4.5.3 Construction Planning for Ben Thanh Central Station Area

1) Objectives in Construction Planning

Ben Thanh Central Station consists of the terminal stations with Line 1, Line 2, Line 3a & Line 4, and USM above those lines.

The general plan of B1 floor and typical cross section of Ben Thanh Central Station are shown in Figure 4.108 and Figure 4.109, respectively. Line 2 station exists at the bottom level (B4F), Line 4 station locates at B3F, Line 1 station locates at B2F, and USM exists above those stations (B1F). The overall structure is relatively complex, and the construction works shall be large scale with deep excavation.

At the study area, soft alluvium sandy layers exist thickly with high ground water level with dense neighbor buildings, many underground utilities and heavy public traffic including pedestrians. The overview of the area for study is shown in Figure 4.107.

Considering the above conditions, the following objectives shall be studied:

(1) The effects to ongoing Line 1 Project shall be minimized.
(2) The connection with TBMs for Line 2 and Line 4 in the future shall be considered.
(3) The effects to the neighbor buildings shall be minimized.
(4) The protection and maintain methods of underground utilities which is difficult to be removed shall be studied.
(5) The effects to public traffic shall be minimized.

Figure 4.107 Overview of Ben Thanh Central Station Area

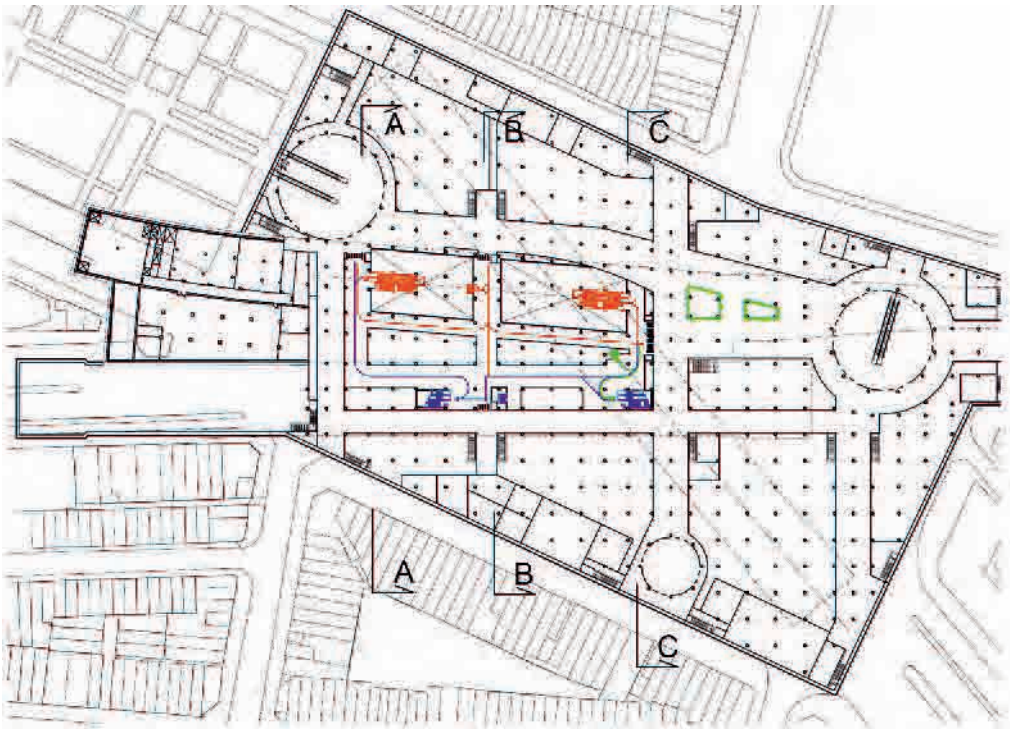


Figure 4.108 The general plan of B1 floor, Ben Thanh Central Station

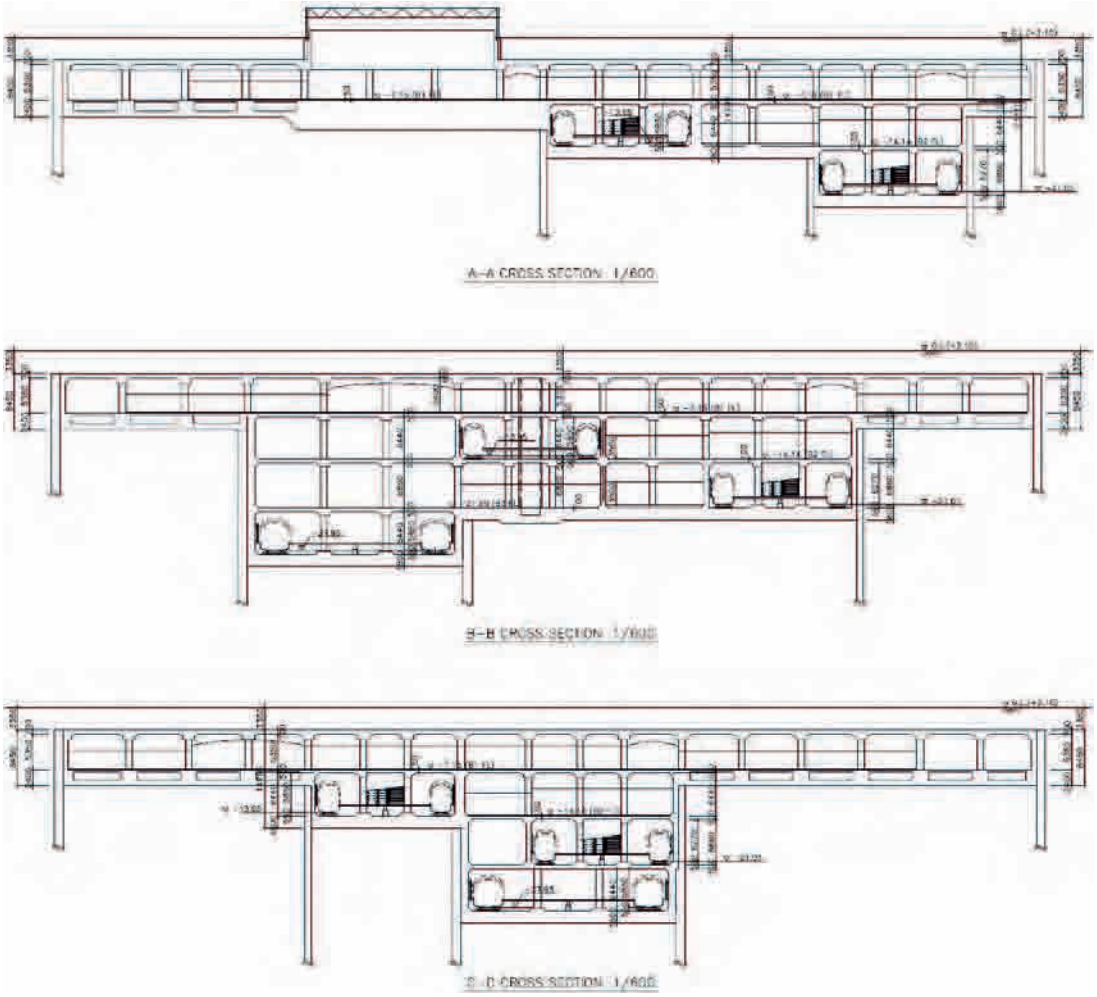


Figure 4.109 Typical Cross Section, Ben Thanh Central Station

2) Study of Phased Construction

Ben Thanh Central Station is planned as the complex station including the individual station for Line 1, Line 2 & Line 4 and USM.

Besides, the preliminary design of "HCMC Urban Railway Construction Project (Line 1)" was already completed and the facilitation of the Project progress is seriously required in HPC. Accordingly, the construction plan of Ben Thanh Central Station (including Line 1 structures) shall be coordinated with the current status of Lien 1 Project, and shall not induce the delay of the construction and the commencement of the commercial operation of Line 1.

Two options, "Unified Construction" and "Phased Construction" were studied.

All of the stations for Line 1, Line 2 & Line 4 and USM are constructed simultaneously in "Unified Construction".

In another option, "Phased Construction", the early completion of the construction of Line 1 Station (in 1st Phase) precedes the other stations and USM which will be constructed in subsequent 2nd Phase. Furthermore, "Phased Construction" is categorized in two detail options, related to the area of the partial construction of Line 2 Station locating under Line 1 Station. In the 1st option, whole structure of Line 2 Station (only civil structures and not including architectural works and E&M) beneath Line 1 Station is planned to be constructed. In the another option, only the part of station structure of Line 2 directly under Line 1 Station will be constructed together with Line 1 Station in Phase 1.

The results of the comparison study of above options are described in Section 4.2.2, and it was concluded to adopt "Phased Construction" for the early commencement of the commercial operation of Line 1 as the first priority, because of the indefiniteness of the construction plan & schedule of USM and Line 4.

About the construction of Line 2 Station in the 1st Phase, "construction of whole structure of Line 2 Station" was selected to avoid the following risks assumed during the construction of Line 2 structures in 2nd Phase:

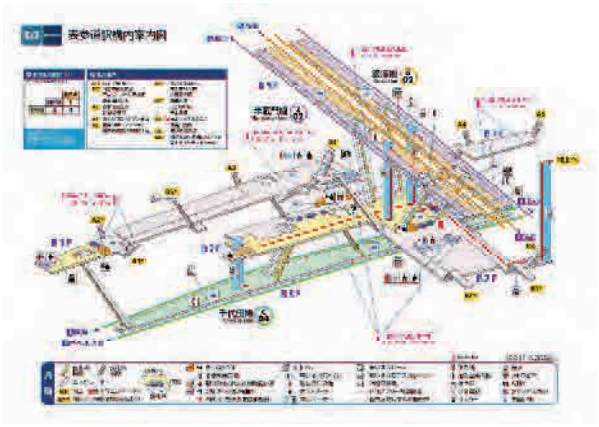
i) Noise and Vibration in Line 1 Station Area caused by the demolition & removal of RC Diaphragm Walls of Line 1 Station
ii) Subsidence of Line 1 Station caused by Cut & Cover Construction of Line 2 Station
iii) Water leaking from Construction Joints between Line 2 structures constructed in 1st Phase and 2nd Phase

In addition to the above, the construction of whole structure of Line 2 Station will contribute the application of common standards for disaster prevention (fire etc.) for Line 1 and Line 2 Stations. In the preliminary design of Line 1 Project, the disaster prevention policy was defined based on Clause 29 of "Japanese Ministerial Ordinance providing the technical standards on railways with commentary enacted by the Japanese Ministry of Land, Infrastructure, Transportation and Tourism", and approved by HCMC. Simultaneous construction of Line 1 and Line 2 Stations applying the common standards for disaster prevention is indispensable to guarantee the safety of underground stations and railways.

<Similar Project> Construction Project of Omote-sando central station, Japan

1. Introduction

Omote-sando metro station locates beneath the intersection of Omote-sando street of Meiji Jingu shrine and Aoyama-Dori street. The commercial operation of this station (as the terminal station) commenced at Nov. 1938 when "Ginza Line" was opened between "Toranomon" and "Aoyama 6 tyo-me". At Dec. 1938, Ginza Line was extended to Shibuya and the station changed as the intermediate station. In this beginning time, the station located slightly near to Shibuya side than the current location. At Aug. 1978, the station removed to the current location. At Oct. 1972, Omote-sando Station of "Chiyoda Line" was opened, and subsequently, Omote-sando Station of "Hanzo-mon Line" was opened and those stations were merged to compose the Central Station.



(General Layout of Omote-sando Central Station)

Source: http://www.tokyometro.jp/station/omote-sando/yardmap/index.html

(Location of Omote-sando Metro Station

Source: http: http://www.tokyometro.jp/station/omote-sando/map/index.html

2. Brief of Construction

Cut & Cover Construction Method for large areas was applied to construct "Omote-sando Metro Station" of "Hanzo-mon Line" between the stations of "Ginza Line" and "Chiyoda Line".

The Site locates around Omote-sando Intersection with National Highway 246 (Aoyama Dori Street) and Local Road 413 (Inogasira Dori Street). Those are major roads in Tokyo Metropolitan Area with large traffic volume. Many Utilities also exist under the ground.

Ginza Line locates along and under the center of National Highway 246. Under Omote-sando Intersection, Chiyoda Line crosses over Ginza Line.

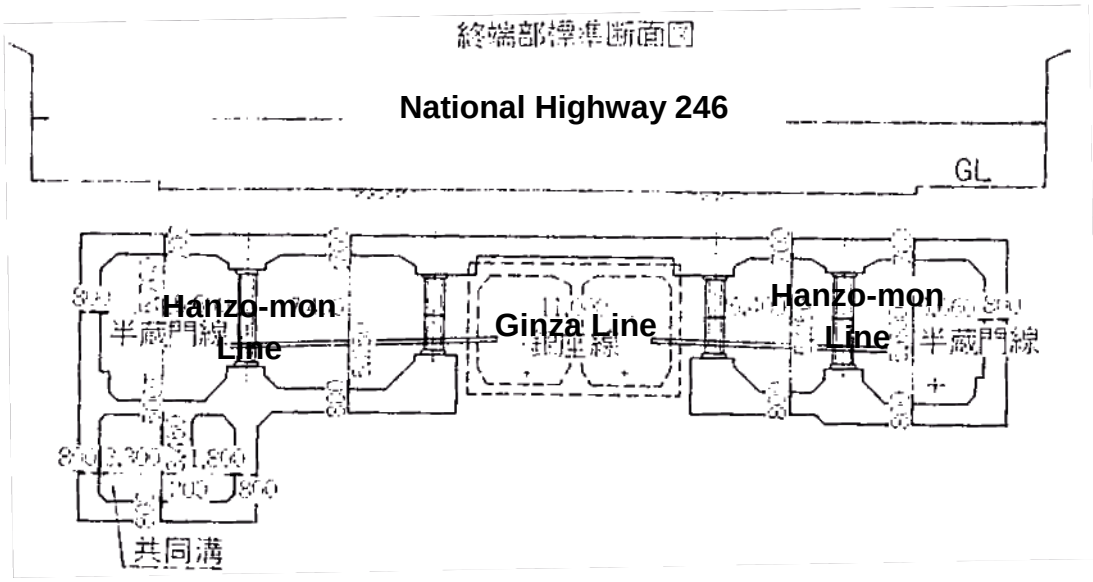
Because of the above mentioned conditions, Hanzo-mon Line was designed and constructed at the same level with Ginza Line at the both sides (refer to cross section below).

The 1st Section for construction is 377m length including the following work items;

- Construction of box type tunnel for single track
- Demolition & removal of the existing Omote-sando Station of Ginza Line

- Demolition & removal of the existing inner walls of Station of Ginza Line for the construction of transition floor
- Construction of Hanzo-mon Line

The 2nd Section for construction includes the construction work of new Omote-sando station of Hanzo-mon Line with Ginza Line, as shown in the following cross section.



Source: Sumio Sikada, Takeo Takayama, Cut & Cover Construction Method under Major Highways – Ginza, Chiyoda, Hanzo-mon Lines Omote-sando Central Station, pp31-41, Tunnel & Underground, 96, Vol. 9, No.8, 1978. 8

3) Study of Retaining Walls

The requirements for the retaining walls for the construction at the study area are as follows:

- High impermeability to prevent the fall down of underground water level
- High rigidity to prevent the settlement of surrounding grounds and neighbor buildings
- Low vibration and noise during construction
- Availability for large and deep excavation

"Diaphragm wall" was adopted to satisfy the above requirements.

4) Study of Excavation Method

Two excavation methods, "Bottom up" and "Top down" are applicable for the Cut & Cover Construction of USM, and "Bottom up" method is categorized in "strut support type" and "ground anchor type".

Based on the results of Preliminary Design of Line 1 Project, "Bottom up" method was adopted for Phase 1 of Option 2, the construction of Line 1 and Line 2 Stations.

For Phase 2, the construction of Line 4 Station and USM, the application of "Top down" method was recommended because of the following disadvantages of "Bottom up" method.

(1) The excavation for the study area is large and deep, about 140m (width) x 240m (width) x 32m (depth). If "Bottom up" method with strut support is applied for this area, many steel struts are necessary for long spans. Installation and removal of many long span

struts makes the rate of work decline, and it also causes the disadvantage for construction cost.

(2) Steel deck slabs are required for large areas to maintain the public traffic around the excavation area, and it causes the increase of cost.

(3) If "Bottom up" method with ground anchor is applied, several anchors are installed beneath the neighbor buildings. Even if the special type of anchors (removal type) are applied, parts of anchors remain under the buildings. Those remained parts may be the obstacles for the development of the underground infrastructure in the future.

In Figure 4.110, the image of "Top down" method is indicated. The advantages of "Top down" method are as follows:

- Traffic diversion is necessary only during the construction of retaining walls and top slabs.
- After the top slab is constructed, construction yards is available at the underground level.

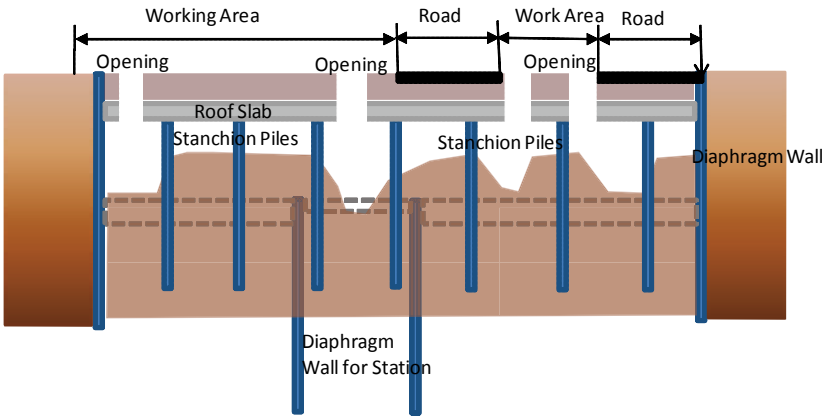


Figure 4.110 Image of "Top down" method

5) Study of Construction Method for Important Points

(1) Crossing Points of Station Structures

Line 2 station structure crosses with and locates beneath Line 1 and Line 4 station structures, and the arrangements of retaining walls at those crossing points become complicated, as shown in Figure 4.111. The retaining walls are constructed from the ground surface level, and the portion of retaining wall from ground surface level to slab at the crossing points shall be casted with lean concrete (or filled by crushed stones).

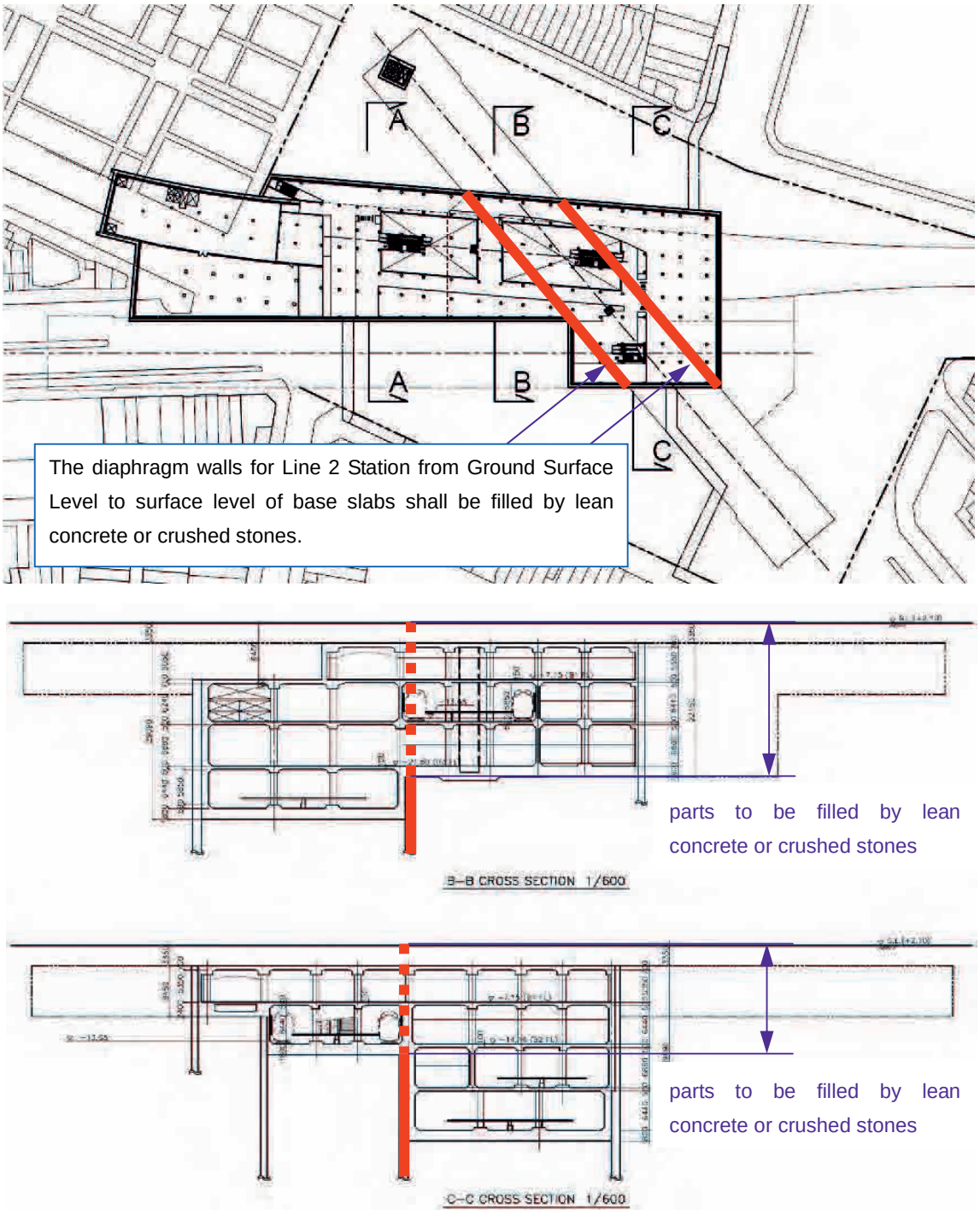


Figure 4.111 Arrangement of Retaining Walls for Line 1 & Line 2 Stations, Phase 1 of Option 2

(2) Preparation for TBM Arrival

Ben Thanh Central Station is the terminal station with Line 1, Line 2, Line 3a and Line 4, and Line 2 and Line 4 tunnels are planned to be constructed by TBM to connect to the constructed central station. Accordingly, the preparation for the arrival of TBMs is necessary to be considered for the central station structure.

Two methods, "Removal of temporary wall" method (conventional method) and "Direct removal of retaining wall" method can be the alternatives for preparation work for TBM arrival. (Refer to Table 4.32.) For the deep excavation with high water pressure, diaphragm walls are commonly adopted as the retaining walls, and recently "Direct removal of retaining wall" method is adopted for diaphragm walls in many cases, because of the advantages for shorter durations, safety and economic aspects.

Table 4.32 Preparation Method for TBM Arrival

Method	Removal Works	Details
"Removal of temporary wall"	By man-power or breaking machines	Removal: Hand-breaker, Hydraulic Breaker, Hydraulic static demolition method, etc. Stability of tunnel face and waterstop: Chemical injection method, Jet grouting method, Freezing method
"Direct removal of retaining wall"	By TBM	Application of specific material for retaining wall to be removed: SEW method, NOMST method Removal of core piles of retaining wall: Specific material for core piles to be removed by electrolytic corrosion method

For the Project, "Direct removal of retaining wall" method shall be adopted. (Refer to Figure 4.112.)

The following issues shall be studied for the construction planning of "Direct removal of retaining wall" method:

- Characteristics and shapes of Shield Cutter Bits, bit arrangement in different levels, preparation of spare bits, etc. to resist the wear and damage by cutting hard walls
- Countermeasure against noise and vibration during cutting of retaining walls
- Waterstop and prevention of soil inflow at TBM arrival

For waterstop and prevention of soil inflow at TBM arrival, installation of partition wall inside of the retaining walls is necessary. (Refer to Figure 4.113.) Partition wall shall be fabricated by steel materials to resist the driving force of TBM, and installed at the concrete entrance of TBM arrival. The core piles of retaining walls at TBM arrival shall be the material available to be cut by TBM.

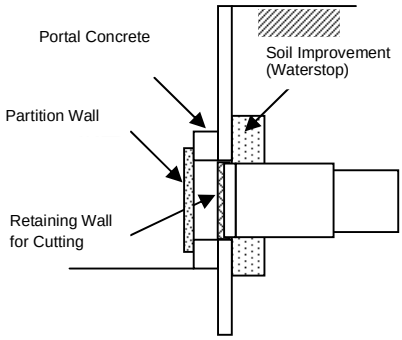


Figure 4.112 Direct Removal of Retaining Wall

Figure 4.113 Partition Wall

6) Protection and Maintenance of Underground Utilities during Construction

Please refer to Section 4.5.2, 6).

7) Construction Sequence and Traffic Management during Construction

Figure 4.115 – Figure4.138 indicate the construction sequence (cross sections and plan) of Ben Thanh Central Station. In Phase 1, Line 1 & Line 2 stations will be constructed, and Line 4 station & USM will be constructed subsequently in Phase 2.

For Phase 2, "Top down" method was adopted, and its construction sequences were shown in Figure 4.114. The entrances for mobilization & demobilization of construction materials & equipments are allocated on the slabs, and closed at the final stage of the construction works.

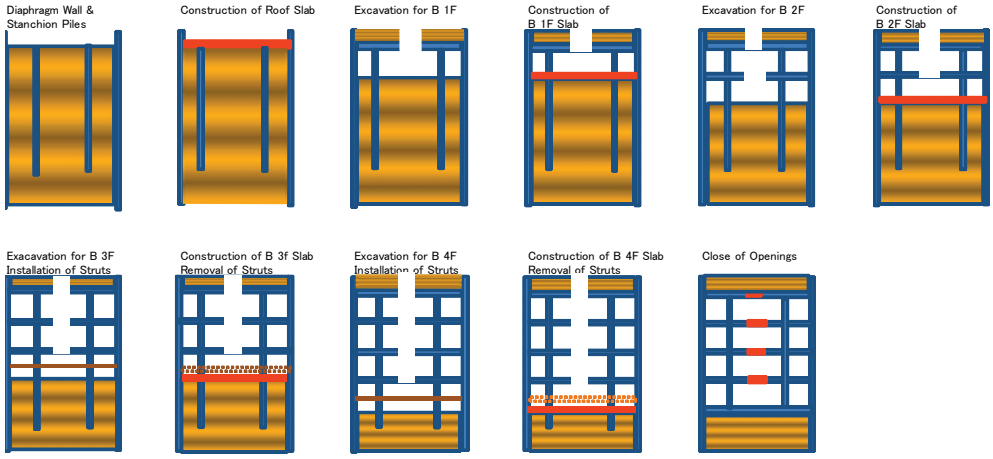


Figure 4.114 Construction Sequences of "Top Down" Method (Cross Sections)

The traffic diversion plans are also indicated in these Figurs. Traffic diversion plans were established considering the current tcondition of the public traffic around the rotary in front of Ben Thanh Market.

8) Preliminary Construction Schedule

The preliminary construction schedule of Ben Thanh Central Station of Option 2, "Phased Construction" is shown in Table 4.33.

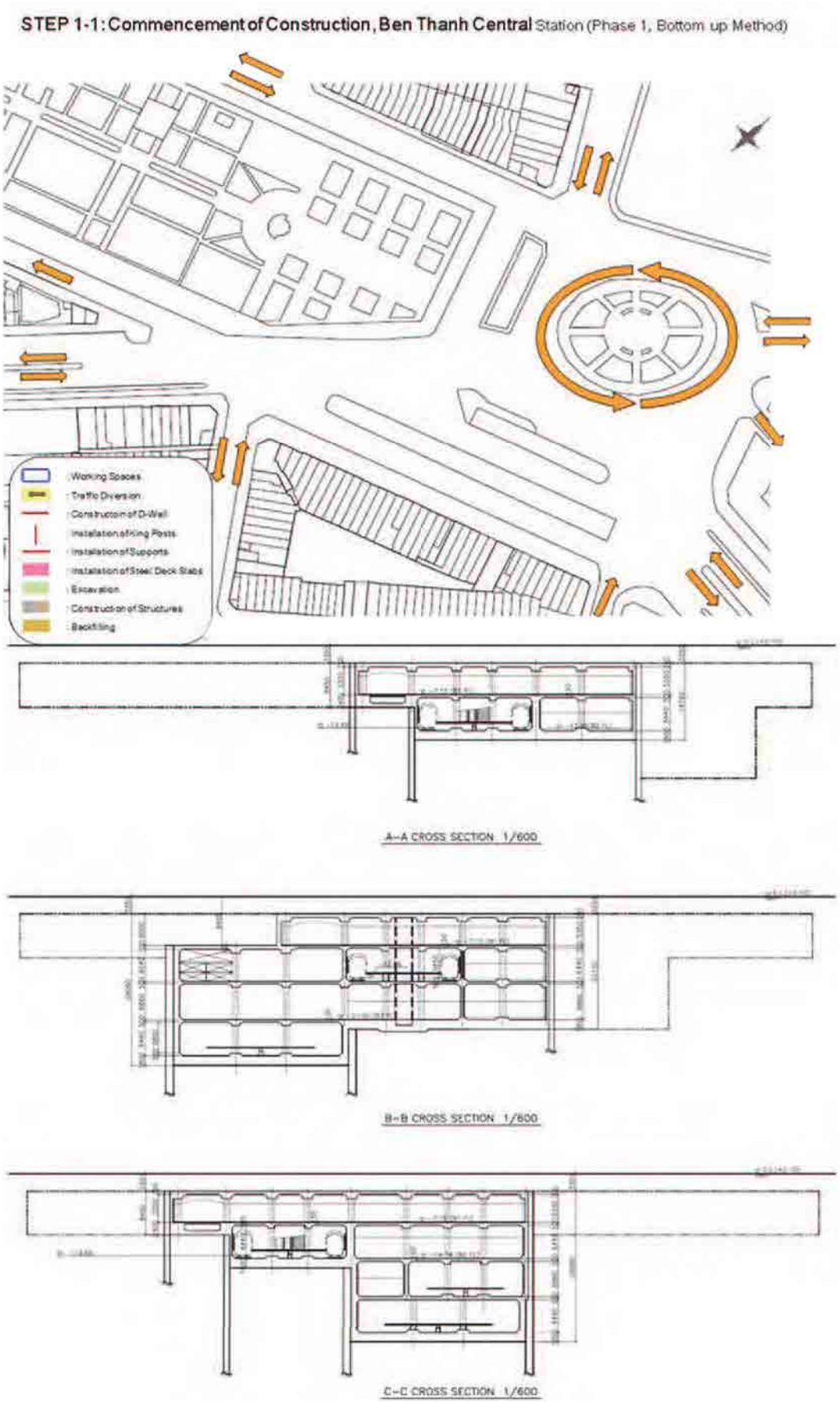


Figure 4.115 Construction Sequences of Ben Thanh Central Station (1/24)

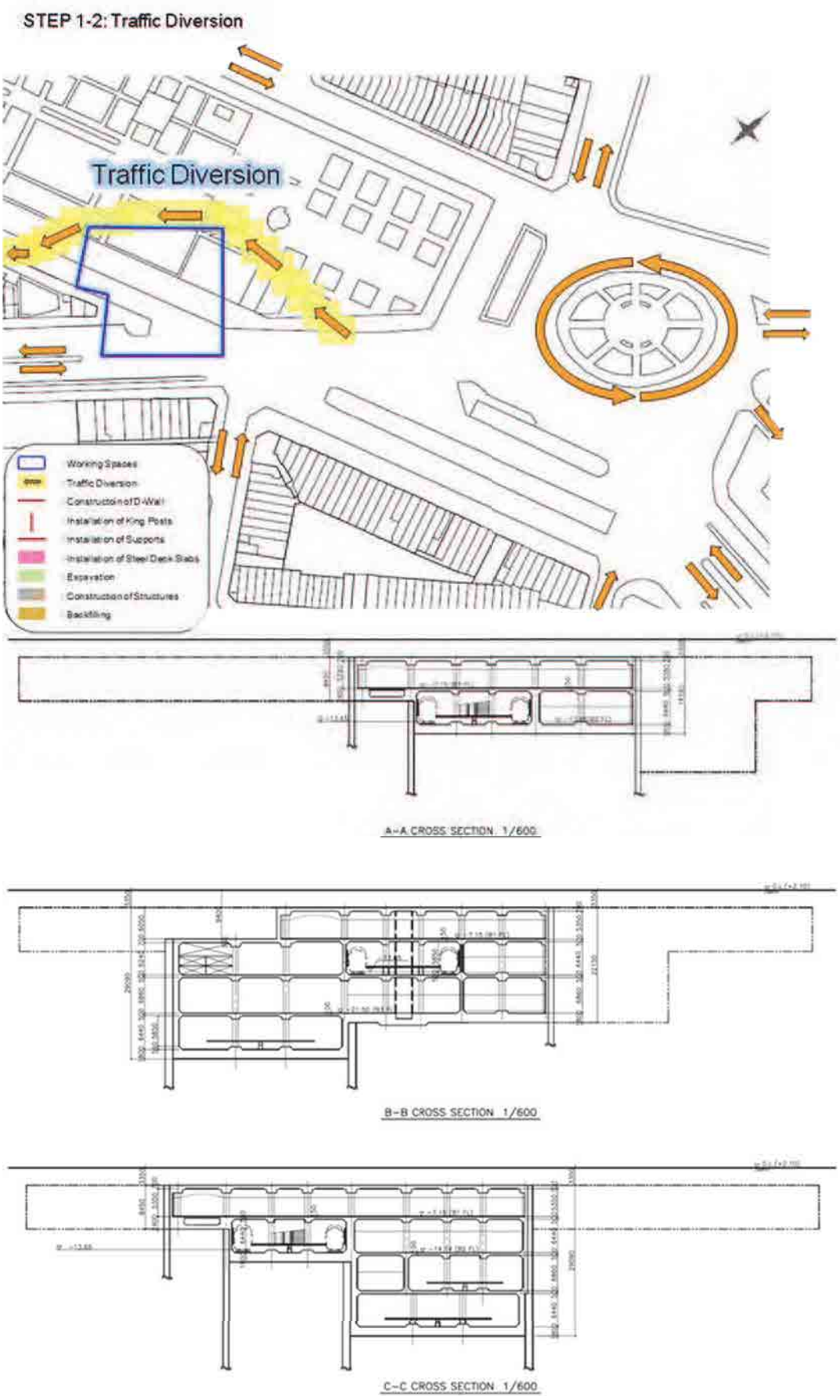


Figure 4.116 Construction Sequences of Ben Thanh Central Station (2/24)

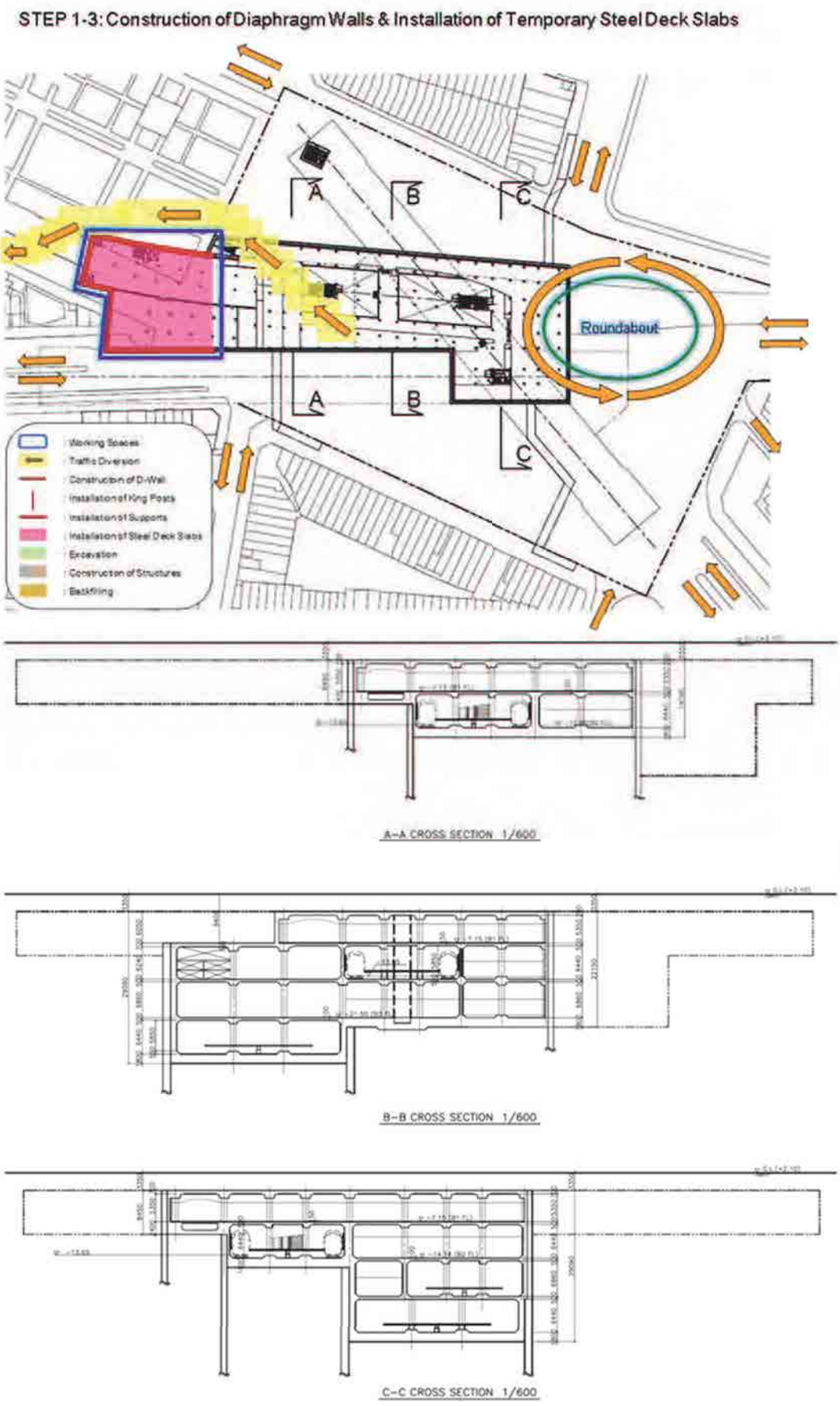


Figure 4.117 Construction Sequences of Ben Thanh Central Station (3/24)

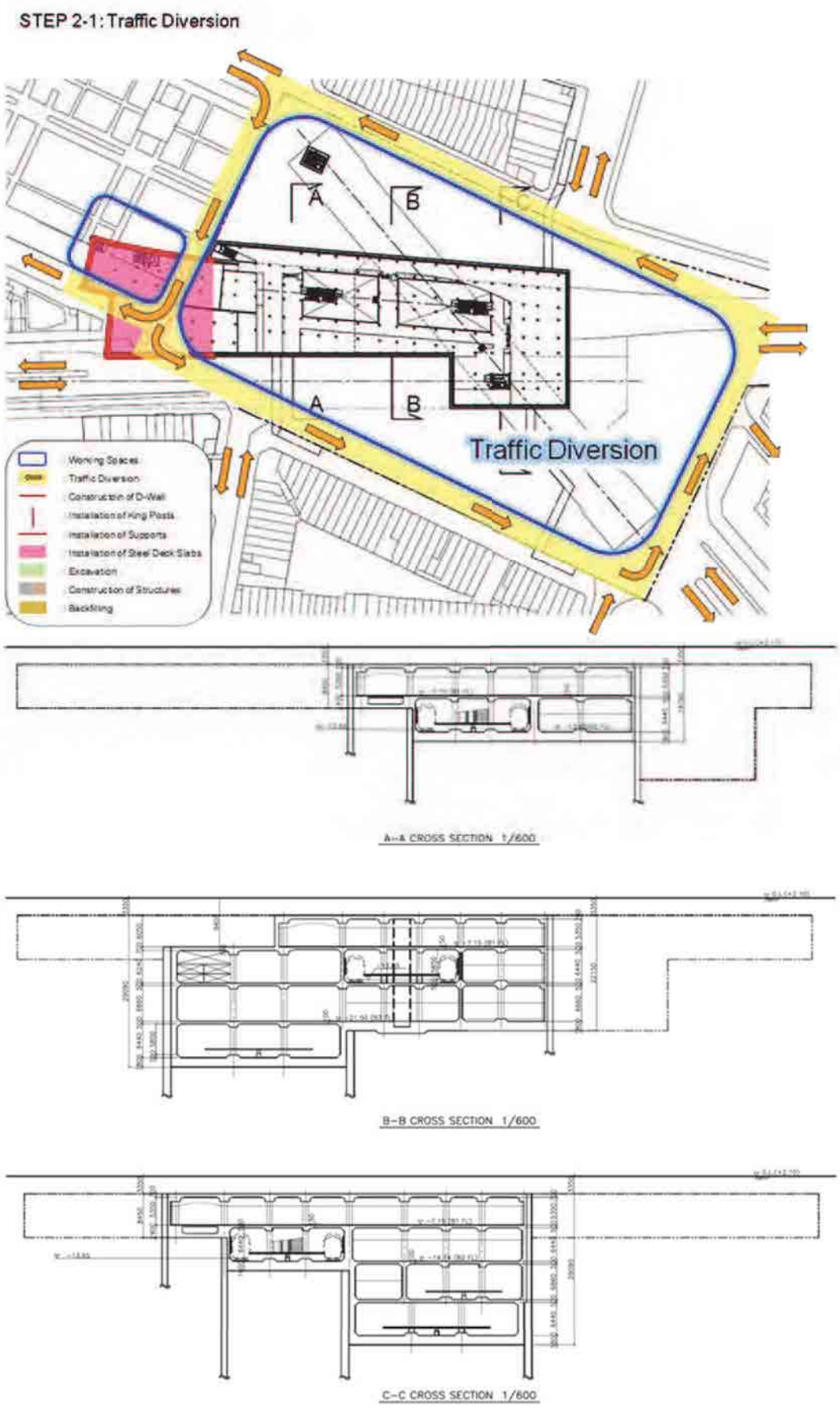


Figure 4.118 Construction Sequences of Ben Thanh Central Station (4/24)

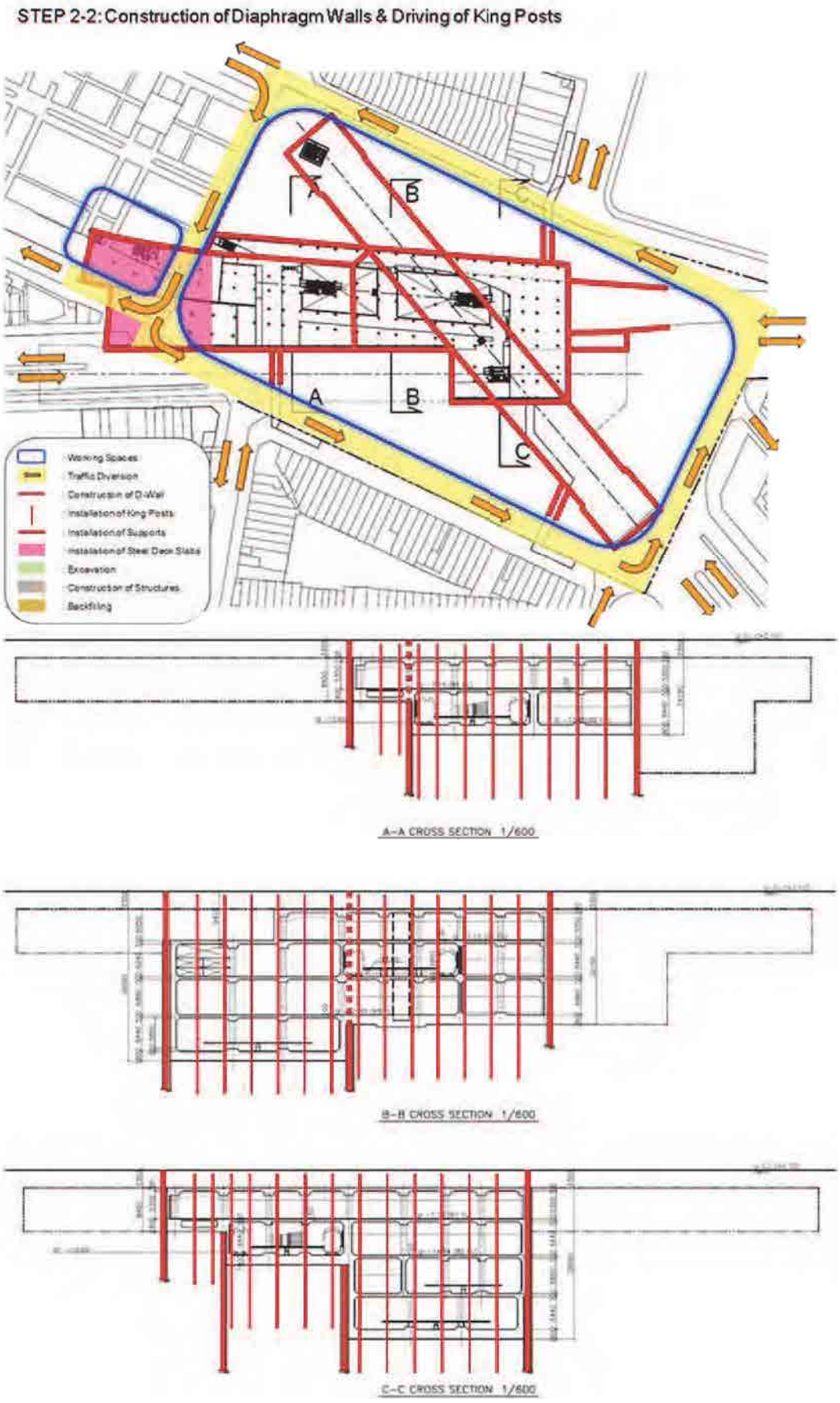


Figure 4.119 Construction Sequences of Ben Thanh Central Station (5/24)

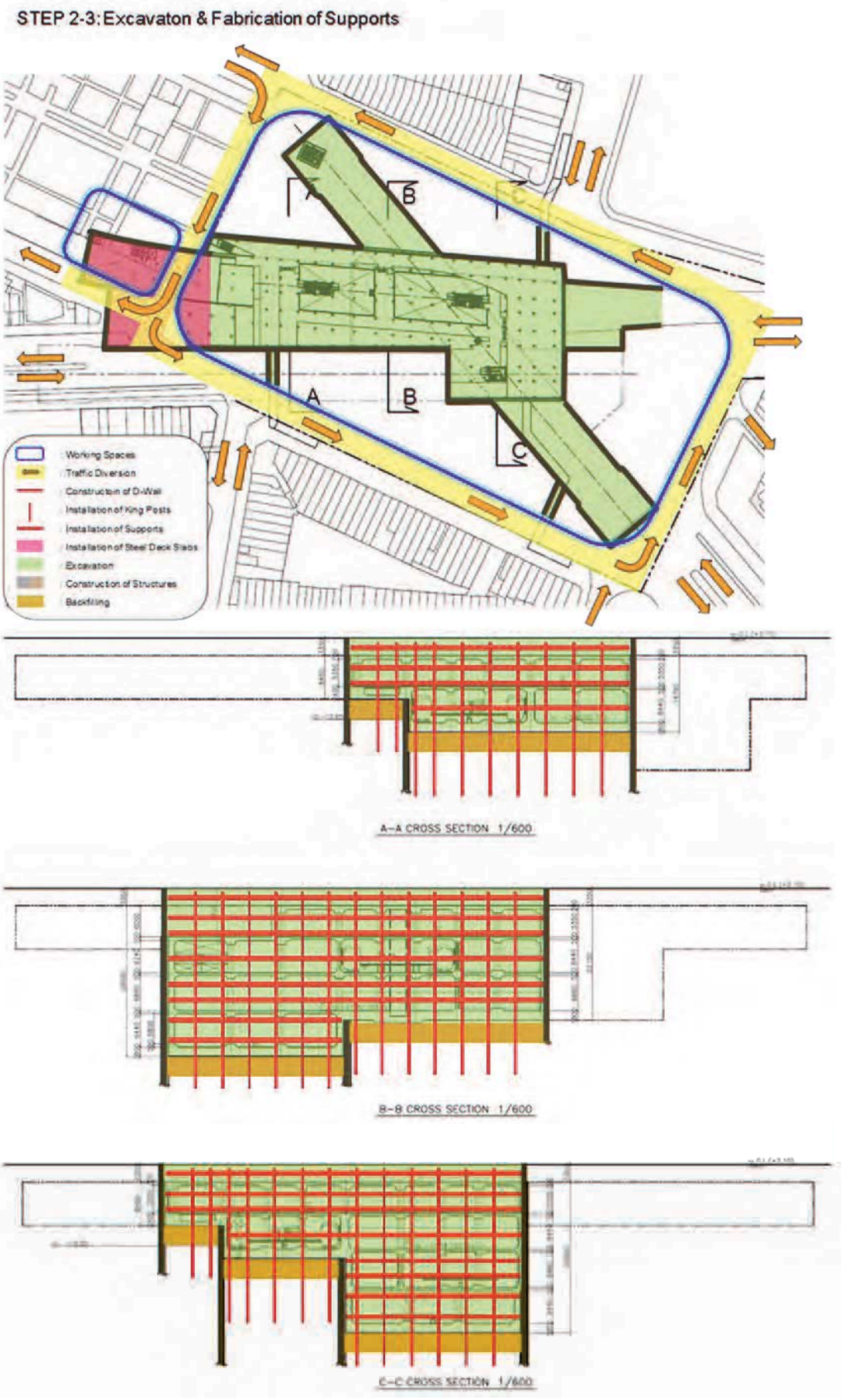


Figure 4.120 Construction Sequences of Ben Thanh Central Station (6/24)

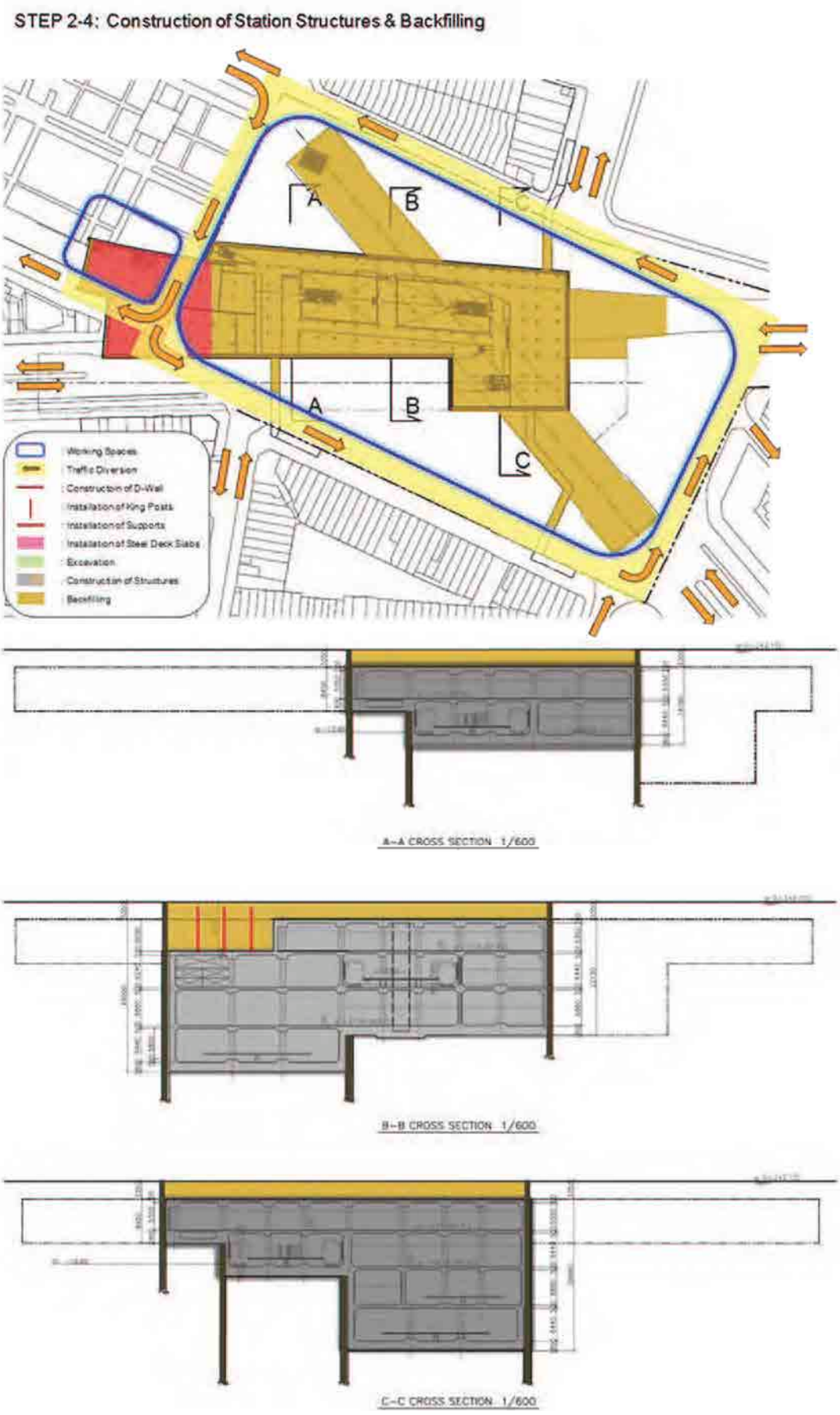


Figure 4.121 Construction Sequences of Ben Thanh Central Station (7/24)

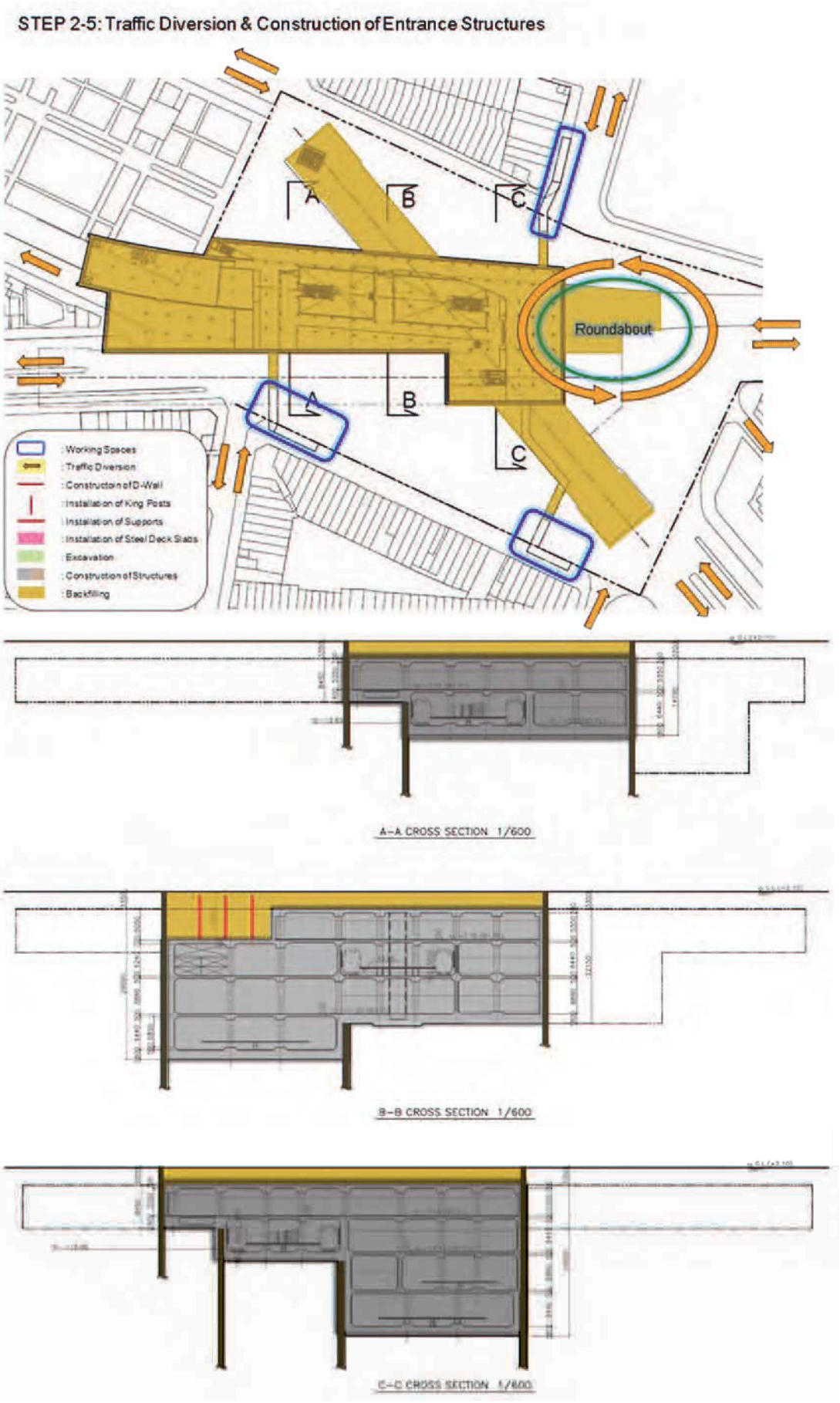


Figure 4.122 Construction Sequences of Ben Thanh Central Station (8/24)

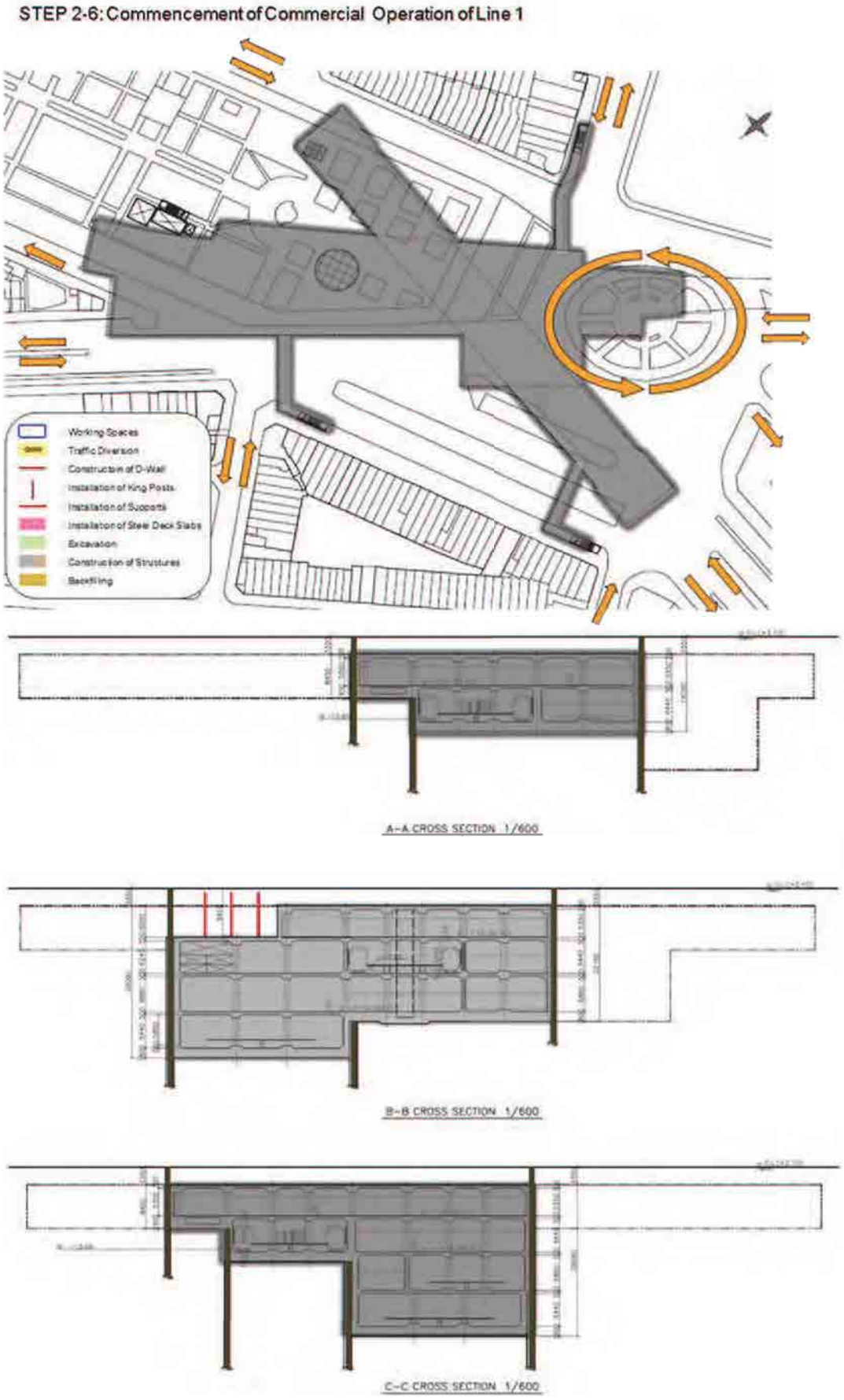


Figure 4.123 Construction Sequences of Ben Thanh Central Station (9/24)

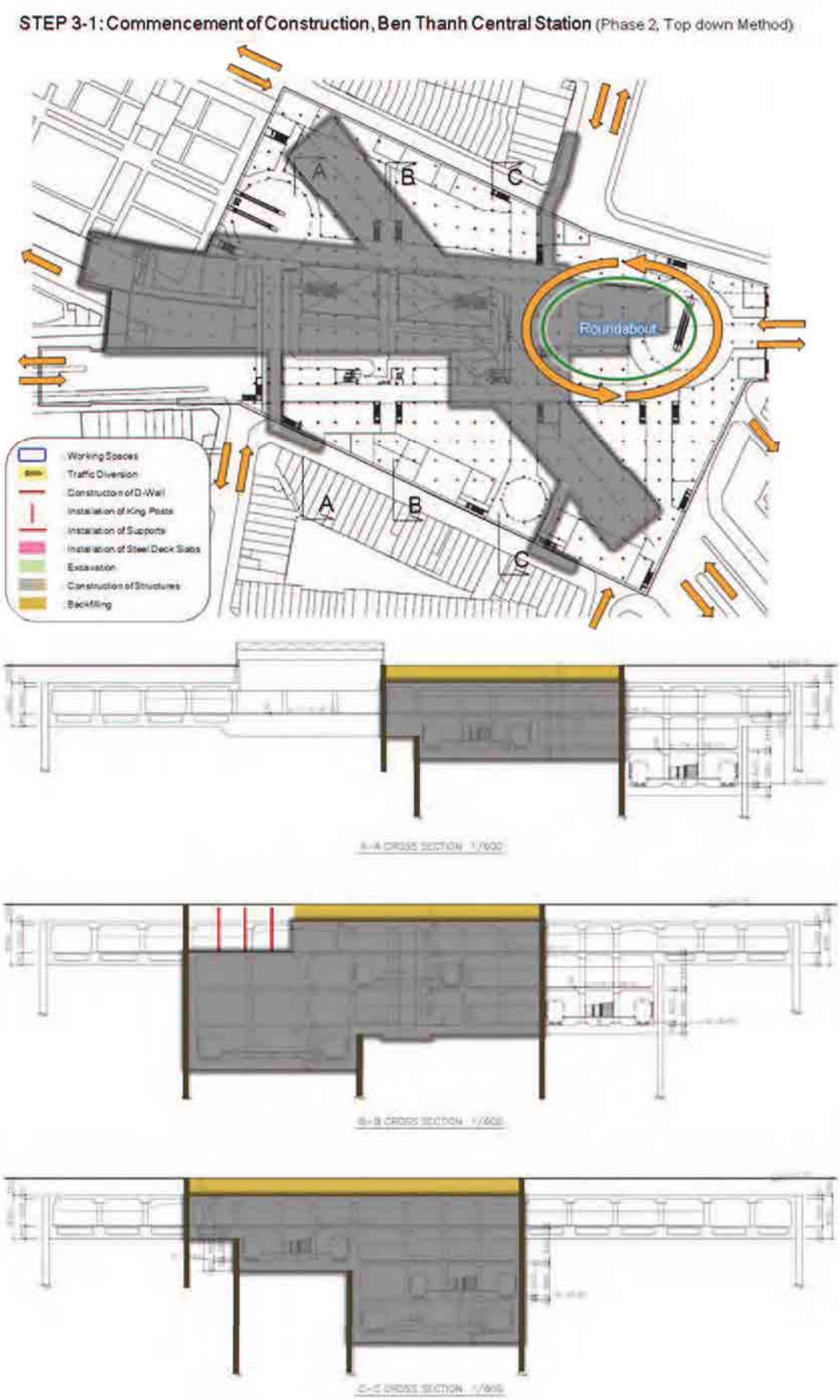


Figure 4.124 Construction Sequences of Ben Thanh Central Station (10/24)

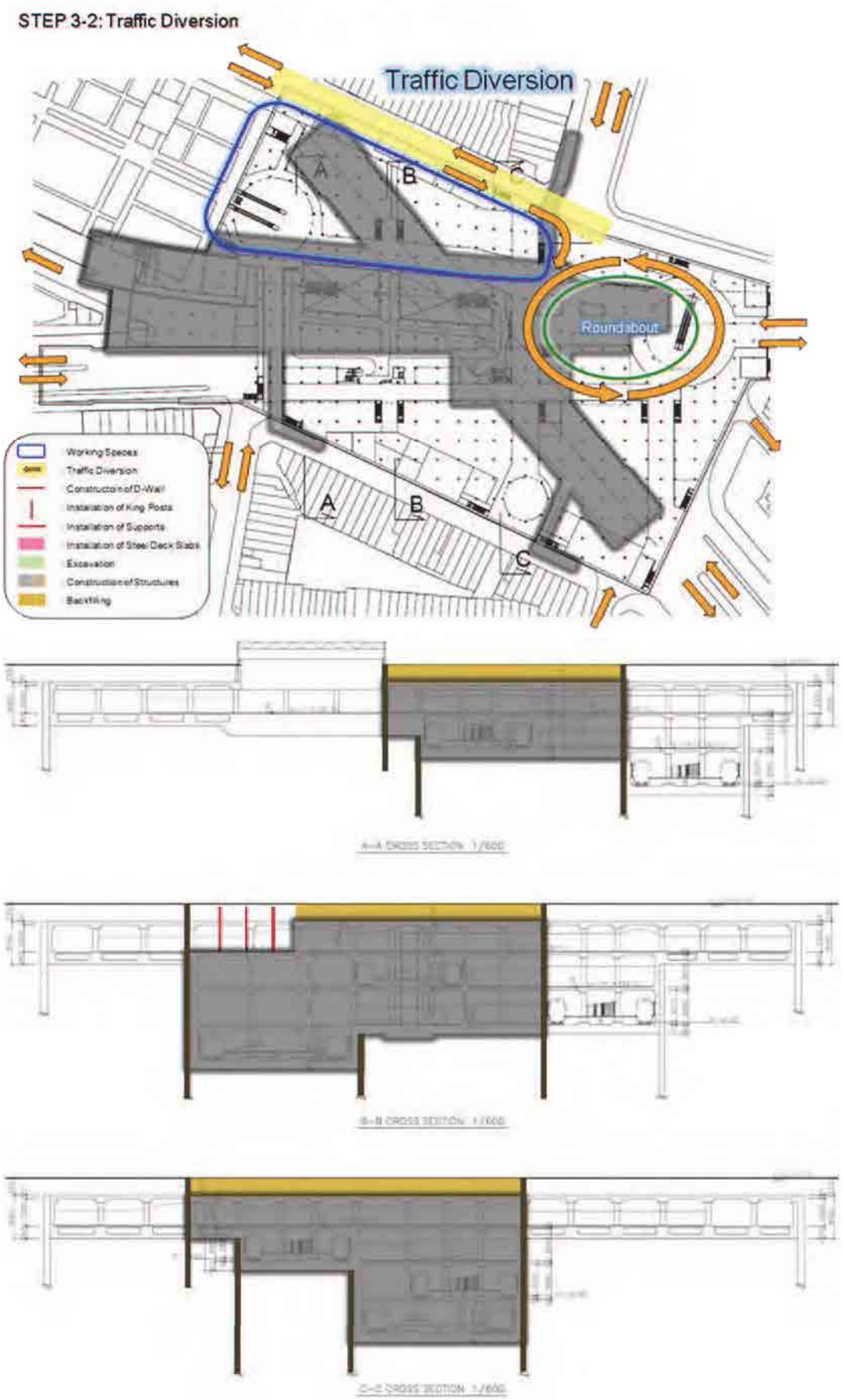


Figure 4.125 Construction Sequences of Ben Thanh Central Station (11/24)

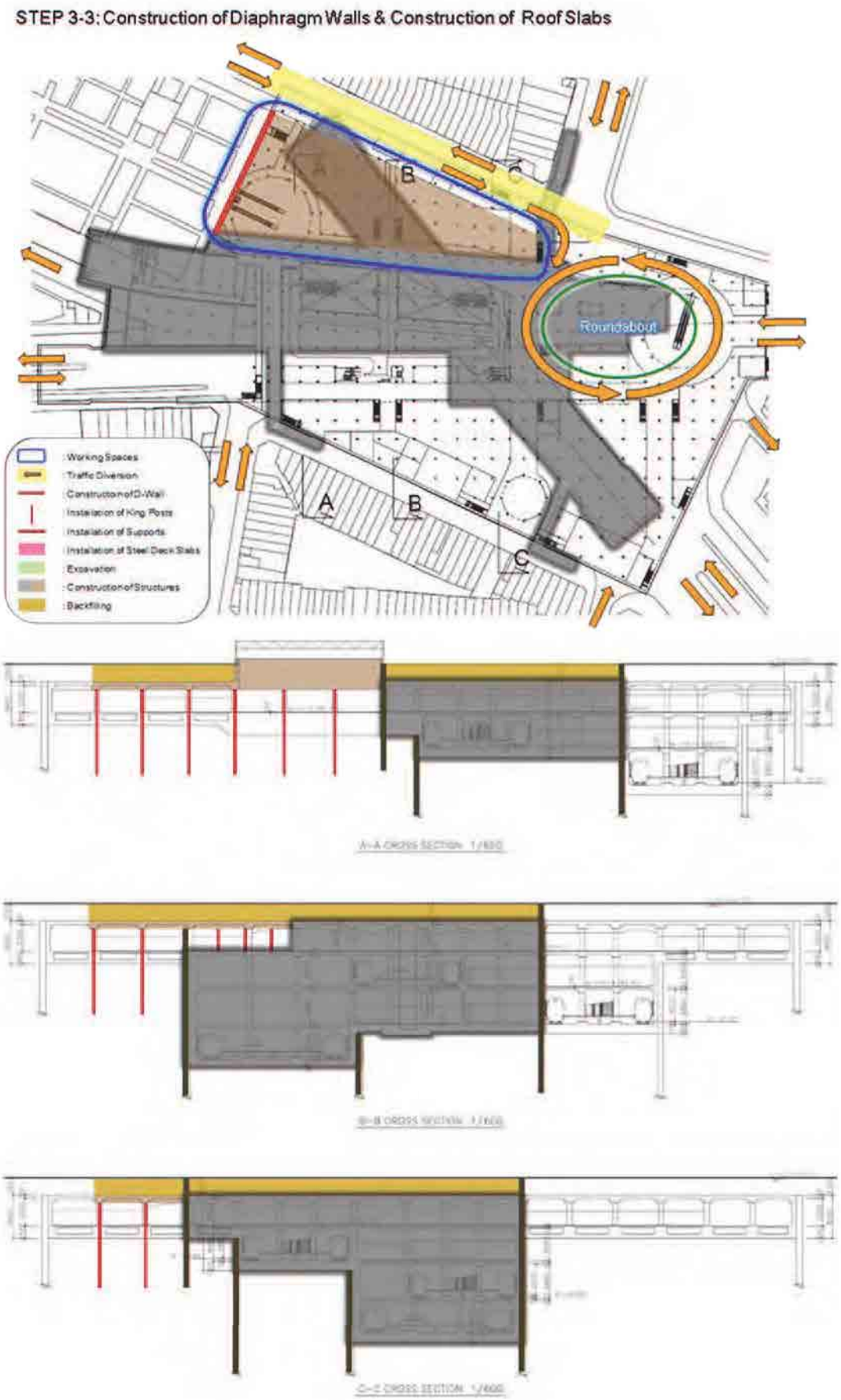


Figure 4.126 Construction Sequences of Ben Thanh Central Station (12/24)

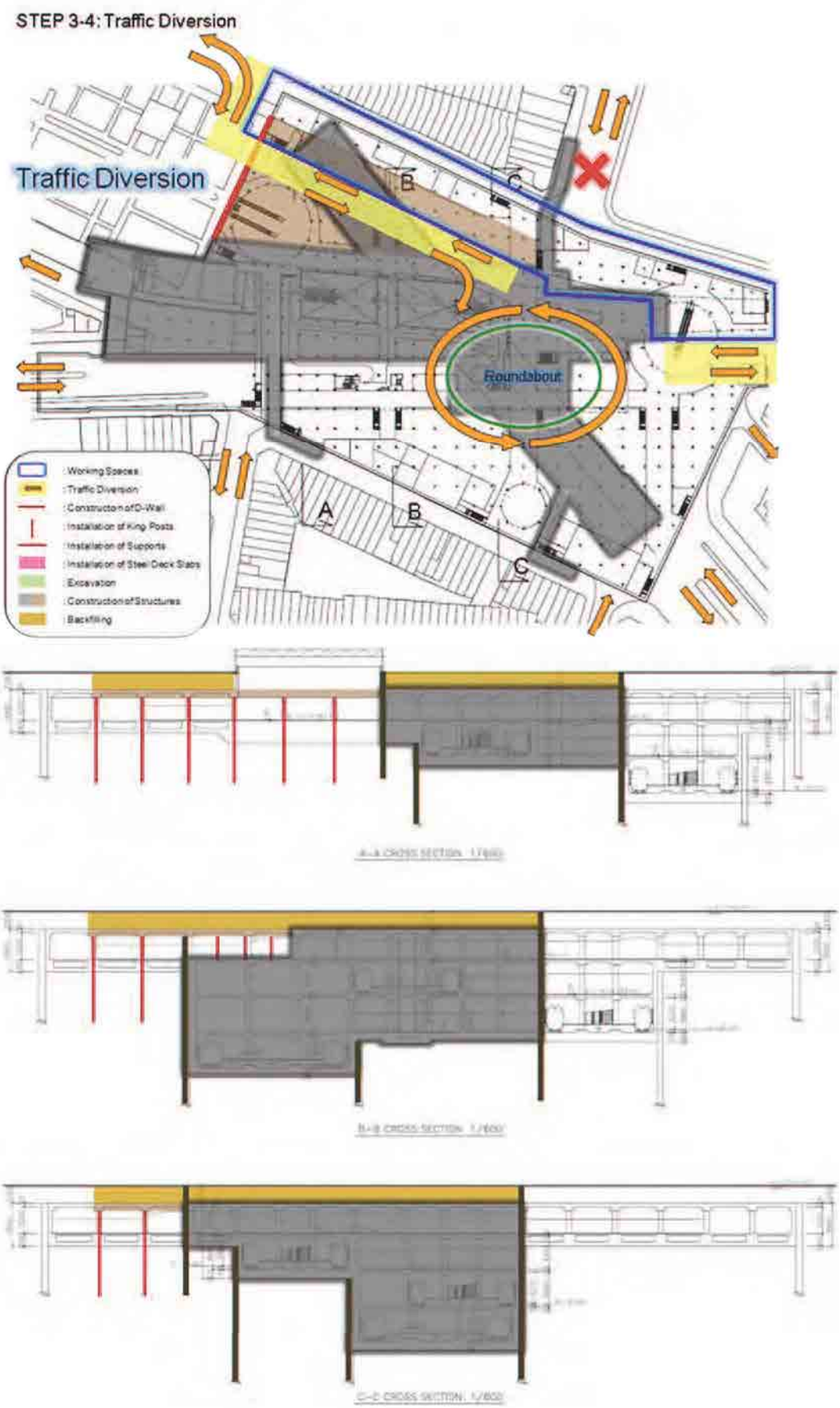


Figure 4.127 Construction Sequences of Ben Thanh Central Station (13/24)

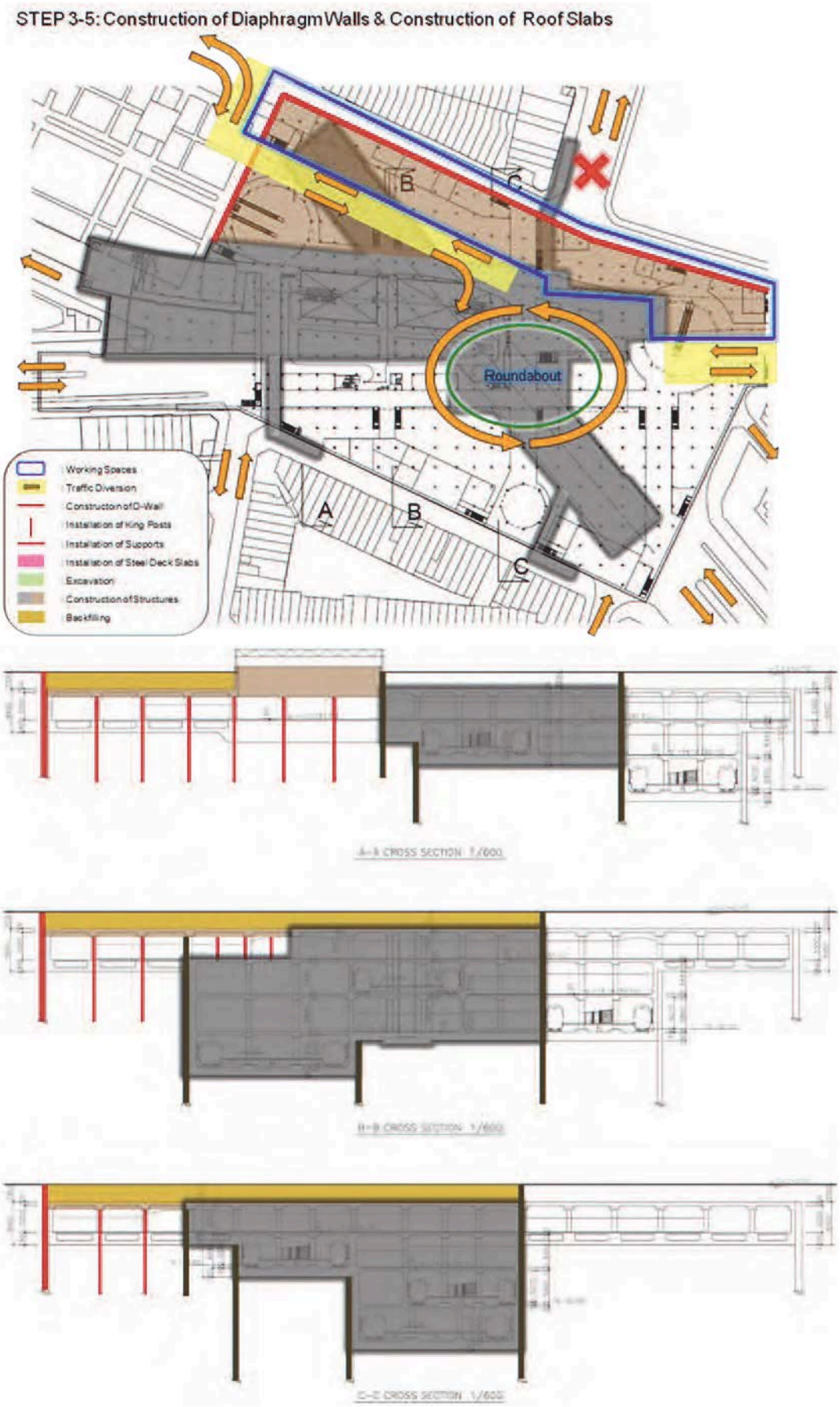


Figure 4.128 Construction Sequences of Ben Thanh Central Station (14/24)

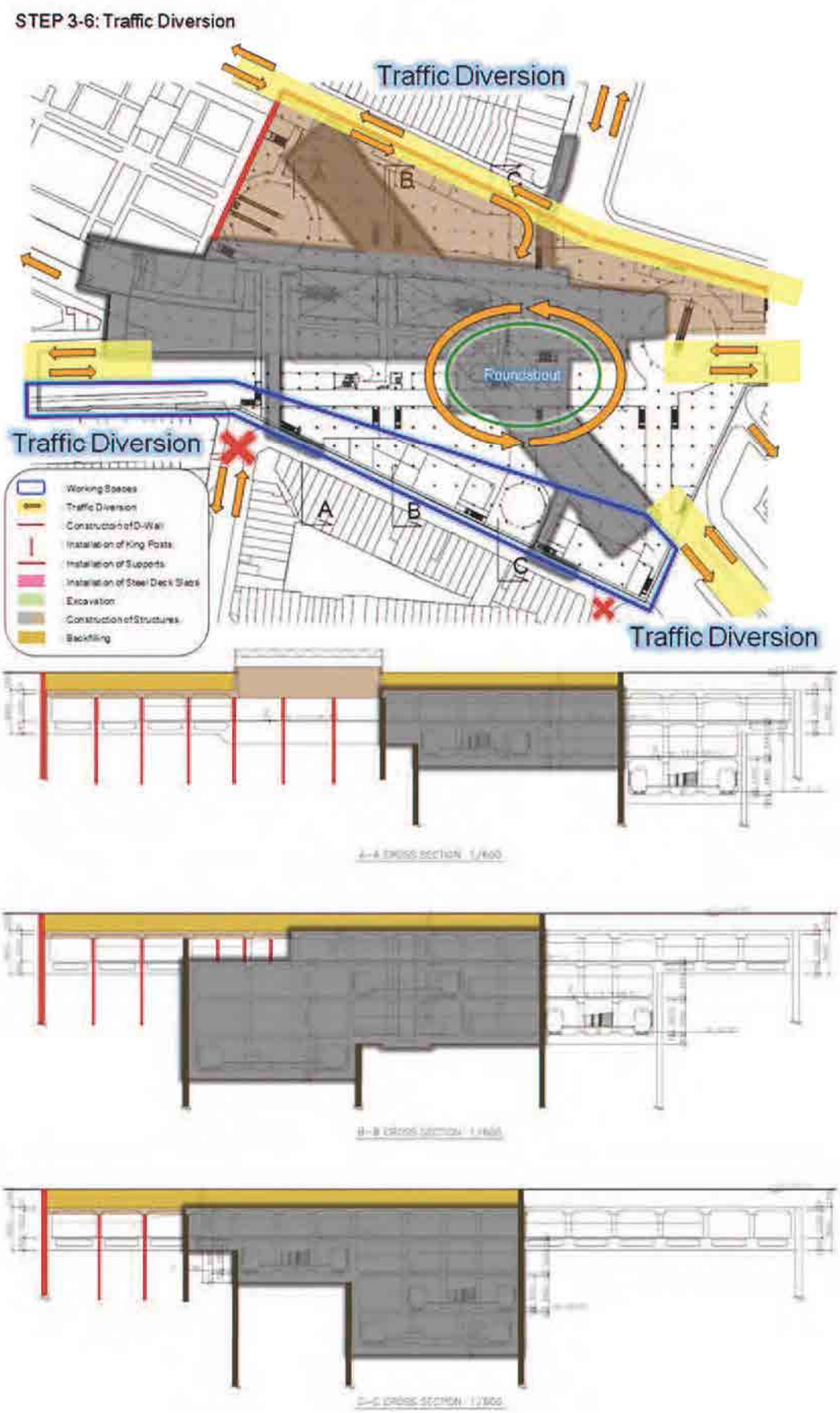


Figure 4.129 Construction Sequences of Ben Thanh Central Station (15/24)

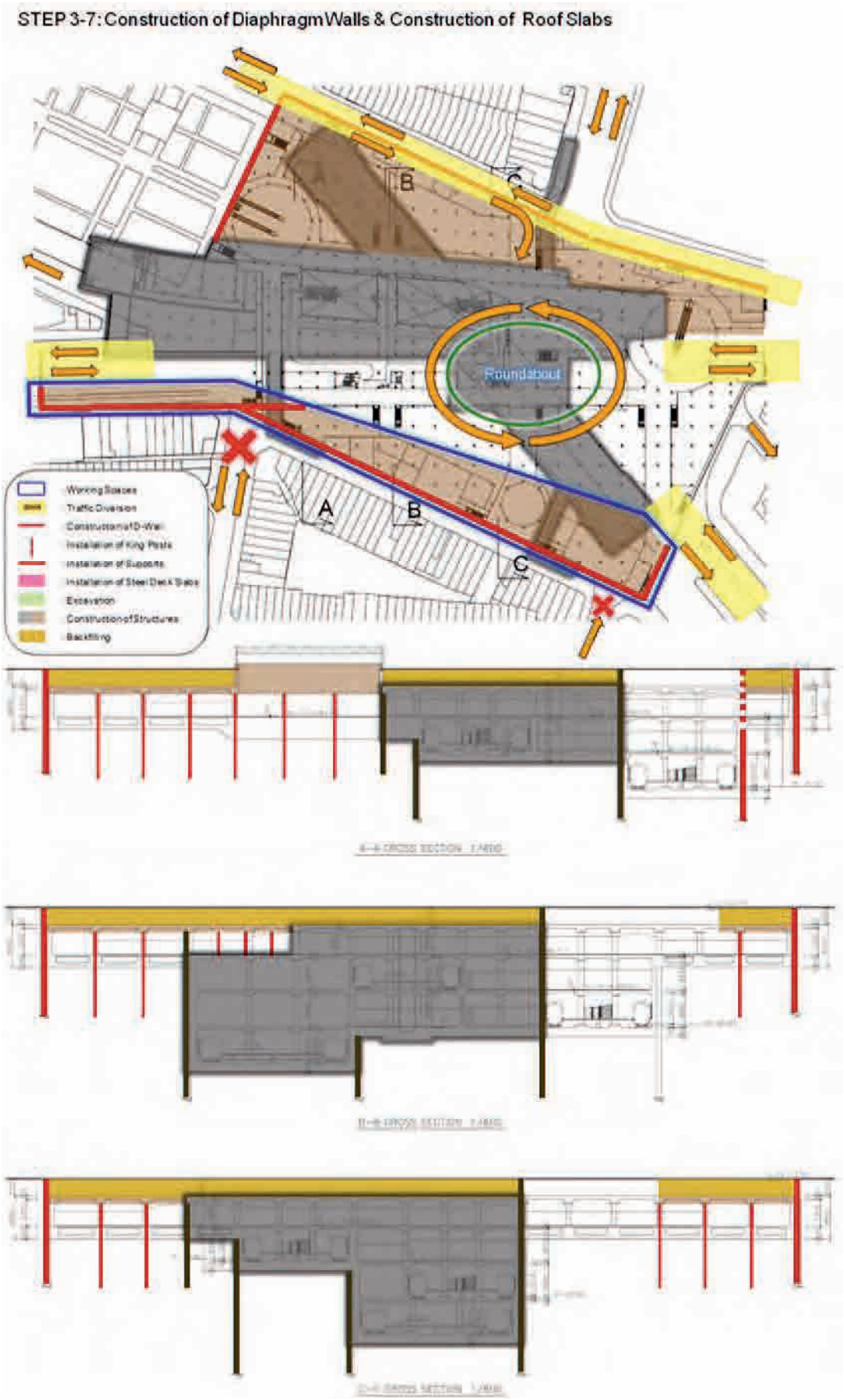


Figure 4.130 Construction Sequences of Ben Thanh Central Station (16/24)

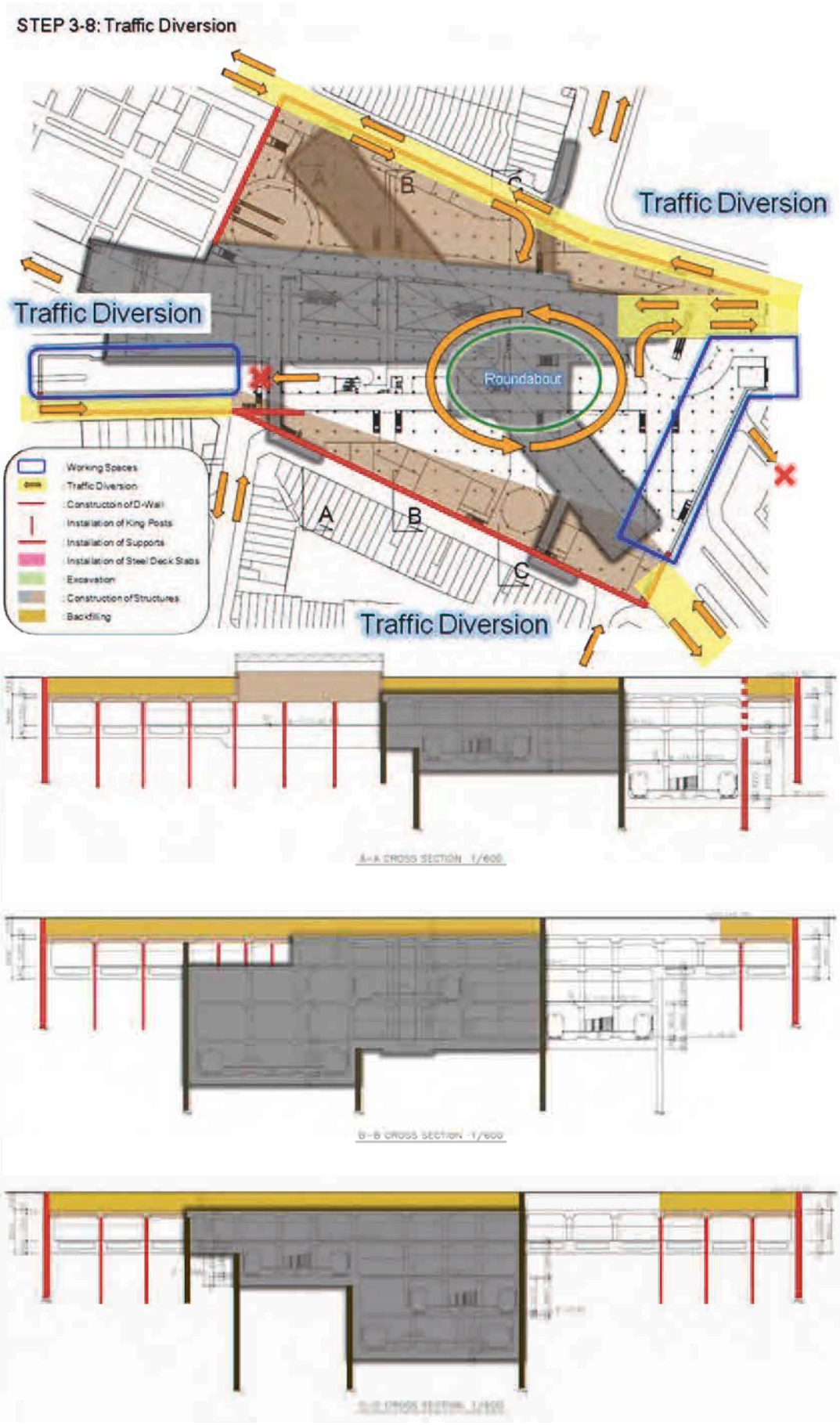


Figure 4.131 Construction Sequences of Ben Thanh Central Station (17/24)

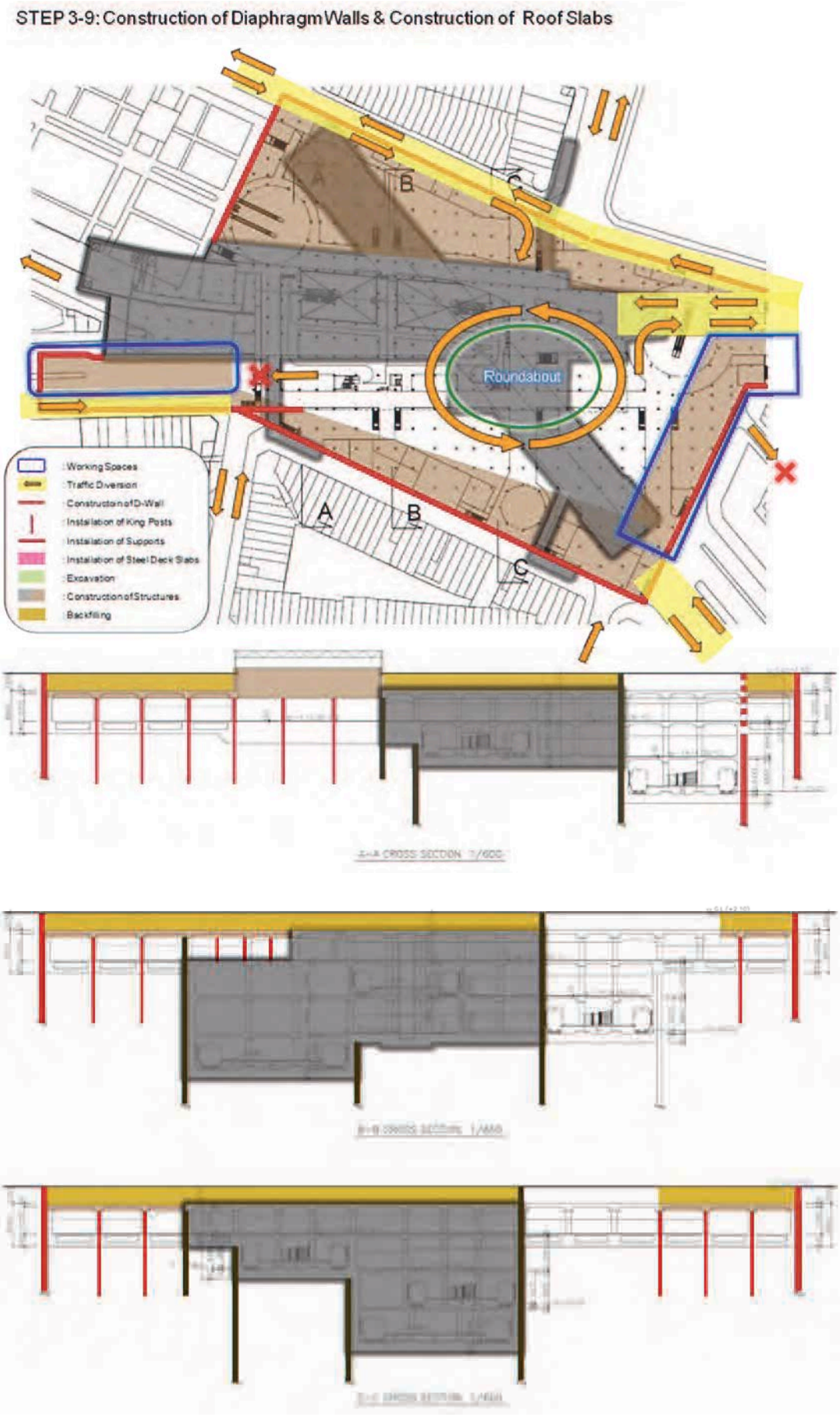


Figure 4.132 Construction Sequences of Ben Thanh Central Station (18/24)

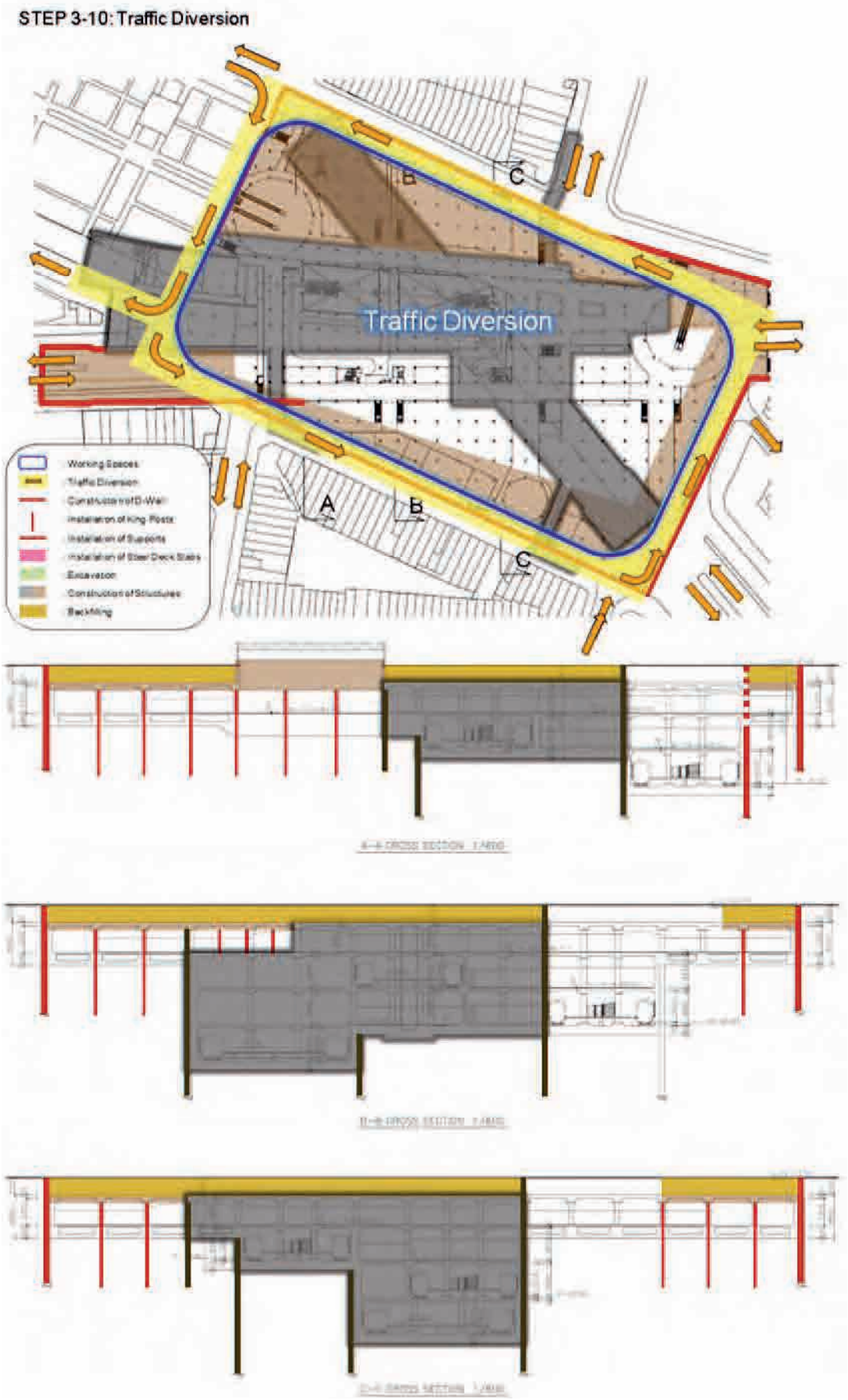


Figure 4.133 Construction Sequences of Ben Thanh Central Station (19/24)

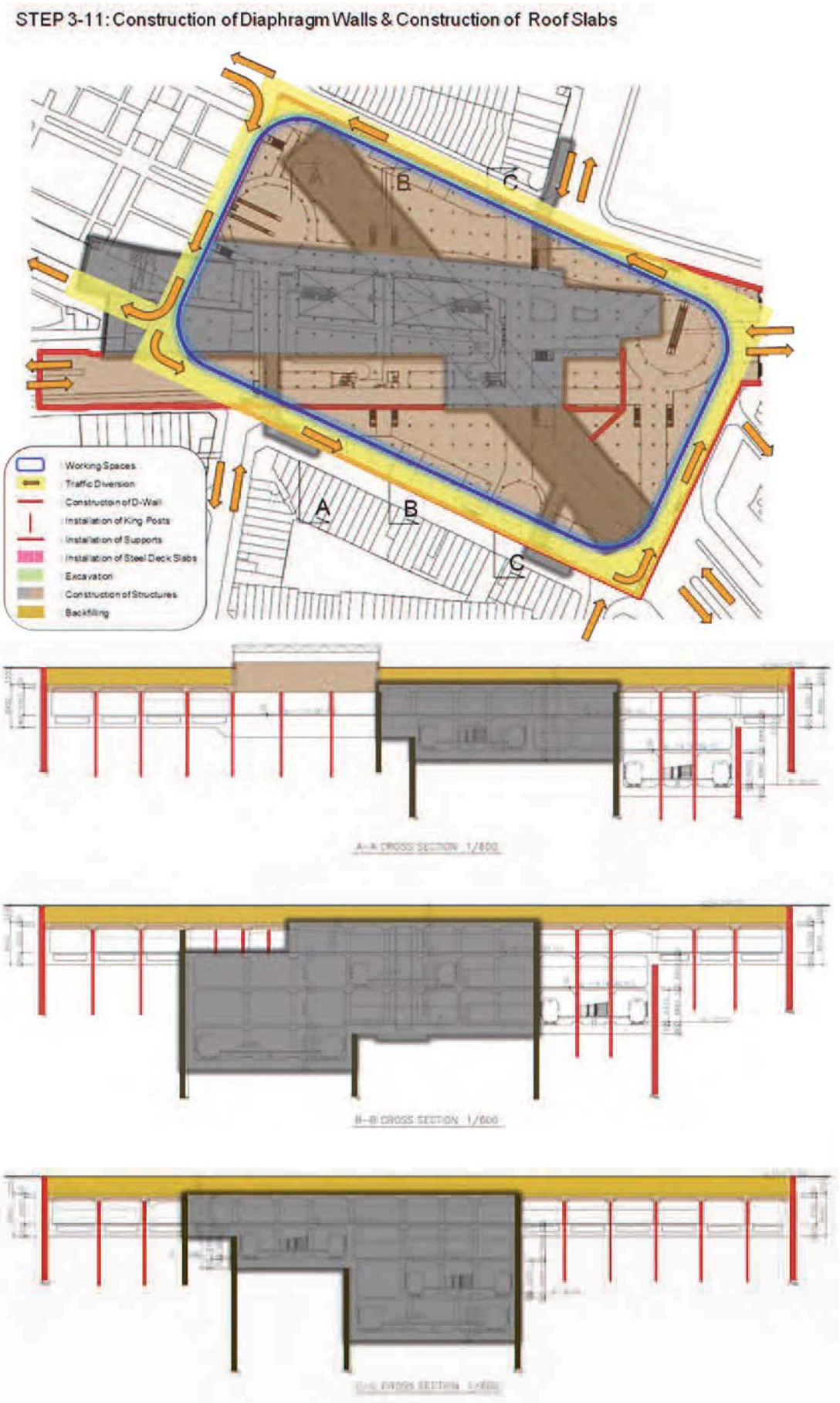


Figure 4.134 Construction Sequences of Ben Thanh Central Station (20/24)

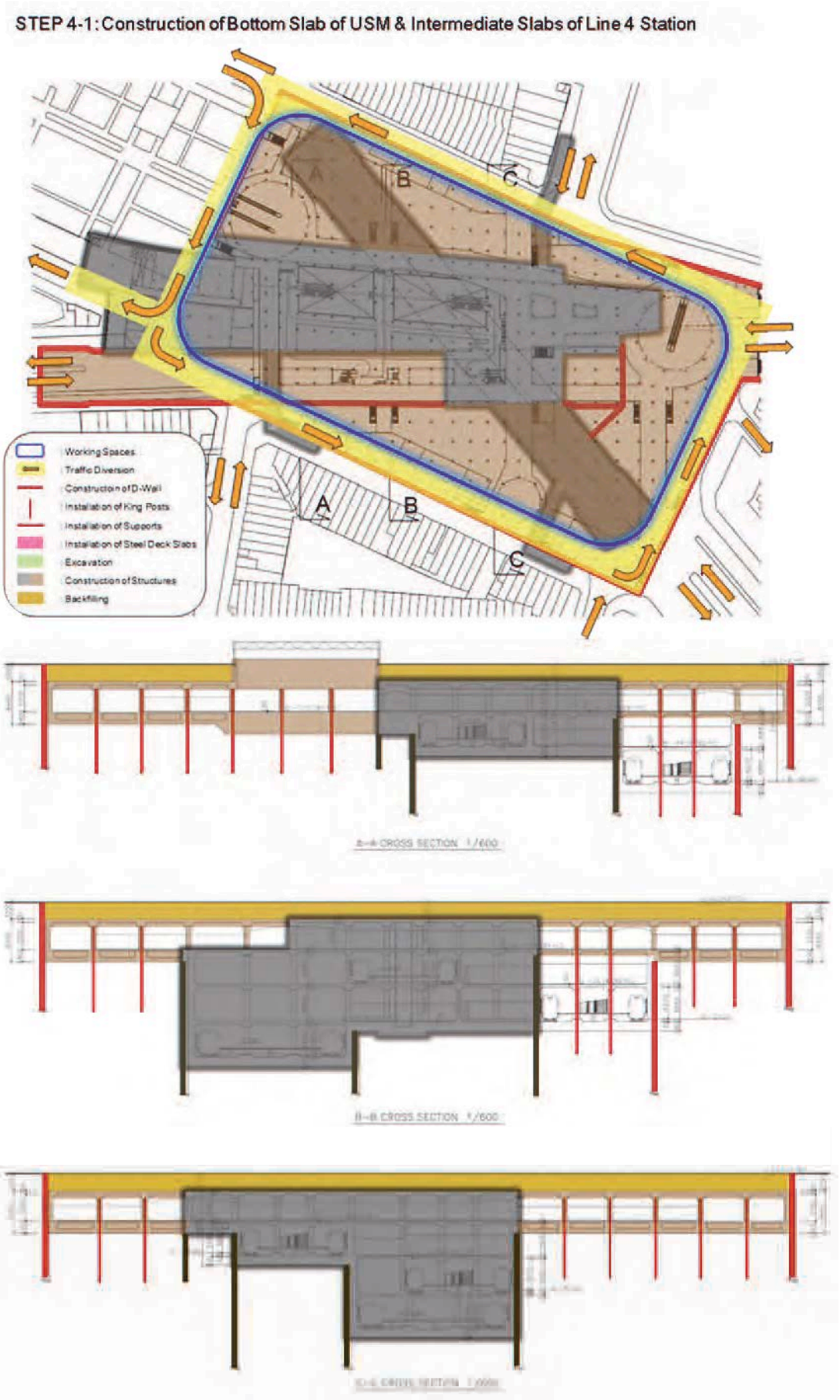


Figure 4.135 Construction Sequences of Ben Thanh Central Station (21/24)

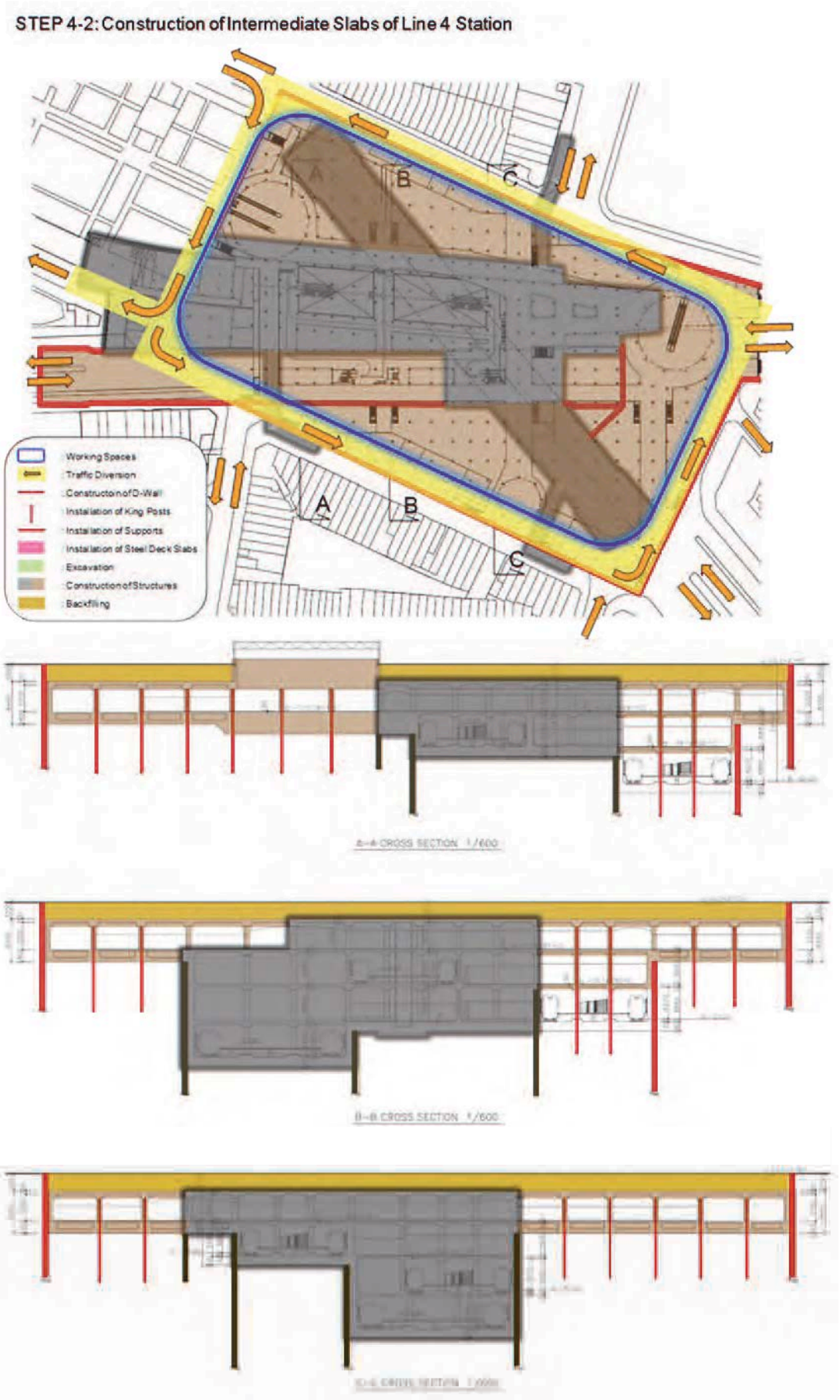


Figure 4.136 Construction Sequences of Ben Thanh Central Station (22/24)

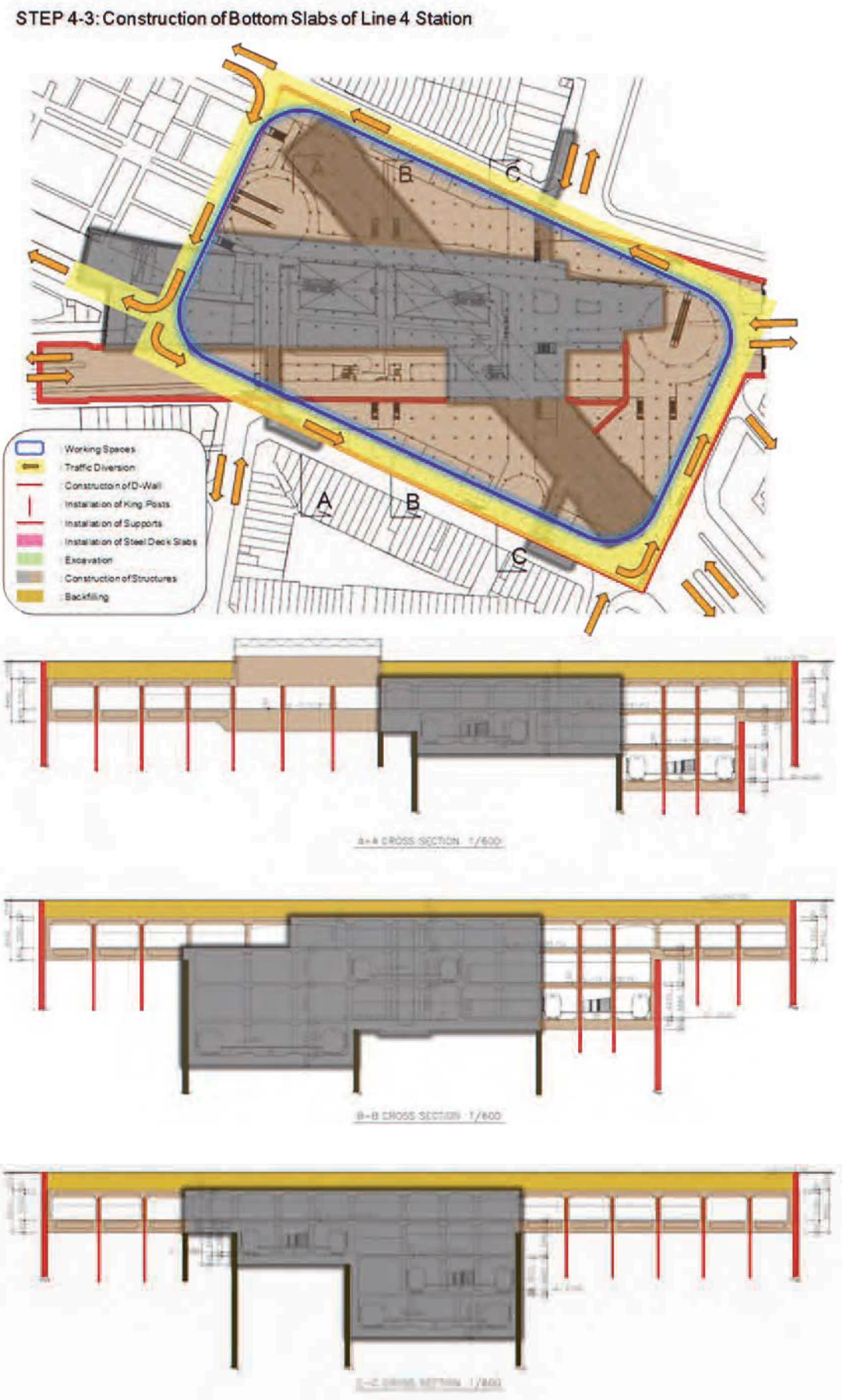


Figure 4.137 Construction Sequences of Ben Thanh Central Station (23/24)

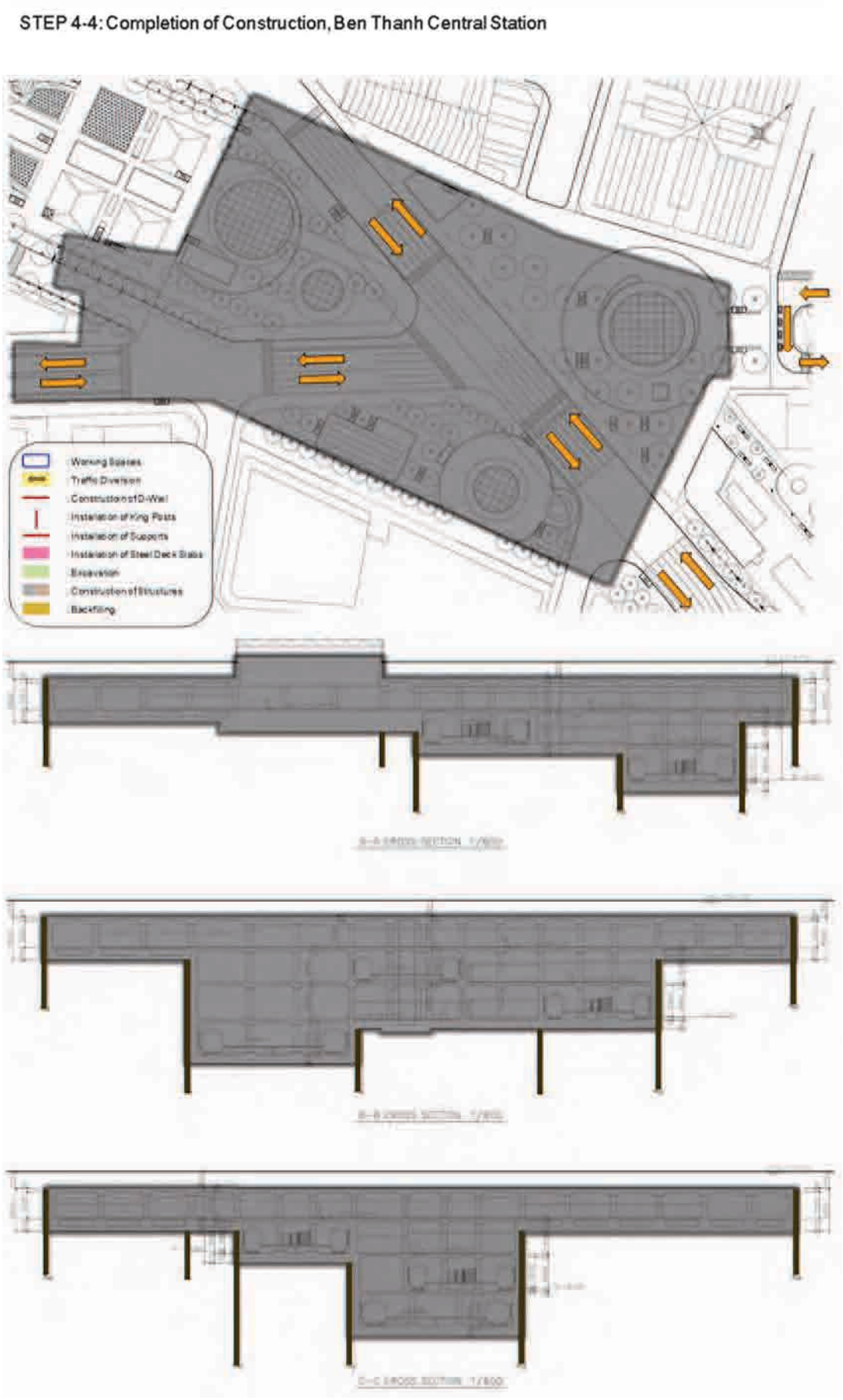


Figure 4.138 Construction Sequences of Ben Thanh Central Station (24/24)

Table 4.33 Preliminary Construction Schedule of Ben Thanh Central Station