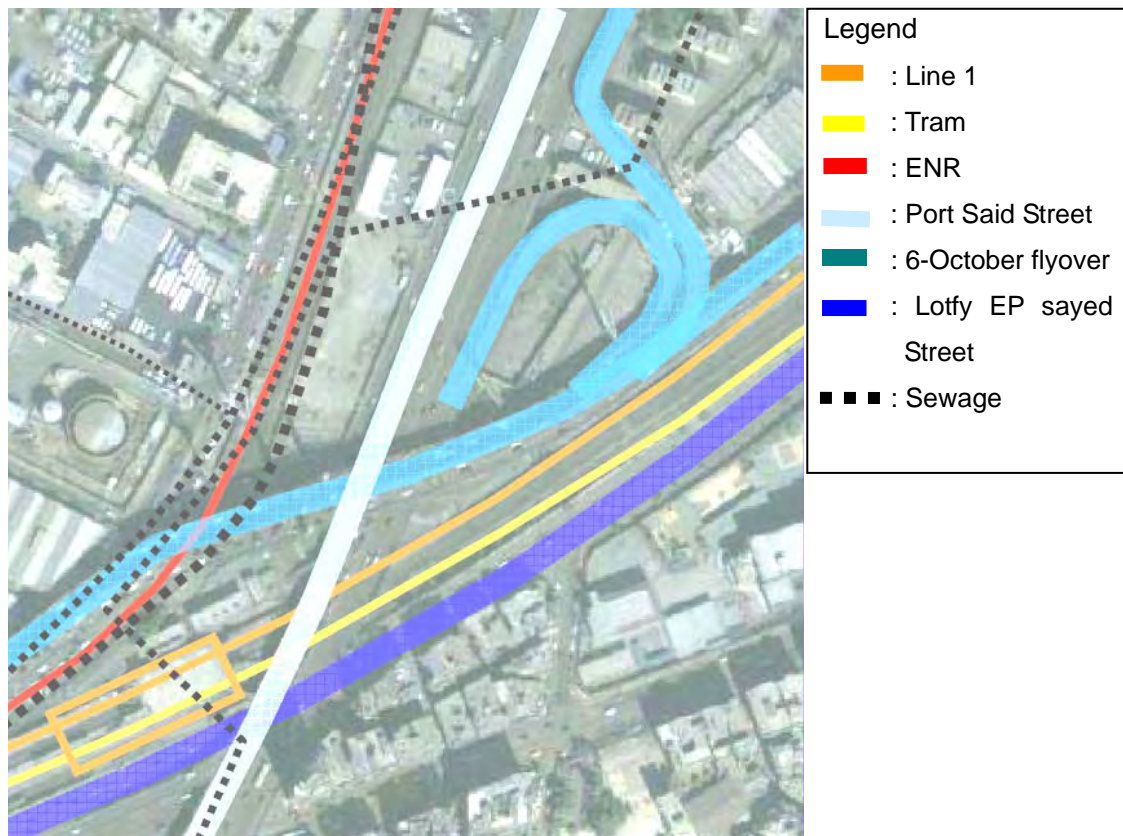
**Figure 5-56 M4N Station No. 5 (AR3)**

5) M4N Station No. 6 (AR3)

From M4N Station No. 5 (AR3) to the northern area, high-rise buildings are densely situated along Port Said Street. In order to minimize the volume of land acquisition, the area should be omitted. However, the station is essential at the connection with Metro Line 1 for the convenience of metro users. Consequently, the interval between M4N station No. 5 and M4N Station No. 6 becomes comparably large (1.8 km) for the minimization of land acquisition. The idea of the location is similar to AR1 as mentioned in Section 5.7.3(1) 5).

#### 5.7.4 Comparison Study for the Connection with Metro Line 1

It is noted that many considerations for construction difficulties should be studied for the connection with Metro Line 1 at Ghamrah Station. In order to find out the main issues and to proceed with the further review and consideration, three different locations for the connection with Metro Line 1 are compared. The existing condition around Ghamrah Station is shown in Figure 5-57.



Source: JICA Study Team

**Figure 5-57 Existing Condition Around Ghamrah Station**

#### (1) Abstract of Each Study Case

The abstract and figure for each location is as follows (Figure 5-58 - Figure 5-60):

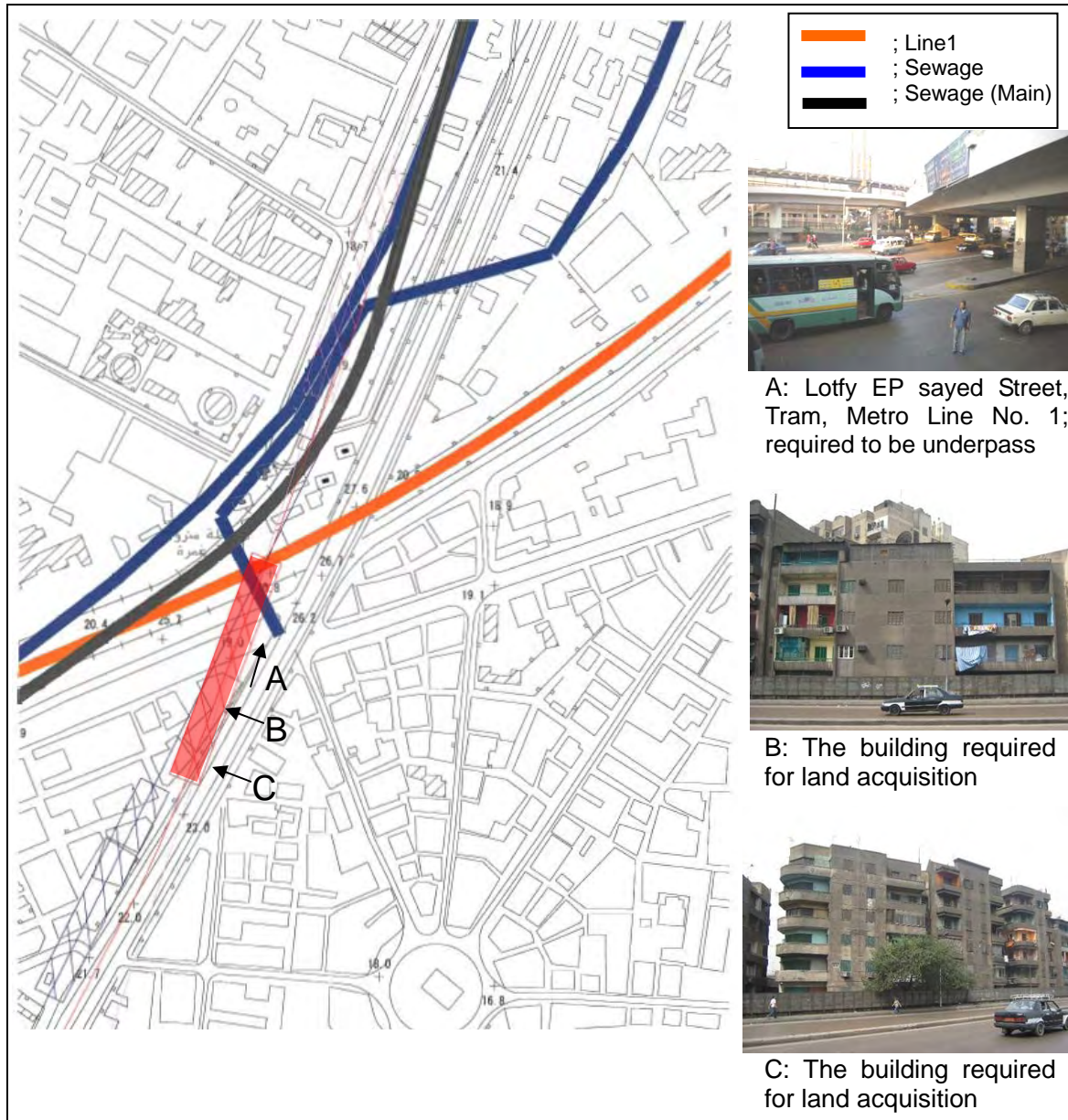
##### 1) Case 1

Location advantage: The direct connection with Metro Line 1, considering the

highest priority to the convenience of metro users.

**Construction difficulties:** Special tunnel method is required to construct the station under the multiple transportations lines.

**Issues:** Large number of land acquisition (it is estimated for seven buildings as referred to Figure 5-67 in the location list)



Source: JICA Study Team

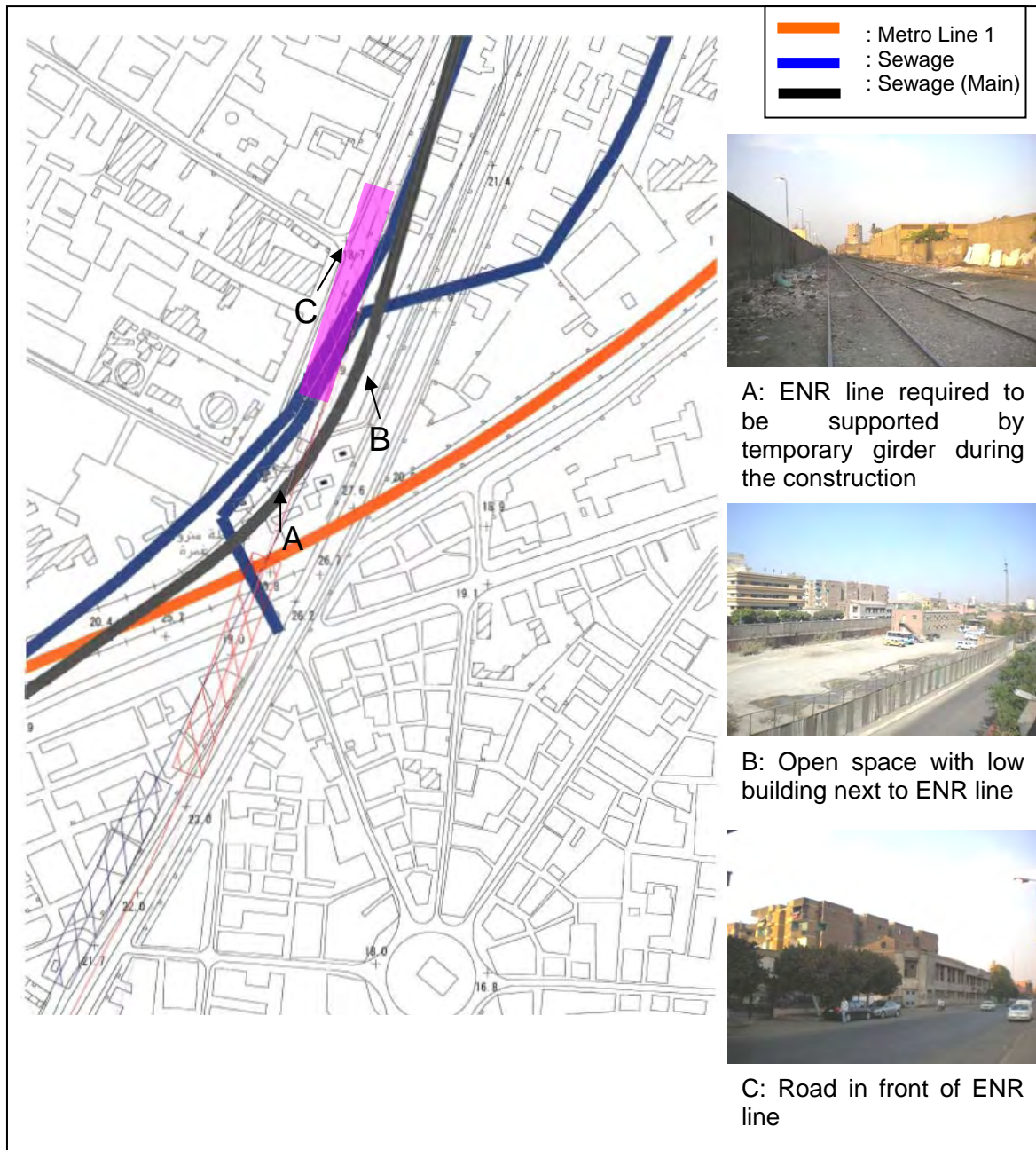
**Figure 5-58 Station Location Case 1**

2) Case 2

Location advantage: The location which minimizes the effects on land acquisition.

Construction difficulties: Temporary supporting girder to construct the station under the currently operating ENR.

Issues: The inconvenience of metro users (the distance from Ghamrah Station is approximately 100 m).



Source: JICA Study Team

**Figure 5-59 Station Location Case 2**

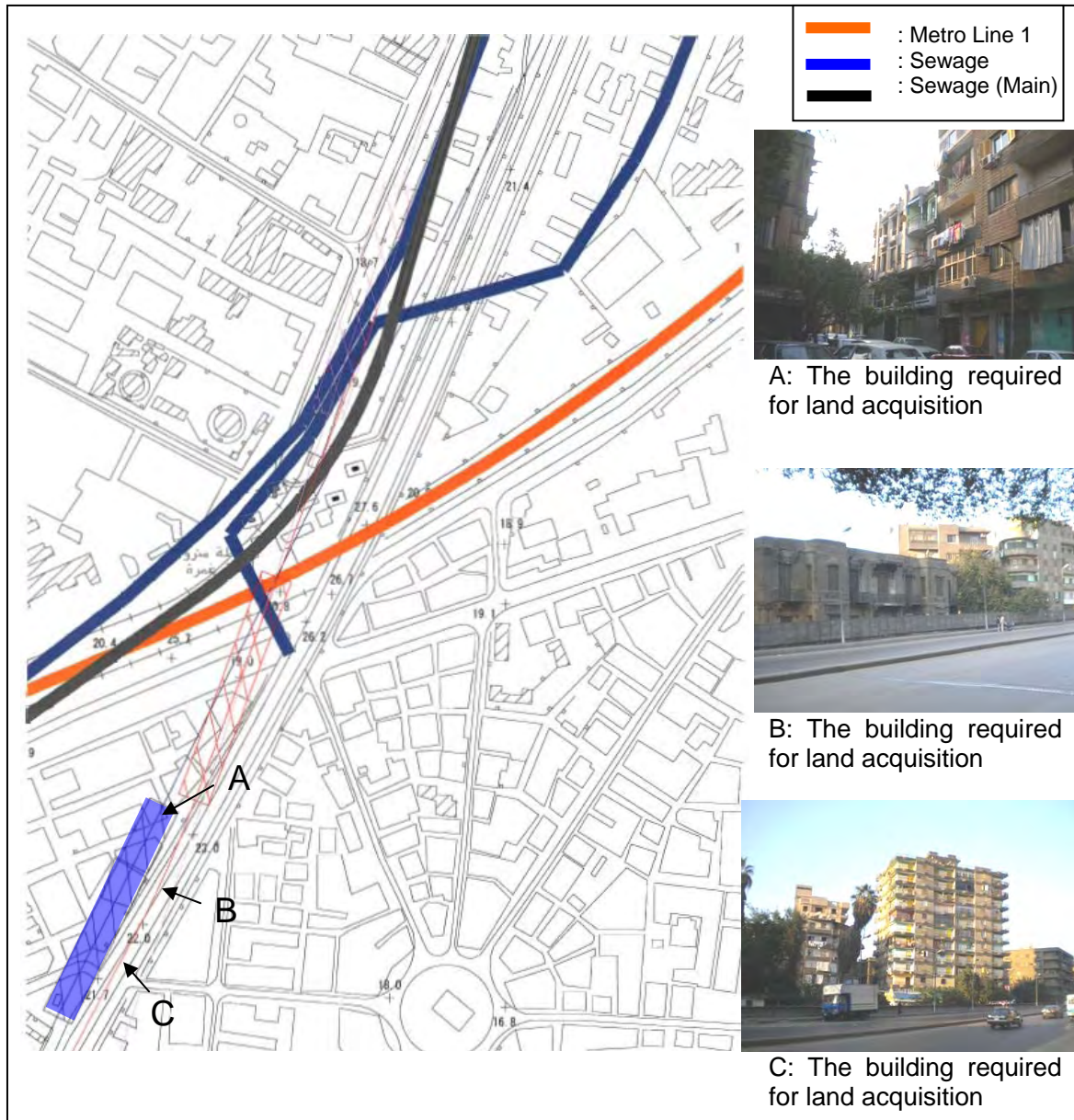


3) Case 3

Location advantage: The location which reduces the construction difficulty except land acquisition.

Construction difficulties: Nothing (Cut and cover method can be adopted).

Issues: Inconvenience for metro users (The distance from Ghamrah Station is approximately 200 m) and substantial land acquisition (estimated for 6 buildings).



Source: JICA Study Team

Figure 5-60 Station Location Case 3

**(2) Comparison of Three Location Cases**

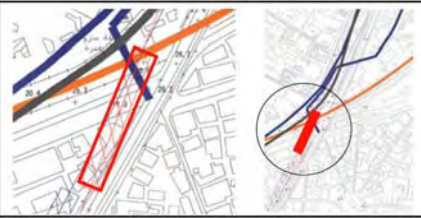
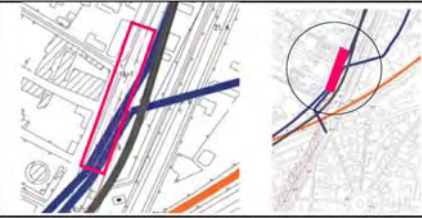

A comparison of the three location cases is shown in Table 5-13.

It is concluded that Case 1 gives the best result, not only in terms of the convenience for metro users but also the potential demand. It is recommended that highest priority is given to the convenience of traffic users in traffic planning, considering the development of the area. It should be noted that renovation of the connection point in the future will generate more difficult situation and higher cost.

In addition, although Case 1 has the highest development cost, the cost difference among the three cases is not significant.

Therefore, Case 1 for the connection station with Metro Line 1 is recommended.

**Table 5-13 Comparison of the Three Location Cases**

	Case1	Case2	Case3
			
Abstract	In order to give the highest priority for the convenience of Metro users, direct connection with Line.1 at GHAMRA station is considered by Hep&Jes method.	In order to realize minimization of effect for land acquisition, a special construction method for existing ENR line is considered.	In order to realize the reduction of construction hardness, large scale of land acquisition is considered.
Accessibility	It is direct connection with GHAMRA Station (L-type connection) Demand is prospected from Metro Line1, from catchment at northern area and at southern area.	It is connected with GHAMRA Station by pedestrian tunnel (L= 100m) Demand is mainly prospected from catchment at northern area.	It is not connected with GHAMRA Station. ( A distance from GHAMRA Station is 200m) Demand is mainly prospected from catchment at southern area.
Construction Difficulties	•It is construction under the existing Line1, tram line, and highway by special method as "Multi Box Jacking Method" or "Hep&Jes method" or etc.	•It is construction with temporary supporting girder under ENR operation. •It is neighboring construction with Spine Waste Water Tunnel.	•It has less construction difficulties compared with other options. •Cut and cover may be possible.
Land acquisition	7 buildings	None	6 buildings
Cost assumption (million USD)	Station (Special method ) 80.0	•Station Unit cost (Dep 30m) 60.0 •Temporary supporting bridge 20.4 •Protection for Spine Sawage tunnel 13.5 •Removal of sawages 2.5 •Pedestrian tunnel between stations 2.7	Station Unit cost (Dep 30m) 60.0
	Subtotal 80	Subtotal 99	Subtotal 60
	Land acquisition 24	Land acquisition 0	Land acquisition 28
Total cost	USD 104 million	USD 99 million	USD 88 million
Other requirement	It is required to have -discussion with ENR, HCWW -stakeholder meeting	It is required to have -discussion with ENR, HCWW -stakeholder meeting	It is required to have -stakeholder meeting
Evaluation	Case1 produce best result in terms of satisfy potencial demand, even though it has a highest development cost.	Construction time and permission will be required more than other alternatives although it isn't convenience for Metro users.	Although land acquisition scale will be highest, there is no advantage for Metro Users.
	○	△	△

Source: JICA Study Team

### 5.7.5 Comparison of Three Alternative Routes

The result of the comparison of the three alternative routes is summarised in Table 5-14.

**Table 5-14 Comparison of Three Alternative Routes**

	AR1	AR2	AR3
Alignment	For the plan, it is nearly straight along Port Said Street. For the profile, it is required to pass under the SWWT "2 times" in this study area.	For the plan, it is nearly straight along Port Said Street. For the profile, it is required to pass under the SWWT "2 times" in this study area.	For the plan, it has "3 curves" between M4N Station No. 3 (AR3) and M4N Station No. 6 (AR3). For the profile, it is required to pass under the SWWT "2 times" in this study area.
Station intervals	The interval in each station is "1.0 km" on average.	The interval in each station is "1.5 km" on average.	The interval in each station is "1.5 km" on average.
Land acquisition	The number of land acquisition is estimated at "48 large buildings*".	The number of land acquisition is estimated at "21 large buildings*".	The number of land acquisition is estimated at "31 large buildings*".
Conclusion	In order to satisfy the short intervals in each station, the large number of land acquisition cannot be avoided.	The potential of the Alternative Route 2 is highest among the three alternatives, by reducing the number of station and by utilizing the road opening space to the fullest. (Although It does not mean that the volume of land acquisition in this route is under the permissible range in the project.)	Although the area for searching the location of the stations and the alignment is wider, better location and better alignment could not be found.
Evaluation	Fair	Good	Fair

The number of "large building" was estimated by eliminating low buildings from the number of land acquisitions estimated in the latter Location List.

Source: JICA Study Team

For the construction of Metro Line 4 along Port Said Street, with keeping the distance from SWWT, the intervals between each station should become larger than the ideal length (1.0 km) because the area along Port Said Street is densely populated by buildings and the location where the station can be located is quite limited.

Moreover, it is noted that even if AR2 was selected among the above three alternatives, larger number of land acquisition than the original route will be required.

In the basic design stage, in order to plan the alignment to have the appropriate distance from SWWT and to avoid excessive diversion from Port Said Street, the following items will be required:

- Information for the possibility of land usage
- Accurate position data of SWWT
- Topographic and geotechnical survey data

-Position and depth data of piles of the high-rise buildings

### 5.7.6 Location List

The locations of each station for the three alternative routes are surveyed and listed below.

#### *Table of Contents*

- AR1

- M4N Station No. 2 (AR1)
- M4N Station No. 3 (AR1)
- M4N Station No. 4 (AR1)
- M4N Station No. 5 (AR1)
- M4N Station No. 6 (AR1)
- M4N Station No. 7 (AR1)
- M4N Station No. 8 (AR1)

- AR2

- M4N Station No. 2 (AR2) \_\_\_Refer to M4N Station No. 2 (AR1)
- M4N Station No. 3 (AR2) \_\_\_Refer to M4N Station No. 3 (AR1)
- M4N Station No. 4 (AR2)
- M4N Station No. 5 (AR2)
- M4N Station No. 6 (AR2) \_\_\_Refer to M4N Station No. 8 (AR1)

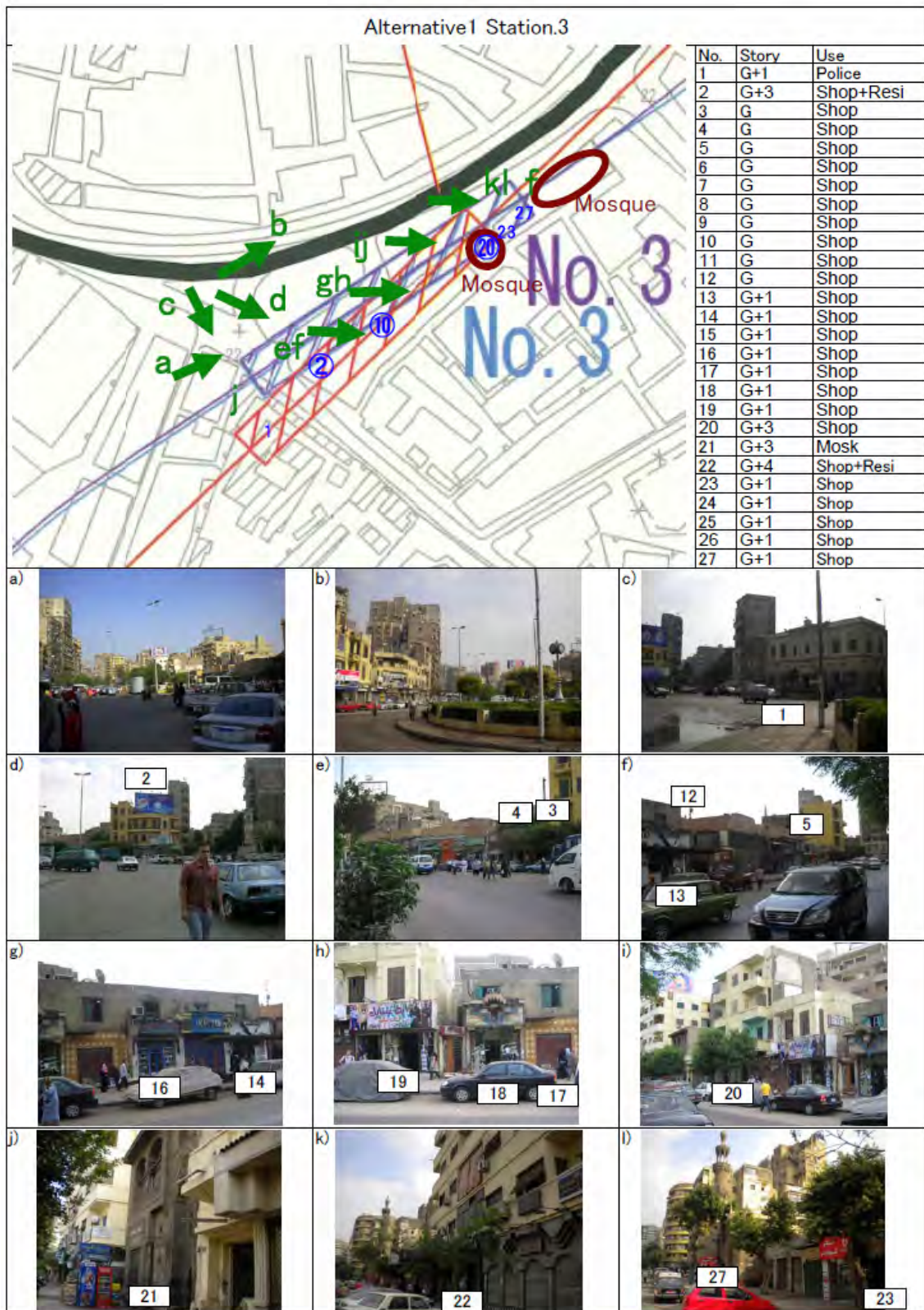
- AR3

- M4N Station No. 2 (AR3) \_\_\_Refer to M4N Station No. 2 (AR1)
- M4N Station No. 3 (AR3) \_\_\_Refer to M4N Station No. 3 (AR1)
- M4N Station No. 4 (AR3)
- M4N Station No. 5 (AR3)
- M4N Station No. 6 (AR3) \_\_\_Refer to M4N Station No. 8 (AR1)

\* All sourced by JICA Study Team

\*Here, the purpose of the list is to grasp the land condition for the route study. The data is based on a 1:5,000 topographic map and several site surveys. Thereby, the list is not as accurate as a RAP survey.





Source: JICA Study Team

Figure 5-62 M4N Station No. 3 (AR1)





















Source: JICA Study Team

Figure 5-71 M4N Station No. 5 (AR3)