Chapter 3

PUMP DRAINAGE INPROVEMENT (PACKAGE B)

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3.1 General

Pump drainage improvement project is proposed to implement for three small low-lying areas, Thanh Da of 15.4ha, Ben Me Coc (1) area of 70.9ha and Ben Me Coc (2) area of 46.0ha. These areas are located on the fringe of inner city of Ho Chi Minh City and have been affected about 10 times a year by the external flood from surrounding river and canals during the high tide season from September to January.

For these areas, the polder dike system with sufficient pumping station and sewer line is proposed as the most economical countermeasure to prevent from the serious external and internal floods. However, in the feasibility study, it was concluded that the construction of pumping stations for the western part of Ben Me Coc (1) area and the whole area of Ben Me Coc (2) shall be postponed to Phase II program, taking their existing development situation into consideration.

3.2 Scope of the Project

Pump Drainage Improvement Project (Package B) for three pump drainage areas consists of the following three components identified in Definitive Plan (refer to Fig. 3.1):

(a) Dike Construction:
- Thanh Da: Permanent dike of 75.0m
- Ben Me Coc (1): Temporary dike of 3,950m
- Ben Me Coc (2): Temporary dike of 3,300m

(b) Sewer Line Construction
- Thanh Da: Diameter: ϕ800 – ϕ1200mm, Length: L = 751m
- Ben Me Coc (1): Diameter: ϕ400 – ϕ1800mm, Length: L = 4,436m
- Ben Me Coc (2): Diameter: ϕ400 – ϕ1800mm, Length: L = 3,940m

(c) Construction of Pumping Station
- Thanh Da: Pump capacity of 42m^3/min.
- Ben Me Coc (1): Pump capacity of 42m^3/min.

Construction of additional pumping station of 48m^3/min. for Ben Me Coc (1) area and new pumping station of 63m^3/min. for Ben Me Coc (2) area are proposed to postpone to Phase II, which will be implemented from the year of 2006 to 2010.

3.3 Dike Construction

3.3.1 General

During the high tide season of 6 months between September and January, Thanh Da, Ben

Me Coc (1) and (2) areas, which are located in north-east and south-west fringe of the city, have been suffered about 10 times a year from the external flood of Saigon River, Tau Hu, Lo Gom and Doi canals. Main causes of the external flood are:

(a) Existing dike or bank elevations are lower than Design High Water Level (DHWL) of the surrounding river and canals.
(b) No gates at the existing sewer pipe outlets, or even if these are installed, water stop function is insufficient due to old and poor facilities.

Accordingly, three pump drainage areas are proposed to employ a polder dike system as the most suitable and economical external flood measure.

3.3.2 Applicable Codes and Standards

The following Vietnamese and Japanese codes and standards are applied:

- Flood Control Embankments, Design Procedure: 14 TNC 84-91, Ministry of Agriculture and Rural Development
- TCVN 4612-1998 and TCVN 5574-1991 Vietnamese design standard for reinforced concrete structure
- TCVN 5573 – 1991 Vietnamese design standard for masonry structures
- Manual for River Works in Japan: Published by River Bureau, Ministry of Construction, Japan
- Standard Specification for Design and Construction of Concrete Structures, 1996, Japan Society of Civil Engineering
- Road Bridge Substructure Design Standard (Japan Road Association 1994)

3.3.3 Design Condition and Criteria

(1) Hydraulic Condition

Design Highest High Water Level (DHWL), Design High Water Level (DHWL) and Design Low Water Level (DLWL) at the project sites of Saigon River, Tau Hu, Lo Gom and Doi canals are as follows:

Pump Drainage Area	DHHWL (m)	DHWL (m)	DLWL (m)
Thanh Da	EL.+1.54	EL.+1.32	EL.-2.11
Ben Me Coc (1)	EL.+1.54	EL.+1.50	EL.-1.86
Ben Me Coc (2)	EL.+1.54	EL.+1.50	EL.-1.86

Note: 1. DHHWL for the dike in Thanh Da area is applied to be +1.54m, which is the recorded historical highest water level at Phu An station on Saigon River. DLWL is applied to be –2.11m, which is average annual minimum water level at Phu An station.
2. DHHWL and DLWL at Ben Me Coc (1) and (2) are estimated with the water level

relation between Phu an station on Saigon River and Ben Luc station on East Van Co River.

(2) Geological Condition

(a) Thanh Da Area

According to the result of soil boring survey of 40m deep (DUT-01) carried out in the definitive plan stage in June 2000, it has found that basic soil at the proposed dike construction site is composed of Holocene deposits of 21.5m thick and Pleistocene deposits, of which thickness has not been confirmed The sub-soil layers are as follows:

Layer	Depth (m)	Thickness (m)	Materials	N-Value	Notation
1	1.0 – 15.8	15.0	Very soft, high plasticity, blackish gray organic clay	0 - 1	OH
2	15.8 – 17.5	1.5	Soft, low plasticity, blackish sandy clay	4.1	CL
3	17.5 – 22.0	4.5	Loose, greenish gray silty clay sand	11 - 12	SC/SM
3	22.0 – 25.5	3.5	Medium dense, yellowish gray silty sand	11 - 12	SM
4	25.5 – 28.6	8.0	Stiff, low plasticity, greenish gray sandy clay	12 - 15	CL
5.	28.6 – 40.0	11.4	Medium dense, yellow gray silty sand	10 – 23	SM

Main characteristics of the sub-soil are:

* Natural Moisture Contents (Wn): 20.0 – 88.7%
* Plastic Limit (Pw): 13.6 – 42.2%
* Dry Density (rd): 0.77 – 1.72g/cm^3
* Specific Gravity: 2.591 – 2.693
* Liquid Limit (Lw): 21.2 – 80.1%
* Wet Density (rt): 1.44– 2.07 g/cm^3
* Cohesion(C): 0.056–0.061kg/cm^2

(b) Ben Me Coc (1) and (2)

The sub-soil conditions of Ben Me Coc (1) and (2) are basically the same as that of Thanh Da site except the depth of expected bearing stratum. The expected bearing stratum at the proposed pumping station in Ben Me Coc (1) and (2) is found at about 40m in depth from the ground. OH layer, which is very soft or soft, high plasticity, blackish gray organic clay, is confirmed as an alluvium deposits with a thickness from 30 to 40m. Typical sub-soil conditions of Ben Me Coc (1) and (2) are shown below:

Layer	Depth (m)	Thickness (m)	Materials	N-Value	Notation
1	0.0 – 18.0	18	Very soft, high plasticity, blackish gray organic clay	0 - 1	OH
2	18.0 – 25.0	7.0	Soft, high plasticity, blackish gray organic clay	2 – 3	OH
3	5.0 – 30.0	5.0	Soft, low plasticity, blackish gray sandy clay	2 – 3	CL

The characteristics of the sub-soil are as follows:

* Natural Moisture Contents (Wn): 33.8 - 80.7 %
* Plastic Limit (Pw): 24.6 - 43.2 %
* Dry Density (rd): 0.82 - 1.06 g/cm^3
* Specific Gravity (Gs): 2.590 - 2.635
* Liquid Limit (Lw): 41.7 - 81.4 %
* Wet Density (rt): 1.39 - 1.47 g/cm^3
* Cohesion (C): 0.08 - 0.12 kg/cm^2

(3) Structural Condition and Criteria

(a) Allowable Stress

Concrete

Item \ Concrete Type	Concrete Type D	Concrete Type E	Concrete Type F	Concrete Type G
28-day compressive strength by cylinder test (300mmx150mm dia.)	250	210	180	100
Bending compressive stress (σca)	83.3	70	60	-
Shearing stress (τca)	4.0	3.6	3.3	-

Note: 1. Unit: kg/cm^2
2. Concrete Type D: Precast concrete, Concrete Type E: Reinforced concrete
Concrete Type F: Plain concrete, Concrete Type G: Leveling concrete

Reinforcing Bar

Reinforcing Bar	Deformed Bar
Tensile and compressive stress (τca)	1,600 kg/cm^2

(b) Design Loads, Earth Pressure and Others

Unit weight

- Soil: upper ground water: $\gamma = 1.8$ t/m^3,
  lower ground water: $\gamma = 0.8$ t/m^3
- Ground water: w = 1.0 t/m^3
- Concrete: $\gamma = 2.4$ t/m^3
- Live load: w = 0.5 t/m^2
- Traffic load: H-30 (w = 1.0 t/m^2)

Earth pressure:	P = (vertical soil load) x Ko,
	(Ko: earth pressure at rest = 0.5)
Horizontal load pressure:	Pv = (vertical load) x Ko
Ground water pressure:	Pw =1.0 t/m^3 x h (m)
	h = depth from ground water level

Other structural design condition and parameters are described on structural design calculation paper in Volume IV Data Book.

3.3.4 Dike Construction along Saigon River in Thanh Da Area

New dike construction of 75m long is proposed to implement at the north bank (right bank) of Saigon River in Thanh Da pump drainage area, which has never been provided with any dike or revetment, because of occupation by some illegal houses. The dike is designed to be almost same revetment type as the existing one constructed before along Saigon River in order to connect smoothly with both dikes.

As shown in Fig.3.2, 52 reinforced concrete piles with 250 x 250mm in section and 12.0m long are to be driven in double line of 3.2m in width and at intervals of 3.0m along the north bank of Saigon River. Top elevation of land and riverside piles are designed to be EL.+1.25 and EL.-1.75m respectively. Top of each pile shall be connected rigidly by upper and lower reinforced concrete coupling with 400 x 400mm and beams with 300 x 300mm in section and 4.3m in length. Top elevation of the upper coupling is designed at EL.+2.00m, which is 0.46m higher than DHWL of EL.+1.54m.

Bank slope filled up by sandy soil is protected from erosion by gravel mat of 20cm thick, leveling concrete of 10cm thick and reinforced concrete slab with 20cm in thickness. Foot of the revetment is protected by riprap of 250 – 300mm size with 50cm thick from scoring by floodwaters.

Along the proposed dike, operation and maintenance space with 5.0m width and 75.0 m long is provide, which is designed to be covered by concrete block paving of 60mm thick with sand bedding of 100mm thick.

3.3.5 Temporary Dike along Ring Road in Ben Me Coc (1) Area

(1) Description the existing condition (refer to Fig. 3.3):

Ring road in Ben Me Coc (1) is divided into 4 sections with the following names:

W1, W2: for the section located in the western part from the existing pond
E1, E3: for the section located in the eastern part from the existing pond

Some of these sections have the existing revetment (dike), which is made of stone masonry. The specific condition for each section is as follows:

Section E1: This section has the existing revetment (dike) of 786m long with many types of shape. It can be divided into the following 4 types:

- Type D: This is along Ngang No.2 Canal. Its top elevation is EL.+1.50m - El.+1.80m and is about 15m far from the edge of existing ring road.
- Type E: This is along Doi canal, of which top width is 1.0m and top elevation is EL.+1.40m - EL.+1.60m. It is adjacent to the edge of existing ring road.
- Type B: This is stone masonry revetment along Doi canal, which is about 5.0m – 15.0m far from the edge of ring road. The top of revetment with 5.0m – 15.0m wide has served as sidewalk. Its top elevation is EL.+1.45m – EL.+1.58m
- Type F: This is along Doi canal. The top elevation is EL.+2.18m – EL.+2.20m and the width is 1.0m. It directly connects with the existing ring road.

Besides, there is a pier with 37.0m long, which is made of concrete and its top elevation is EL.+1.40m.

Section E3: This section has 2 types of existing dike with 1,016m long as follows:

- Type B: This is the same type as section E1. Most of E3 section is this type. The top elevation is from EL.+1.36m to +EL.1.63m and the top width of dike is from 1.45m to 4.90m. Total length of this type is 792m long.
- Type G: This is along the Ngang No.2 canal Bridge. It is reinforced concrete vertical retaining wall, of which length is 224m long.

Section W1: Most of this section has no revetment (dike). Only existing dike of 30m long exists and its width and top elevation is 1.0m and EL.+2.24m – EL.+2.26m respectively. It connects with the edge of ring road and is the same type as that of the section E1 (type F).

Section W2: Canal revetment with stone masonry is planned to construct by HCMC Office of Waterway Management. The design top elevation of dike is EL.+1.55m, which is 45cm lower than design one of the dike. The bank slope is designed at 1:1.5 and the length is 910m. It is called Type C.

(2) Option of Proposed Dike: (refer to Fig. 3.3)

Based on the existing conditions mentioned above, it is suggested the design of temporary dike as follow:

(a) New dike construction for the sections having no existing dike: Type A.

The total length of new dike is 1,550m. The position of this dike is 1.5m to 2.0m far from the edge of ring road in order to avoid the existing electric cables. It is made of stone masonry and has the shape of a stair with 2 steps. The first step elevation is the same elevation of the design sidewalk and its width is 1.0m. The second step has the elevation EL.+2.00m and the width of 0.5m. Foot of this dike is 0.5m – 0.8m deeper than existing ground elevation.

(b) Raising of existing revetment. There are 6 types (B, C, D, E, F, G) respectively the existing types mentioned above.

Type B: Construct the new stone masonry with top elevation of EL.+2.00m and width of 0.5m above the concrete surface of existing revetment, at the top of canal revetment slope. (1,077m)

Type C: To construct the new stone masonry at the top of revetment slope of Tau Hu canal. Its width and top elevation is 0.5m long and EL.+2.00m respectively. This dike is constructed above the existing revetment, which will be conducted by Waterway Management Division. (910m)

Type D: To construct the new stone masonry at 0.3m far from the existing vertical stone revetment along Ngang No.2 canal. It has the top elevation +2.00m and the width of 0.5m above the stone surface of existing revetment. The existing stone surface is extended until 1.0m wide. (365m)

Type E: To construct the new stone masonry dike with top elevation of EL.+2.00m and the width of 0.5m above the existing stone revetment. The existing stone masonry revetment is expanded to improve the sidewalk of 1.0m wide. (61m)

Type F: To improve the existing stone masonry revetment to increase the existing top width of 1.0m to 1.7m. (105m)

Type G: To construct the new stone masonry wall with the top elevation of EL.+2.00m and the width of 0.5m above the existing concrete retaining wall along the Ngang No. Canal Bridge. To construct the stone masonry sidewalk of 1.0m wide connecting with newly constructed dike. (224m)

Pier: To construct the stone masonry stair at the pier, which has 3 steps of both side (canal and ring road) in order to be easy for people's passing and loading. Every step is 0.25m wide and 0.2m high. (37m)

3.3.6 Temporary Dike along Ring Road in Ben Me Coc (2) Area

(1) Description the existing condition (refer to Fig. 3.4):

Ring road in Ben Me Coc 2 is divided into 4 sections with the following names:

N1, N2: for the section located in the west of the existing pond of the area.
S1, S2: for the section located in the east of the existing pond of the area.

Some of these sections have the existing revetment (dike), which is made of stone masonry. The specific condition for each section is as follows:

Section N1, N2: The existing revetment (dike) has been constructing based on the design of HCMC Waterway Management Division. The design top level of dike is +1.55m and its slope is 1:1.5 to the canal side and the length is 1,467m. It is called Type C.

Section S1, S2: These sections have no the existing dike.

(2) Option of design: (refer to Fig. 3.4)

Based on the existing condition mentioned above, the following temporary dike is designed:

(a) New dike construction for the sections having no existing dike: Type A

The total length of new dike is 2,019m. This dike is designed at 2.5m far from the edge of ring road in order to avoid the existing electric cables. It is made of stone masonry and has a stair with 2 steps. The first step elevation is the same elevation of the design sidewalk and its width is 1.0m for people' walk. The second step has the elevation +2.00m and the width of 0.5m. Foot of this dike is 0.5m – 0.8m deeper than existing ground elevation.

(b) Raising of existing revetment: Type C

The total length of Type C dike is 1,467m. The new stone masonry dike is constructed at the top of existing Tau Hu canal revetment constructed by OWM. The new dike top elevation and width is EL.+2.00m and 0.5m respectively. The existing revetment is expanded to increase the width of sidewalk up to 1.0m by stone masonry.

3.4 Sewer Line Construction

3.4.1 General

The southern area from Xo Viet Nghe Tinh road in Thanh Da area has been flooded at least 10 times at the high tide season every year, due to low ground elevation of EL.+0.90 to EL.+1.20m. The surface of this area is 15.4 ha. The existing sewer system consists of 4 main sewer of ϕ800 - ϕ1000. Therefore, this southern low-lying is proposed to apply pump drainage system to solve the inundation problems taking into consideration of

difficulty of filling up to EL.+2.0m. In order to complete the successful drainage pipe network in Thanh Da area, some additional new sewers are designed.

Ben Me Coc (1) area with 70.9 ha is topographically low. The ground elevation is from +0.900 to +1.300. During high tide season, most of area has been flooded at least 10 times per year because of no sufficient dike around the area, no existing main sewer system and no water gate at some existing outlets. Inundation depth and duration have surveyed at 30 to 50 cm and 4 to 6 hours respectively. Therefore, new sewer lines are proposed to construct under the ring road in combination with dike, pumps and retarding ponds.

Ben Me Coc (2) area of 46.0ha has low – lying topography. The ground elevation is from +0.900 to +1.300. There is no main sewer system, only some of pipes from the small inner road drain into Doi, Tau Hu and Ngang No.3 canals. Flood condition of the area and the reason is almost the same as that of the western part of Ben Me Coc (1). This area is not fully developed. There are still some natural ponds as storm water storage area.

In order to mitigate flood condition caused by high tide, it is proposed to construct the temporary dike and main sewer line system. Main sewer line system will connect all the small existing sewer pipes and discharge into the surrounding canal by some of main outlets with flap gate.

3.4.2 Applicable Codes and Standards

The following design codes and standards are applied in this detailed design of sewers.

- Vietnamese Design Standard 20 TCN – 51 – 84 from Ministry of Construction on "Outside Sewer Network" .
- Proceedings of Vietnam Construction Standards, Volume III (Ministry of Construction 1997)
- Typical Sewer Design from HCMC Urban Drainage Company for reference
- Standard Specification for Design and Construction of Concrete Structure (The Japan Society of Civil Engineers 1996)
- Structural Design Index (Japan Sewage Works Agency 1998)
- Temporary Structure Design Index (Japan Sewage Works Agency 1998)

3.4.3 Design Condition and Criteria

(1) Existing Conditions

(a) Thanh Da area

There is an existing sewer network including the pipes with the size from 600mm to 1000mm. This network drains directly into Saigon River by 6 outlets. Some pipes

discharge into the existing pond and this pond is connected with Saigon River by the pipe of ϕ1000. The site of new pump station will be near the retarding pond. Existing facilities information is mentioned in the table below:

Section	Length of Section (m)	LENGTH OF FACILITIES		
		Electric cables	Water Supply Pipes	Telephone cables
TD 2	154	-	-	-
TD 4	216	-	-	-
TD 5	49	-	-	-
TD 6-7	235	-	235	-
Total	654	0	235	0

(b) Ben Me Coc (1)

There is no existing main sewer network in the area, only some small pipes (ϕ300 - ϕ600) from the inner road directly discharge into Ngang 2, Lo Gom, and Doi canal by the outlets without valves. An existing natural pond that divides Ben Me Coc 1 into 2 parts will be used as retarding pond. The site of new pump station will be next to this retarding pond.
Data of the existing facilities are shown in the table below:

Section	Length of Section	Length of Facilities		
		Electric Cables	Water Supply Pipes	Telephone Cables
E1	1,022	1,022	1,022	-
E2	378	-	378	-
E3	817	-	817	817
W1	1,328	1,328	1,328	-
W2	829	-	829	829
Total	4,374	2,350	4,374	1,646

(c) Ben Me Coc (2)

There is no existing main sewer network in the area, only some small pipes (ϕ300 - ϕ600) from the inner road directly discharge into Ngang 3, Lo Gom, and Doi canal by the outlets without valves. Data of the existing facilities in Ben Me Coc (2) area are as follows:

Section	Length of Section	Length of Facilities		
		Electric cables	Water Supply Pipes	Telephone cables
N1	878	-	878	878
N2	892	892	892	892
S1	953	953	953	-
S2	489	489	489	-
S1-3	128	128	128	-
S1-5	137	-	137	-
N1-2	208	-	208	--
N1-4	207	-	207	
Total	3,892	2,462	3,892	1,770

(2) Design Criteria

Design criteria for sewer line studied in Master Plan and F/S stage are as follows:

(a) Thanh Da Area
- Design rainfall frequency: 2 - year return period.
- Design rainfall intensity: $I = 13{,}567/(t^{1.18} + 89)$ $t < 3$ hours,
  where, I : point rainfall intensity (mm/hr), t : duration .
- Design high water level: EL.+1.32m
- Design mean water level: EL.+0.230m
- Design low water level: EL.-2.110m
-

(b) Ben Me Coc (1) Area
- Design rainfall frequency and intensity: same as Thanh Da area
- Design high water level: EL.+1.500m
- Design mean water level: EL.+0.270m
- Design low water level: EL.-1.860m
- Min invert elevation: EL.-2.000m

(c) Ben Me Coc (2)
- Design rainfall frequency and intensity: same as Thanh Da area
- Design high water level: EL.+1.500m
- Design mean water level: EL.+0.270m
- Design low water level: EL.-1.860m
- Min invert elevation: EL.-2.000m

3.4.4 Sewer Line in Thanh Da Area

(1) Main Features of Sewers

Main features of sewer in Thanh Da area. are shown in the table below:

Catchment			Sewer Dimension			Hydraulic Property		Sewer Invert Elevation (IE)	
Name	Name of Sub -catchment	Area (ha)	Length (m)	Diameter (mm)	Slope (‰)	Velocity (m/s)	Discharge (m3/s)	Upstream (m)	Downstr-eam (m)
TD 2		2.81	154	800	1.7	1.11	0.6	-0.388	-0.650
TD 4	TD 4.1	7.66	47	1200	1.2	1.2	1.4	-1.000	-1.056
	TD 4.2	7.90	36	1200	1.2	1.2	1.4	-1.056	-1.100
	TD 4.3	8.28	63	1200	1.2	1.2	1.4	-1.100	-1.175
	TD 4.5	10.14	61	1200	1.2	1.2	1.4	-1.175	-1.248
	TD 4.6	10.37	9.4	1200	1.2	1.2	1.4	-1.248	-1.260
TD 5		0.83	145	800	1.1	0.9	0.4	-0.340	-0.500
TD 6-7	TD 7	2.44	137	1000	1.7	1.2	1.0	-0.700	-0.933
	TD 6.2	3.72	80.5	1000	1.7	1.2	1.0	-0.933	-1.070
	TD 6.3	4.15	17.5	1000	1.7	1.2	1.0	-1.070	-1.100

(2) Design for Layout, Profile of Sewer Line (refer to DWG.No.PB-PDI-TD-202 to205 in Tender Drawings):

(a) Layout Design:

Based on the position of the existing facilities (electric cables, telephone cables, water supply pipes) and the excavation trench needed, layout design for every sewer lines in Thanh Da area is as follows:

Line TD 2:
Centerline of new sewer pipe ϕ800 is 0.6m far from centerline of road in the right side. The start point of this line is 1.5m far after from the survey station (0+000). The new pipe ϕ800 is connected with the existing upstream pipe ϕ800 at manhole M1 and the existing downstream pipe ϕ1000 at manhole M6. There is no designed inlet pit on this line because the width of road is small (B=4.0m). So, 5 new manholes constructed at the center of the road, will be covered by the grid cast iron cover, which can collect surface water directly. The distance between manholes is about 30m – 32m.

Line TD4, Section TD 4.1, TD 4.2:
Centerline of new sewer pipe ϕ1200 is the same one of existing road. The start point of this line is 4.0m far after from the survey station (0+000). There is no designed inlet pit on this line because the width of road is also small (B=4.0m). So, 4 new manholes will be covered by the grid cast iron cover, which can collect surface water directly. The distance between manholes is about 30m.

Line TD4, Section TD 4.3, TD 4.5:
Centerline of new sewer pipe ϕ1200 is designed at 3.0m far from the right edge of existing road (in the housing side). The new pipe ϕ1200 is connected with the existing pipe ϕ800 at manhole M5, M6 by the pipe ϕ800 and with the existing pipe ϕ1000 at manhole M8 by the pipe ϕ1000. There are 2 new inlets to be constructed for this line, respectively with the positions of manhole M5, M7.

Line 4, Section TD 4.6:
Centerline of new sewer pipe is defined by the location of pump station. Detailed design of last manhole, Mp1 of this line is conducted in the design of pump station.

Line TD 5
Centerline of new sewer pipe ϕ800 is the same one of existing road. The start point of this line is 4.5m far after from the survey station (0+000). The new pipe ϕ800 is connected with the existing downstream pipe ϕ1000 at manhole M7. Because the width of road is small (B=4.0m) and there is no existing sidewalk, 7 new manholes that are above the new main sewer will be covered by the grid cast iron cover in order to collect surface water directly. The

distance between manholes is about 25m. There are 3 inlets to be constructed at the intersection of this line and the small inner road for preparing to connect with the future pipes from these ones. These 3 inlets will have function as manholes when the future pipes to be connected. Now, they are connected with the main sewer by the pipe ϕ600.

Line TD 6 – 7, Section TD 7:
Centerline of new sewer pipe ϕ1000 is the same one of existing road. The start point of this line is 3.5m far after from the survey station (0+000). There is no designed inlet pit on this line because the width of road is small (B=4.0m). So, 6 new manholes that are above the new main sewer will be covered by the grid cast iron cover in order to collect surface water directly. The distance between manholes is about 30m – 33m.

Line TD 6 – 7, Section TD 6.2:
Centerline of new sewer pipe ϕ1000 is 3.0m far from the right edge of the existing road (the existing pond side). The new pipe ϕ1000 is connected with the existing pipe ϕ1000 at manhole M9. There are 2 existing inlets that are reused for this line, they are connected with the new pipes by the pipe ϕ400 at the positions of manhole M7, M8.

Line TD 6 – 7, Section TD 6.3:
Centerline of new sewer pipe is defined by the location of pump station. Detailed design of the last manhole, Mp2 of this line is included in the design of pump station.

(b) Profile Design (refer to DWG. No. PB-PDI-TD-201 to 205 in Tender Drawings):

Based on (i) the result of hydraulic calculation, (ii) the invert elevation of the existing pipes that will be connected and (iii) the existing ground elevation, profile of sewers are designed as follows:

Line TD 2:
- At the manhole M1: IE = EL.-0.338m
- At the manhole M6: IE = EL.-0.650m
- Gradient for ϕ800: i = 1.7‰

Line TD 4
- At the manhole M1: IE = EL.-0.600m
- At the manhole Mp1: IE = EL.-1.260m
- Gradient for ϕ1200: i = 1.2‰

Line TD 5:
- At the manhole M1: IE = EL.-0.340m
- At the manhole M7: IE = EL.-0.500m
- Gradient for ϕ800: i = 1.1‰

Line TD 6 – 7:
- At the manhole M1: IE = EL.-0.700m
- At the manhole Mp2: IE = EL.-1.100m
- Gradient for ϕ1000: i = 1.7‰

(3) Design for Structure

- Pipes: Precast centrifugal reinforced concrete Type D - 250KG/cm^2.
- Foundation of sewer pipes: Driving wooden piles ϕ80 - ϕ100 with 16trees/m2, L = 4.5m/tree, Cast in situ concrete Type G - 100KG/cm2

- Manholes: Cast in situ reinforced concrete Type E - 210KG/cm2. (refer to DWG. No. PB-TD-210, 211 in Tender Drawings)
- Inlets: Cast in situ reinforced concrete Type E - 210KG/cm2. (refer to DWG. No. PB-TD-216 in Tender Drawings)
- Manhole cover: 05 circle cast iron covers with the load 30 Tons (Type A) and 25 grid cast Iron covers with the load 30 Tons (Type C) (refer to DWG. No.PB-TD-215)
- Inlet cover: 05 square cast iron covers with the load 6 Tons (Type E) and water trap; 03 square concrete covers (Type D) with the load 30 Tons. (refer to DWG. No. PB-TD-216 in Tender Drawings)

(4) Installation of Flap Gates at Outlets in Thanh Da Area.

In the project area, there are 8 existing sewer outlets along Saigon River. They are installed with wooden flap gate. However, these gates have not sufficient function to stop the river water from Saigon River during high tide. This is one of causes of external flood in the project area. So, it is necessary to replace new flap gate.

Out of 8 outlets, three outlets are integrated to Thanh Da sluice way with sluice gate of 1,400W x 1,400H. So, remaining five outlets are designed to replace the wooden flap gate to new steel ones of ϕ1,000mm diameter. The location of five outlets replaced flap gates is referred to DWG. No. PB-PDI-TD-218 in Tender Drawings

The material of flap valves is proposed as follows:

- Frame is made of mild steel and completely covered with a rigid compressed composite plastic.
- Door is made of composite sand formed a rigid compressed composite plastic.
- Hinge links are manufactured from stainless steel with replaceable bronze brushes.
- Door sealing and gasket between frame and wall are in ethylene propylene.
- Anchor bolts are made of stainless steel.

(5) Construction method: using machine in combination with manual.

Cutting the road first by road cutter, then excavate the soil by using backhoe, because the depth is below 6m. Install the pipes by the suitable crane. The trench in Thanh Da area is lower than 4.0m deep, it shall be supported the trench by using the timber strut and wailing of 60mm x 120mm (double) in section and the timber board with section of 30mm x 300mm.

The excavation width is proposed as follow:

Diameter (mm)	ϕ300	ϕ400	ϕ500	ϕ600	ϕ800	ϕ900	ϕ1000	ϕ1200	ϕ1500	ϕ1800	ϕ2000
Width (m)	1.4	1.4	1.4	1.7	2.0	2.1	2.2	2.6	2.9	3.3	3.7

The works, such as construction of the manholes, inlets, outlets, and adjustment work for the position of pipes will be conducted by manual.

3.4.5 Sewer Line in Ben Me Coc (1) Area

(1) Design Parameters

Main features of sewers in Ben Me Coc (1) area are as follows:

Catchment			Sewer Dimension			Hydraulic Property		Sewer Invert Elevation (IE)	
Name	Name of Sub-catchment	Area (ha)	Length (m)	Diameter (mm)	Slope (‰)	Velocity (m/s)	Discharge (m3/s)	Upstream (m)	Downstream (m)
BM1 – E1	BM1 – E1.1	3.35	371	1000	1.0	1.0	0.8	-0.378	-0.749
	BM1 – E1.2	6.38	339	1200	1.0	1.1	1.2	-0.949	-1.288
	BM1 – E1.3	16.11	312	1500	1.0	1.3	2.2	-1.588	-1.900
BM1 – E2	BM1 – E2	7.20	378	1200	1.3	1.3	1.4	-0.717	-1.200
BM1 – E3	BM1 – E3.1	-	35	600	1.8	0.9	0.3	-0.163	-0.227
	BM1 – E3.2	2.87	144	900	1.0	0.9	0.6	-0.527	-0.671
	BM1 – E3.3	10.97	638	1500	1.0	1.3	2.2	-1.271	-1.909
BM1 – W1	BM1 – W1.1	3.46	371	900	0.5	0.6	0.4	-0.360	-0.545
	BM1 – W1.2	9.04	501	1200	0.5	0.8	0.9	-0.845	-1.095
	BM1 – W1.4	23.23	456	1800	0.5	1.0	2.6	-1.695	-1.923
BM1 – W2	BM1 – W2.1	5.54	430	1000	1.2	1.1	0.8	-0.705	-1.221
	BM1 – W2.2	10.47	399	1200	1.2	1.2	1.4	-1.421	-1.900
	BM1 – W2.3	-	67	400	1.5	0.6	0.1	-0.200	-0.300

(2) Design for Layout, Profile of Sewer Line:

(a) Layout Design:(refer to DWG.No.PB-PDI-BMC1-201 to 218 in Tender Drawings)

Based on (i) the position of the existing facilities (electric cables, telephone cables, water supply pipes), (ii) the excavation trench needed, and (iii) the position of temporary dike, layout for every sewer lines in Ben Me Coc (1) are designed principally as follows:

Layout of inlets:
Inlets have one function: collection of the storm water and wastewater from households. So, the distance of inlets is about 30m – 40m. There are 2 cases, as shown in Fig. 3.5:

Case 1: Construct the inlets in both side of the ring road when the dike is not next to the road and the space in the canal side is rather big, the volume of surface water is not small. They are connected with the manholes by the pipes ϕ400 or ϕ600 if inlet is installed at the intersection of this ring road and the small inner road).

Case 2: Construct the inlets in one side of the ring road (in the housing side) because the temporary dike is next to or nearly next to the edge of the ring road, and connect them into the manholes by the pipes ϕ400 or ϕ400 if inlet is installed at the intersection of this ring road and the small inner road).

Layout of manholes:
Manholes are located at the positions of connection pipes from the inlets in order to be easy to maintain and connect with the inlets.

Layout of outlets:
There are 10 outlets with flap gates, which are constructed at the last manhole of every type diameter calculation sections. The positions of outlets are next to the existing bank of canal. All the small existing outlets will be closed by cast in situ concrete wall (type F – 210 KG/cm2).
Data of outlets in Ben Me Coc (1) are as follows:

Section	Position	Diameter (mm)	Inside Bottom Elevation (m)
E1	M9	1000	-0.623
	M25	1200	-1.292
	Mps	1500	-1.900
E3	M6	900	-0.679
	M27	1500	-1.903
W1	M8	900	-0.474
	M28	1200	-1.101
	M42	1800	-1.925
W2	M13	1000	-1.194
	M26	1200	-1.914

Layout of centerline of pipe for each section is as follow:

Line BM1 – E1: Section BM1 – E1.1 (from manhole M1 to manhole M14):
Centerline of new sewer ϕ1000 is 2.5m far from the right edge of existing ring road way (in the housing side). The start point of this line is 6.0m far before from the survey station (0+000). Layout of inlets is designed in Case 1 (two inlet pits at both side of the road).

One sewer outlet of ϕ1000 with flap gate is designed at the same position of the existing ϕ600 (at the manhole M9).

Line BM1 – E1: Section BM1 – E1.2 (from manhole M14 to manhole M25):
Centerline of new sewer ϕ1200 is 3.0m far from the right edge of existing ring road way (in the housing side). Layout of inlets is designed in Case 2 (one inlet pit at the edge of road way). One sewer outlet ϕ1200 with flap gate is designed at the position of manhole M25.

Line BM1 – E1: Section BM1 – E1.3 (from manhole M25 to manhole Mps):
Centerline of new sewer ϕ1500 is 3.0m far from the right edge of existing ring road (in the housing side). Layout of inlet pit is designed in Case 1.

1 outlet ϕ1500 with flap gate is constructed at the same position of the existing ϕ600

(respectively manhole Mps).

Line BM1 – E2: (from manhole M1 to manhole M15):
Center line of new sewer ϕ1200 is 3.0m far from the right edge of existing road .The start point of this line is the same position of the existing manhole. There are 15 manholes that use the circle cast iron cover with the load 30 Tons (Type A). The distance between manholes is average 25m - 30m based on the existing inlets and manholes positions.

All the existing inlets and manholes in both side of the road are still reused. The connection pipes ϕ400 from the existing inlets in the left side are replaced with new ones in order to change flow direction into the new pipe ϕ1200. Some of them (4 connection lines) are replaced with the pipe ϕ600 in order to transfer the flows from the existing pipe ϕ600 (on the left sidewalk) to the new pipe ϕ1200.

The new sewer pipe ϕ1200 is connected to the manhole M25 on the main sewer pipe ϕ1500 of section BM1 – E1.3.

Line BM1 – E3: Section BM1 – E3.1 (from manhole M1 to manhole M6):
In this section, along the Bridge Ngang Canal No.2, there is a new – constructed ϕ600 sewer line on the sidewalk. This sewer will be reused and connected into the new ϕ900 sewer line.

Centerline of new sewer ϕ900 is 2.0m far from the right edge of existing ring road (in the canal side).). Layout of inlet pit is designed in Case 2. One outlet ϕ900 with flap gate is designed at manhole of M6.

Line BM1 – E3: Section BM1 – E3.2 (from manhole M6 to manhole M28):
Centerline of new sewer ϕ1500 is 2.0m far from the right edge of existing ring road (in the canal side). The last manhole (M28) is 11.0m far from the foot of Vinh Mau Bridge. Layout of inlet pit is designed in Case 2. One outlet ϕ1500 with flap gate is constructed at the position of manhole M27.

Line BM1 – W1: Section BM1 – W1.1 (from manhole M1 to manhole M13):
Centerline of new sewer ϕ900 is 2.5m far from the right edge of existing ring road (in the housing side). The start point of this line is 7.0m far after from the survey station (0+000). Layout of inlet pit is designed in Case 2. One outlet ϕ900 with flap gate is constructed at the manhole M8.

Line BM1 – W1: Section BM1 – W1.2 (from manhole M13 to manhole M28):
Centerline of new sewer ϕ1200 is 3.0m far from the right edge of existing ring road (in the housing side). Layout of inlet pit is designed in Case 2. One outlet ϕ1200 with flap gate is constructed at the position of manhole M28.

Line BM1 – W1: Section BM1 – W1.4 (from manhole M28 to manhole M42):
Centerline of new sewer ϕ1800 is 3.0m far from the right edge of existing ring road (in the housing side). This sewer line is not connected to the pump station in this phase. The last manhole (M42) is 23.4m far after the survey station (1+311.6). Layout of inlet pit is designed in Case 2. One outlet ϕ1800 with flap gate is constructed at the manhole M42.

Line BM1 – W2: Section BM1 – W2.1 (from manhole M1 to manhole M14):
In this section, there is another project - fund by HCMC capital – named "Ngang No.3 Canal Bridge – District 8 - HCMC". This project is in FS submit step. Based on the data of this FS, the dimensions of typical cross section is as follows:

- Road along the bridge (in the housing side): 3.5m
- Sidewalk of the road (in the housing side): 2.0m
- Sidewalk on the bridge: 1.8m
- Road on the bridge: 7.0m
- Road along the bridge (in the canal side): 3.5m
- Sidewalk of the road (in the canal side): 2.0m

Therefore, centerline of new sewer ϕ1000 is proposed as follows:

- From manhole M1 to M10: it is under the road along the bridge (in the housing side) and 1.5m far from the right edge of this road.
- From manhole M10 to M14: it is under the existing ring road and 3.0m far from the edge of this road (in the housing side)

Construction of the inlets is proposed as follows:
- From manhole M1 to M4: they are on the sidewalk of both roads along the bridge and connect with the main sewer ϕ1000 mentioned above by the connection pipe ϕ400.
- From manhole M5 to M7: this section has the earth retaining concrete wall, so inlets will be installed:

  (i) In the housing side: 3 inlets are on the sidewalk of the road along the bridge.
  (ii) In the canal side: Centerline of the sewer ϕ400 constructed under the road along the bridge is 0.6m far from the edge of this road. There are 3 manholes above this line and using the cast iron grid cover (Type C) to collect surface water. This line will be connected with the main sewer ϕ1000 at the manhole M7.
- From manhole M7 to M14: they are in both sides of the existing ring road (because the dike is not next to the road and the space in the canal side is rather big, the volume of surface water will be not small). One outlet ϕ1000 with flap gate is constructed at manhole M13.

Line BM1 – W2: Section BM1 – W2.2 (from manhole M14 to manhole M26):
Centerline of new sewer ϕ1200 is 3.0m far from the right edge of existing ring road (in the housing side). The last manhole (M28) is 10.8m far from the foot of Vinh Mau Bridge. Layout of inlet pit is designed in Case 2. One outlet ϕ1200 with flap gate is constructed at the position of manhole M26.

(b) Profile Design: (refer to DWG.No.PB-PDI-BMC1-201 to 218 in Tender Drawings)

Based on (i) the result of hydraulic calculation and (ii) the invert elevation of the existing pipes that will be connected, profile of the objective sewers are designed as follows:

Line BM1-E1:
- At the manhole M1: IE = EL.-0.378m (ϕ1000)
- At the manhole M14: IE = EL.-0.749m (ϕ1000), IE = EL.-0.949m (ϕ1200)
- At the manhole M25: IE = EL.-1.288m (ϕ1200), IE = EL.-1.588m (ϕ1500)
- At the manhole M35: IE = EL.-1.900m (ϕ1500)
- Gradient : 1.0‰

Line BM1-E2:
- At the manhole M1: IE = EL.-0.717m
- At the manhole M25 (BM1-E1.3): IE = EL.-1.200m
- Gradient for ϕ11200: 1.3‰

Line BM1-E3:
- At the manhole M0: IE = EL.-0.163m (ϕ600)
- At the manhole M1: IE = EL.-0.227m (ϕ600), IE = EL.-0.527m (ϕ900)
- At the manhole M6: IE = EL.-0.671m (ϕ900), IE = EL.-1.271m (ϕ1500)
- At the manhole M28: IE = EL.-1.909m (ϕ1500)
- Gradient: 1.0‰

Line BM1-W1:
- At the manhole M1: IE = EL.-0.360m (ϕ900)
- At the manhole M13: IE = EL.-0.545m (ϕ900), IE = EL.-0.845m (ϕ1200)
- At the manhole M28: IE = EL.-1.095m (ϕ1200), IE = EL.-1.695m (ϕ1800)
- At the manhole M42: IE = EL.-1.923m (ϕ1800)
- Gradient: 0.50‰

Line BM1-W2:
- At the manhole M1: IE = EL.-0.705m (ϕ1000)
- At the manhole M14: IE = EL.-1.221m (ϕ1000), IE = EL.-1.421m (ϕ1200)
- At the manhole M26: IE = EL.-1.900m (ϕ1200)
- Gradient: 1.2‰

(3) Design for Structure

- Pipes: Precast centrifugal reinforced concrete Type D - 250KG/cm2.
- Foundation of sewer pipes: Driving wooden piles ϕ80 - ϕ100 with 16trees/m2, L = 4.5m/tree, Cast in situ concrete Type G - 100KG/cm2
- Manholes: Cast in situ reinforced concrete Type E - 210KG/cm2. (refer to DWG. No. PB-PDI-BMC1- 247,248,250, 251 and 251 in Tender Drawings)
- Inlets: Cast in situ reinforced concrete Type E - 210KG/cm2. (refer to DWG. No. PB -PDI-BMC1- 249, 252 and 252 in Tender Drawings)
- Manhole cover\: 147 circle cast iron covers with the load 30 Tons (Type A) and 03 grid cast Iron covers with the load 30 Tons (Type C). (refer to DWG. No. PB-PDI-TD-215 in Tender Drawings)
- Inlet cover: 180 square concrete cover with the load 6 Tons (Type D) and water trap. (refer to DWG. No.PB-PDI-TD-216 in Tender Drawings)

(4) Installation of Flap Gates at Outlets in Ben Me Coc (1) Area :

In order to mitigate external flood caused by high tide, the construction of the new outlets with flap gate as few ad possible are designed. Because it is very important to integrate the existing many small outlets without any flap gate in order to avoid the external flood risk.

10 new reinforced concrete outlets with flap gates are planned to construct at the most appropriate location, which is the last manhole of every type diameter calculation sections.

Main features of outlets in Ben Me Coc (1) are shown in the table below:

SECTION	POSITION	DIAMETER (mm)	INSIDE BOTTOM ELEVATION (m)
E1	M9	1000	-0.623
	M25	1200	-1.292
	Mps	1500	-1.900
E3	M6	900	-0.679
	M27	1500	-1.903
W1	M8	900	-0.474
	M28	1200	-1.101
	M42	1800	-1.925
W2	M13	1000	-1.194
	M26	1200	-1.914

The material of flap valves is the same as that in Thanh Da area. (refer to Section 3.4.4.(4).

(5) Construction method: using machine in combination with manual.

Construction method of sewer line in Ben Me Coc (1) is same as that in Thanh Da area. (refer to Section 3.4.5, (4))

3.4.6 Sewer Line in Ben Me Coc (2) Area

(1) Design Parameters:

Main features of sewers in Ben Me Coc (2) area are shown in the table below:

Catchment			Sewer Dimension			Hydraulic Property		Sewer Invert Elevation (IE)	
Name	Name of Sub -catchment	Area (ha)	Length (m)	Diameter (mm)	Slope (‰)	Velocity (m/s)	Discharge (m3/s)	Upstream (m)	Downstream (m)
BM2 – N1	BM2– N1.1	4.21	581	1000	1.1	1.0	0.8	-0.484	-1.123
	BM2 – N1.2	2.62	225	800	1.4	1.0	0.5	-0.630	-0.824
	BM2 – N1.3	8.46	219	1500	1.1	1.2	1.8	-1.623	-1.864
	BM2 – N1.4	2.96	207	900	1.2	1.0	0.6	-0.614	-0.860
	BM2 – N1.5	12.04	78	1500	1.1	1.3	2.3	-1.864	-1.950
BM2 – N2	BM2 – N2.1	3.66	344	900	1.1	1.0	0.6	-0.381	-0.759
	BM2 – N2.2	8.34	370	1200	1.1	1.2	1.3	-1.059	-1.453
	BM2 – N2.3	11.95	178	1500	1.1	1.3	2.4	-1.753	-1.949
	BM2 – N2.4	-	50	400	2.0	0.7	0.1	-0.250	-0.350
BM2 – S1	BM2 – S1.1	4.71	544	1000	0.5	0.7	0.5	-0.426	-0.698
	BM2 – S1.3	4.29	128	1000	1.2	1.0	0.8	-0.546	-0.697
	BM2 – S1.4	10.42	252	1500	0.5	0.9	1.6	-1.198	-1.323
	BM2 – S1.5	2.39	168	800	1.5	1.0	0.5	-0.419	-0.623
	BM2 – S1.6	13.90	155	1800	0.5	1.0	2.6	-1.623	-1.700
BM2 – S2	BM2 – S2.1	4.54	330	1000	0.9	0.9	0.7	-0.460	-0.757
	BM2 – S2.2	8.06	159	1500	0.9	1.2	2.1	-1.257	-1.400

(2) Design for Layout, Profile of Sewer Line:

(a) Layout Design: (refer to DWG.No.PB-PDI-BMC2-201 to 217 in Tender Drawings)

Based on (i) the position of the existing facilities (electric cables, telephone cables, water supply pipes), (ii) the excavation trench needed, and (iii) the position of temporary dike, layout of every sewer lines in Ben Me Coc (2) is designed the same general principle of Ben Me Coc (1).

Layout of inlets:
Inlets have two functions: collect the storm water and wastewater from households. So, the distance of inlets is about 30m – 40m. There are 2 cases, as shown in Fig.3.5:

Case 1: Construct the inlets in both side of the ring road when the dike is not next to the road and the space in the canal side is rather big, the volume of surface water is not small. They are connected with the manholes by the pipes ϕ400 (or ϕ600) if inlet is installed at the intersection of this ring road and the small inner road).

Case 2: Construct the inlets in one side of the ring road (in the housing side) because the temporary dike is next to or nearly next to the edge of the ring road, and connect them into the manholes by the pipes ϕ400 or ϕ600 if inlet is installed at the intersection of this ring road and the small inner road).

Layout of manholes:
Manholes are located at the positions of connection pipes from the inlets in order to be easy to maintain and connect with the inlets.

Layout of outlets:
There are 09 outlets with flap gate, which are constructed at the last manhole of every type diameter calculation sections. The positions of outlets are next to the existing bank of canal. All the small existing outlets shall be closed by cast in situ concrete wall (type F – 210 KG/cm2).

LIST OF OUTLETS IN BEN ME COC (2)

Section	Location	Diameter (mm)	Inside Bottom Elevation (m)
S1	M10	1000	-0,595
	M19	1500	-1.242
	M30	1800	-1.708
S2	M11	1000	-0.746
N1	M15	1000	-0.967
	M29	1500	-1.964
N2	M7	900	-0.617
	M23	1200	-1.470
	M28	1500	-1.962

Layout of centerline of pipe for each section is as follow:

Line BM2 – N1: Section BM2 – N1.1 (from manhole M1 to manhole M20):
Centerline of new sewer ϕ1000 is 1.8m far from the left edge of existing ring road (in the canal side). The start point of this line is survey station (0+000). Layout of inlets is designed in Case 1 (two inlet pits at both side of the road). One outlet ϕ1000 with flap gate is constructed at the manhole M15.

Section BM2 – N1.3, N1.5 (from manhole M21 to manhole M29):
Centerline of new sewer ϕ1000 is 1.8m far from the left edge of existing ring road (in the canal side). The last manhole is 22m far from the survey station 0+900. Layout of inlets is designed in Case 1. One outlet ϕ1500 with flap gate is constructed at the manhole M29.

Line BM2 – N1.2 (from manhole M1 to manhole M7):
Centerline of new sewer ϕ800 is 1.5 m far from the right edge of existing road. The start point is 17m far after the survey station 0+000. The last manhole is connected with manhole M20 of section BM2 – N1.5. Layout of inlets is designed in Case 1.

Line BM2 – N1.4 (from manhole M1 to manhole M7):
Centerline of new sewer ϕ900 is 2.0 m far from the right edge of existing road. The start point is 2.5m far after the survey station 0+000. The last manhole is connected with manhole M27 of section BM2 – N1.5. Layout of inlets is designed in Case 1.

Line BM2 – N2: Section BM2 – N2.1 (from manhole M1 to manhole M11):
Centerline of new sewer ϕ900 is 1.5m far from the right edge of existing ring road (in the canal side). The start point is 7.0m far after the survey station 0+000. Layout of inlets is designed in Case 2. One outlet ϕ900 with flap gate is constructed at the position of manhole M7.

Line BM2 – N2, Section BM2 – N2.2 (from manhole M12 to manhole M23):
In this section, there is another project - fund by HCMC capital – named "Ngang No.3 Canal Bridge – District 8 - HCMC". This project is in FS submit step. Based on the data of this FS, the dimensions of typical cross section is as follow:

- Road along the bridge (in the housing side): 3.5m
- Sidewalk of the road (in the housing side): 2.0m
- Sidewalk on the bridge: 1.8m
- Road on the bridge: 7.0m
- Road along the bridge (in the canal side): 3.5m
- Sidewalk of the road (in the canal side): 2.0m

Therefore, centerline of new sewer ϕ1200 is proposed under the road along the bridge (in the housing side) and 1.5m far from the right edge of this road.

There are 12 manholes in the bridge section that use the circle cast iron cover with the load 30 Tons (Type A). The distance between manholes is average 30m – 40m in order to be easy for maintain and connect with the inlets. Installation of the inlets is proposed as follow:

From manhole M12 to M17 and from manhole M20 to M23: They are on the sidewalk of both roads along the bridge and connect with the main sewer ϕ1000 mentioned above by the connection pipe ϕ400.

From manhole M18 to M19: This section has retaining concrete wall, so inlets can be installed:

- In the housing side: Two inlets are on the sidewalk of the road along the bridge.
- In the canal side: Install the sewer ϕ400 under the road along the bridge and this centerline is 0.6m far from the edge of this road. There are 3 manholes above this line and using the cast iron grid cover (Type C) to collect surface water. This line will be connected with the main sewer ϕ1000 at the manhole M19.

One outlet ϕ1200 with flap gate is constructed at manhole M23.

Line BM2 – N2, Section BM2 – N2.3 (from manhole M24 to manhole M28):
Centerline of new sewer ϕ1500 is located at 1.8m far from the right edge of existing ring road (in the canal side). Layout of inlets is designed in Case 1. One outlet ϕ1500 with flap gate is constructed at manhole M28.

Line BM2 – S1: Section BM2 – S1.1 (from manhole M1 to manhole M18):
Centerline of new sewer ϕ1000 is 3.0m far from the left edge of existing ring road (in the housing side). The start point of this line is the same position of the survey station 0+000. Layout of inlets is designed in Case 2. One outlet ϕ1000 with flap gate is constructed at manhole M10.

Line BM2 – S1: Section BM2 – S1.2 (from manhole M18 to manhole M26):
Centerline of new sewer ϕ1500 is 3.0m far from the left edge of existing ring road (in the housing side). Layout of inlets is designed in Case 2. One outlet ϕ1500 with flap gate is constructed at manhole M19.

Line BM2 – S1: Section BM2 – S1.6 (from manhole M26 to manhole M31):
Centerline of new sewer ϕ1800 is 3.0m far from the left edge of existing ring road (in the housing side). Layout of inlets is designed in Case 2. One outlet ϕ1500 with flap gate is constructed at manhole M30.

Line BM2 – S1.3 (from manhole M1 to manhole M4):
Centerline of new sewer ϕ1000 is 2.0 m far from the left edge of existing road. The start point is the same position of the survey station 0+000. The last manhole is connected with manhole M18 of section BM2 – S1.4. Layout of inlets is designed in Case 1.

Line BM2 – S1.5 (from manhole M1 to manhole M7):
Centerline of new sewer ϕ800 is 2.0 m far from the left edge of existing road. The start point is 31m far after the survey station 0+000. The last manhole is connected with manhole M26 of section BM2 – S1.6. Layout of inlets is designed in Case 1.

Line BM2 – S2: Section BM2 – S2.1 (from manhole M1 to manhole M12):
Centerline of new sewer ϕ1000 is 3.0m far from the left edge of existing ring road (in the housing side). The start point of this line is 19m far after the survey station 0+000. Layout of inlets is designed in Case 2. One outlet ϕ1000 with flap gate is constructed at manhole M11.

Line BM2 – S2: Section BM2 – S2.2 (from manhole M13 to manhole M16):
Centerline of new sewer ϕ1500 is 3.0m far from the left edge of existing ring road (in the housing side). Layout of inlets is designed in Case 2.

(b) Profile Design: (refer to DWG.No.PB-PDI-BMC2-201 to 217 in Tender Drawings)

Based on (i) the design hydraulic calculation, (ii) the invert elevation of the existing pipes that will be connected and (iii) the existing ground elevation, profile of sewers are designed as follows:

Line BM2-N1:
- At the manhole M1: IE = -0.484 (ϕ1000)
- At the manhole M20: IE = -1.123 (ϕ1000), IE = -1.623 (ϕ1500)
- At the manhole M29: IE = -1.950 (ϕ1500)
- Gradient: 1.1‰

Line BM2-N2
- At the manhole M1: IE = -0.381 (ϕ900)
- At the manhole M11: IE = -0.759 (ϕ900), IE = -1.059 (ϕ1200)
- At the manhole M23: IE = -1.453 (ϕ1200), IE = -1.753 (ϕ1500)
- At the manhole M28: IE = -1.950 (ϕ1500)
- Gradient: 1.1‰

Line BM2-S1 :
- At the manhole M1: IE = -0.426 (ϕ1000)
- At the manhole M18: IE = -0.698 (ϕ1000) IE = -1.198 (ϕ1500)
- At the manhole M26: IE = -1.323 (ϕ1500), IE = -1.623 (ϕ1800)
- At the manhole M31: IE = -1.700 (ϕ1800)
- Gradient: 0.5‰

Line BM2-S2:
- At the manhole M1: IE = -0.460 (ϕ1000)
- At the manhole M12: IE = -0.757 (ϕ1000), IE = -1.257 (ϕ1500)
- At the manhole M17 (31): IE = -1.400 (ϕ1500)
- Gradient: 0.90‰

Line BM2-N1.2:
- At the manhole M1: IE = -0.630 (ϕ800)
- At the manhole M8 (20): IE = -0.923 (ϕ800)
- Gradient: 1.4‰

Line BM2-N1.4:
- At the manhole M1: IE = -0.612 (ϕ900)
- At the manhole M8 (27): IE = -0.860 (ϕ900)
- Gradient: 1.2‰

Line BM2-S1.3:
- At the manhole M1: IE = -0.546 (ϕ1000)

- At the manhole M5 (18): IE = -0.697 (ϕ1000)
- Gradient: 1.2‰

Line BM2-S1.5:
- At the manhole M1: IE = -0.419 (ϕ800)
- At the manhole M5 (26): IE = -0.623 (ϕ800)
- Gradient: 1.5‰

(3) Design for Structure

- Pipes: Precast centrifugal reinforced concrete Type D – 250kg/cm2.
- Foundation of sewer pipes: Driving wooden piles ϕ80- ϕ100 with 16trees/m2, L = 4.5m/tree, Cast in situ concrete Type G – 100kg/cm2
- Manholes: Cast in situ reinforced concrete Type E – 210kg/cm2. Dimensions of manholes refer to DWG. No.PB-PDI-BMC2-240, 241, 243 and 244)
- Inlets: Cast in situ reinforced concrete Type E – 210kg/cm2. Dimensions of manholes refer to DWG. No.PB-PDI-BMC2-242 and 245)
- Manhole cover: 126 circle cast iron covers with the load 30 Tons (Type A) and 03 grid cast Iron covers with the load 30 Tons (Type C) (refer to DWG. No. PB- PDI -TD-215 in Tender Drawings)
- Inlet cover: 176 square concrete covers with the load 6 Tons (Type D) and water trap (refer to DWG. No.PB-PDI-TD-216 in Tender Drawings)

(4) Installation of Flap Gates at the Outlets in Ben Me Coc (2) Area :

As shown in Ben Me Coc (1), 9 new reinforced concrete outlets with flap gate are designed to construct at the most appropriate location, which are shown in Fig. 3.1.

Main features of outlets in Ben Me Coc (2) is as follows :

SECTION	POSITION	DIAMETER (mm)	INSIDE BOTTOM ELEVATION (m)
S1	M10	1000	-0,595
	M19	1500	-1.242
	M30	1800	-1.708
S2	M11	1000	-0.746
N1	M15	1000	-0.967
	M29	1500	-1.964
N2	M7	900	-0.617
	M23	1200	-1.470
	M28	1500	-1.962

The material of flap valves is the same as that in Thanh Da area. (refer to Section 3.4.4.(4).

(5) Construction method: using machine in combination with manual.

Construction method of sewer line in Ben Me Coc (2) is the same as that of Thanh Da. (refer to 3.4.4, (3))

3.5 Road Construction

3.5.1 General

As mentioned in the previous Section, under some local roads in Thanh Da and the ring roads in Ben Me Coc (1) and (2) areas, new sewer pipes will be constructed to improve drainage condition of the areas. There is, however, no sufficient collection system of rainwater along these roads, so not only re-pavement but also new road design will be necessary to install the inlet pit at both sides of the road. Number of road section and its total length to be designed is as follows:

- Than da area: 5 sections, L = 550m
- Ben Me Coc (1) area: 6 sections of ring road, L = 3,500m
- Ben Me Coc (2) area: 6 sections of ring road, L = 4,000m

Classification of road system in Thanh Da and Me Coc (1) and (2) is “Local Street”.

3.5.2 Applicable Codes and Standards

The following Codes and Standard of Vietnam are applied in this road design:

- 20 TCN 104-83 “Standard for Urban Highway Design” approved by Ministry of Construction, (MOC)
- TCVN 4054-98 “Standard for Rural Highway Design” approved by Ministry of Transportation, (MOT)
- 22 TCN 211-93 “Standard for Flexible Pavement Design” approved by MOT
- TCVN 2201-1993 “Soil for Construction – Testing method for compacting index in laboratory” approved by MOC
- 22 TCN 249-98 “Specification for asphalt concrete construction, hot laid“ approved by MOT
- A policy on Geometric Design of Highways and Streets – AASHTO 1990
- Guide for Design of Pavement Structures – AASHTO 1986
- Standard specification for transportation materials and methods of sampling and testing. AASHTO 1990

3.5.3 Design Condition and Criteria

According to 20 TCN 104-83, objective roads in Thanh Da, Ben Me Coc (1) and Ben Me Coc (2) areas are classified into "Local Street", which composes of the following design parameters:

(1) Basic Design Parameters.

- Design load for pavement: Axle load: 12 ton
  Tire pressure: 6 Kg/cm2
  Diameter of tire mark: 36 cm
- Design Traffic Volume (H10): 100 vehicle/Day
- Design speed: 60 Km/h
- Pavement structure: Type P3

(2) Basic Design Geometric Parameters

Basic design geometric parameters by each road in Thanh Da, Ben Me Coc (1) and (2) areas are shown in the table below:

Basic Design Geometric Parameters	Thanh Da	Ben Me Coc (1)	Ben Me Coc (2)
Existing Pavement Level (m)	1.30-1.50	1.10-1.90	1.00-1.80
MWL (Maximum water level) (m)	1.46	1.50	1.50
Top Design Level of Dike (m)	2.00	2.00	2.00
Wide of existing pavement (m)	4.00-4.80	4.00-7.50	4.50-5.50
Design wide of pavement (m)	4.00-4.80	6.00	6.00
Type of Typical Cross Section	S2, S3	S1, S2	S1, S2
Total Length of Roads (m)	709	4055	4197
Profile slop	0.001-0.004	0.001-0.004	0.001-0.004

Details are shown in No PB-PDI-TD-219 for Thanh Da, No PB-PDI-BMC1-253 for Ben Me Coc (1), and No PB-PDI-BMC2-246 for Ben Me Coc (2).

(3) Geological Condition

In general, geological condition of sub-soil in Thanh Da, Me Coc (1) and (2) areas are similar as shown in the Tender Drawings No. PB-PDI-G-104.

(a) Thanh Da Area

According to the soil investigation data of borehole number DSP-01 in Thanh Da (Aug-2000), geological characteristics of sub-soil is as following:

SUBSOIL CHARACTERISTICS IN THANH DA AREA

Properties	*Unit*	*Layer2*	*Layer4*	*Layer4a*	*Layer5*
Thickness of layer	m	2.0-4.2	2.8-5.0	33.7-42.2	>7.8
Wet density (γ_w)	g/cm^3	1.404	2.065	2.063	1.987
Unconfined compressive strength (q_u)	Kg/cm^2	0.119	0.448	0.405	1.395
Compression index, (Cc)	cm^2/kg	1.3397	0.100	0.131	0.196
Coefficient of consolidation, (C_y)	cm^2/s	$2.78*10^{-4}$	$1.39*10^{-4}$	$7.89*10^{-4}$	$7.25*10^{-4}$
Coefficient of volume compressibility (m_v)	cm^2/g	$8.01*10^{-5}$	$4.50*10^{-5}$	$6.22*10^{-5}$	$2.64*10^{-5}$
Standard penetration resistance (SPT, N)	Blow	0 - 1	9 - 10	10 - 20	36 - 46

Note: - Layer 1: right on surface, thickness is from 0.50 to 1.50m

Properties of layers 2, 4, 4a, 5 are following:

- Layer 2: Blackish gray, Organic Clay (OH), - Layer 4: Greenish grey, Clayey Sand (SC)
- Layer 4a: Yellowish grey, Silty Sand (SM), - Layer 5: Clay (CH)

(b) Ben Me Coc Area

Reference data of borehole number DUB-01 in Me Coc area (June-2000) is as following:

SUBSOIL CHARACTERISTICS IN BEN ME COC AREA

Properties	Unit	Layer 2	Layer 3	Layer3a	Layer4
Thickness of layer	m	14.0-15.2	21.0-36.0	3.6-39.6	4.0-43.6
Wet density (γ_w)	g/cm^3	1.471	1.582	1.647	2.051
Unconfined compressive strength, (q_u)	Kg/cm^2	0.112	0.235		
Compression index, (Cc)	cm^2/Kg	1.327	1.251		
Coefficient of consolidation, (Cv)	cm^2/s	$3.64*10^{-4}$	$3.04*10^{-4}$		
Coefficient of volume compressibility (m_v)	cm^2/g	$1.13*10^{-4}$	$7.59*10^{-5}$		
Standard penetration resistance (SPT, N)	Blow	0 - 1	2 - 3		

Note: - Layer 1: right on surface, thickness is 1.00m .

Properties of layers 2, 3, 3a, 4 are following:

- Layer 2: Blackish grey, Organic Clay (OH), - Layer 3: Blackish grey, Organic Clay (OH)
- Layer 3a: Blackish grey, Sandy Clay (CL), - Layer 4: Silty Sand (SM)

3.5.4 Design Layout, Profile and Cross Section of Proposed Road

(1) Layout

Most of objective roads in Thanh Da area are too narrow from 4.0 to 4.8m in width and many houses exit along both sides of the road. There are some road sections to be installed the new sewers and manholes with inlet at centerline of the road. Thus, road restoration works are designed for the whole width of existing road to improve rainwater collection system.

In Ben Me Coc (1) and (2) areas, the existing road width is only about 5.0m, however, there is some space to expand the existing road. According to UPI road plan, the existing ring road in Ben Me Coc (1) and (2) is proposed to expand 12.0m roadway with 4.0m

sidewalk at both side in future. In this project, it is proposed to expand the existing road providing with 6.0m roadway for installation of trunk sewers and sidewalk to install inlet pit, due consideration of the following view points:

(a) To construct sufficient rainwater collection and drain system.
(b) To increase the existing road width as much as possible, however it should be conducted without any house relocation

(2) Profile Slope

According to "Standard for Urban Highway Design 20 TCN 104-83" approved by Ministry of Construction, minimum profile slop of roads is prescribed at 0.4%. However, the existing roads in the areas are likely flat and these profile slopes are 0.0 – 0.2% only. Therefore, profile slop is designed at 0.1 - 0.4% to preserve sufficient drainage condition.

(3) Cross Section (refer to Fig.3.6)

Based on the collection system of rainwater, the following three types of typical road cross sections are designed for the roadway of 4.0 – 4.8m in Thanh Da and of 6.0m in Ben Me Coc (1) and (2) areas:

(a) Type S1: This is the most typical cross section. Usually, this type is applied for road construction. Cross section slope of 2.0% is designed from the center to both sides of the roadway. In this type, inlet pit is provided at both sides of the road.

(b) Type S2: This type is applied for the specific road section of very narrow road in Thanh Da and of ring road connecting directly with O/M space along the canal in Ben Me Coc areas. Cross section slope is also 2%. In this type, inlet pit is constructed at only edge (housing side) of roadway.

(c) Type S3: This type is also applied to the specific section of very narrow road in Thanh Da area. Cross section is 2% from both roadway edges to road center. In this type, inlet pit and manhole are constructed at the center of the roadway.

Finally, very narrow roads in Thanh Da area are employed Type S2 and S3 and the ring road in Ben Me Coc (1) and (2) areas are applied Type S1 and S2.

Detailed design drawings of road construction in three areas are shown on DWG. No. PB-PDI-TD-202 to 205, PB-PDI-BMC1-201 to 218, and PB-PDI-BMC2-201 to 217 in Volume III Tender Drawings.

3.5.5 Pavement Structure and Concrete Curb

(1) Pavement structure

It is proposed to apply the flexible type of road pavement, asphalt concrete pavement, taking into consideration of assumed a traffic volume of 100 vehicleH10/day and a demand elastic modulus (Eyc) of 1,600kg/cm^2. Pavement structure of Type P3 is as following:

- 5cm Wearing course: Asphalt concrete with small size gravel
- Emulsified asphalt: Tack coat 0.2~0.7 l/m2
- 5cm Binder course: Asphalt concrete with middle size gravel
- Emulsified asphalt Prime coat 1.0~2.0 l/m2
- 19cm Base course: crush aggregate (size 2~4 cm)
- 20cm Sub-base course, aggregate (size 4~6 cm)

Total thickness of pavement is designed to be 49 cm. The proposed pavement structure is shown in Fig. 3.6.

(2) Concrete Curb

Both sides of asphalt concrete pavement are connected with concrete curve with 180W x 210H, which is constructed by cast-in-situ concrete (Concrete Type E). Top elevation of curb is 15cm higher than that of pavement surface.

3.6 Civil Works of Pumping Station and Other Structures

3.6.1 General

In Definitive Plan, most appropriate main mechanical equipment in pumping station, sluiceway and control gate, such as pump equipment, bar screen, sluice gate and flap gate, were selected. Then, based on the preliminary design of mechanical equipment, civil structures, such as inlet pit, pump pit, discharge basin, sluice way, etc. were also preliminarily designed

In this Detailed Design stage, structural calculation for each civil structure is carried out to decide the most economical structural section and bar arrangement. Finally, the Tender Drawings, Bill of Quantity and Technical Specification are prepared

3.6.2 Applicable Codes and Standards

The following Codes and Standard are applicable for the design of pumping station and other civil structures.

1. Design Standards of Exterior and Project Drainage Network No. 20 TNC-51-84:

Ministry of Construction, Viet Nam Government
2. Manual for River Works in Japan: Published by River Bureau, Ministry of Construction, Japan
3. Standard Specification for Design and Construction of Concrete Structures, 1996, The Japan Society of Civil Engineering
4. Structural Design Index (Japan Sewage Works Agency 1998)
5. Specification for Highway Bridges: Part 4 (Japan Road Association 1990)
6. Temporary Structure Index for Earth Works of Road (Japan Road Association 1990)
7. Temporary Structure Design Index (Japan Sewage Works Agency 1998)

3.6.3 Design Condition and Criteria

(1) Hydrological Condition

Design water levels (DHHWL, DHWL, DLWL) at Thanh Da and Ben Me Coc (1) pumping station are as follows:

Canal	DHHWL (m)	DHWL (m)	DLWL (m)
Thanh Da P.S.	+1.54	+1.32	-2.11
Ben Me Coc (1) P.S.	+1.54	+1.50	-1.86

Note: 1. DHHWL: Design highest high water level (recorded historical maximum water level at Phu An station at Saigon River)
2. DHWL: Design high water level (Average of monthly maximum water levels for the month August and November)
3. DLWL: Design low water level (Average of annual minimum water level)

(2) Geological Condition

Geological condition at Thanh Da and Ben Me Coc (1) pumping station are mentioned in the previous section of 3.3.3, (3) Geological Condition of Dike Construction and 3.5.3, (3) Geological Condition of Road Construction.

(3) Structural design Criteria

(a) Allowable Stress

Concrete

Item \ Concrete Type	Concrete Type D	Concrete Type E	Concrete Type F	Concrete Type G
28-day compressive strength by cylinder test (300mmx150mm dia.)	250	210	180	100
Bending compressive stress (σca)	83.3	70	60	-
Shearing stress (τca)	4.0	3.6	3.3	-

Note: 1. Unit: kg/cm^2
2. Concrete Type D: Precast concrete, Concrete Type E: Reinforced concrete
Concrete Type F: Plain concrete, Concrete Type G: Leveling concrete

Reinforcing Bar

Reinforcing Bar	Deformed Bar
Tensile and compressive stress (τca)	1,600 kg/cm^2

(b) Design Loads, Earth Pressure and Others

Unit weight
- Soil: upper ground water: $\gamma = 1.8$ t/m^3,
lower ground water: $\gamma = 0.8$ t/m^3
- Ground water: $w = 1.0$ t/m^3
- Concrete: $\gamma = 2.4$ t/m^3
- Live load: $w = 0.5$ t/m^2
- Traffic load: H-30 ($w = 1.0$ t/m^2)

Dynamic load of mechanical equipment
- Main pump: ϕ400, including column, water, and some allowance: 2.16 ton/unit
- Flap valve (force occurred at valve closing): 1.1 ton/unit

Earth pressure: P = (vertical soil load) x Ko,
(Ko: earth pressure at rest = 0.5)
Horizontal load pressure: Pv = (vertical load) x Ko
Ground water pressure: Pw =1.0 t/m^3 x h (m)
h = depth from ground water level

Other structural design condition and parameters are described on structural design calculation paper in Volume IV Data Book.

3.6.4 Civil Works of Pumping Station, Sluice Way and Control Gate

(1) Thanh Da Pumping Station (refer to Fig. 3.7 to 3.9)

Detailed design of Thanh Da pumping station is conducted for pump capacity of 42.0 m^3/min., which is the future requirement in 2020, because of fully developed area.

General layout of the pumping station and main features of each component of the facilities are summarized below:

(a) General Layout of Pumping Station

Thanh Da pumping station consists of two inlet pits, pump pit, connection box culvert, discharge basin , sluice way, O/M office and related structures. As shown in Fig. 3.7, location of most of structures is designed at built up area (EL.+1.40 to EL.+1.50m), in which dozens of illegal house exist and these houses will be relocated before construction. Pumping station is located at almost center between the retarding pond in Thanh Da Park and Saigon River and is designed to connect with them by connection box culvert and sluice way respectively. O/M office is designed at eastern edge of the site and small park is designed at southern part of the site.

(b) Inlet Pit

Two inlet pits are designed to drain stormwater and wastewater from the combined sewer network into pump pit. The pits are constructed to connect with east and west wall of pump pit. East and west pits are connected with sewer pipe of ϕ1,000mm and ϕ1,200mm diameter respectively, which serve the drainage from the eastern and western part of the basin. These pits are designed to install a automatic steel sluice gate, which are usually closed and opened before the pump operation. Main features of the inlet pits are as follows:

Inlet Pit	Outside Structure Dimension (mm)	Sewer Pipe (mm)	Sluice Gate (mm)
East Pit	2,350W x 3,300L x 3,450H	ϕ1,000mm	1,000W x 1,000H
West Pit	1,250W x 2,300L x 3,550H	ϕ1,200mm	1,200W x 1,200H

(c) Pump Pit

The pump pit is a key reinforced concrete structure to install bar screen for removal of trash and main pump equipment of ϕ400mm diameter x 2 units submergible motor pump. The pump pit is designed to have sufficient width of 5.20m, depth from 3.10m to 4.10m and length of 9.80m to control small hydraulic loss for pump operation and to acquire enough space for gravity discharge channel. Top elevation of pump floor is designed at EL.+1.60m. Bottom elevation of pump pit is designed from EL.-1.50m to EL.-2.50m, which is deeper than three times of pump bore (1.20m) from the emergency pump stop elevation of EL.–1.30m. As bearing capacity of subsoil is not enough for spread foundation, the pump pit is supported by precast reinforce concrete pile of 300mm x 300mm in section and 24.0m in total length. No pump house is designed, because all mechanical and electrical equipment are designed in outdoor type with due consideration of economic point of view.

(d) Connection Box Culvert

Pump pit is designed to connect with retarding pond located in Thanh Da Park by this connection box culvert. The connection box culvert serves to convey surplus inflow of stormwater in pump pit to the retarding pond and to return again the temporary storage rainwater in the retarding pond to the pump pit, after decreasing of inflow to the pump pit. Connection box culvert is a reinforced concrete structure of 1,400mmW x 1,400mm H x 27,000mmL. Bed elevation of box culvert is designed at EL.-1.50m, which is the same elevation as upper one of pump pit. At connection with retarding pond, connection pit with bar trash screen is designed. Its outside dimension is 3,500W x 3,500L x 3,650H. Connection box culvert and connection pit are supported with wooden pile of ϕ80 – ϕ100 dia., 4,500mm long and 25 piles/m^2.

(e) Discharge Basin

Discharge basin is connected with pump pit and is likely a reinforced concrete water tank having an internal size of 1,800W x 5,200L x 3,700H. It serves to momentarily storage storm water pumped up from pump pit and to smoothly convey them to the sluice way. Top elevation of the discharge basin is EL.2.20m, which is 20cm higher than that of the existing dike. Discharge basin has two sewer outlets with flap gate (ϕ1,000, ϕ1,200)and one outlet with manual sluice gate (1,400W x 1,400H), which connects with the retarding pond through the box culvert of 1,400W x 1,400 H. Discharge basin is supported by precast RC concrete pile of 300W x 300H in section and 24m in total length.

(f) Sluice way

Sluice way connecting between discharge basin and Saigon River has two function. First is to drain pumped water into Saigon River during pump operation in high tide season. Second is to convey clean river water to the retarding pond and to change the polluted water in the pond during dry season. The sluice way having a manual steel sluice gate of 1,400W x 1.400H at its outlet is designed to be reinforced concrete box culvert for 1.400W x 1,400H in section and 38.80m long excluding outlet U-channel of 5.50m. Saigon River bed around the outlet channel is planned to protect by rip rap of 250 – 300mm diameter with thickness of 0.50m from scoring. Sluice way and outlet structure are supported by wooden piles of 80 – 100mm diameter, 4.50m long and 25 piles/m^2.

(2) Ben Me Coc (1) Pumping Station (refer to Fig. 3.10 to 3.12)

Detailed design of Ben Me Coc (1) pumping station is carried out for pump capacity of 42.0m^3/min. in Phase I program. This pumping station is constructed for pump drainage of eastern part of Ben Me Coc (1) area (A = 32.6ha). General layout of the pumping station and main features of each component of the facilities are summarized below:

(a) General Layout of Pumping Station with Sluice Way

Ben Me Coc (1) pumping station consists of inlet pit, pump pit, discharge basin, sluice way, O/M office and other related structures. As shown in Fig.3.10, These structures are deigned to locate on the filled up land (EL.+1.80m) at southern edge of the existing pond, taking into consideration of the building restriction boundary line for future road construction, which is 10m far from the centerline of existing ring road to the north. Sluice way connecting with pumping station and Doi Canal crosses at right angle with the existing ring road. O/M office is planned at eastern edge of the filled up land.

(b) Inlet Pit

Inlet pit drains storm water from the sewer pipe of ϕ1,500mm diameter into the retarding pond. The inlet pit connecting with pumping station is constructed with reinforced concrete and designed to install an automatic sluice gate of 1,400W x 1,400H, which is usually closed and opened before pump operation in high tide season. External dimension of the pit is designed to be 2,000W x 3,000L x 4,300H. The pit is supported by reinforced concrete pile of 300mm x 300mm in section and 44.0m long.

(c) Pump Pit

The pump pit is a reinforced concrete substructure to provide a steel bar trash screen and main pump equipment of ϕ400mm diameter submergible motor pump. The pump pit is designed to have sufficient width of 2.6m (more than three times of pump bore), depth from3.60 to 4.3m and length of 8.1m to keep low hydraulic loss during pump operation. Top elevation of pump floor is designed EL.+1.80m. Bottom elevation of pump pit is designed at EL.-2.72m, which is to be deeper than three times of the pump bore from the pump stop level of EL.-1.10m. The pump pit is supported by precast reinforced concrete pile of 300mm x 300mm in section and 44.0m long.

(d) Pump House

No pump house is designed, because all mechanical and electrical equipment are designed in outdoor type with due consideration of economic point of view.

(e) Discharge Basin

Discharge basin connected with the pump pit has function to smoothly convey pumped water to the sluice way. Top elevation of the discharge basin is designed at the same elevation of EL.+2.00m as that of temporary dike. The discharge basin has outlet provided with sluice gate of 2,000W x 2,000H to be able to change from pump discharge to gravity discharge during low tide by opening the gate. The precast reinforced concrete

piles having the same dimension as that of pump pit support the discharge basin.

(f) Sluice Way

A function of sluice way is to drain pumped water directly into Doi Canal. The sluice way providing a steel sluice gate of 2,000W x 2,000H at its outlet is designed to be reinforced concrete box culvert running through the temporary flood dike. Inner section of box culvert is designed to be 2.00m wide and 2.00m high considering the maximum discharge velocity of 2.0m/s (maximum design discharge is 8.0m^3/s). Total length of sluice way is designed to be 27.00m including outlet wall. Canal bed in front of outlet is protected by rip rap of 250 – 300mm diameter from scoring. Sluice way is designed to support by wooden pile of 80 –100mm diameter, 4.50m long and 25 piles/m^2.

(3) Ben Me Coc (1) Control Gate (refer to Fig.3.10 and 3.13)

Ben Me Coc (1) control gate connecting with the retarding pond, Lo Gom Canal and sewers constructed under the ring road is designed. Main purpose of the control gate is to control the discharge of pond water by two sluice gates (1,500W x 1,800H) and inflow of storm water from sewers (Phase I: 1,400W x 1,400H, Phase II: 1,100W x 1,100H). The control gate consists of sluice way with two sluice gates of 1,500W x 1,800H and two inlet pits with flap gate of 1,400W x 1,400H(Phase I) and 1,100W x 1,100H (Phase II) each, which connect with sewer of ϕ1,500mm and ϕ1,200mm diameter each. The control gate is designed to support by wooden piles of 80 –100mm diameter, 4.50m high and 25piles/m^2.

Both banks of the connection channel from control gate to Lo Gom Canal (L = 15.25m) and control gate to retarding pond (L = 20.30m) shall be rehabilitated and protected by stone masonry lined with 1:0.5 to 1:1.5 slope, of which concrete foundation is supported by wooden piles having the same dimension as foundation pile of control gate. Bottom of the connection channel is protected by rip rap of 250 to 300 diameter with thickness of 300mm.

General layout and detailed drawing of control gate are shown in Fig.3.10 and PB-PDI-BMCI-259 to 264 compiled in Volume III Tender Drawings respectively.

3.6.5 Retarding Pond

(1) Thanh Da Retarding Pond

The existing pond in Thanh Da Park is proposed to employ as retarding pond for Thanh Da pumping station to reduce the requirement of pump capacity and to economize the pump drainage cost. In order to acquire the storage requirement of 4,200m^3, existing pond bed, of which elevation is surveyed to be from EL.-0.60m to EL.-1.00m, shall be

excavated up to EL.-1.50m. The maximum excavation depth is about 0.90m only. Existing bank around the pond is protected by stone masonry constructed in May 2000. So, after drying up of the pond, additional revetment with stone masonry of maximum 0.90m high shall be constructed at about 1.00m in front of the foot of existing stone masonry revetment. The footing of the additional revetment is designed to support by wooden pile of 80 –100 diameter, 4.50m long and 25piles/m^2.

Cross section of bank of retarding pond is shown in Fig. 3.14. Detailed drawings of Thanh Da retarding pond are shown in PB-PDI-TD-229 and 230 compiled in Volume III Tender Drawings.

(2) Ben Me Coc (1) Retarding Pond

The proposed Ben Me Coc (1) retarding pond is planned to improve the existing pond located at center of the basin in two phases, because of adjustment of the storage requirement in each phase. Main works in Phase I program consist of:

(a) Excavation of the existing pond: The existing pond is to be divided into some parts by temporary cofferdam. After drying up of each part of pond, existing pond bed shall be excavated up to EL.-0.70m in combination with bulldozer and backhoe. Total excavation volume is estimated at about 3,800m^3. Excavated soil shall be hauled and dumped to the designed dumping site. Some excavated soil could be used as filling materials for the bank slope, if possible.

(b) Protection of bank slope: Banks around the pond shall be reformed by filling and provision of slope protection. Slope of the bank is designed at 1:2 protected by sod from EL.+0.30m to EL.+1.20m. Total filling volume and area of slope protection are estimated at about 3,500m^3 and 1,700m^2.

(c) Construction of operation and maintenance walk: O/M walk of 1.60m wide and its shoulder of 0.30m wide are designed along east and west banks of the pond. O/M walk is covered with concrete of 10cm supported with compacted sand base course of 10cm. Length of east and west O/M walks are estimated at about 340 and 440m respectively.

(d) Replacement of guard fence: The retarding pond shall be protected by replacing of new fence along the same centerline of existing one. Wire net type fence of 2.10m high with additional spike of 0.50m high (Type B), which is supported by reinforced concrete pole of 3.30m high, is designed outside of O/M walk. Total length of the guard fence is estimated at about 880m.

Cross section of bank of retarding pond is shown in Fig. 3.14. Detailed drawings of Ben Me Coc (1) retarding pond are shown in PB-PDI-BMC1-265 to 268 compiled in Volume

III Tender Drawings.

3.7 Architectural Works for Operation and Maintenance Office and Guard House

3.7.1 General

This report presents the outline of the Detail Design of Architectural Works for package B – Pump Drainage Improvement. The Detail Design was prepared based on the Concept design, which had approved in last stage. The Detail Design aims to develop details sufficient for the tendering of the project under the financial assistance from the Japanese Government and Vietnamese Government. This report explains studies carried out since the Concept Design, and should be read in conjunction with the relevant Tender Drawings, Finish Schedules, Bills of Quantities and Engineer's Cost Estimates, which are prepared and submitted in separate volumes.

Scope of architectural works includes:

(a) Detailed design of O/M office for Thanh Da pumping station
(b) Detailed design of O/M office and guard house for Ben Me Coc (1) pumping station and control gate

3.7.2 Applicable Codes and Standards

The following codes and standards are applied for the detailed design of O/M office and Guard house.

(a) National Building Codes of Vietnam, 1999 (TCVN) for construction codes and material requirements.
(b) Fire prevention & fire protection for buildings – Design requirements TCVN 2622 – 1995.
(c) National Building Codes of Japan : JISS & JASS.

3.7.3 Design Concept and Criteria

(1) Design Concept

(a) Overall Concept:

The Design Concept applied for all building is:
- Fit for purpose and function
- Friendly to environment, society of Vietnam
- Harmonize with material market in Vietnam
- Accordant and united architecture external language in whole project.

(b) Thanh Da Pump Station

The design concept specific to O/M office building is
- Facilities for 4 users
- Functional and economical

(c) Ben Me Coc (1) Pump Station

The design concept specific to O/M office building is
- Facilities for 11 users
- Functional and economical

(2) Design Criteria

All design criteria for structural design are mentioned in the structural calculation sheet compiled in Data Book.

3.7.4 Design of Operation and Maintenance Office in Thanh Da Pumping Station

(1) Building Site

Thanh Da Pump Station located in Thand Da peninsula (Binh Thanh district, Ho chi Minh City)

(2) Functional Requirement

The total area and its breakdown were estimated to provide necessary facilities for 4 users

(3) Floor Plan

The plan of O/M office is designed under the following considerations (refer to Detail Design Drawing No. PB-PDI-TD-301)

Floor plan includes a small office, meeting room, night duty room and toilet. All rooms have air conditioning except toilet, which have ventilating fan. Total floor area of the building is designed as follows:

- Office: 23.0 m^2
- Meeting Room: 14.5 m^2
- Night Duty: 11.0 m^2
- Toilet: 7.0 m^2

Total: 55.5 m^2

(4) Elevations and Sections

The footprint of this building is 5.3 m x 10.3 m, and the height is about 4.5m (From the ground to the top of roof ridge). The super structure is of one story with concrete frames. The curved roof with zincalume roofsheet is used to suit weather condition, the corrosion resistance, long life, and have the same architectural language in the whole project.

(5) Finishing

The key words of the appropriate finishing materials for O/M office building are:

- Durability
- Low cost
- Ease of maintenance

Proposed exterior and interior finishing schedules are shown in Finish Schedule for Architectural Works, which are prepared and submitted, in separate volumes.

3.7.5 Design of Operation and Maintenance Office and Guardhouse in Ben Me Coc (1) Pumping Station

(1) Building Site

Ben Me Coc (1) Pump Station located in district 8, Ho Chi Minh city

(2) Functional Requirements

The total area and its breakdown were estimated to provide necessary facilities for 11 users.

(3) Floor Plan

The plan of O/M office is designed under the following considerations (Ref. To Detail Design Drawing No. PB-PDI-BMC1-301)

Floor plan includes a small office, meeting room, night duty room and toilet. All rooms have air conditioning except toilet, which have ventilating fan. Total floor area of the building is as follows:

-	Office:	45.0 m^2
-	Meeting Room:	17.5 m^2
-	Night Duty:	34.0 m^2
-	Toilet:	7.0 m^2
-	Office (Guard house):	10.0 m^2
-	Toilet (Guard house):	4.0 m^2
	Total:	103.5 m^2

(4) Elevations and Sections

The footprint of O/M office is 6.3 m x 16.3 m, and the height is about 4.95m (From the ground to the top of roof ridge). And the footprint of Guard house is 3.2 m x 4.2 m, the height is about 4.1m (From the ground to the top of roof ridge). The super structure is of one story with concrete frames. The curved roof with zincalume roofsheet is used to suit weather condition, the corrosion resistance, long life, and have the same architectural language in the whole project.

(5) Finishing

The key words of the appropriate finishing materials for O/M office building are:

- Durability
- Low cost

- Ease of maintenance

Proposed exterior and interior finishing schedules are shown in Finish Schedule for Architectural Works, which are prepared and submitted, in separate volumes.

3.7.6 Design of Guardhouse in Ben Me Coc (1) Control Gate

The guardhouse of Ben Me Coc (1) control gate is designed the same house as that of Ben Me Coc (1) pumping station.

3.7.7 Design of Landscape Works

(1) Thanh Da Pumping Station (refer to DWG. No. PB=PDI-TD-301 and 311 in Tender Drawings)

Landscaping of the Than Da pumping station site shall be considered the surrounding environs and provision of aesthetic solution to the community. Drainage pumping stations site is expected to be as a landscaped focal point to such residential area.

Landscape layout of the site shall have a safety and functional spaces community use outside of boundary fences.

(a) Landscape facilities

Area inside of the pumping facility is paved with concrete from the entrance to O/M office. And plaza shall be furnished with concrete block paving of which size of 19cm x 8.9cm x 6cm thick. Concrete curb of the planting area is 1.8m square type and L shaped planting area is 1.8m x 9.8m. The curb rises 20cm in height from the paving level and width of top to be 20cm.

All the facility area beside plaza shall be enclosed with steel grid fence and pair of main gateposts is equipped with steel sliding door of 4.25m openings at front entrance.

- Main gate post (pair of posts): 1 (pair) Nos. Steel reinforced concrete post of 565 x 450 x H2500,
- Sliding gate door: 1 Nos., Size of 2,000H x 500W x 4,250L.
- Steel 50 x 50 framed door with wheels on bottom (both side of door) and railway included.
- Grid fence: H2,200 x @3,000 span unit of steel bar with base trim. Concrete column of H2,500 x W335 x 220 shall be installed at 3.000 intervals and end concrete column of H2,500 x W335 x 335 shall be installed at corner where fence change it's direction.

(b) Plantings

Medium size canopy trees are planted within the planting area at the plaza and inside of the pumping facility site. flowering low shrubs and ground cover plants are introduced within the planting area.

Introduced plants species are shown as follows. All planting work shall required proper

size of planting hole and existing soil to be replaced agriculture soil.

Medium size canopy tree:

- *Lagaestromea reginae (=Lagaestroemia speciosa)* 3 Nos. and *Mimusops elengi* 2 Nos. shall be planted. Both species are H=4.0m, stem diameter is 4cm in 1.2m height from the ground.

- *Plumeria alba* (White flower) 1 No. shall be planted. H=3.0m, stem diameter is 4cm in 1.2m height from the ground. All trees shall be supported by tripod type support with pole individually to sustain trees in stable.

Flowering shrub:

- *Ixora chinensis rosa (=Ixora coccina),*11.6m2, *Lantana camara,*19Nos. and *Musaenda pubescens* 18 Nos. shall be planted in total. All flowering shrubs are 40cm in height and crown width is 25cm, Ixora is planted in group with 10 Nos/m2. Other are planted independently in proper location.

Grass sods and sprigs:

- *Axonopus compressus* 5.9m2 for grass sods and 78.9m2 for grass sprigs shall be applied. grass sods is applied only in the planting area at the plaza

(2) Ben Me Coc 1 Pumping Station: Landscape (refer to DWG. No. PB-PDI-BMC1-311 to 313 in Tender Drawings)

Service access space for maintenance shall be considered enough turning allowance for vehicle moving within limited space.

Front side to the road shall be installed steel grid type fence and along the retention pond site shall be enclosed by net fence with 2.3 m in height. Major gate door is 5.65m for main facility area and gate door of 4.25m for the control gate.

Medium trees as major objectives shall be introduced for provision of canopy silhouette with seasonal flowering to the vicinity peoples. Some small flowering shrubs shall be also provided for an accent of the planting scheme. Along the enclosure fence especially it faces either to the frontage road or the access road, flowering shrub shall be introduced as a hedge planting.

Facility spaces in which without any paving provision shall be furnished with grass sprigs and in some strategic small area, some group planting of shrubs shall be introduced. So that all the facility site will be covered with clean and amicable environment.

(a) Landscape facilities

Area surrounding of the pumping facility is concrete paving. The concrete curb is installed at edge of the paving when it faces to the non-paved area.

At the area of main facility and control gate shall be enclosed with steel grid fence. Pair of main gateposts at both areas shall be equipped with steel sliding door of 5.65m and 4.25m for entrance.

- Main gate post (pair of posts): 2 (pair) Nos. at the main facility site and the control gate site, Steel reinforced concrete post of 565 x 450 x H2500,

- Sliding gate door: 1 Nos., Size of H=2,000 x W500 x L5,650 for the main facility site and 1 Nos. Size of H=2,000 x W500 x L4,250 for control gate site. Steel 50 x 50 framed door with wheels on bottom (both side of door) and railway included.

- Grid fence: H2,200 x @3,000 span unit of steel bar with base trim. Concrete column of H2,500 x W335 x 220 shall be installed at 3.000 intervals and end concrete column of H2,500 x W335 x 335 shall be installed at corner where fence change it's direction. This type fence shall be applied front side of the facilities.

- Wire net fence: H2.500 x @3,000 span net fence with concrete column of 200 x 200 x H2.200. This column shall be installed at each interval of 3,000 and at corner where fence change its direction. This type fence shall be applied along the retention pond area.

(b) Plantings

Medium size canopy trees and flowering shrubs are planted inside of the pumping facility site. Introduced plants species are shown as follows. All planting work shall required proper size of planting hole and existing soil to be replaced agriculture soil.

Medium size canopy tree:

- *Lagaestromea reginae (=Lagaestroemia speciosa)* 6 Nos. and *Mimusops elengi* 2 Nos. shall be planted in both main facility and control gate areas. Both species are H=4.0m, stem diameter is 4cm in 1.2m height from the ground.
- *Plumeria alba* (White flower) 1 No. shall be planted in the main facility area. H=3.0m, stem diameter is 4cm in 1.2m height from the ground. All trees shall be supported by tripod type support with pole individually to sustain trees in stable.

Flowering shrub:

- Species of *Ixora chinensis rosa (=Ixora coccina),*11.6m2, *Lantana camara,*19Nos. and *Musaenda pubescens* 18 Nos. for main facility area and *Hibis rosa-sinens* 4 Nos. for control gate area shall be planted in total. Flowering shrub of Isora and Musaenda is 40cm in height and crown width is 25cm, Ixora is planted in group with 10 Nos/m2. Hibiscus is 60cm in height. Shrubs except of Ixora are planted independently in proper location.

Grass sods and sprigs:

- *Axonopus compressus* for main facility site and control gate site shall be planted in the front area of the facility. A Grass sprig is applied for the planting area.

3.8 Mechanical Works of Pumping Station, Sluice Gate and Control Gate

3.8.1 General

This section covers the applicable codes and standards, design conditions and criteria, system description and key specification of mechanical equipment for workmanship, design, supply, delivery, installation, testing and commissioning of mechanical works at Thanh Da and Ben Me Coc (1) pumping stations comprising pumps, pipes, gates, screens, stop logs and other accessories.

3.8.2 Applicable Codes and Standards

All mechanical plant is to be manufactured and tested in accordance with the Specification and applicable Vietnamese standards.

All materials and tests to be furnished under the Contract shall conform to the following standards as applicable.

Japanese Industrial Standard (JIS)
International Standard Organization (ISO)
American National Standards Institute (ANSI)
British Standards Institution (BS)

Other international standards may be accepted, provided that the requirements therein are equivalent to the latest issue of the relevant Japanese Industrial Standard (JIS). If no standard is indicated, then the relevant Japanese Industrial Standard shall apply.

All electrical equipment shall comply with the requirements and latest revisions of the following codes and standard where applicable:

Japanese Electro - Technical Committee's Standard (JEC)
Japanese Electric Machine Industry Association's Standard (JEM)
Japanese Cable - makers Association Standard (JCS)
International Electrical Committee (IEC)

3.8.3 Design Condition and Criteria

Design condition and criteria has been established, aiming to propose more practical, economical and sustainable project. These are as follows:

(1) Design Water Level and Pump Head

Taking into consideration of HWL of the surrounding rivers/canals and minimum ground elevation of the residential areas, DHWL and DLWL of these pumping stations are proposed as follows:

Name of P.S.	Inner side DHWL (m)	(Land side) DLWL (m)	Outer side DHWL (m)	(River side) DLWL (m)
Thanh Da P.S.	0.90	-1.00	+1.32	-2.11
Ben Me Coc (1) P.S.	0.90	-1.00	+1.50	-1.86

Note:
a. DHWL of inner side is planned to be the same as minimum ground elevation of residential area.
b. DLWL of inner side is planned to easily maintain the water level by tidal effect of Saigon River and Doi canal.
c. DHWL and DLWL of outer side are planned to be average of maximum monthly high water level and low water level of Saigon River and Doi canal respectively.

So, the pump static head (Hs) and pump total head (Ht) are estimated as follows:

Hs = DHWL (river side) – DLWL (land side)
Ht = Hs + Hl

Where, Hl: hydraulic losses of pump equipment, valves and sluice way (m)
Hl is roughly estimated to be 0.60m for pump facility and 0.60m for valves and outlet facilities. Therefore, design pump static head and pump total head of each pumping station are shown below:

Name of P.S.	Pump Static Head (Hs) (m)	Hydraulic loss (Hl) (m)	Pump Total Head (Ht) (m)
Thanh Da P.S.	2.32	1.20	3.52
Ben Me Coc (1) P.S.	2.50	1.20	3.70

3.8.4 System Description

(1) Pump Type Alternatives

As the result of previous study for pump type alternatives, “Submersible motor type” was recommended as the most applicable and economical pump type.

(2) Number of Pump Unit and Its Bore

The area of retarding pond for Thanh Da pumping station was reduced to approx. one-fourth comparing with the previous study, capacity of pumping station is required to increase from 0.35m3/s to 0.7m3/s. The proposed pump capacity and pump bore for Thanh Da and Ben Me Coc (1) are as follows:

Pumping Station	Capacity Total (m3/s)	Capacity Unit (m3/s)	Number of Unit	Bore of Pump (mm)
Thanh Da P.S.	0.70	0.35	2	400
Ben Me Coc (1) P.S.	0.70	0.35	2	400

(3) Proposed Source of Pump Operation

The proposed submersible pump is driven by an electric motor. Since total operation hours of each pumping stations in a year are estimated to be 480 hours (= 20days) only, the following two (2) alternatives of power supply are examined to minimize the

construction cost of electrical facilities.

Alternative	Power source	Supply voltage
Alt.1	Commercial power source	AC380V x 50Hz
Alt.2	Generating unit	AC380V x 50Hz

As shown in previous study, initial and running costs of Alt. 1 are lower than those of Alt. 2 and since the pumping stations are located near the residential area, commercial power source is recommendable for the source of pump operation taking into consideration of environment affects such as noise, vibration, pollution, etc. to the residential areas.

3.8.5 Key Specification of Mechanical Equipment

The mechanical equipment to be required for the installation, operation and maintenance works of the pumping stations is listed in 4.7 “Bill of Quantities”.

Key specifications of major mechanical equipment are shown as follows;

(1) Main Pump

Station Name	**: Thanh Da**	**: Ben Me Coc (1)**
Type	: Submersible motor, vertical shaft, axial flow pump	: Submersible motor, vertical shaft, axial flow pump
Pump discharge	: 400mm dia.	: 400mm dia.
Number of units	: 2 units	: 2 units
Total capacity	: 0.70 m3/sec	: 0.70 m3/sec
Unit capacity	: 0.35 m3/sec	: 0.35 m3/sec
Expected range of static head	: 0 m to 2.32 m	: 0 m to 2.50 m
Rated static head	: 2.32 m	: 2.50 m
Total dynamic head	: 3.52 m	: 3.70 m
Pump speed	: Not more than 970 min-1	: Not more than 970 min-1
Motor output	: Not less than 18.5kw	: Not less than 18.5kw
Pump rated efficiency	: Not less than 79.0%	: Not less than 79.0%
Drive method	: Driven by dry type motor	: Driven by dry type motor

(2) Pipework

Station name	**: Thanh Da**	**: Ben Me Coc (1)**
Nominal bore	: 400 mm dia.	: 400 mm dia.
Number of pipe	: 2 sets	: 2 sets
Type of flange	: JIS B 2220 PN10 or higher class flange	: JIS B 2220 PN10 or higher class flange
Thickness of pipe	: Not less than 6.0 mm	: Not less than 6.0 mm
Hydrostatic test pressure	: Not less than 100 kPa ($1.0\ kgf/cm^2$)	: Not less than 100 kPa ($1.0\ kgf/cm^2$)

(3) Flap Valve

Station name	**: Thanh Da**	**: Ben Me Coc (1)**
Nominal bore	: 600 mm dia.	: 600 mm dia.
Number of pipe	: 2 sets	: 2 sets
Type of flange	: JIS B 2220 PN10 or higher class flange	: JIS B 2220 PN10 or higher class flange
Maximum designed differential head	: Not less than 2.53m	: Not less than 2.70m

(4) Gate

Gates for the Thanh Da Pumping Station

Gate name	**: Inlet gate**	**: By-pass gate**	**: Outlet gate**	**: Flap gate**
Type	: Steel fabricated, rectangular shape, sluice gate	: Do.	: Do.	: Steel fabricated, round shape, swing type gate
Quantity	: 1 / 1	: 1	: 1	: 1 / 1
Effective width	: 1000mm/ 1200mm	: 1400mm	: 1400mm	: 1000mm dia. / 1200mm dia.
Effective height	: 1000mm/ 1200mm	: 1400mm	: 1400mm	: 1000mm dia. / 1200mm dia.
Design water level	: +0.900 (P) -1.100 (A)	: +1.320 (P) -1.000 (A)	: +1.320 (P) -1.000 (A)	: +1.320 (P) -1.000 (A)
Operation water level	: +0.900 (P) -1.100 (A)	: +1.320 (P) -1.000 (A)	: +1.320 (P) -1.000 (A)	: +1.320 (P) -1.000 (A)
Gate sill level	: -1.300 / -1.200	: -1.500	: -1.500	: -0.700 / -0.700 (gate center level)
Operating floor level	: +1.600 / +1.600	: +2.000	: +2.000	: N.A.
Operation	: Manual	: Manual	: Manual	: N.A.
Operation force	: Not more than 150N	: Not more than 150N	: Not more than 150N	: N.A.
Corrosion allowance	: Not less than 0.5mm	Not less than 0.5mm	Not less than 0.5mm	Not less than 0.5mm

Note: (P) – Pressure side, (A) – Anti-pressure side

Gates for the Ben Me Coc (1) Pumping Station

Gate name	: By-pass gate	: Outlet gate	: Flap gate
Type	: Steel fabricated, rectangular shape, sluice gate	: Do.	: Steel fabricated, round shape, swing type gate
Quantity	: 1 / 1	: 1	: 1
Effective width	: 1400mm / 2000mm	: 2000mm	: 1500mm dia.
Effective height	: 1400mm / 2000mm	: 2000mm	: 1500mm dia.
Design water level	: +1.500 (P),-1.000 (A)	: +1.500 (P),-1.000 (A)	: +1.500 (P),-1.000 (A)
Operation water level	: +1.500 (P),-1.100 (A)	: +1.500 (P),-1.000 (A)	: +1.500 (P),-1.000 (A)
Gate sill level	: -2.000	: -2.000	: -1.250 (gate centre level)
Operating floor level	: +1.600 / +2.000	: +2.000	: N.A.
Operation	: Manual	: Manual	: N.A.
Operation force	: Not more than 150N	: Not more than 150N	: N.A.
Corrosion allowance	: Not less than 0.5mm	: Not less than 0.5mm	: Not less than 0.5mm

Note: (P) – Pressure side, (A) – Anti-pressure side

Key specification for other mechanical equipment is referred in Section 12 "Mechanical Works" of the Tender Specification.

3.9 Electrical Works of Pumping Station, Sluice Gate and Control Gate

3.9.1 General

This Chapter describes the detailed design base of the electrical facilities for the Thanh Da and Ben Me Coc Pumping Stations.

(1) Equipment Selection

All electrical equipment shall be selected in accordance with the general principles:

(a) Equipment shall be sufficient rated values.
(b) Future expansion shall be considered.
(c) Operation must be easy with an extended maintenance period.

(2) Scope of Works

The work covers the construction of the complete electrical systems for above mentioned both pumping stations and supply of spare parts for electrical equipment comprising the following items:

(a) 22kV power receiving system (not included to transmission line)
(b) Power distribution system
(c) Instrumentation and control system
(d) Materials

3.9.2 Applicable Codes and Standards

The equipment, materials, design and test and installation of the electrical facilities shall conform to the local law and regulation and the applicable portions of the latest edition of the standard and codes.

(a) International Electrotechnical Commission (IEC)
(b) Japanese Industrial Standards (JIS)
(c) Standards of Japanese Electrotechnical Committee (JEC)
(d) Standards of the Japanese Electrical Manufactures Associations(JEM)
(e) Vietnam Standards (TCVN)

3.9.3 Site Conditions

(a) Altitude: less than 1,000m above sea level.
(b) Ambient temperature:
  - Maximum: 45^{o}C
  - Minimum: 5^{o}C
  - Design temperature: 40^{o}C
(c) Relative humidity: Maximum 95%
(d) Climatic atmosphere: Tropical
(e) Wind pressure: 45m/s
(f) Salt contamination:

Unless otherwise specified, under the contract, design for salt contamination of the insulators and bushings shall be applied the following conditions:0.03mg/sq.cm

3.9.4 Design Criteria

The design of the electrical system shall be carried out with the following clarifications.

(1) Electrical system

(a) Power receiving system

Power supply from the electric power company will be one-circuit of 15(22)kV overhead lines and connected to the 15(22)kV/380V receiving transformer in the substation within Pumping Station.
The technical parameters of electrical power from the electric power company will be as follows:

- Voltage system: AC15(22)kV, 50Hz, 3 phase 3wire,Solidly grounded
- Voltage variation: ±5%
- Frequency variation: ±2%

(b) Power distribution system

Power distribution trough out the plant shall be 50Hz, at the following voltage levels with earthing system:

Power Distribution System

Service	Rated voltage	Phase/Wire	Earthing	Remarks
Power receiving (Transmission line)	15(22) kV	3/3	Solid	with earthing wire
Low voltage distribution				
- Power	380 V	3/4	Solid	
- Lighting & Miscellaneous	380/220 V	3/4	Solid	

(c) Equipment and load voltage rating shall be as follows:

Equipment and Load Voltage

Service	Rated voltage	Phase/Wire	Remarks
Motor	380 V	3/3	
Lighting fixtures & Convenient sockets	220 V	1/2 + E	E: Earthing

(2) Allowable Voltage Drop

The maximum allowable voltage drops in cables, as a percentage of system nominal line to line voltage, a full load shall be as follows:

(a) Main power distribution:
- 380volt motor: 5%

(b) Total voltage drop at the terminal of low voltage motor shall not exceed 20% during staring period.

(c) Voltage drop between lighting panel-board and the furthest fixture shall not exceed 3% voltage drop between main distribution board in substation and local lighting panel-board shall not exceed 2%.

(3) Transformer sizing

The transformer shall be sized for the maximum demand of load connected to the associated switchgear plus 10 to 15% spare capacity for design allowance and/or future expansion.

The maximum demand of load shall be calculated by summing up the following loads:

(a) The normally running loads.
(b) 30% of the intermittent loads (i.e. pumps, etc.).

(4) Cable sizing

The cable shall be sized based on the thermal limits in normal service conditions, and the maximum allowable voltage drops in the circuit. The current carrying capacity (thermal limit) of cables in normal service condition shall take account of the de-rating due to the laying conditions or grouping. The cables for main power distribution system shall be sized also to withstand without damage the maximum short circuit thermal stress for the full clearance time of the protective devices (i.e. fuses, or circuit breakers with protection relays).

The current rating of the circuit for cable sizing shall be as follows:

(a) The transformer primary and secondary cables shall be coved on the rated current of the transformer.
(b) For switchgear/panel feeder circuit without a transformer, cables shall have a current carrying capacity equal to the maximum demand of loads connected to the switchgear/panel with 10% surplus.
(c) The motor feeder cables shall be sized based on the 110% of motor name-plated rated current.
(d) Other cables not mentioned above shall be covered to the maximum current demand.

(5) Lighting Arrangement

The lighting fixture shall be designed and arranged for required areas so as to meet the following illumination level:

ILLUMINATION LEVEL

Installation Location	*Illumination Level (Lux)	Elevation	Remarks
Office	300	Floor	Architecture Works
Meeting Room	250	Floor	Architecture Works
Worker Room	100	Floor	Architecture Works
Tea Room	100	Floor	Architecture Works
Toilet	50	Floor	Architecture Works
Substation (Outdoor)	20	Floor	Architecture Works
Guard Room	250	Floor	Architecture Works
Outdoor Area	10	Floor	Architecture Works

3.9.5 System Description

(1) Power supply and distribution system

Power receiving system of main substation for Thanh Da and Ben Me Coc 1 Pumping Station are 3 [three]-phase, 50Hz, 1[one]-circuit of 15(22)kV line. Power will be supplied from distribution line owned by HCMC Power Company. Transformer substation distributes and supplies power to pump and gate control panels by power cable with voltage 380V. Pump and gate panel supply power to each equipment in the pumping station.

(2) Control and Instrument system

The control and instrumentation equipment installed in pump station shall have following functions:

(a) Pump and gate control

Pump and gate control shall be indicated pump operating condition, fault indication and instrument indication for pump gate and instrument equipment.

(b) Equipment operation

The local control panel near the equipment shall control the operation of the equipment such as pumps and gates. Operation for equipment shall be as follows;

- Manual operation: Local control
- Automatic operation: Automatic sequential operation by the water level

(3) Other

Outdoor lighting switchboard shall be installed in control room.

3.9.6 Key Specification of Mechanical Equipment

Key specifications of the major items are described as follows:

(1) Power receiving system

15(22)kV transmission line

(a) Thanh Da Pumping Station:
- Connection point: At the existing 12m centrifugal concrete towers No. 63/7/8 belongs Ⅱ 15kV Thanh Da Line.
- Phase/Wire: 3 phase/4 wires
- Transmission Line: 24kV steel-aluminum conductor covered PVC, 50sq-mm for phase wire and AC50 grounding one, with length of 84m

(b) Ben Me Coc 1 Pumping Station:
- Connection point: Install new 12m centrifugal concrete pole on the existing route. Electric power supplies from this position to receiving transformer.
- Phase/Wire: 3 phase/4 wires
- Transmission Line: 24kV steel-aluminum conductor covered PVC, 50sq-mm for phase wire and AC50 grounding one, with total length of 25m.

Receiving transformer

(a) Thanh Da Pumping Station:
- Capacity: 3phase-250kVA-50Hz
- Rated voltage: 15(22)+2x2.5%/0.38(0.22)kV

(b) Ben Me Coc 1 Pumping Station:
- Capacity: 3phase-160kVA-50Hz
- Rated voltage: 15(22)+2x2.5%/0.38(0.22)kV

(2) Power distribution system

(a) Distribution Panels

The distribution panels installed in the pumping stations shall be outdoor use, metal enclosed and self-standing type, and shall include necessary protection devices, circuit breakers and accessories.

(b) Pump and Gate Control Panel

The pump and gate control panel installed in the pump station shall be outdoor use, metal

enclosed and self-standing type, and shall include necessary pump starting equipment with protection device, accessories and control relay(s).

(c) Local Control Switch Box

The local control switch box shall be weatherproof outdoor stand type, corrosion resistant, vermin-proof and shall include necessary motor control equipment and accessories.

(3) Instrumentation and Control System

(a) Level Meter

The level meter installed in the pump station area shall be as following type:

- Submerged Diaphragm Type Level Meter
  The submerged diaphragm type level meter shall be measured the water level by detecting water pressure with detection element installed in the water.

(b) Level Control Switch

The level control switch installed in the plant area shall be as following type:

- Electrode Type Level Control Switch
  The electrode type level control switch shall be measure the water level by the difference between energizing of the electrode and interruption of electrode.

(4) Earthing System

(a) General

The exposed metal frames of all electrical apparatus and machinery not forming parts of the electric circuits, neutral of transformers, etc., shall be grounded.

(b) Earthing conductor, plate and rods

The following materials shall be used for earthing systems;

- Earthing conductor
  Annealed copper stranded conductor.
  The Contractor shall be calculated and selected the adequate size of conductors for main mesh, arrester, transformer neutral connection and each equipment earthing conductors.
- Earthing plate
  90 cm square, 1.5 mm thickness copper plate or equivalent
- Earthing rods
  16 mm diameter, 3 m length copper clad steel rod with coupling
- Connectors
  Compression type connectors which shall be able to connect the annealed copper stranded conductors each other, earthing plate and rod.

(c) Earthing works

- Earthing rods, plate and conductors shall be buried deeper than 0.6 m or more

from the ground surface.

- The connection between earthing conductor and ground rod, plate and equipment connection conductor shall be electrically and mechanically rigid.
- Earthing systems of the instruments equipment shall be done by separately from common ground.
- The earthing for transformer neutrals and lightning arresters, earthing rod shall be installed in additionally for interconnections with earthing mesh.
- Boundary fences shall be earthed by means of earthing rods, separately from the main earthing mesh.

(5) Materials

This section covers cables, conduits, pull boxes, cable ducts and trays which will be used for the main circuit and secondary circuit of power, control, instrumentation and other requirement.

Power Cables, Control Cables and Instrument Cables

Conductor size for cables shall be adequate for the load requirements, voltage drop, short circuit current, and diversity factor for individual circuit application.

(a) Power cables

- 600V power cables for motor circuit, heater circuit and other power circuits shall be of jacket type, 600 V cross-linked polyethylene insulated PVC sheathed type (CV).
- 600 V cross-linked polyethylene insulated PVC sheathed, welded and corrugated steel armoured PVC sheathed power cable (CVMAZV) shall be used for burred portion in the ground of outdoor lighting power cables.
- Section area of cores for 600 V power cables shall not be less than 3.5sq.mm.

(b) Control and instrumentation cables

- Except for small wiring of equipment, control cables shall be of jacket type, 600 V polyvinyl chloride insulated and sheathed control cable with copper tape shielding (CVV-S).
- Section area of cores for control and instrumentation cables shall not be less than 2.5sq.mm. In case of important circuits, such as section areas of CT and VT circuits shall be 3.5sq.mm or more. In consideration of cables, the Contractor shall, if possible, design in such a manner that the size of cores or cables shall be unified.

Steel conduits and flexible conduits

Steel conduits shall be steel, hot-dipped galvanized and equipped with couplings and

thread protector caps. All surfaces and threads shall be coated with zinc. The sectional areas of a steel conduit shall be, at least, 2.5 times the total cross sectional area of cables to be pulled in.

- Rigid steel conduits shall be installed for all exposed cable route.
- PVC coated conduits shall be installed for corrosive area cable route.
- Couplings and elbows shall be of the same materials as conduit pipes.

(a) Flexible metal conduits shall be used for flexible cable connection route. Flexible metal conduits shall have a interlocked flexible galvanized steel core with a permanently bonded outer polyvinyl chloride jacket.

Boxes and Fittings

The pull boxes, outlet boxes, fittings and covers shall be of mild steel and/or cast iron alloy with adequate strength and have sufficient size to provide free space for all conductors enclosed.

- Pull boxes shall be sufficient size to accommodate the connected conduits and enclosed conductors.
- Boxes and fittings shall be plated by melting zinc or coated with rust-preventive paint and tow or more finish coatings.
- Outlet boxes shall be of galvanized steel, square and of sufficient size to accommodate all the required conductors enclosed in the box.

Supporting Steel Materials

The supporting steel materials shall be of hot-dipped galvanized steel with adequate strength for support conduits, cable tray and/or wiring duct.

Outdoor Lighting

The pumping station shall be equipped with outdoor lightings apparatuses at appropriate areas. The Contractor shall provide all necessary materials and furnish complete lighting systems. In the selection of lamps and fittings consideration should be given to ensure the maximum lamp life, the minimum likelihood of internal moisture accumulation, and also effects of vibration, operating temperature, and breathing.

Types of outdoor lighting fixture shall be of straight pole with pole head type lighting fixture and equipped with screwed base lamp holders, and shall be of high power factor suitable for stable operation in tropical climate and weatherproof type. The lamp shall be of high pressure sodium type and approximately 360 W rating.

Lighting supports for outdoor lighting shall be of base plate type steel poles painted with suitable colour. Ballast, cut out switch and terminals shall be equipped in the pole and other attachments necessary for wiring and fixing of the lighting fixtures shall also be

provided with the pole.

The Contractor shall provide suitable outdoor lighting switch box for lighting systems. The lighting switch box shall be indoor use, metal enclosed wall mounted type and switching operated by manual at control room. The Contractor shall be provided enough capacity of branch circuit breakers for high pressure sodium lights to avoid tripped by increase of starting current.

600 volt PVC insulated wires of 3.5sq.mm in size shall be laid in the lighting pole for connection from the lighting switch box to the lighting fixtures.

3.10 Work Quantities

Work Quantities of Pump Drainage Improvement Project (Package B) are summarized in Table 3.1 (1/4) to (4/4). Details of Work Quantities are compiled in Design Report, Volume III.

3.11 Construction Plan

This section deals with the construction plan and schedule of Package B: Pump Drainage Improvement Project.

3.11.1 Basic Condition

For preparation of construction plan and schedule, the following considerations have been taken as a basic concept of construction works.

(1) Scope of Package B Project

Package B: Pump Drainage Improvement Project consists of the following main construction component:

(a) Dike Construction
- Thanh Da: Permanent dike by RC pile of 75.0m
- Ben Me Coc (1): Temporary dike by stone masonry of 3,950m
- Ben Me Coc (2): Temporary dike by stone masonry of 3,300m

(b) Sewer Line Construction
- Thanh Da: Diameter: ϕ800 – ϕ1200mm, L = 751m
- Ben Me Coc (1): Diameter: ϕ400 – ϕ1800mm, L = 4,436m
- Ben Me Coc (2): Diameter: ϕ400 – ϕ1800mm, L = 3,940m

(c) Construction of Pumping Station with Sluice Way
- Thanh Da: Submergible pump of ϕ400mm, Q = 42m^3/min.
- Ben Me Coc (1): Submergible pump of ϕ400mm, Q = 42m^3/min.

(2) Other Conditions

(a) Mode of construction:
The construction shall be executed by sufficient contractor(s) selected through international competitive bidding (ICB).

(b) Availability of Construction Plant and Equipment:
The major construction work shall be conducted by applying heavy equipment, which mostly supplied locally, due to limited construction period and keeping good quality of construction.

(c) Construction Materials
Most of basic construction materials could be found available in this country. Some particular processed materials (steel sheet pile, H type steel beam, etc) are to be procured from outside.

(d) Pattern of Construction Method

Main work comprises of temporary cofferdam work, earth work, concrete work and stone masonry work. Temporary coffer dam and earth works are planned to conduct by heavy machinery (pile driver, clamshell, backhoe, barge, tug boat, etc.) in combination with manpower. While, concrete and stonemasonry works will be conducted by mainly manpower.

3.11.2 Major Works of the Project

Major works of Package B Project (Pump Drainage Improvement) consists of the followings:

(a) Dike Construction
(b) Sewer Line Construction
(c) Construction of Pumping Station with Sluice Way and Retarding Pond

Construction plan of the above major works are described below:

(1) Dike Construction

Two (2) kinds of dikes are designed, one is reinforced concrete pile dike along Saigon River in Thanh Da and the other is stone masonry dike along Tau Hu, Lo Gom and Doi canals in Ben Me Coc (1) and (2) areas.

(a) RC Pile Dike in Thanh Da

This dike is designed to be almost the same revetment type as the existing one, of which main material is reinforced concrete pile. After completion of cleaning, grubbing and a partial filling at the construction site, 52 reinforced concrete piles in total, of which dimension is 250W x 250H x 12000L, shall be driven by pile driver in double line of 3.2m wide and at interval of 3.0m long along Saigon River as shown in Fig. 3.2.

During low tide of Saigon River, lower pile concrete coupling work of 400W x 400H in section shall be conducted to connect rigidly with each top of lower pile. Top of lower and upper piles shall also be connected by reinforced concrete beam of 300W x 300H in section.

After completion of concrete coupling work, lower bank shall be filled up by sandy soil and simultaneously gravel mat (t = 20cm) work, leveling concrete (t = 10cm) work and reinforced concrete (t = 20cm) work shall be carried out. Rip rap work is to be done underwater.

(b) Stone Masonry Dike in Ben Me Coc (1) and (2)

Seven and two types of stone masonry dikes are designed for Ben Me Coc (1) and (2) area respectively, as shown in Fig. 3.3 and 3.4. However, these dikes are classified broadly into only two categories. One is additional dike to be connected with the existing revetment and other structures and the other is independent stone masonry dike.

In additional dike construction, the surfaces of all existing revetment and other structures on which new stone masonry is to be constructed shall be wire blushed and chipped to remove all lose material and shall be thoroughly wetted prior to placing new work. While, for independent dike construction, excavation of existing soil shall be made and the bottom trimmed and tamped sufficiently with a mechanical tamper. Sand bedding and lean concrete work shall be conducted prior stone masonry work.

(2) Sewer Line Construction

In order to improve inner flood situation, new sewer lines of more than 9,100m ranging ϕ400 – ϕ1800mm in diameter are designed for three pump drainage area, Thanh Da, Ben Me Coc (1) and (2).

These sewers are designed as a shallow drainage pipeline, of which the lowest invert elevation is designed at EL.–1.90m. Considering average ground elevation of EL.+1.2m, the maximum excavation depth will be within 4.0m. Accordingly, these sewers could be constructed by ordinal trench open cut method. Details of trench open cut method for sewer pipe construction are mentioned in Section 4.9, Chapter 4: Package C (Interceptor Sewer construction Project).

(3) Pumping Station

Construction scale of Thanh Da and Ben Me Coc (1) pumping station is almost same after due consideration of these pump capacity of 42m^3/min., concrete volume of more than 250m^3, earth work of about 3,500m^3, reinforced concrete piling of about 500m, etc. Construction of pumping station comprises (i) civil work, (ii) architectural work, (iii) mechanical work, and (iv) electrical work.

(a) Civil Work

Major work items of the civil work include temporary coffer dam work earth work (excavation, filling, backfilling), foundation work, concrete work, etc.

Coffer Dam

For construction of sluice way, temporary coffer dam with steel sheet piles (PU 8, l = 8.0m) supported by H section steel beam (200 x 200 and 260 x 260) shall be constructed in front of the outlet to stop the river and canal water and to obtain the dry condition. Temporary coffer dam shall be constructed in Saigon River for Thanh Da and Doi canal for Ben Me Coc (1).

Excavation

Excavation shall be conducted by construction equipment, such as, backhoe, clamshell and other excavator, in combination with some manpower. During excavation, excavated wall shall be protected by steel sheet pile retaining wall. Excavated soil shall be loaded to the dump car and transported to low-lying dumping site near the construction site. If the quality of excavated soil is available as backfill material, it shall be hauled to stockpile provided in vicinity of the site.

Foundation Work

In succession of excavation work, piling work shall be commenced. Pump pit is designed to be supported by reinforce concrete pile of 300mm x 300mm in section and other structures, such as sluice way, inlet pit, outlet, etc. are to be supported by wooden pile of ϕ80 – ϕ100 in dia., l = 4.5m long and n = 25pcs/m^2. RC pile and wooden pile shall be driven by mechanical equipment of pile driver and wooden driver by manpower operation respectively.

Concrete Work

After completion of sand bedding and leveling concrete, concrete work including fabrication and installation of reinforcing bars for intake, pump pit, discharge basin, sluice way , outlet and other structures shall be carried out.

Backfill

After removal of forming, timbering and scaffolding for concrete works, backfill work shall be conducted. Backfill materials shall be used sandy soil (black sand) or good

quality soil from stockpile.

(b) Architectural Work

Architectural works consists of the construction of operation/maintenance office (56m^2 for Thanh Da and 90m^2 for Ben Me Coc (1) O/M office) and guardhouse (14m^2 for Ben Me Coc (1) pumping station). These buildings are designed in the manner of local construction method. Building is designed reinforced concrete structure with brick wall supported by wooden pile.

(c) Mechanical and Electrical Works

After completion of civil works for pumping station, mechanical and electrical works shall be commenced. Major mechanical and electrical equipment to be installed are as follows:

Name of Major Equipment	Thanh Da P.S.	Ben Me Coc (1) P.S.
A. Mechanical Equipment		
(1) Main Pump (ϕ400mm, Q = 42m^3/min)	2 sets	2 sets
(2) Pipe Work (ϕ400 to ϕ600mm)	2 sets	2 sets
(3) Flap Gate (ϕ600mm)	2 sets	2 sets
(4) Sluice Gate (1.0mx1.0m to 2.0mx2.0m)	4 sets	5 sets
B. Electrical Equipment		
(1) Distribution Panel	1 unit	1unit
(2) Control Panel	2 units	2 units
(3) Gate Control Panel	1 unit	1unit
(4) Switch Box	5 units	5 units

Details of mechanical and electrical work items quantities are shown in Table 3.1 (4/4).

3.11.3 Construction Schedule

Construction schedule is prepared based on the following assumptions:

(a) Construction could be commenced at the beginning of July 2002.
(b) Based on the regional priority sequence, urban drainage improvement works of Thanh Da, shall be commenced first and Ben Me Coc (1) and (2) shall be conducted in turn.
(c) Since it takes long time to design, manufacturing and transportation of main mechanical and electrical equipment, dike and sewer construction shall be conducted firstly.

The construction schedule of Package B Project is shown in Table 3.2.

TABLE 3.1 (1/4) WORK QUANTITIES OF PACKAGE B (PUMP DRAINAGE IMPROVEMENT)

No.	Item	Unit	Thanh Da	Ben Me Coc (3	Ben Me Coc (2	Total
A. Civil Works						
A.1 Dike Construction						
	A.1.1 Clearing and Grubbing	m2	390	4,880	2,870	8,140
	A.1.2 Excavation	m3	290	1,660	1,790	3,740
	A.1.3 Sandy Soil Filling	m3	400	12	0	412
	A.1.4 Sandy Soil Backfilling	m3	0	1,310	710	2,020
	A.1.5 RC Pile (250x250x24000)	No.	52	0	0	52
	A.1.6 Concrete Type E	m3	90	0	0	90
	A.1.7 Concrete Type G	m3	45	220	183	448
	A.1.8 Reinforcing Bar	kg	3,960	0	0	3,960
	A.1.9 Forming	m2	270	0	0	270
	A.1.10 Gravel Bedding	m3	20	0	0	20
	A.1.11 Free Drain Gravel	m3	65	0	0	65
	A.1.12 O/M Space Pavement					
	(1) Concrete Curb	m	80	0	0	80
	(2) Concrete Block	m2	360	0	0	360
	(3) Fence w/ Concrete Post	m	80	0	0	80
	A.1.13 Rip Rap	m3	135	0	0	135
	A.1.14 Wet Stone masonry	m3	0	2,390	2,200	4,590
	A.1.14 Joint Filler	m2	60	350	90	500
A.2 Sewer Line Construction						
	A.2.1 Clearing and Grubbing	m2	1,750	11,880	9,880	23,510
	A.2.2 Excavation (D<6m)	m3	4,710	42,300	32,080	79,090
	A.2.3 Channel Excavation	m3	0	1,130	1,730	2,860
	A.2.4 Sand Backfill	m3	1,520	11,900	9,560	22,980
	A.2.5 Sandy Soil Backfill	m3	2,320	22,480	15,860	40,660
	A.2.6 Pipe					
	(1) 400mm dia	m	0	66	50	116
	(2) 600mm dia		0	34	0	34
	(3) 800mm dia		286	0	335	621
	(4) 900mm dia		225	515	545	1,285
	(5) 1000mm dia		206	785	1,560	2,551
	(6) 1200mm dia		0	1,567	350	1,917
	(7) 1500mm dia		0	919	880	1,799
	(8) 1800mm dia		0	444	168	612
	Total		717	4,330	3,888	8,935
	A.2.7 Foundation Pile (Timber Pile)	m	60,420	517,020	424,500	1,001,940
	A.2.8 Foundation Concrete (Type G)	m3	290	2,670	2,035	4,995
	A.2.9 Construction of Manhole					
	(1) Foundation Pile (Timber Pile)	m	10,620	67,490	54,480	132,590
	(2) Sand Bedding	m3	30	190	160	380
	(3) Concrete Type E	m3	150	1,010	760	1,920
	(4) Concrete Type F	m	27	165	320	512
	(5) Concrete Type G	m2	15	95	35	145
	(6) Invert Mortal	m2	65	440	360	865
	(7) Reinforcing Bar	kg	9,440	61,500	23,480	94,420
	(8) Manhole Cover (Type A)	set	5	150	0	155
	(9) Manhole Cover (Type C)	set	25	0	0	25
	(10) Manhole Cover (Type D)	set	0	0	176	176
	(11) Ladder Rungs	No.	160	940	1,180	2,280
	(12) Connection Pipe (400,600 dia	m	0	0	524	524
	A.2.10 Construction of Inlet Piit					
	(1) Foundation Pile (Timber Pile)	m	1,170	26,180	25,600	52,950
	(2) Sand Bedding	m3	5	75	70	150
	(3) Concrete Type E	m3	15	360	320	695
	(4) Concrete Type G	m3	2	40	35	77
	(5) Reinforcing Bar	kg	1,130	26,640	23,480	51,250
	(8) Manhole Cover (Type D)	set	3	180	176	359
	(9) Manhole Cover (Type E)	set	5	0	0	5
	(11) Ladder Rungs	No.	60	1,330	1,180	2,570
	(12) Connection Pipe (400-1000 di	m	36	604	524	1,164

TABLE 3.1 (2/4) WORK QUANTITIES OF PACKAGE B (PUMP DRAINAGE IMPROVEMENT)

No.		Item	Unit	Thanh Da	Ben Me Coc (3	Ben Me Coc (2	Total
		A.2.11 Construction of Outlet					
		(1) Foundation Pile (Timber Pile)	m	0	63,980	54,000	117,980
		(2) Sand Bedding	m3	0	50	40	90
		(3) Concrete Type E	m3	0	207	165	372
		(4) Concrete Type F	m3	0	30	26	56
		(5) Concrete Type G	m3	0	30	24	54
		(6) Reinforcing Bar	kg	0	13,490	10,770	24,260
		(7) Free Drain Gravel	m3	0	90	77	167
		(8) Geotexitile Cloth	ton	0	290	256	546
		(9) Wet Stone Masonry	m3	0	90	77	167
		(10) Pip Rap	m3	0	200	180	380
		(11) Flap Gate (900 dia - 1800 dia.	set	0	10	9	19
		A.2.11 Rehabilitation of Flap gate	set	5	0	0	5
		A.2.12 Road works					
		(1) Concrete Curb	m	1,460	8,350	8,650	18,460
		(2) Subgrade Prepartation	m2	3,160	25,070	25,940	54,170
		(3) Sub Base Course	m3	630	5,010	5,190	10,830
		(4) Base Course	m3	600	4,760	4,930	10,290
		(5) Asphalt Binder Couese	ton	345	2,760	2,850	5,955
		(6) Asphlt Surface Course	ton	345	2,760	38,900	42,005
		(7) Prime Coat	litre	4,740	37,600	38,900	81,240
		(8) tack Coat	litre	1,580	12,530	12,970	27,080
	A.3 Construction of Pumping Station						
		A.3.1 Clearing and Grubbing	m2	900	600	0	1,500
		A.3.2 Demolition of Stone Masonry	m3	7	15	0	22
		A.3.3 Demolition of Revetment	m3	16	0	0	16
		A.3.4 Excavation	m3	1,870	2,125	0	3,995
		A.3.5 Sandy Soil Backfill	m3	1,100	550	0	1,650
		A.3.6 Sandy Soil Fill	m3	0	1,810	0	1,810
		A.3.7 Concrete Type E	m3	250	215	0	465
		A.3.8 Concrete Type F	m3	20	16	0	36
		A.3.9 Concrete Type G	m3	30	20	0	50
		A.3.10 Forming	m2	1,330	810	0	2,140
		A.3.11 Reinforcing Bars	kg	21,620	18,270	0	39,890
		A.3.12 Sand Bedding	m3	60	45	0	105
		A.3.13 Foundation Pile					
		(1) RC Pile , L = 24m	No.	19	0	0	19
		(2) RC Pile, L = 44m	No.	0	13	0	13
		(3) Timber Pile	m	20,460	4,030	0	24,490
		A.3.14 Revetment					
		(1) Foundation Pile (Timber Pile)	m	0	8,800	0	8,800
		(2) Concrete Type E	m3	0	60	0	60
		(3) Concrete Type F	m3	0	11	0	11
		(4) Concrete Type G	m3	0	10	0	10
		(5) Sand Bedding	m3	0	17	0	17
		(6) Reinforcing Bar	kg	0	4,350	0	4,350
		(7) Stone Masonry	m3	0	40	0	40
		(8) Free Drain Gravel	m3	0	22	0	22
		(9) Geotexitile Cloth	m2	0	110	0	110
		(10) Weeep Hole	No.	0	40	0	40
		A.3.15 Rip rap	m3	37	120	0	157
		A.3.16 RC Pipe					
		(1) 1000mm dia	m	13	0	0	13
		(2) 1200mm dia.	m	14	0	0	14
		(39 1500mm dia	m	0	25	0	25
		A.3.17 Manhole Cover					
		(1) Cast Iron Cover	No.	5	1	0	6
		(2) Fabricate Manhole Cover	No.	2	2	0	4
		A.3.18 Rudder Rungs	No.	90	70	0	160
		A.3.19 Expansion Joint	m	28	10	0	38
		A.3.20 Stone Masonry Restoration	m3	7	5	0	12
		A.3.21 Revetment Restoration	m3	10	0	0	10

TABLE 3.1 (3/4) WORK QUANTITIES OF PACKAGE B (PUMP DRAINAGE IMPROVEMENT)

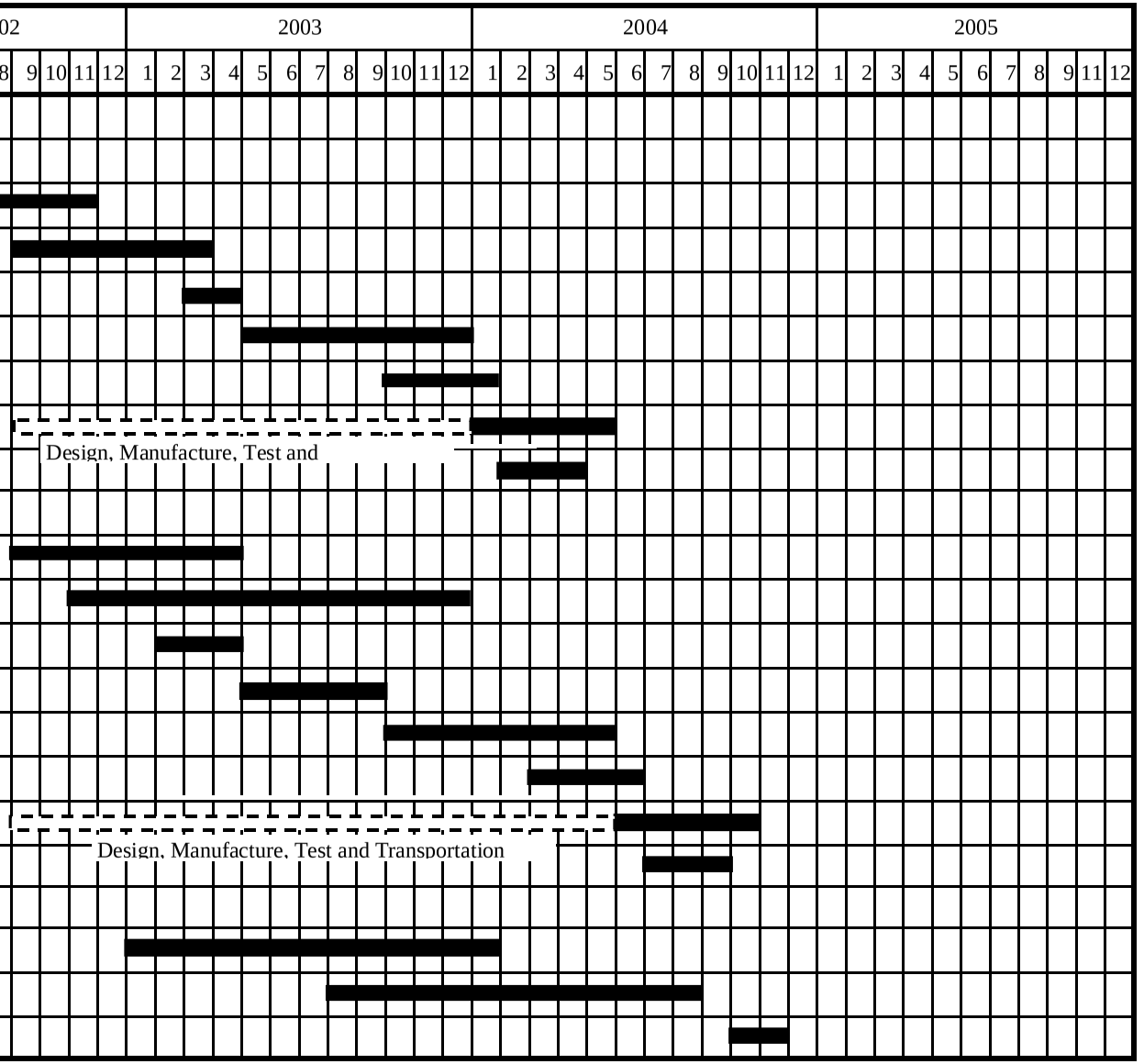
No.	Item	Unit	Thanh Da	Ben Me Coc (3	Ben Me Coc (2	Total
	A.3.22 Landscape Works					
	(1) Gate and Fencing	m	85	82	0	167
	(2) Concrete Curb	m	100	85	0	185
	(3) Concrete Block Pavement	m2	90	0	0	90
	(4) Concrete Pavement	m2	140	270	0	410
	(5) Planting Work	L.S.	1	1	0	2
	A.3.23 Road Works					
	(1) Concrete Curb	m	260	145	0	405
	(2) Subgrade Preparation	m2	690	390	0	1,080
	(3) Sub Base Course	m3	140	80	0	220
	(4) Base Course	m3	130	75	0	205
	(5) Asphalt Binder Couese	ton	75	45	0	120
	(6) Asphalt surface Course	ton	75	45	0	120
	(7) Prime Coat	litre	1,040	585	0	1,625
	(8) Tac Coat	litre	350	195	0	545
	(9) Concrete Block Paving	m2	35	160	0	195
A.4 Construction of Control Gate						
	A.4.1 Clearing and Grubbing	m2	0	310	0	310
	A.4.2 Demolition of Existing Gate	m3	0	32	0	32
	A.4.3 Excavation	m3	0	790	0	790
	A.4.4 Sandy Soil Backfill	m3	0	35	0	35
	A.4.5 Sandy Soil Fill	m3	0	580	0	580
	A.4.6 Concrete Type E	m3	0	55	0	55
	A.4.7 Concrete type F	m3	0	1	0	1
	A.4.8 Concrete Type G	m3	0	39	0	39
	A.4.9 Reinforcing Bars	kg	0	6,070	0	6,070
	A.4.10 Sand Bedding	m3	0	10	0	10
	A.4.11Timber Pile	m	0	10,740	0	10,740
	A.4.12 Stone masonry Revetment					
	(1) Timber Pile	m	0	5,090	0	5,090
	(2) Concrete Type E	m3	0	14	0	14
	(3) Concrete Type F	m3	0	25	0	25
	(4) Concrete Type G	m3	0	5	0	5
	(5) Gravel Bedding	m3	0	10	0	10
	(6) Stone Masonry	m3	0	82	0	82
	(7) Free Drain Gravel	m3	0	47	0	47
	(8) Geotexitile Cloth	m2	0	220	0	220
	(9) Weep Hole	No.	0	56	0	56
	A.4.13 Rip rap	m3	0	52	0	52
	A.4.14 Fabricated Manhole Cover	No.	0	2	0	2
	A. 4.15 Ladder Rungs	No.	0	22	0	22
	A.4.16 Landscape Works					
	(1) Gate and Fence (Type a9	m	0	17	0	17
	(2) Fence : Type B	m	0	75	0	75
	(3) Concrete Curb	m	0	20	0	20
	(49 Cocrete Pavement	m2	0	290	0	290
	(5) Plantation	L. S.	0	1	0	1
A.5 Construction of Retarding Pond						
	A.5.1 Clearing and Grubbing	m2	0	1,600	0	1,600
	A.5.2 Excavation	m3	1,640	3,760	0	5,400
	A.5.3 Sandy soil Filling	m3	0	3,440	0	3,440
	A.5.4 Stone Masonry					0
	(1) Timber Piling	m	14,030	0	0	14,030
	(2) Stone Masonry	m3	90	0	0	90
	(39 Concrete Type G	m3	13	0	0	13
	A.5.5 Sodding	m2	0	1,730	0	1,730
	A.5.6 O/M Road					
	(1) Subgrade Prepareation	m2	0	1,360	0	1,360
	(2) Sand Bedding	m3	0	140	0	140
	(3) Concrete pavement	m3	0	130	0	130
	(4) Fence (Type B)	m	0	835	0	835

TABLE 3.1 (4/4) WORK QUANTITIES OF PACKAGE B (PUMP DRAINAGE IMPROVEMENT)

No.	Item	Unit	Thanh Da	Ben Me Coc (3	Ben Me Coc (2	Total
B. Archutectural Work Quantities			Refer to Design Report, Volume III: Work Quantities			
	B.1 Construction Pump House and O/M Office					
	B.3 Construction og Guard House					
C. Mechanical Works						
	C.1 Mechanicak Equipment					0
	C.1.1 Main Pump (400mm dia.)	set	2	2	0	4
	C.1.2 Pipe Work (400mm dia.)	set	2	2	0	4
	C.1.3 Siphon Flap Valve (600mm di	set	2	2	0	4
	C.1.4 Inlet Gate (1.4m W x 1.4m H)	set	0	1	0	1
	C.1.5 Inlet Gate (1.2m W x 1.2m H)	set	1	0	0	1
	C.1.6 Inlet Gate (1.0mW x 1.0m H)	set	1	0	0	1
	C.1.7 By-pass Gate (2.0mW x 2.0mH	set	0	1	0	1
	C.1.8 By-pass gate (1.4mW x 1.4mH	set	1	0	0	1
	C.1.9 Outlet gate (2.0mW x 2.0mH)	set	0	1	0	1
	C.1.10 Outlet Gate (1.4mW x 1.4mH	set	1	0	0	1
	C.1.11 Flap Gate (1.5m dia)	set	0	1	0	1
	C.1.12 Flap Gate (1.2m dia)	set	1	0	0	1
	C.1.13 Flap Gate (1.0m dia)	set	1	0	0	1
	C.1.14 Control Gate (1.5mW x 1.8m	set	0	1	0	1
	C.1.15 Inlet Gate (1.4m W x 1.4mH)	set	0	1	0	1
	C.1.16 Wooden Stop Log (2.6mW)	set	0	8	0	8
	C.1.17 Wooden Stop Log (1.5mW)	set	8	0	0	8
	C.1.18 Bar Screen	set	2	2	0	4
	C.1.19 Pump Lifting Divice (1 ton)	set	1	1	0	2
	C.1.20 Flap Gate for Sewer (900 dia	set	0	2	0	2
	C.1.21 Flap Gate for Sewer (1000 di	set	5	2	0	7
	C.1.22 Flap Gate for Sewer (1200 di	set	0	3	0	3
	C.1.23 Flap Gate for Sewer (1500 di	set	0	2	0	2
	C.1.24 Flap Gate for Sewer (1800 di	set	0	1	0	1
	C.1.25 Spare Parts	lot	1	1	0	2
D. Electrical Works						
	D.1 Electric Equipment					
	D.1.1 Distribution Panel	unit	1	1	0	2
	D.1.2 Pump and gate Control Panel	unit	2	2	0	4
	D.1.3 Gate Contro Panel	unit	1	1	0	2
	D.1.4 Switch Box	unit	5	5	0	10
	D.1.5 Others (refer to Design Report, Volume III)	L.S.	1	1	0	2
	D.2 Instrumentation equipment					0
	D.2.1 Submergible Diaphragm Type Level meter	sets	1	1	0	2
	D.2.2 Electrode Type Level Control Switch	set	2	2	0	4
	D.2.3 Others (refer to Design Report, Volume III)	L.S.	1	1	0	2
	D.3 Cable and Wiring Materials					0
	D.3.1 Power Cable	L.S.	1	1	0	2
	D.3.2 Control Cable	L.S.	1	1	0	2
	D.3.3 Piping Materials	L.S.	1	1	0	2
	D.3.4 Earthing Materials	L.S.	1	1	0	2
	D.4 Outdoor Lighting Equipment					
	D.4.1 Straight Pole Head Type Lighting Fixture	set	4	4	0	8
	D.4.2 Outdoor Lighting Control Pan	set	1	1	0	2
	D.4.3 Others (refer to Design Report, Volume III)	L.S.	1	1	0	2

TABLE 3.2 CONSTRUCTION SCHEDULE OF PACKAGE B (PUMP DRAINAGE IMPROVEMENT)

No.	Major Work Item	Unit	Quantity
1	Relocation and Tendering		
2	Thanh Da Pump Drainage Improvement		
2.1	Dike Construction	m	75
2.2	Sewer Line Construction	m	751
2.3	Retarding Pond Construction	L.S.	1
2.4	Construction of Pumping Station	L.S.	1
2.5	Architectural Work		
2.6	Mechanical and Electrical Work	L.S.	1
2.7	Landscape Work	L.S.	1
3	Ben Me Coc (1) Pump Drainage Improvement		
2.1	Temporary Dike Construction	m	3,950
2.2	Sewer Line Construction	m	4,436
2.3	Retarding Pond Construction	L.S.	1
2.4	Construction of Control Gate	L.S.	1
2.5	Construction of Pumping Station	L.S.	1
2.6	Architectural Work	L.S.	1
2.6	Mechanical and Electrical Work	L.S.	1
2.7	Landscape Work	L.S.	1
4	Ben Me Coc (1) Drainage Improvement		
2.1	Temporary Dike Construction	m	3,300
2.2	Sewer Line Construction	m	3,940
5	Cleaning and Handing Over	L.S.	1



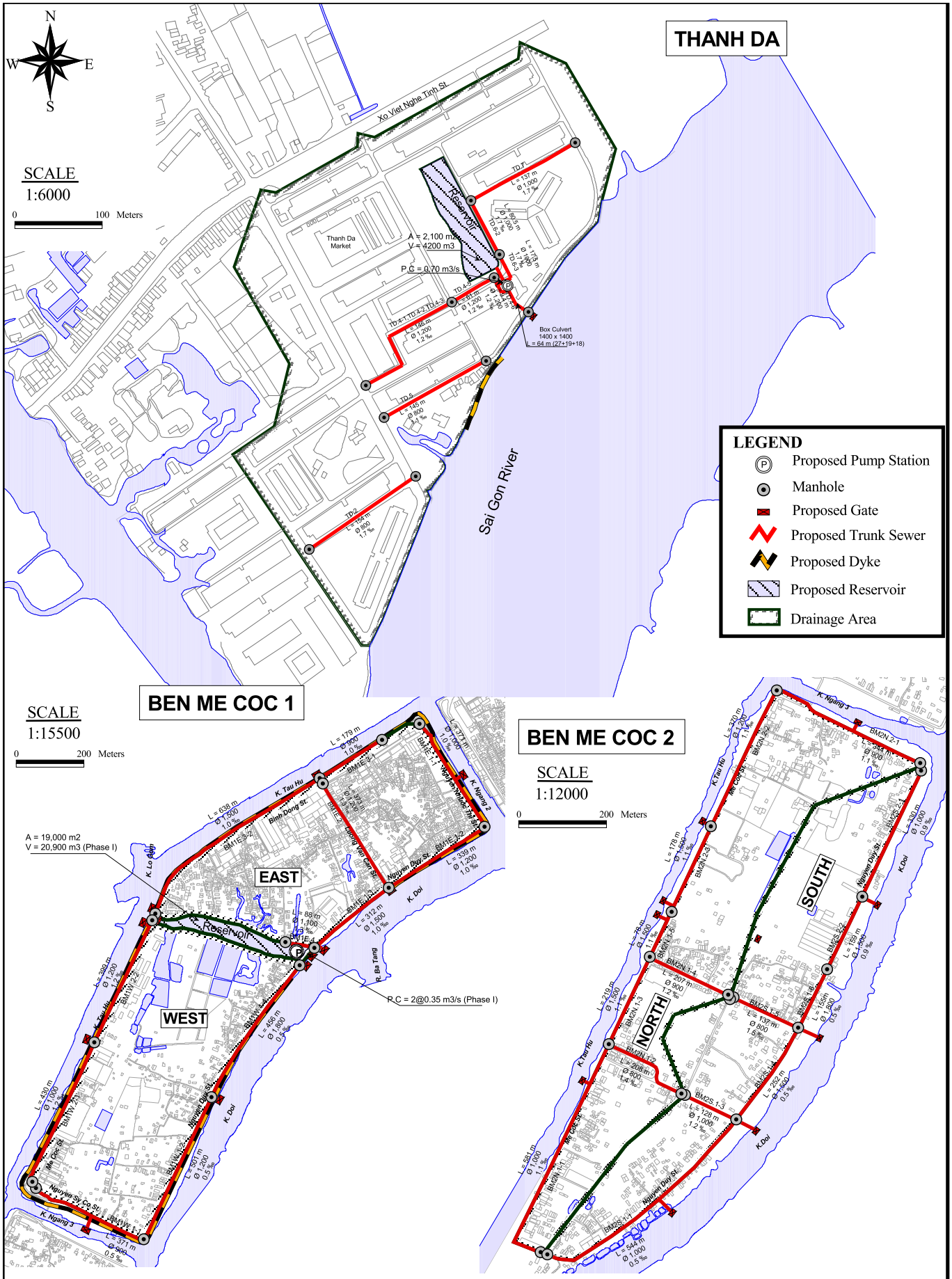


FIG. 3.1 PUMP DRAINAGE IMPROVEMENT FOR PHASE I PROJECT

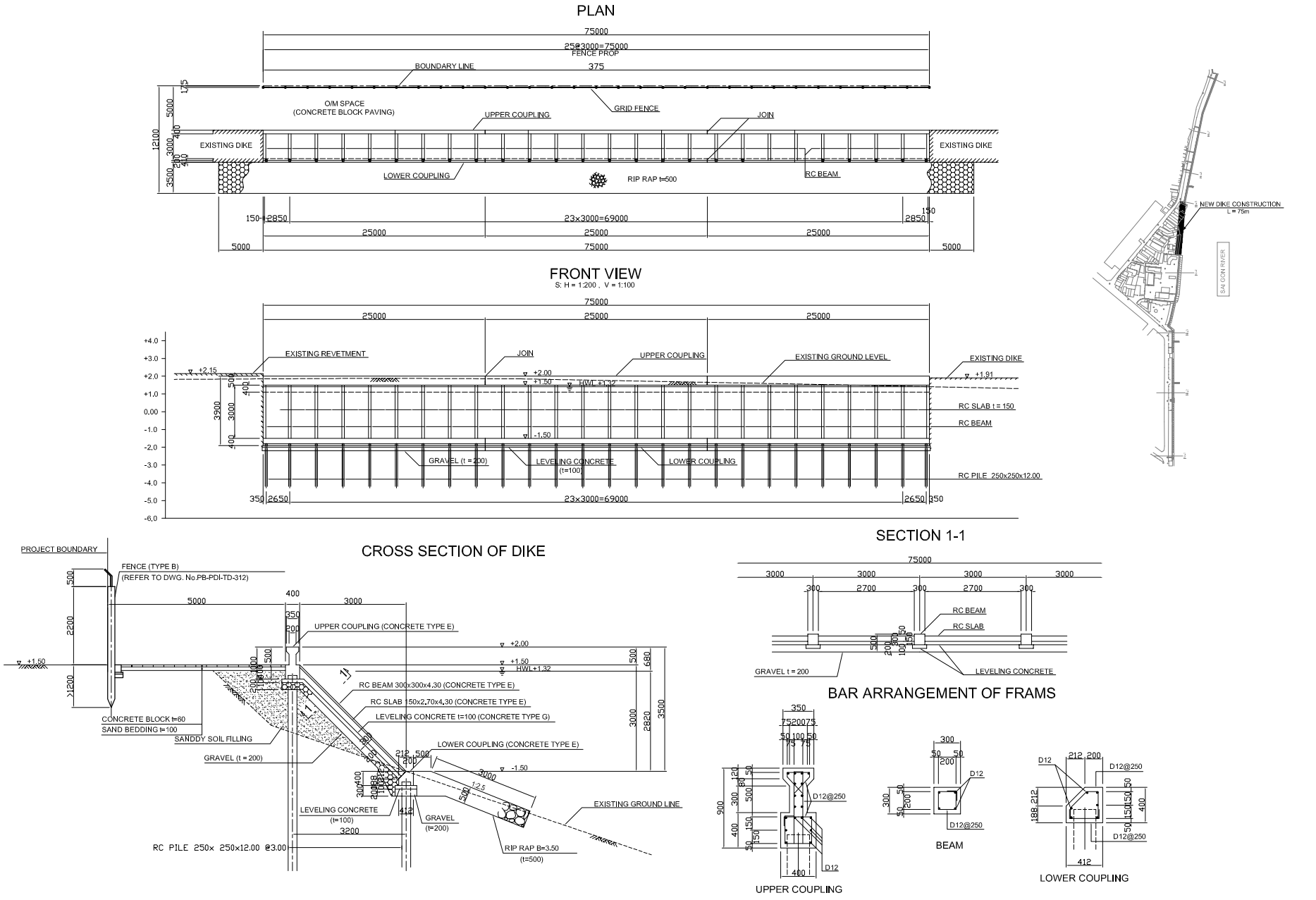
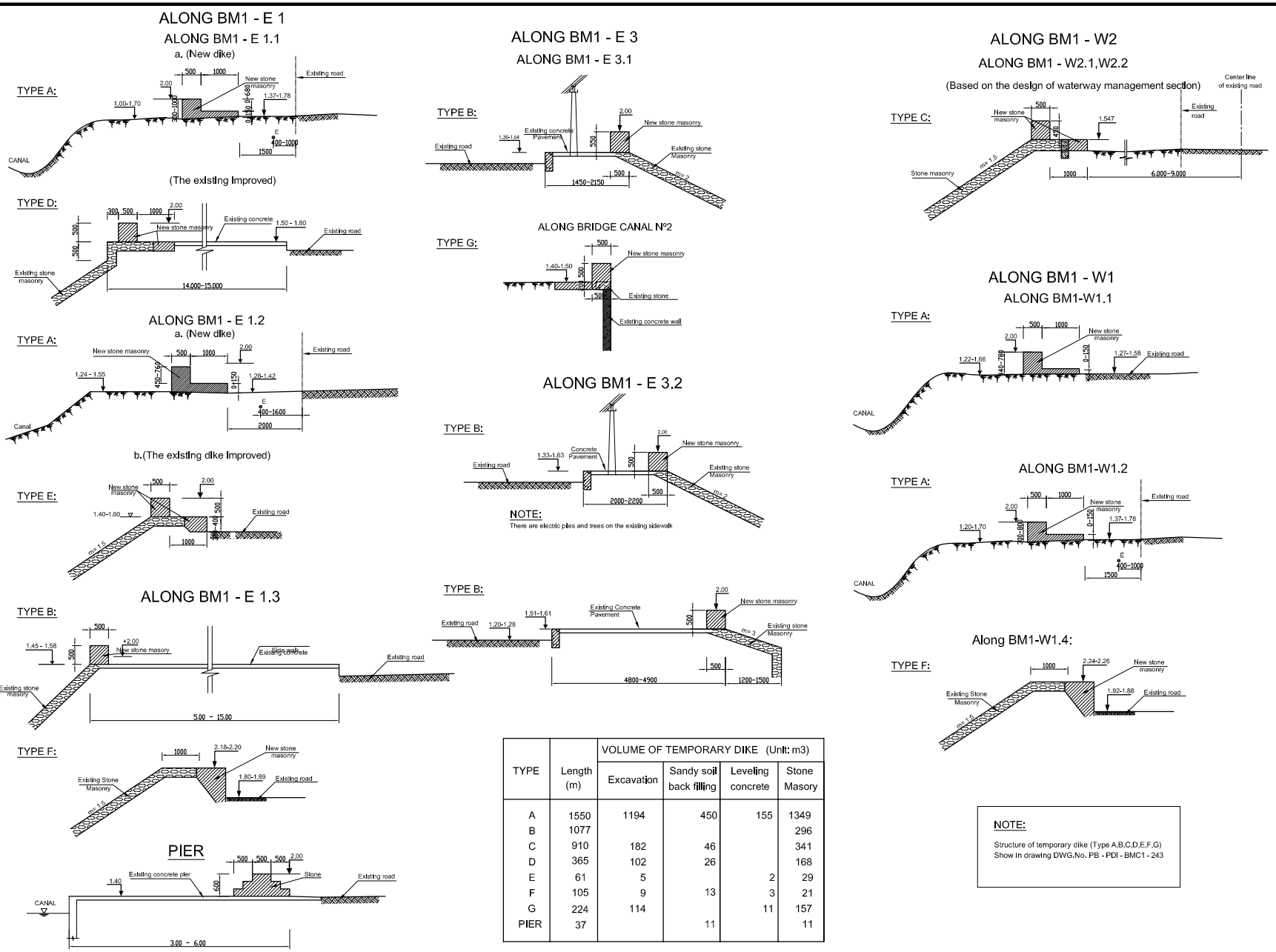


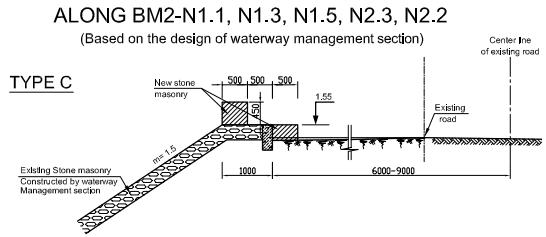
FIG. 3.2 DIKE ALONG SAIGON RIVER

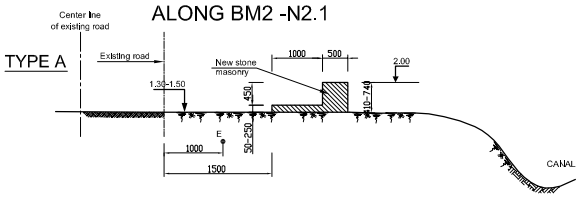


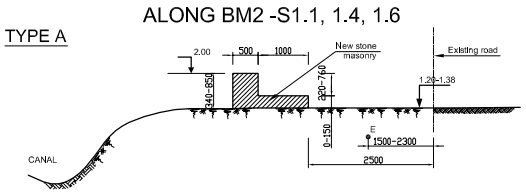
TYPE	Length (m)	VOLUME OF TEMPORARY DIKE (Unit: m3)			
		Excavation	Sandy soil back filling	Leveling concrete	Stone Masory
A	1550	1194	450	155	1349
B	1077				296
C	910	182	46		341
D	365	102	26		168
E	61	5		2	29
F	105	9	13	3	21
G	224	114		11	157
PIER	37		11		11

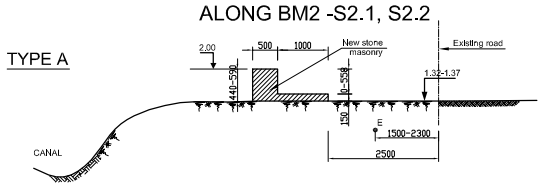
NOTE:
Structure of temporary dike (Type A,B,C,D,E,F,G)
Show in drawing DWG.No. PB - PDI - BMC1 - 243

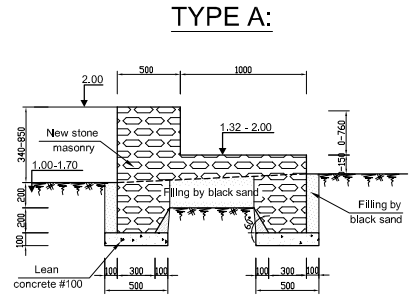
FIG. 3.3 TYPICAL CROSS SECTION OF TEMPORARY DIKE IN BEN ME COC (1)

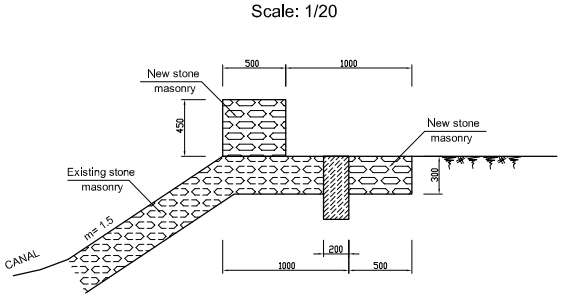










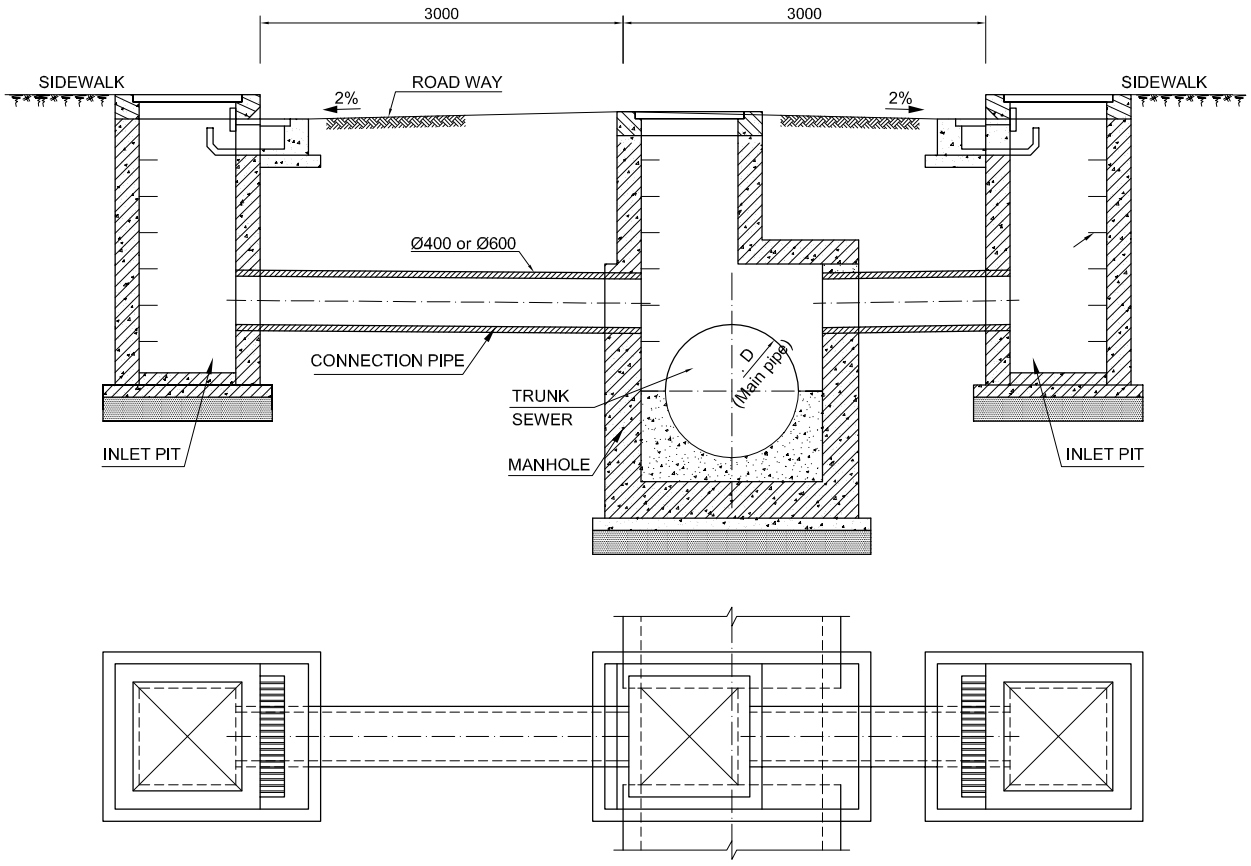


TYPE	VOLUME OF (PER 1m LONG) (Unit: m3)			
	Excavation	Sandy soil back filling	Leveling concrete	Stone Masory
A	0.71	0.257	0.1	0.81
C	0.2	0.05		0.375

TYPE	VOLUME OF TEMPORARY DIKE (Unit; m3)				
	Length (m)	Excavation	Sandy soil back filling	Leveling concrete	Stone Masory
A	2019	1433	519	202	1635
C	1467	293	73		550

FIG. 3.4 TYPICAL CROSS SECTION AND DETAILS OF TEMPORARY DIKE IN BEN ME COC (2)

CASE 1:



CASE 2:

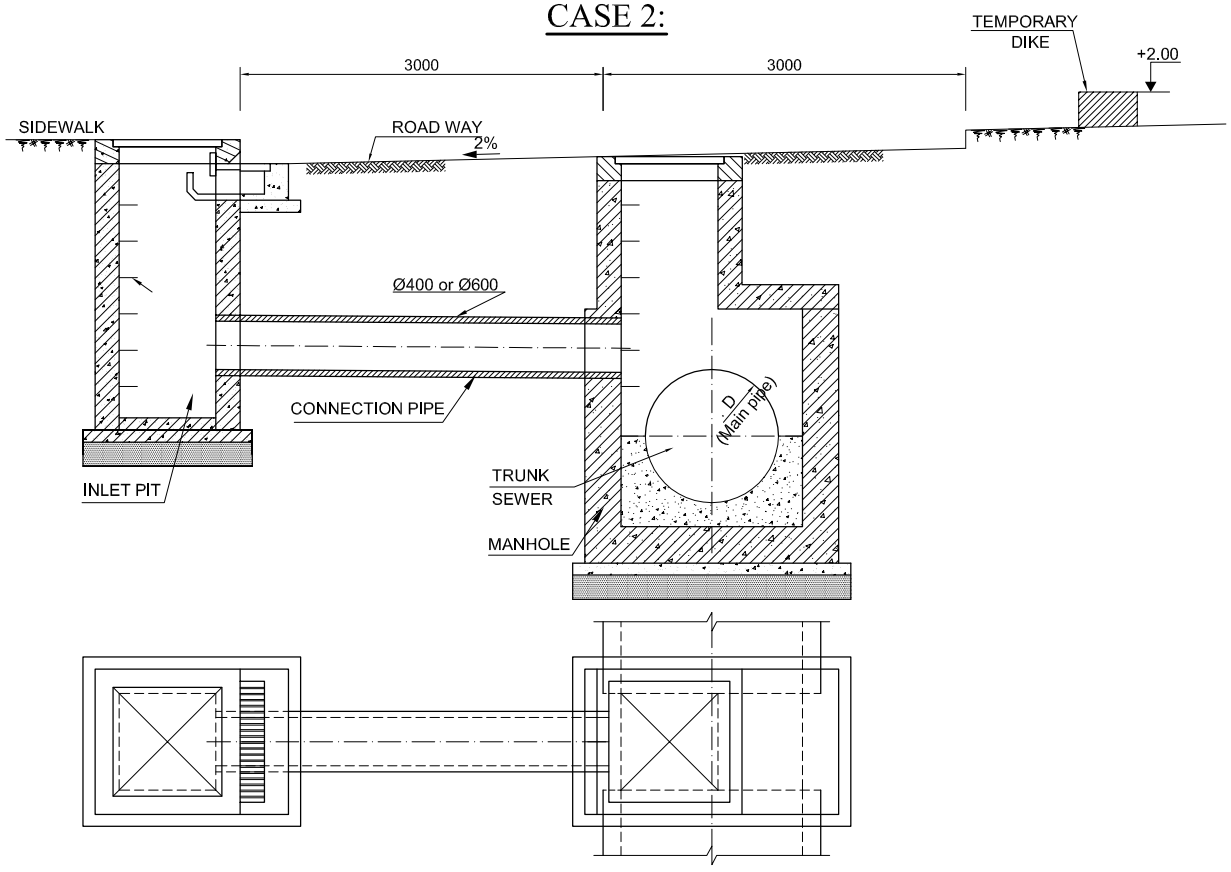
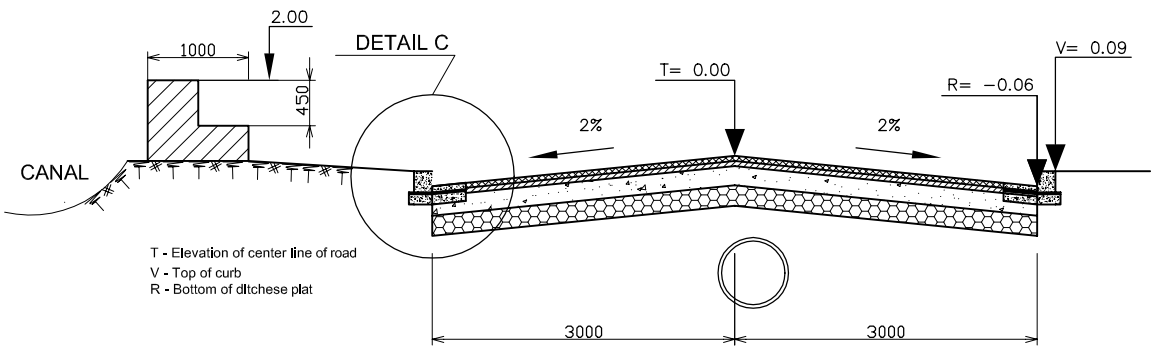
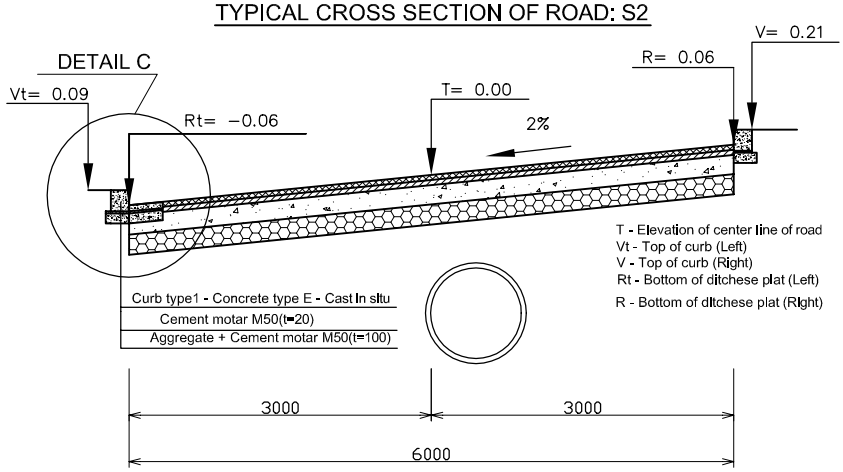


FIG. 3.5 TYPICAL LAYOUT OF TRUNK SEWER AND COLLECTION SYSTEM

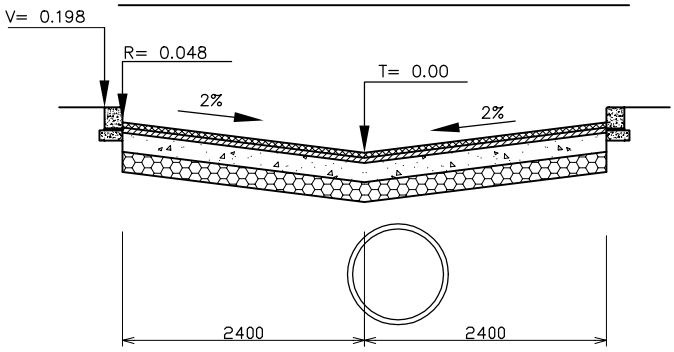
TYPICAL CROSS SECTION OF ROAD: S1



TYPICAL CROSS SECTION OF ROAD: S2

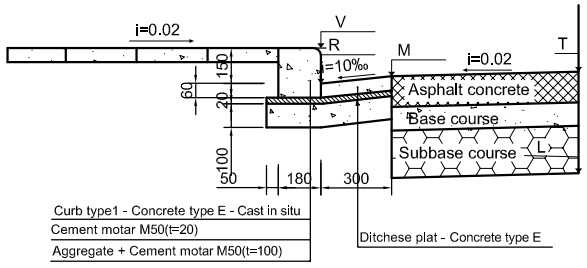


TYPICAL CROSS SECTION OF ROAD: S3



DETAIL C

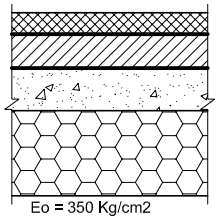
ORDINARY CURB



RECONSTRUCTION PAVEMENT

(LOAD STREET)

Type P3: demand elastic modulus Eyc = 1600kg/cm²



5cm wearing course, asphalt concrete (small size)
Emultifies asphalt tack coat 0.2 ~ 0.7 l/m²
5cm binder course asphalt concrete (gross size)
Emultifies asphalt prime coat 1.0 ~ 2.0 l/m²
19cm base course, crushed aggregate (size 2 ~ 4 cm)

20cm subbase course, aggregate 4 ~ 6cm (or red gravel grading)

49 cm IS TOTAL THICKNESS OF PAVEMENT

T_ Elevation of center line of road
V_ Top of curb (cm)
M_ Edge of pavement (cm)
R_ Bottom of ditchese plat (cm)
L_ Bottom of subbase (=subgrate level) (cm)

FIG.3.6 TYPICAL CROSS SECTION OF ROAD IN THANH DA BEN ME COC (1) AND BEN ME COC (2)

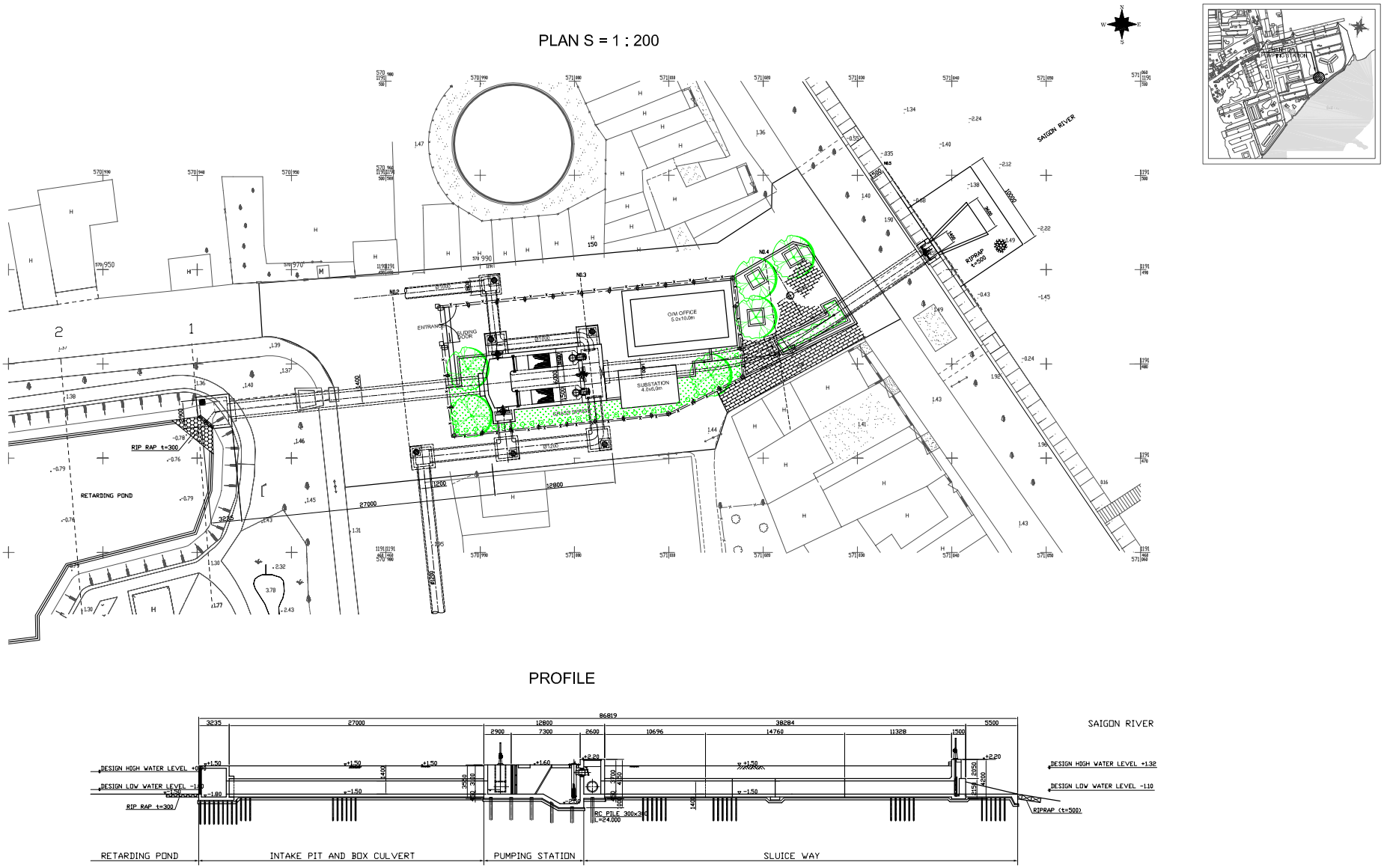


FIG. 3.7 GENERAL LAYOUT OF THANH DA PUMPING STATION

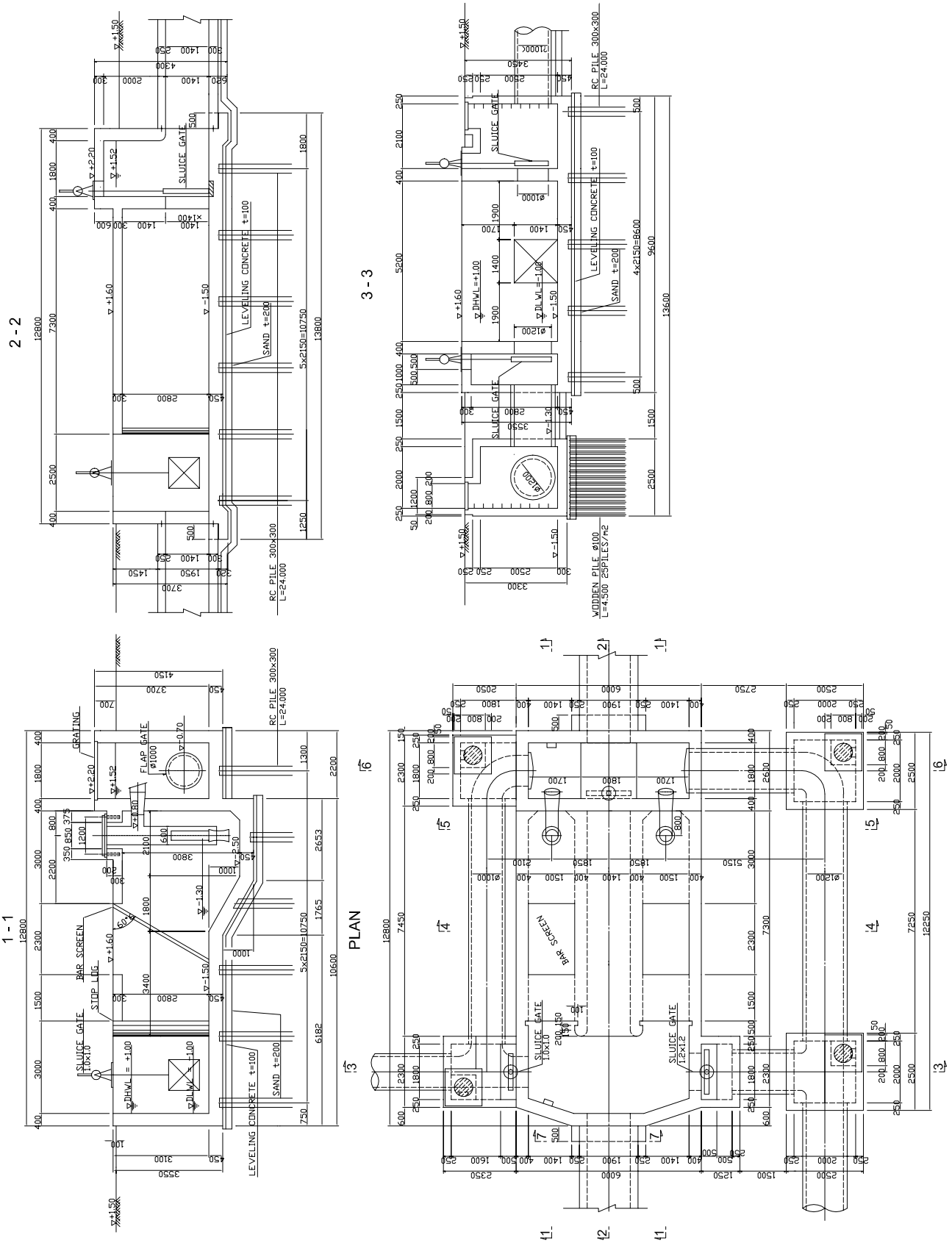


FIG. 3.8 PLAN AND SECTION OF THANH DA PUMPING STATION

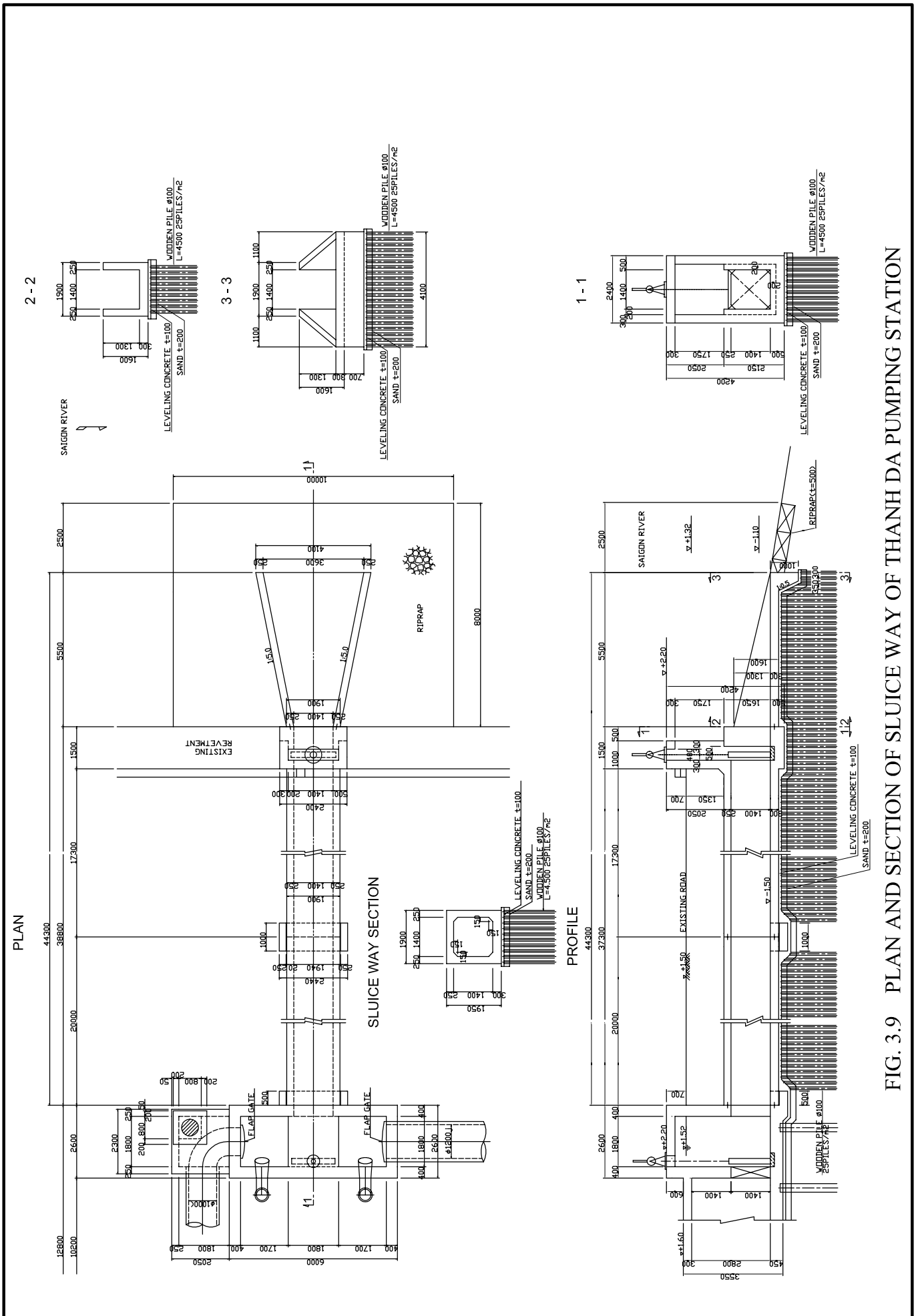


FIG. 3.9 PLAN AND SECTION OF SLUICE WAY OF THANH DA PUMPING STATION

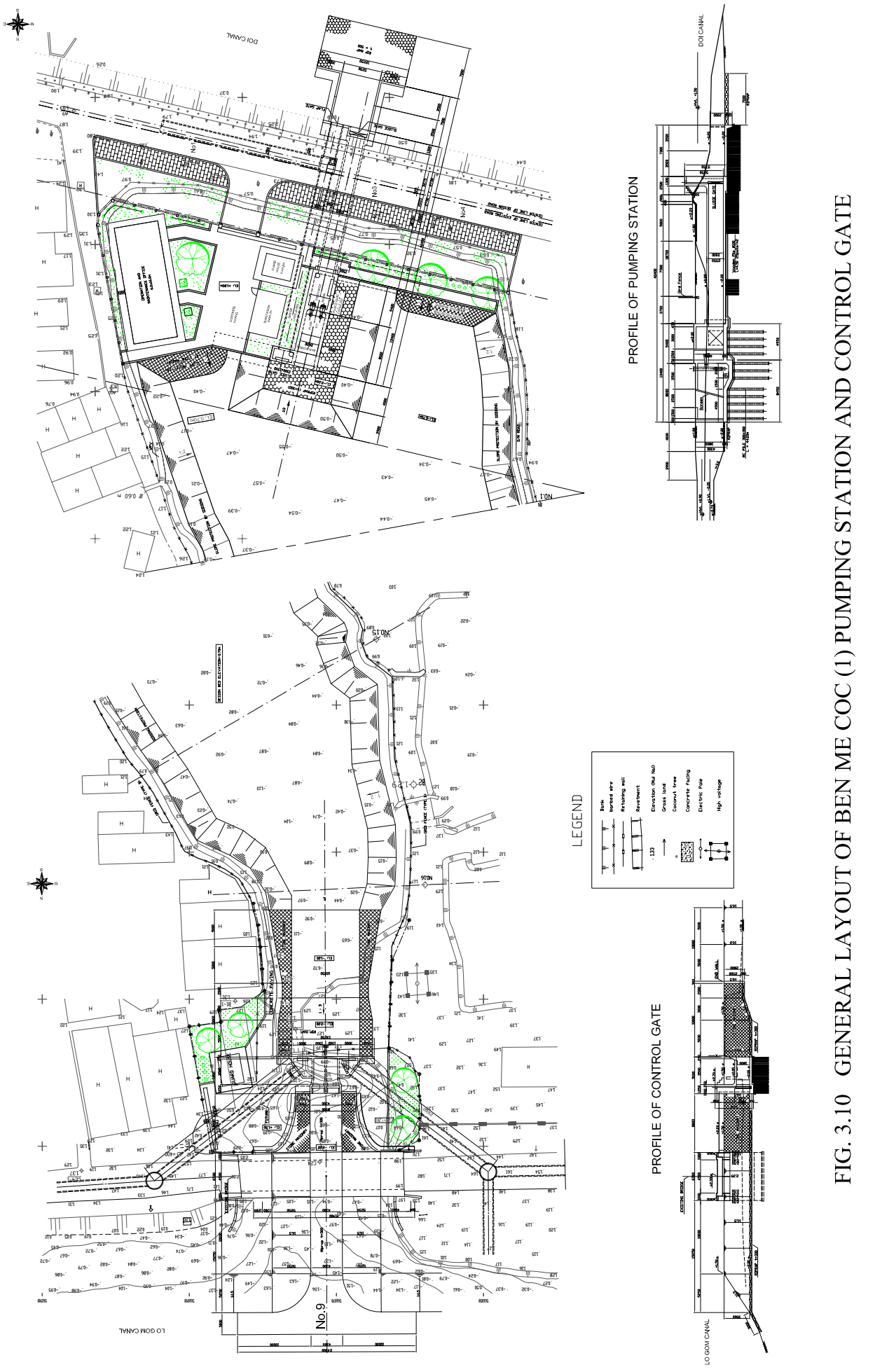


FIG. 3.10 GENERAL LAYOUT OF BEN ME COC (1) PUMPING STATION AND CONTROL GATE

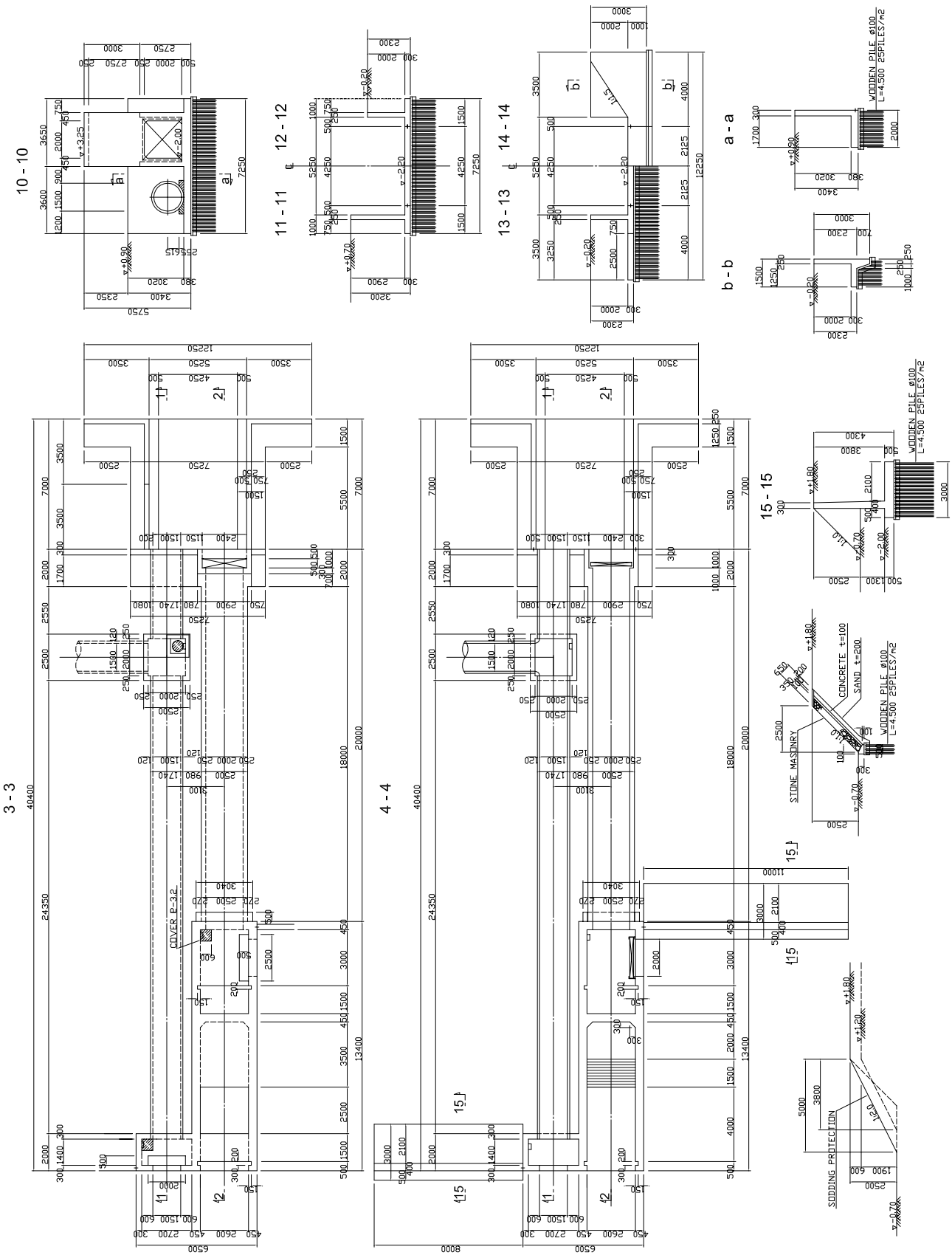


FIG. 3.11 PLAN AND SECTION OF BEN ME COC (1) PUMPING STATION

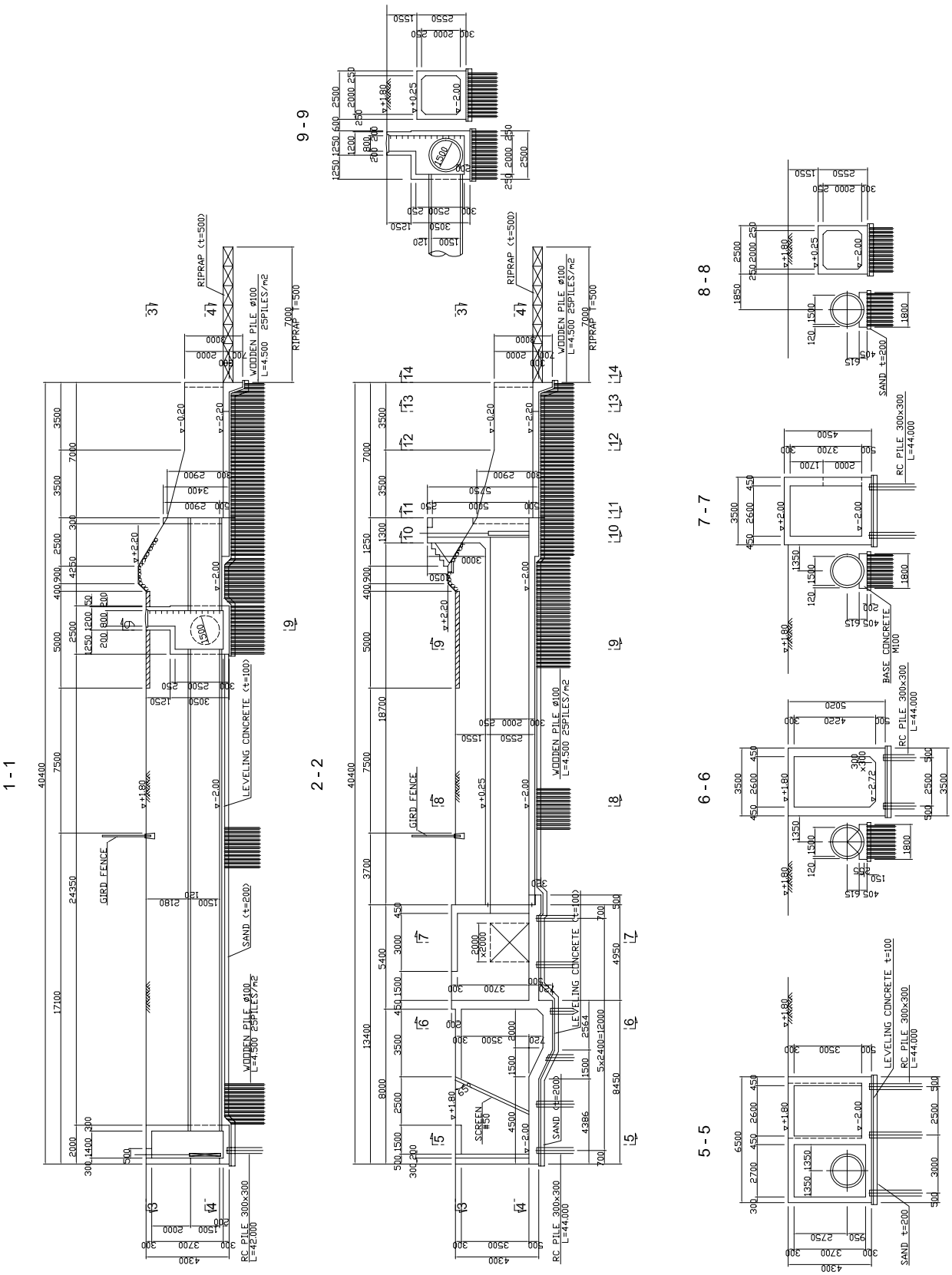


FIG. 3.12 SECTION OF BEN MEC COC (1) PUMPING STATION

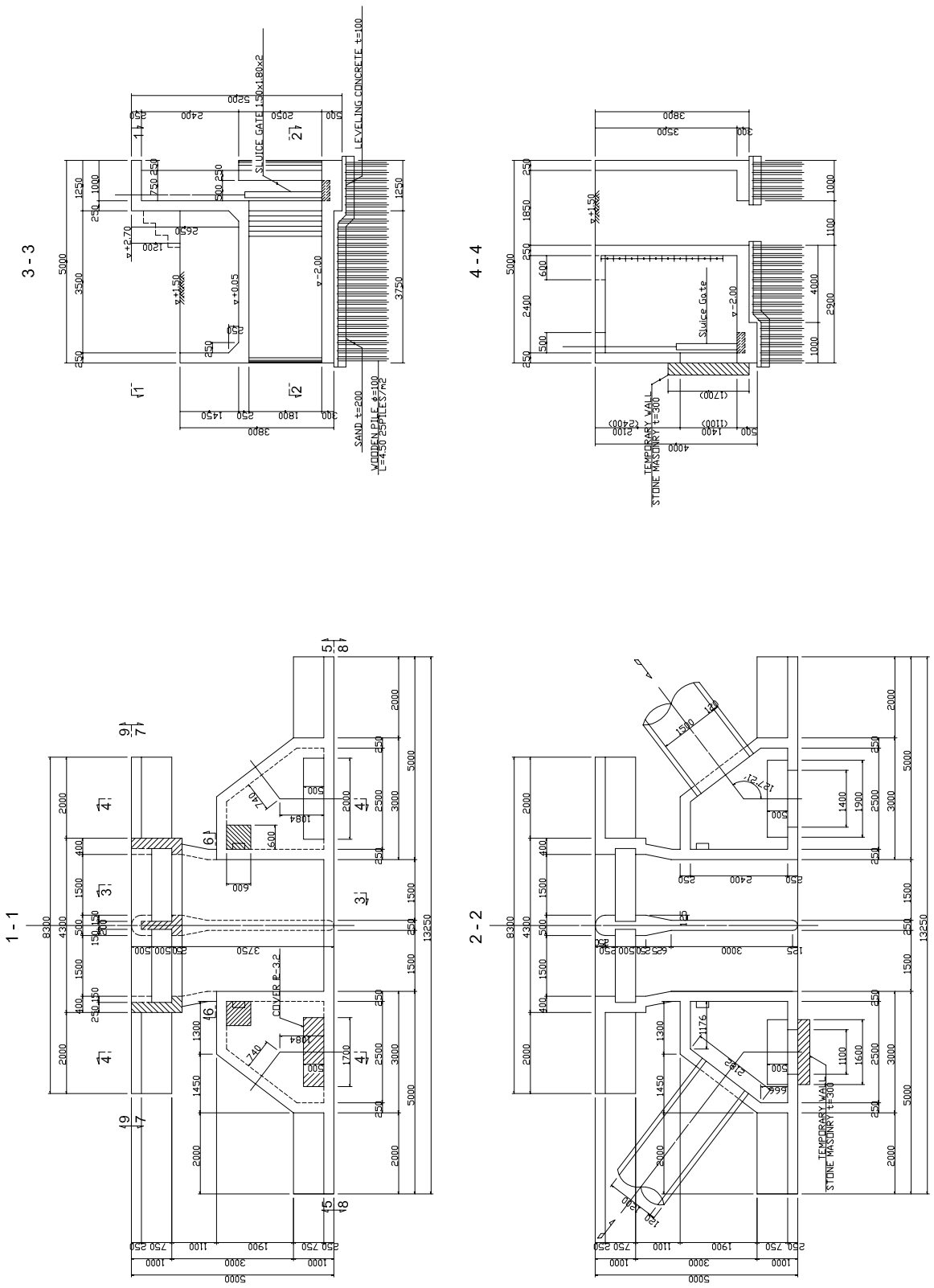
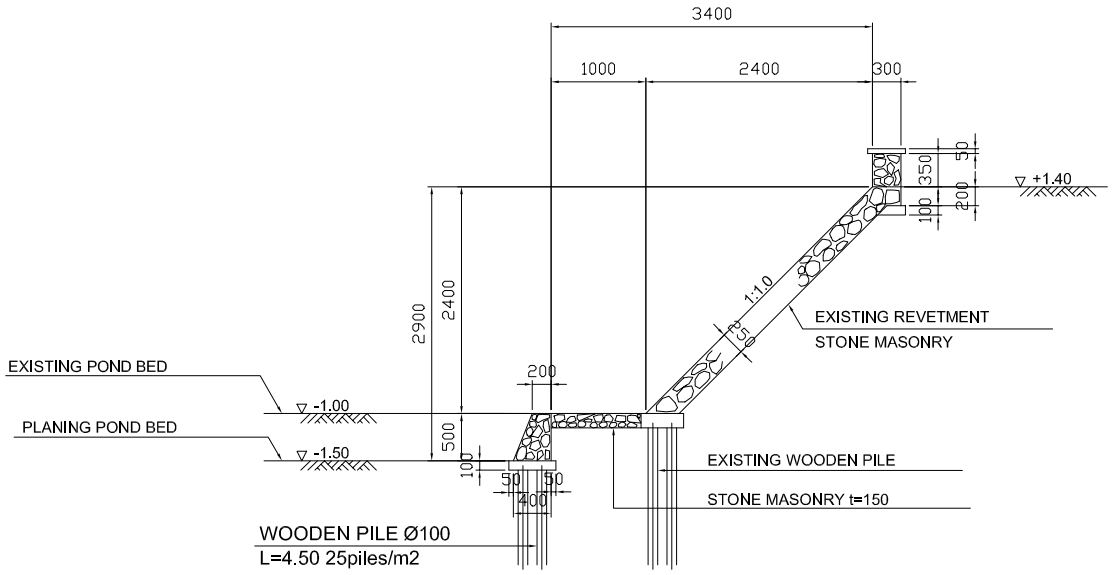
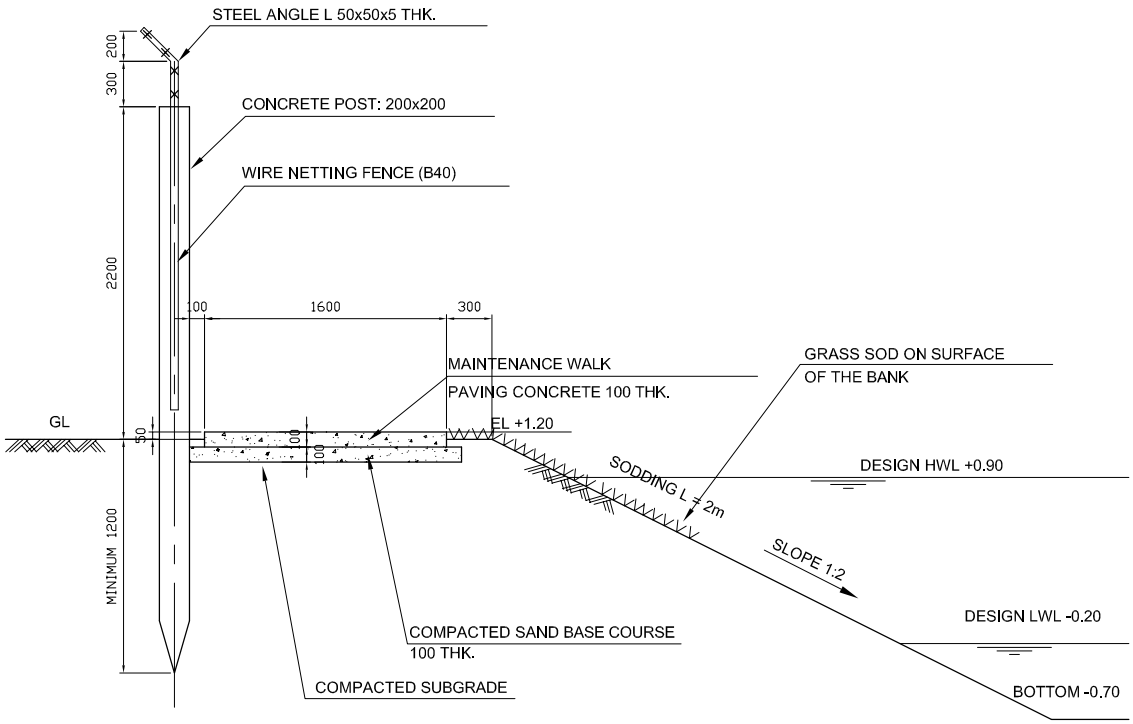


FIG. 3.13 PLAN AND SECTION OF BEN ME COC (1) CONTROL GATE

TYPICAL SECTION BANK



THANH DA RETARDING POND



BEN ME COC (1) RETARDING POND

FIG. 3.14 TYPICAL BANK CROSS SECTION OF RETARDING POND

Chapter 4
INTERCEPTOR SEWER CONSTRUCTION (PACKAGE C)

CHAPTER 4 INTERCEPTOR SEWER CONSTRUCTION (Package C)

4.1 General

The combined sewer system has been completely developed in the project area, thus the wastewater collected by the combined sewer is directory discharged to the water body, such as Tau Hu – Ben Nghe Canal and the Saigon River.

Interceptor sewer system is proposed to utilize the existing combined sewer system and to collect the wastewater before the water body as much as possible from the economical viewpoint (Figs. 4.1and 4.2).

The interceptor sewer system covers the eastern part area of the Tau Hu – Ben Nghe Canal basin of 914.7 ha. The served population, the daily average wastewater discharged and the hourly maximum discharge are estimated as follows:

Year	1997 (Existing)	2005	2010	2020
Served population	442,000	432,000	426,000	414,000
Design daily average wastewater (m^3/s)	83,000	123,000	141,000	153,000
Design hourly maximum wastewater (m^3/s)	113,000	167,000	192,000	208,00

4.2 Scope of Project

Interceptor sewer construction consists of main and secondary interceptor sewers with a total length of 12,180 m and a diameter ranging from Ø300 mm to Ø2200 mm, and manholes and diversion chambers.

The main interceptor starts at Ton Duc Thang Street and is installed through Ham Nghi and Tran Hung Dao Street. After crossing the Ben Nghe Canal the main interceptor reaches the wastewater intermediate pumping station constructed under Package C.

Sewer	Diameter (mm)	Sewer Length (m)	Manhole (places)	Diversion Chamber (places)
Main Interceptor	Ø300 – Ø2200	6,538	48	10
Secondary Interceptor	Ø225 – Ø800	5,642	92	18
Total		12,180	140	28

4.3 Applicable Code and Criteria

There has been no change in applying the following codes and standards since the Definitive Plan Study.

1) Vietnamese Standard (TCVN)
2) Design Criteria of Exterior and Project Drainage Networks No. 20 TCN-51-84,

Ministry of Construction
3) Sewerage Facilities Planning and Design Manual, Japan Sewerage Works Agency Standards (JSWAS), 1994
4) Japanese Industrial Standard (JIS)
5) Reinforced Concrete Sewer Pipe, Japan Sewerage Works Agency Standards (JSWAS), 1987
6) Reinforced Concrete Pipe Jacking Sewer Pipe, Japan Sewerage Works Agency Standards (JSWAS), 1999
7) American Society for Testing and Materials (ASTM)
8) American Association of State High Way and Transportation Officials (AASHTO)
9) Specification of Highway Bridges: Part 4 (Japan Road Association 1994)
10) Standard Specification for Design and Construction of Concrete Structure (The Japan Society of Civil Engineers 1996)
11) Proceedings of Vietnam Construction Standards, Volume III (Ministry of Construction 1997)
12) Proceedings of Cost Estimate for Sewerage Design, Japan Sewerage Works Agency Standards (JSWAS)

4.4 Design Condition and Criteria

(1) Design Load

Design ground water level	:	same as ground level
Unit weight of soil	:	$\gamma = 1.8$ t/m^3
Friction angle	:	$\phi = 30$ º
Unit weight of soil under ground water	:	$\gamma' = 0.8$ t/m^3
Live load	:	H-30 (30 t)
Earth pressure at rest	:	$K_0 = 0.5$

(2) Allowable Stress

Concrete		
Design strength	:	$\sigma_{ck} =$ 210 kgf/cm^2
Compressive stress	:	$\sigma_{ca} =$ 70 kgf/cm^2
Steel		
Yield stress	:	$\sigma_{sy} =$ 3,000 kgf/cm^2
Tensile stress	:	$\sigma_{sa} =$ 1,600 kgf/cm^2
Shearing stress	:	$\tau_{ca} =$ 3.6 kgf/cm^2

(3) Construction Method of Pipe

A calculation of temporary works results that total length of steel sheet pile become more than 20 m and is not practical if the exaction depth is deeper than 10 m. Otherwise, soil improvement is applied to the whole area of the trench bottom with a depth of about 4 m.

In this case, the construction cost of sewer pipe per meter by open cut method is more expensive than by pipe jacking method. Consequently, construction of pipe by Open Cut Method is limited to excavation on 10 m deep and construction method by the excavation

depth is classified into two (2) types as follows:

Excavation Depth (m)	Construction Method
less 10	Open Cut
over 10	Pipe Jacking

4.5 Design of Main Interceptor Sewer – Open Cut Method

4.5.1 Earth Work

(1) Alternative of Excavation Method

Excavation depth at the main interceptor sewer ranges from 4.6 m to 10.0 m. The following alternatives are compared for excavation method:

- Open Cut Method
- Earth retaining method, Soldier Pile and Lagging Method
- Earth retaining method, Braced Sheeting Method

Based on cost and reliability of construction, soil condition and other matter, Braced Sheeting Method shall be adapted for main interceptor construction. The detail comparison is described in Table 4.1.

(2) Braced Sheeting

Calculation of temporary works by using braced sheeting is conducted for different excavation depth and nine (9) types of the braced sheeting are designed for the open cut method. The excavation depth used for the designing are 5.0 m, 6.0 m, 6.5 m, 7.5 m, 8.0 m, 9.0 m, 9.5 m, 10.0 m, and 10.5 m.

(3) Excavation Depth

Excavation depth is varied depending on installation depth of pipe and pipe bedding. Regarding type of the bedding, excavation depth is described as follows:

- Sand bedding : 200 mm below the pipe
- Concrete bedding : 200 mm below the concrete base

The bedding is described in section 4.5.3.

(4) Excavation Width

Excavation width is determined by pipe installation, excavation equipment, base of pipe and thickness of retaining wall. Excavation width for the main interceptor sewer is summarized in Table 4.2.

(5) Excavation Equipment

Backhoe is used for excavation depth less than 6 m. Over 6 m, clamshell is used.

(6) Backfill Materials

Two (2) types of backfill materials is used, sand (yellow sand) and sandy soil (black sand). Sand is filled up to 200 mm from the crown of pipe. The rest area is filled by sandy soil up to under pavement.

4.5.2 Pipe

Pipe design standard in Vietnam and Japan is not much different. However, it is different concept of vertical load by soil to an installed pipe. The difference is mentioned as follows:

Vietnam
The vertical load is considered as uniform load to a width of a pipe over the width of the pipe.

Japan
The vertical load is considered as uniform load to a width of a pipe over the width of the trench excavation after pulled out of sheet pile.

In Vietnam, sewerage pipe is generally installed in shallow with timber wall. However, the main interceptor sewer is installed at a depth ranging from 4 to 10 m by Open Cut Method with Braced Sheeting. Considering installation depth and retaining wall material, Japanese standard is adopted for the pipe deign.

If the vertical load exceeds strength of pipe, pipe is bedded on concrete. The detail is described in the following section.

4.5.3 Pipe Bedding

Pipe bedding is considered sand and concrete, 120°, 180°, and 360°. Concrete bedding is placed when vertical load is over design strength of pipe. Sand at a thickness of 200 mm is placed under concrete bedding. Table 4.2 shows pipe bedding for each diameter in main interceptor.

4.5.4 Manhole

Interval
Interval of manhole is reviewed by Vietnamese and Japanese Standards. As a result, the following distance is designed for maximum distance between manholes except special case.

Pipe Diameter (mm)	Interval Distance (m)
less than Ø 300	50
Ø 400 - Ø 600	75
Ø 700 - Ø 1000	100
over Ø 1100	150

Type

Manhole is classified into six (6) types based on diameter and angle of pipe connection. Typical drawing for manhole is shown in Fig. 4.3.

Type	Pipe Diameter (mm)	Connection Angle (degree)	Inside Width*1) (mm)	Inside Length*2) (mm)
SPM-1	Ø 300 - Ø 600	180	1600	3100
SPM-2	Ø 800 - Ø 1200	180	2200	3100
SPM-3	Ø 1500	180	2500	3100
SPM-4	Ø 2200	180	3200	3100
SPM-5	Ø 800 - Ø 1200	150	2200	2600*3)
SPM-6	Ø 1500	90	2500	3100

Note

*1): Width is adjusted if necessary. For example, pipe is not connected exactly described angle above.

*2): If secondary interceptor is connected to parallel to main interceptor, the length becomes longer.

*3): Dimension indicates inner side.

Landing

Landing is installed when a height of one floor exceeds 5 m except special case.

Open Mouth for Manhole

Two (2) open mouths are designed one for persons to enter and the other for maintenance equipment to be brought up and down.

Invert Concrete

1) Height between Invert Level of Pipe and Base

A height of manhole is rounded 100 mm. To do that, a height between invert level of pipe and base is adjusted ("h_1" in Fig. 4.3). The range of the height is as follows:

Pipe Diameter (mm)	Height between Invert Level and Base (mm)
Ø 300 - Ø 600	180 - 280
Ø 800 - Ø 1200	190 - 290
Ø 1500	240 - 340
Ø 2200	290 - 390

2) Height between Invert Level of Pipe and Surface of Invert Level

The height between invert level of pipe and surface of invert level is a half of internal diameter of pipe ("h_2" in Fig. 4.3). However, the height for pipe diameter greater than Ø 1000 mm is 500 mm.

4.6 Design of Main Interceptor Sewer - Pipe Jacking Method

4.6.1 General

Open Cut Method is applied at an excavation depth of less than 10 m. For deeper than 10 m, tunneling method of pipe jacking or shield tunneling method shall be applied. Based

on soil property and construction cost, pipe jacking method is appropriate method for this construction.

4.6.2 Alternative of Pipe Jacking

Two (2) types of pipe jacking method is compared, (i) Open Cutting Edged type and (ii) Semi-Shield. Because of high groundwater level, semi-shield method should be applied.

Then slurry and earth pressure balance semi shield methods are compared. Based on soil condition and cost, the earth pressure balance type is applied.

The detail comparison is described in Table 4.3.

4.6.3 Jacking Pipe

Jacking pipe is made of reinforced concrete. The pipe is designed based on JSWAS A-2 Type 1.

4.6.4 Shaft

Interval

Based on soil condition and Japanese standard, a maximum interval of shaft applying secondary jack is set 300 to 315 m.

Excavation Depth

A height of jacking machine below invert level shall be considered for the excavation depth. Under the jacking machine, base concrete of 200 mm thick is placed.

Excavation Width

Excavation width is determined by comparison of two items; width of jacking machine and width of manhole, which is constructed at a shaft after completion of jacking pipe work. In this design, a width of manhole is larger than width of jacking machine. Therefore, the excavation width shall be applied width of manhole. In addition, as a working space, 1 m in each side is added to width of manhole.

Earth Retaining Wall and Excavation Machine

Steel sheet pile shall be used. Since excavation depth is greater than 6 m, clamshell shall be used for the excavation.

Backfill

Sandy soil shall be used. Sand is not necessary to used because concrete is placed around jacking pipe between manhole and the edge of excavation.

4.7 Design of Secondary Interceptor Sewer

4.7.1 General

Secondary interceptor sewer is constructed to connect between existing sewer and main interceptor. The sewer is constructed by trench method. Diversion chamber is installed at the connection between existing sewer and secondary interceptor.

4.7.2 Earth Work

(1) Alternative of Excavation Method

Excavation depth at secondary interceptor is from 3.2 m to 6.6 m. Since there are many experiences of shallow excavation in Vietnam, excavation method at a depth of less than 4.5 m is applied local method. The local method is to apply timber sheet pile as retaining wall. Excavation depth deeper than 4.5 m is applied by braced sheeting.

(2) Steel Sheet Pile

Maximum excavation depth is less than 7.5 m. Therefore, FSP-2 is applied for all steel sheet pile. Refer to section 4.5.2.

(3) Excavation Depth

Excavation depth is varied depending on pipe bedding. Type of the bedding and excavation depth is described as follows:

- Sand bedding : 200 mm below the pipe
- Concrete bedding : 200 mm below the concrete base

The detail of bedding is described in section 4.7.3.

(4) Excavation Width

Excavation width is determined by pipe installation, excavation machine, base of pipe and thickness of retaining wall. Excavation width for secondary interceptor sewer is summarized in Table 4.4.

(5) Excavation Equipment

Backhoe is used for excavation depth less than 6 m. Over 6 m, clamshell is used.

(6) Backfill

Two (2) types of backfill materials is used, sand (yellow sand) and sandy soil (black sand). Sand is filled up to 200 mm crown of pipe. The rest is used sandy soil up to under pavement.

4.7.3 Pipe

Refer to 4.5.3.

4.7.4 Pipe Bedding

Pipe bedding is considered sand and concrete. The bedding for pipe with excavation depth is summarized in Table 4.4.

4.7.5 Manhole

Interval

The interval of manhole is designed as follows:

Pipe Diameter (mm)	Interval Distance (m)
< Ø 300	50
Ø 400 – Ø 600	75
Ø 700 – Ø 1000	100

Type of Manhole

Manhole is categorized by pipe diameter (2 types) and connection type (2 types). Fig.4.4 shows typical figure of manhole and connection type.

Open Mouth for Manhole

One open mouth is designed for persons to enter and maintenance equipment brought up and down.

Invert Concrete

1) Height between Invert Level of Pipe and Base

   To round 100 mm for height of manhole, height between invert level of pipe and base is adjusted. The range of the height is as follows:

Pipe Diameter (mm)	Height between Invert Level and Base (mm)
Ø 300 - Ø 600	180 - 280
Ø 800 - Ø 1200	190 - 290

2) Height between Invert Level of Pipe and Surface of Invert Level

   The height between invert level of pipe and surface of invert level is a half of internal diameter of pipe. However, the height for pipe diameter greater than Ø1000 mm is 500 mm.

4.7.6 Diversion Chamber

Diversion chamber is installed in main and secondary interceptor, and designed as following concept:

Open mouth

Several open mouths are designed for person to enter, replacement of flap gate and sluice valve, control of stop log, and maintenance of trash screen.

Flap Gate

Size of flap gate is designed the same size or the equivalent cross section area of existing drainage to reduce head loss as low as possible. A water depth at drainage is 9 cm at maximum hourly wastewater discharge. Based on this, the bottom level of open mouth at flap gate is designed 15 cm higher than invert level of existing drainage.

Orifice

Pipe is installed for orifice. Size of orifice is designed at a capacity of hourly maximum flow in the sewage catchments. Top of orifice is the same as invert level of existing drainage. As mentioned above, a bottom level of flap gate is 15 cm higher than invert level of drainage. This 15 cm plus radius of pipe becomes a head of orifice for this design. Since the head is not so high, head loss at orifice is neglected.

Structure

Based on function and installed location, four types of diversion chamber are designed.

1) DC 1

   DC 1 is installed in main and secondary interceptor. This type just has function of diverting sewage.

2) DC 2

   DC 2 is installed in main interceptor. A structure of DC 2 consists of DC 1 and manhole.

3) DC 3

   DC 3 is installed in secondary interceptor. A structure of DC 3 consists of DC 1 and manhole where sluice valve and water level alarm are installed. Secondary interceptor is installed perpendicular to existing drainage.

4) DC 4

   DC 4 is the same as DC 3 except that secondary interceptor is installed parallel to existing drainage.

DC2 and DC4 are shown in Figs. 4.5 and 4.6, respectively.

4.8 Design of Road Restoration

Pavement structure of the road in the project area is classified into five (5) types according to the Vietnamese standard of " 20 TCN 104-83, Urban Highway Design, MOC ". The pavement structure of road by each type is listed below.

Type / Material	P1	P2	P3	P4	P5
Wearing Course	5 cm	-	5 cm	5 cm	5 cm
Tack Coat	0.2 – 0.7 l/m^2	-	0.2 – 0.7 l/m^2	0.2 – 0.7 l/m^2	0.2 – 0.7 l/m^2
Binder Course	8 cm	9 cm	5 cm	7 cm	9 cm
Prime Coat	1.0 – 2.0 l/m^2	1.0 – 2.0 l/m^2	1.0 – 2.0 l/m^2	1.0 – 2.0 l/m^2	1.0 – 2.0 l/m^2
Base Course	10 cm	10 cm	19 cm	26 cm	29 cm

Sub Base Course	20 cm	20 cm	20 cm	15 cm	20 cm
Total Thickness	43 cm	39 cm	49cm	53 cm	63 cm

The roads where the existing combined sewers are installed are identified as Type 4 for the secondary interceptor sewer construction and Type 5 for the main interceptor sewer construction.

4.9 Bill of Quantity

The quantities of major works item are as listed below. Details of Bill of Quantities of Interceptor Sewer Construction Project are compiled in Design Report.

Item	Unit	Quantity
Sewer Pipe (300 mm to 1000 mm)	m	7,660
Sewer Pipe (1200 mm to 2200 mm)	m	6,320
Excavation	m^3	120,500
Backfill	m^3	81,300
Road Works	m^2	10,930
Concrete	m^3	8,270
Reinforcement Bar	tonne	410

4.10 Construction Plan and Schedule

This section deals with construction plan and schedule of the interceptor sewer construction.

4.10.1 Basic Condition

For preparation of construction plan and schedule, the following consideration has been taken as a basic concept of construction works.

(1) Scope of Work

The construction work consists of the following main construction component:

(a) Construction of main interceptor sewer (Total length = 6,538 m)

- Excavation of trench and shaft : V = 74,239 m^3
- Sand Backfill : V = 4,073 m^3
- Sandy Soil Backfill : V = 60,271 m^3
- Reinforced Concrete : V = 1,307 m^3
- Pipe Jacking : L = 3,867 m

(b) Construction of secondary interceptor sewer (Total length = 5,642 m)

- Excavation of trench : V = 46,217 m^3
- Sand Backfill : V = 8,474 m^3
- Sandy Soil Backfill : V = 32,278 m^3

(c) Construction of Manhole (31+92 = 123 places)

- Reinforced Concrete : V = 4,671m^3

(d) Construction of Diversion Chamber (10 places)

- Reinforced Concrete : V = 1,049 m^3

(2) Other Conditions

(a) Model of Construction

The construction shall be carried out by sufficient contractor(s) selected through the international bidding (ICB).

(b) Availability of Construction Plant and Equipment

The major construction works shall be conducted by applying heavy equipment, which are mostly supplied locally, due to limited construction period and keeping good quality of construction.

(c) Construction Materials

Most of basic construction materials could be considered available in this country. Some particular processed materials (steel sheet pile, H-type steel beam, mechanical and electrical equipment and etc.) are to be procured from outside.

(d) Pattern of Construction Method

Main work comprises of trench excavation and backfilling, concrete work and pipe jacking work.

4.10.2 Major Works of the Construction

Major works of interceptor sewer construction consists of the followings:

(1) Excavation and shoring works for trench

Excavation shall be conducted by back hoe for excavation depth smaller than 6.0 m and shall be conducted by clamshell for excavation depth greater than 6.0 m.

Timber sheeting has been considered as a shoring for a trench with a depth less than 4.5 m. While, continuous sheet piling with H-type steel bracing have been designed as shoring for a depth greater than 4.5 m. Sheet piles shall be driven into the required depth by vibro hummer. Excavation shall be limited to 0.5 m below at each strut level.

As shown in Fig. 4.7, the trench depth for the main interceptor is greater than 4.5 m, therefore the shoring with sheet pile and H-type steel has been applied. Length of trench section has been considered 30 m. Recycling time of sheet pile and H-shape have been estimated at between 30 and 50 times depending on the length of trench section along which the same length of sheet pile is used.

The excavated soil is directly loaded to dump track by excavators and is transported to the proposed dumping site.

The trenches should be dewatered for concrete placement and pipe laying, and they should be kept continuously dewatered for as long as necessary. Dewatering shall be executed by sump drainage method.

(2) Installation of pipe by Open Cut Method

Pipe installation work consists of the following works.

(a) Sand backfilling

Sand backfill of 200 mm thick shall be executed at the bottom of any trench. Sand backfilling shall be carried out with the yellow sand and by tamper.

Sand backfill for sand bedding shall be carried out up to 200 mm above the pipe crown with the same material and manner.

(b) Concrete work for concrete cradle and encasement

(c) Pipe placement

Pipe should be handled in a manner that eliminate any possibility of high impact or point loading due to dropping or impacting, with care taken always to protect the joints.

Sewer pipe should be laid on a firm, true to line and grade, with uniform bearing under the full length of its barrel with the socket ends of bell and spigot.

(3) Excavation and shoring works for shafts

Prior to excavation, soil improvement work shall be executed below the bottom of shaft with depths ranging from 2.0 m to 3.0 m by cement-mixing method.

The excavation faces of launching and receiving sides of shaft shall be improved by cement-mixing method at the same time. The improvement area differs according to the pipe diameter as shown below.

Diameter (mm)	Width (m)	Length (m)		Height (m)
		Launching	Reception	
1200	3.5	3.2	5.5	4.0
1500	3.8	3.3	5.9	4.3
2200	4.7	3.6	7.5	5.2

Excavation works shall be conducted in the same manner as trench described in (a) Excavation and shoring works for trench

(4) Installation of pipe by Pipe Jacking Method

Location of shaft for pipe jacking work have been determined based on the required are in consideration of hindrance to traffic and residents.

Total number of shaft is 18 places and the location of shafts is shown in Fig. 4.8. 9 shafts

have been designed as a launching shaft and the remaining 9 shafts including the intermediate pumping station site have been designed as reception shaft.

Construction plan of pipe jacking work is described as shown in Fig, 4.10. On the ground, a space of lubricant equipment, grouting equipment, muck tank crane genetor, power pack, control cabin, stock yard for pipe, transportation and other minor works is required at the launching shaft has been carefully considered to determine the locations of the shaft.

The connection with the IWPS is executed by pipe jacking work to excavated the wall of the pump well of the IWPS. The structure of the pump well has been designed to receive the excavation machine and to be utilized as a reception shaft.

(5) Concrete work for manholes and diversion chambers

Ready mixed concrete, which is produced in a factory and transported to the site by truck with agitator, shall be used for all concrete structures. The concrete shall be placed to the required position by crane with bucket.

(6) Backfill work

Backfilling should proceed immediately on curing of trench-made joints and after the concrete cradle, or other structures gain sufficient strength to withstand loads without damage. Backfilling shall be executed with the black sand up to the road sub-grade level. The pipe zone extends from the foundation material to 200 mm above of the sewer pipe or structure and consists of the specified material according to the bedding type. This zone should be compacted by rammer in such a manner as not to disturb the sewer pipe and structure.

(7) Removal of struts and sheet pile for shoring

Struts shall be removed when backfilling reaches the strut levels. After backfilling complete to road sub-grade, sheet piles shall be carefully drawn without loosing the surrounding ground.

4.10.3 Construction Schedule

To consider the construction conditions, such as possible working area, working items, applicable construction machines and numbers, construction period for each works are expected as following:

(1)	Preparatory Work	2 Months
(2)	Main Interceptor Sewer by Open Cut Method	27 Months
(3)	Pipe Jacking Work for Ø1200mm Pipe	
	- Earth Work for Shafts	16 months
	- Pipe Jacking Works	12 Months
	- Structure Work for Manholes	11 Months

(4)	Pipe Jacking Work for Ø1500mm Pipe	
	- Earth Work for Shafts	12 months
	- Pipe Jacking Works	8 Months
	- Structure Work for Manholes	10 Months
(5)	Pipe Jacking Work for Ø2200mm Pipe	
	- Earth Work for Shafts	7 months
	- Pipe Jacking Works	6 Months
	- Structure Work for Manholes	7 Months
(6)	Secondary Interceptor Sewer by Open Cut Method	33 Months
(7)	Cleaning and Handing Over	1 Month

Construction schedule of the interceptor sewer is shown in Table 4.5.

TABLE 4.1 ALTERNATIVES OF EXCAVATION METHOD

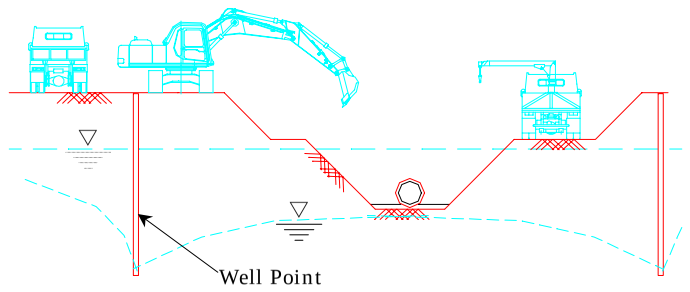
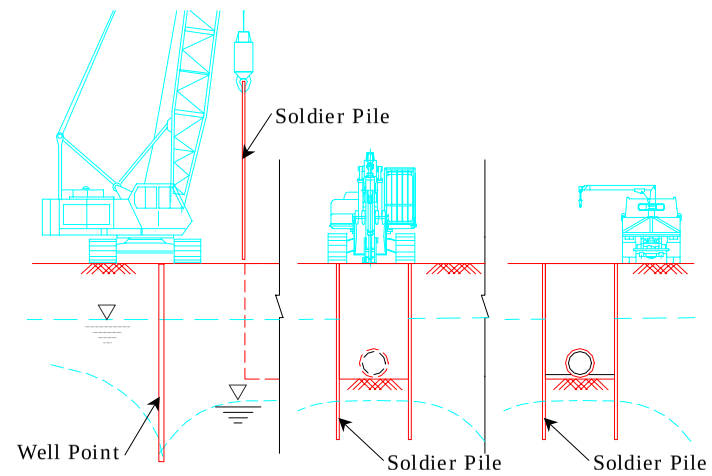
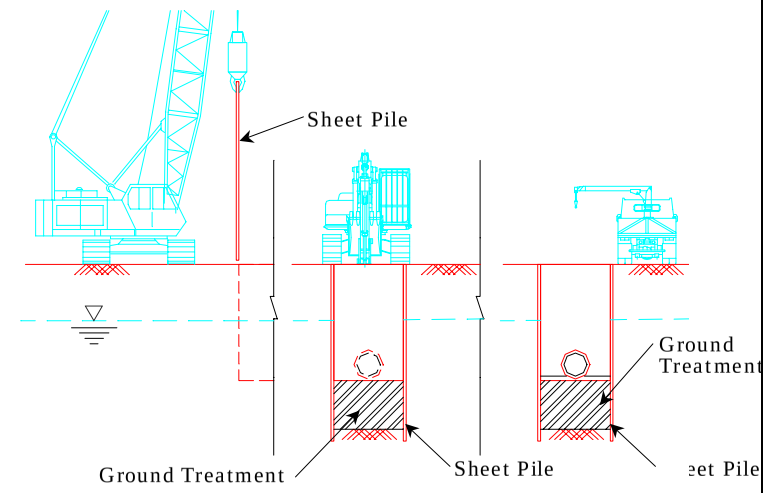
	Open Cut Method	Earth Retaining Method	
		Soldier Piles and Lagging Method	Braced Sheeting Method
General figure			
Execution process	1. A slope is decided by the condition of the ground. 2. Excavate it to the fixed depth. 3. Install a pipe in the ground. 4. Back-filling.	1. Install soldier piles in the interval, which is suitable for the ground. 2. Install a lagging between soldier piles at the same time with excavating. 3. Install a pipe in the ground. 4. Back-filling.	1. Install sheet piles in the ground. 2. Install a pipe in the ground. 3. Back-filling.
Characteristics	・This method isn't suitable for the soft ground. ・A special material shouldn't be necessary for excavating. ・A ground water countermeasure is necessary to prevent a leak from excavation slope. ・The excavation width becomes wide by the nature of the soil.	・This method can be applied in the soft ground. ・A ground water countermeasure is necessary because the lagging can't cut-off a water with the wall. ・It must make the interval of soldier piles small when the ground is very soft. ・The pile driving machine is necessary.	・This method can be applied in the soft ground as well. ・A ground water countermeasure isn’t necessary because sheet pile can cut-off a water with the wall. ・The pile driving machine is necessary.
Site	The area of site for this method is the widest than other methods because the excavation width is wide.	The area of site of this method is smaller than open cut method because the excavation width is small.	The area of site of this method is smaller than open cut method because the excavation width is small.
Adaptability to the soil concerned	Excavation slope is gentle because this ground is claily-silty sand. N value of the soil is about 10. An auxiliary construction is necessary because a ground water level is high.	It must make the interval of soldier piles small toward the ground concerned because the ground is very soft. An auxiliary construction is necessary because a ground water level is high.	An auxiliary construction is necessary because a ground water level is high.
Auxiliary construction	It thinks about a drainage countermeasure and a drainage countermeasure with the necessity.	It thinks about a drainage countermeasure and a drainage countermeasure with the necessity.	It thinks about a drainage countermeasure with the necessity.
Influence on the environment	Settlement by this method is bigger than the settlement, which other methods depend on.	Settlement by this method is bigger than the settlement, which the sheet pile method depend on. Because the wall stiffness of this method is lower than the sheet pile.	Settlement by this method is smaller than the settlement, which the soldier pile and lagging method depend on. Because the wall stiffness of this method is higher than the soldier pile and lagging method.
Cost	Expensive	Expensive	Cheep
Evaluation	× (A large Auxiliary construction and large area of site are necessary.)	△ (A large Auxiliary construction is necessary.)	○

TABLE 4.2 EXCAVATION WIDTH AND TYPE OF PIPE BEDDING IN MAIN INTERCEPTOR

	Excavation Depth (GL-)	Excavation Machine	Width of trench	Pipe Bedding*	Sheet pile Type
ϕ 300	4.6 - 4.6	Backhoe	2.00	S 360	FSP-2
ϕ 400	4.7 - 6.0			S 360	
	6.0 - 6.4	Clamshell	3.50	C 120	
ϕ 500	6.5 - 7.1			C 120	
ϕ 600	7.1 - 7.2			C 180	
ϕ 800	7.4 - 7.5			C 180	
	7.5 - 8.0			C 180	FSP-3
	8.0 - 8.9			C 360	FSP-4
ϕ 900	9.0 - 9.6			C 360	
ϕ 1200	9.7 - 10.0			C 360	

Note *: S 360 Sand base
C 120 Concrete base 120 degree
C 180 Concrete base 180 degree
C 360 Concrete base 360 degree

TABLE 4.3 ALTERNATIVES OF PIPE JACKING TUNNELING METHOD

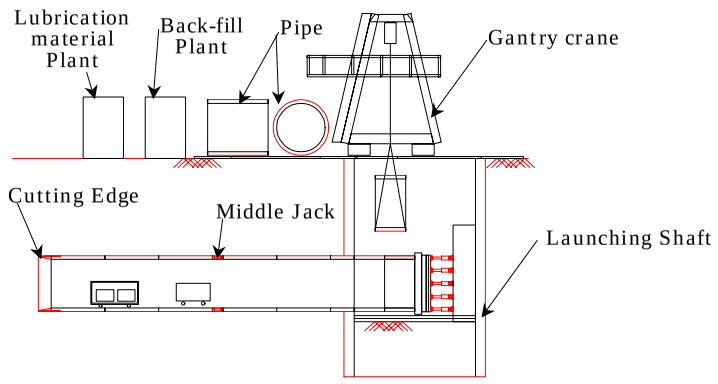
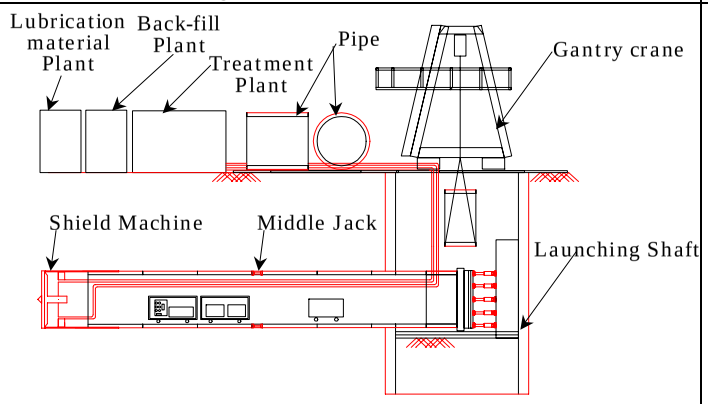
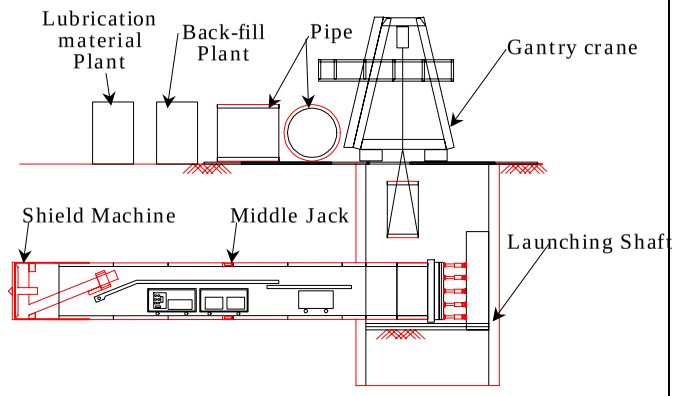
	Cutting Edge Type Pipe Jacking Method	Semi Shield Method	
		Slurry Semi Shield Method	Earth Presser Balance Semi Shield Method
Conceptual Figure of Method			
Outline of Method and Operation System	This method use the cutting edge set on the front end of reinforced concrete pipe which is thrust into the ground by the base jack located in the launching shaft. There is no support equipment for the face of ground in front of the cutting edge. Excavation is carried out by hand. Excavated soil is transported and mucked out by the trolley and the crane.	This method uses the shield machine, which dose not have shield jacks, set on the front end of reinforced concrete pipe and thrust into the ground by the base jack located in the launching shaft. The shield machine has a bulkhead between the face of ground and the machine inside. The cutter chamber, where is constituted between the cutter face and the bulkhead, is entirely filled by the slurry. The excavated soil is mixed into slurry by the agitator and transported to the slurry treatment plant. The cutter head generally has face plate with slits. The slurry consists of water and additive that can filter out and settle on the face to form an impervious layer. This layer then transfers the pressure of the support fluid to the ground.	This method uses the shield machine, which dose not have shield jacks, set on the front end of reinforced concrete pipe and thrust into the ground by the base jack located in the launching shaft. The shield machine has a bulkhead between the face of ground and the machine inside. The rotating cutter wheel at the front of shield machine scrapes off the ground that is pressed into the cutter chamber. At the same time, the equivalent amount of spoil is removed from the cutter chamber by the screw conveyor. The excavated soil is transported and mucked out by the trolley and the gantry crane. The type of cutter head is open type having the spokes of cutter wheel or semi-closed type having face plate. Excavated soil in the cutter chamber is agitated by the cutter wheel for plastic fluidity and entirely filled in the cutter chamber to provide earth pressure balance to the excavated face.
Adaptability to Ground Condition	The highly stable soil of the face ground (self-standing) should be required to this method. However, the ground where the tunnels are driven mostly consists of loose claily-silty sand layers. The N values of these layers are about 10. The ground water level appears 2.0m below the ground surface. The collapse of face ground is expected. In case that the ground condition is unstable and/or the large water inflow appears, the supplemental methods for shield excavation should be required.	The ground condition is shown in left column. It is certain that the impervious layer could be fully formed on the face. Therefor, this method is applicable to this ground. However, the change of support pressure maintained by controlling the pumping rate of slurry into and out of the cutter chamber is very sensitive to the face stability. The significant fluctuation of face pressure is possible to occur when starting the slurry pumps and/or the slurry pipes are clogged. At the portion where the earth cover is small, the collapse of face ground caused by the fluctuation of face pressure would have the effect of ground settlement directly.	The ground condition is shown in next to left column. The support medium for face ground is the excavated material itself that required high viscosity. In case that the fine contents (silt and clay) are little, it is necessary to inject additives to generate the plastic fluidity of excavated soil and make it impervious. Face pressure is controlled by balancing the rate of advance of the shield machine and the rate of discharge of the excavated soil from the screw conveyor. The fluctuation of the face pressure is possible to occur by the delay of controlling the screw conveyor. The effect of face instability is not as serious as it is for slurry shield. Even large stress differences between earth/water pressures and the support pressure in the cutter chamber can result in only limited face deformation, because the stress in the excavated soil mass would immediately rise.
Supplemental Methods	The soil improvement applied to the face ground all around tunnel section and along the tunnel or compressed air tunnelling method should be required. The blow-out of compressed air is suspected at the small earth cover portion.	Supplemental methods are not required.	Same as left column.
Environmenta l Impact	Because of the open excavation is carried out at the front of shield machine, the stress at the face ground is released completely. Therefore, the huge settlement on the ground surface is expected.	The slurry pressure transferring to the form an impervious layer supports the face ground. The settlement due to release of the stress at the face ground is little.	The face ground is supported by the fluidity-excavated soil in the cutter chamber. The settlement due to release of the stress at the face ground is little.
Plants and Yards	The gantry crane for mucking out and mobilizing the concrete pipes and other materials are located around the shaft area. The pipes storage yard and excavation soil pits are required in the stock yard. The area of stock yard for this method is the smallest.	The area for slurry treatment plant should be required in addition to the area of open type shield method. The area of stock yard for this method is the largest.	In case that the additive injection is necessary, the area for plants of additives is required in addition to the area of open type shield method. The area of stock yard for this method is smaller than slurry shield.
Cost	Expensive	Expensive	Cheep
Assessment	× (Supplemental methods are required.)	△ (A large treatment plant is necessary.)	○

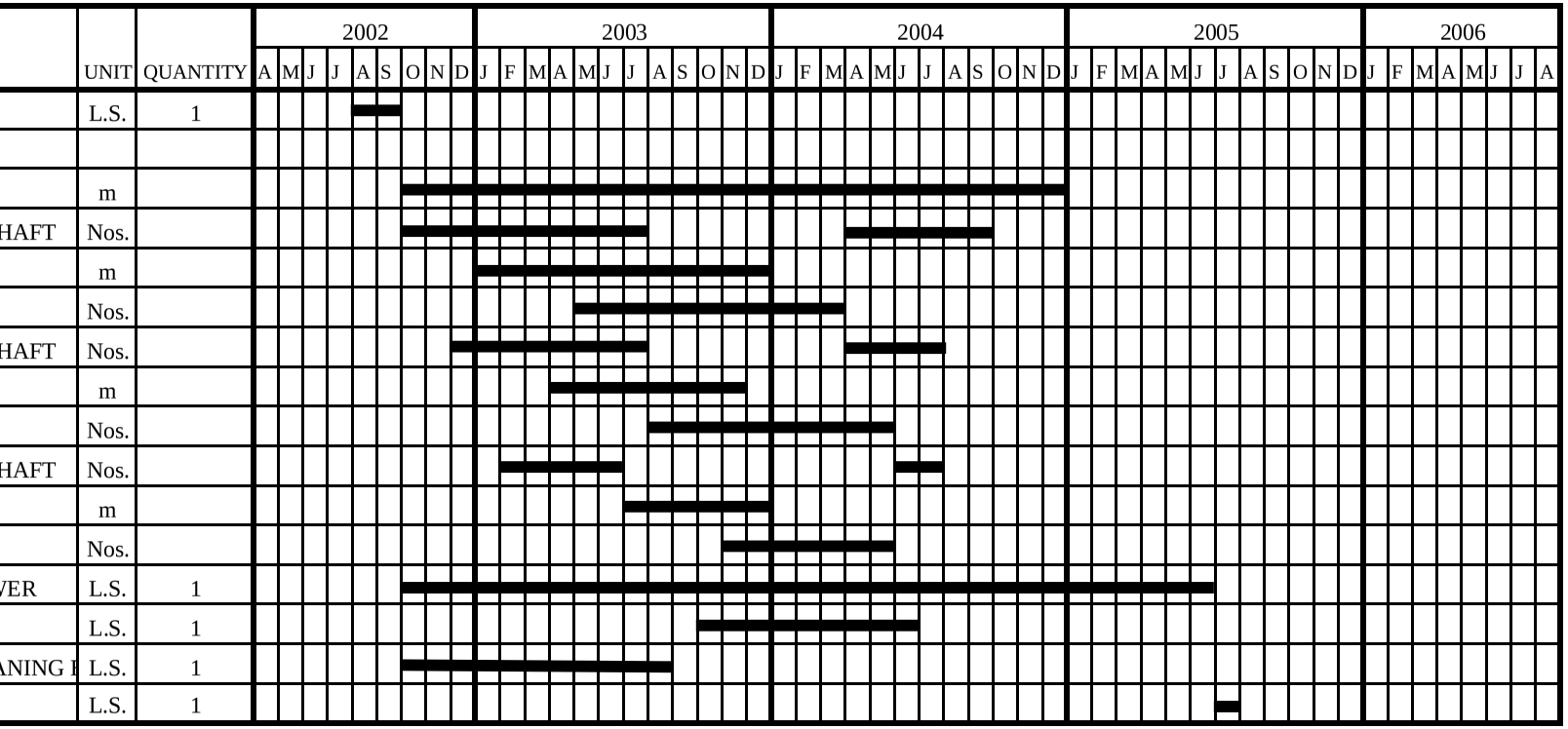
TABLE 4.4 EXCAVATION WIDTH AND TYPE OF PIPE BEDDING IN SECONDARY INTERCEPTOR

	Excavation level (m)									
	h < 4.0m		4.0m<h<5.0m		5.0m<h<6.0m		6.0m<h<6.5m		6.5m<h<7.1m	
	Excavation Width (m)	Bedding*	Excavation Width (m)	Bedding	Excavation Width (m)	Bedding	Excavation Width (m)	Bedding	Excavation Width (m)	Bedding
	Excavation Machine: Backhoe						Excavation Machine: Clamshell			
ϕ 300	1.40	S 360	2.00	S 360	2.00	S 360	3.50	C 120	3.50	C 120
ϕ 400	1.40	S 360	2.00	S 360	2.00	S 360	3.50	C 120	3.50	C 120
ϕ 500	1.40	S 360	2.00	S 360	2.00	S 360	3.50	C 120	3.50	C 120
ϕ 600	1.50	S 360	2.00	S 360	2.00	S 360	3.50	C 120	3.50	C 120
ϕ 800	1.70	S 360	2.00	S 360	2.00	C 120	3.50	C 120	3.50	C 180

Note *: S 360 - Sand base
C 120 - Concrete base 120 degree
C 180 - Concrete base 180 degree

TABLE 4.5 CONSTRUCTION SCHEDULE OF INTERCEPTOR SEWER (PACKAGE C)

NO	DESCRIPTION	UNIT	QUANTITY
1	PREPARATORY WORK	L.S.	1
2	MAIN INTERCEPTOR SEWER		
	OPEN CUT WORK	m	
	ϕ1,200 PIPE JACKING WORK SHAFT	Nos.	
	PIPE JACKING	m	
	MANHOLE	Nos.	
	ϕ1,500 PIPE JACKING WORK SHAFT	Nos.	
	PIPE JACKING	m	
	MANHOLE	Nos.	
	ϕ2,200 PIPE JACKING WORK SHAFT	Nos.	
	PIPE JACKING	m	
	MANHOLE	Nos.	
3	SECONDARY INTERCEPTOR SEWER	L.S.	1
4	CONVEYANCE SEWER	L.S.	1
5	PROCUREMENT OF SEWER CLEANING E	L.S.	1
6	CLEANING , HANDING OVER	L.S.	1



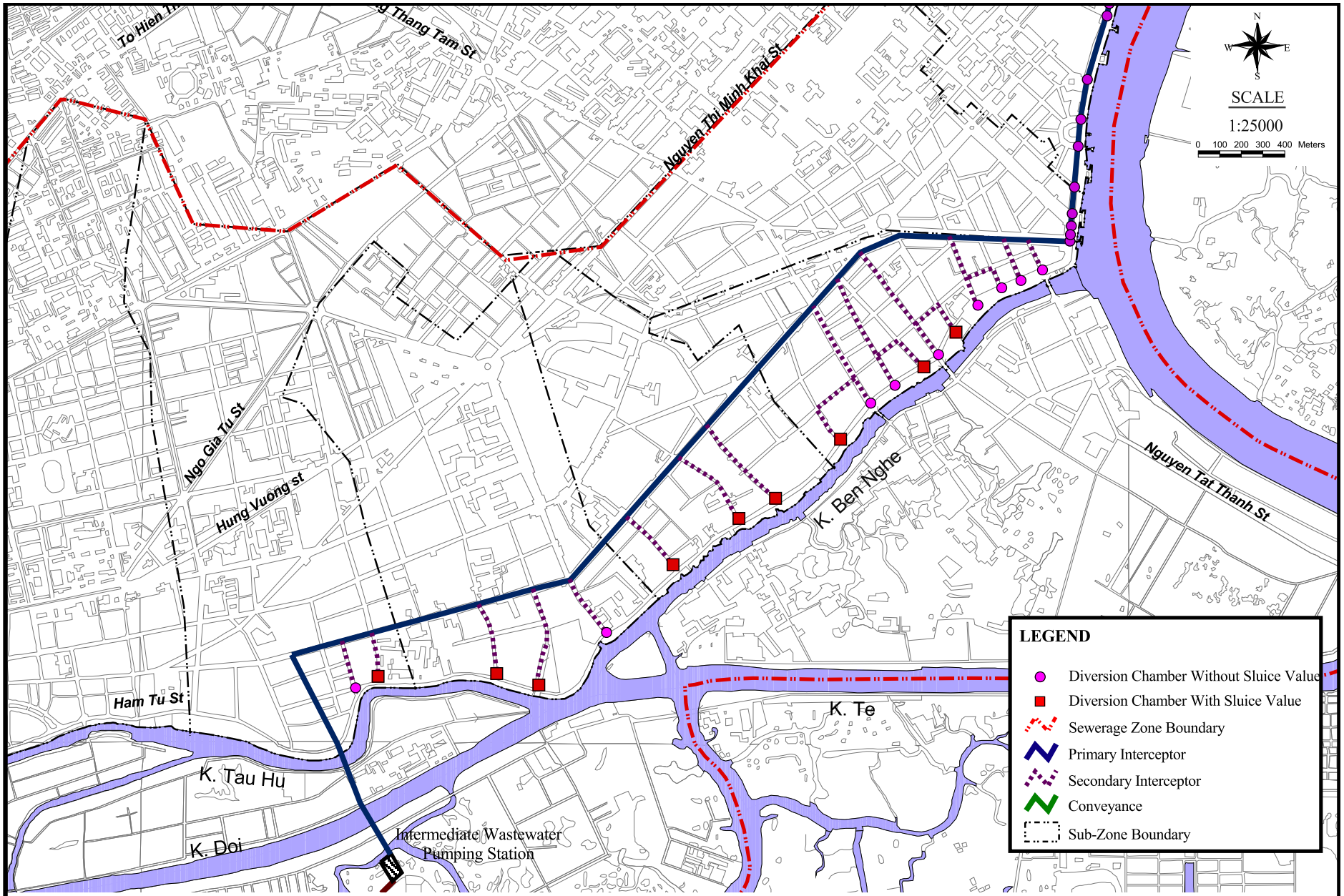


FIG. 4.1 INTERCEPTOR IN WEST AREA OF LEFT BANK OF TAU HU, BEN NGHE CANAL

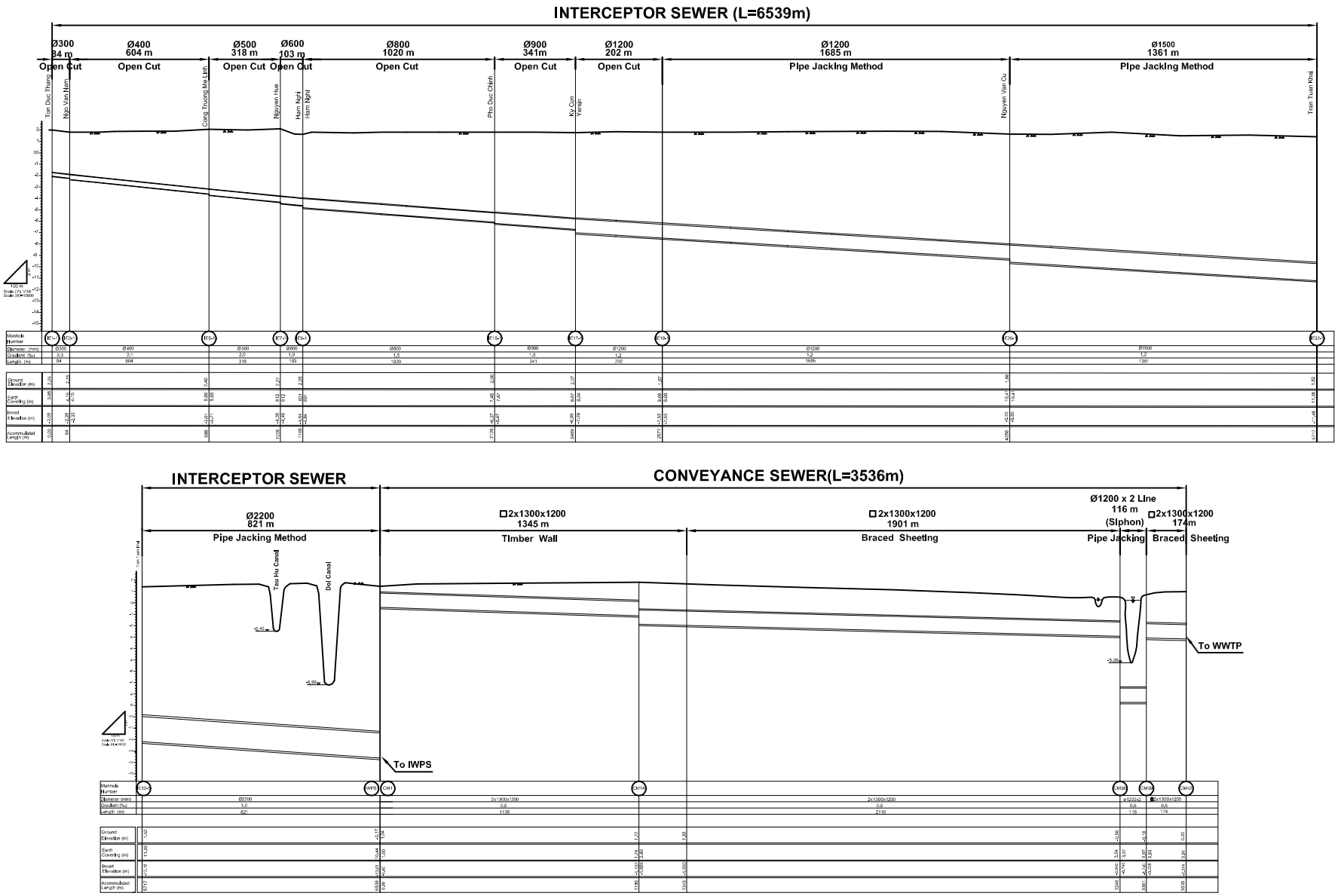


FIG. 4.2 LONGITUDINAL PROFILE OF INTERCEPTOR AND CONVEYANCE SEWERS

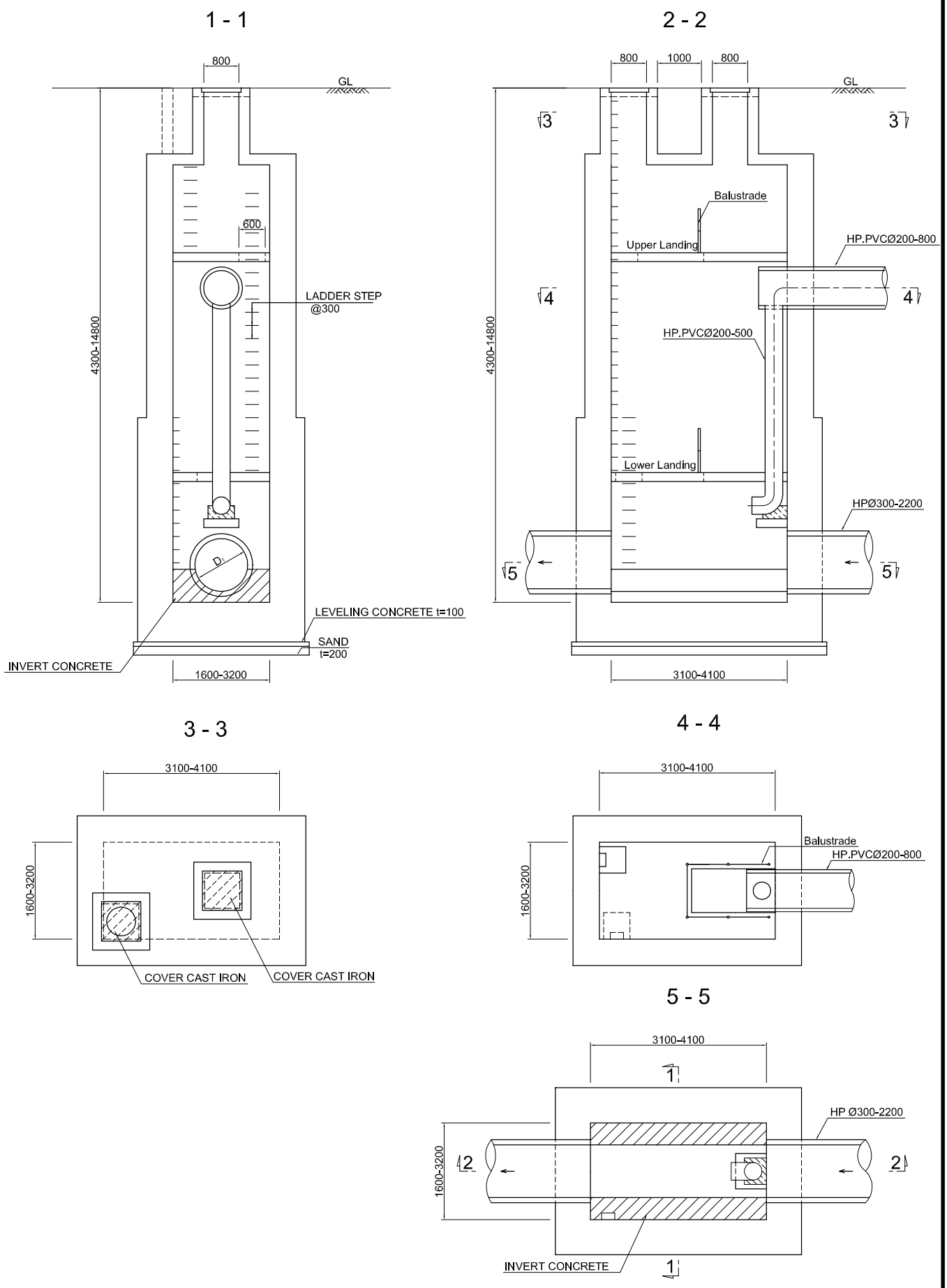


FIG. 4.3 TYPICAL MANHOLE IN MAIN INTERCEPTOR

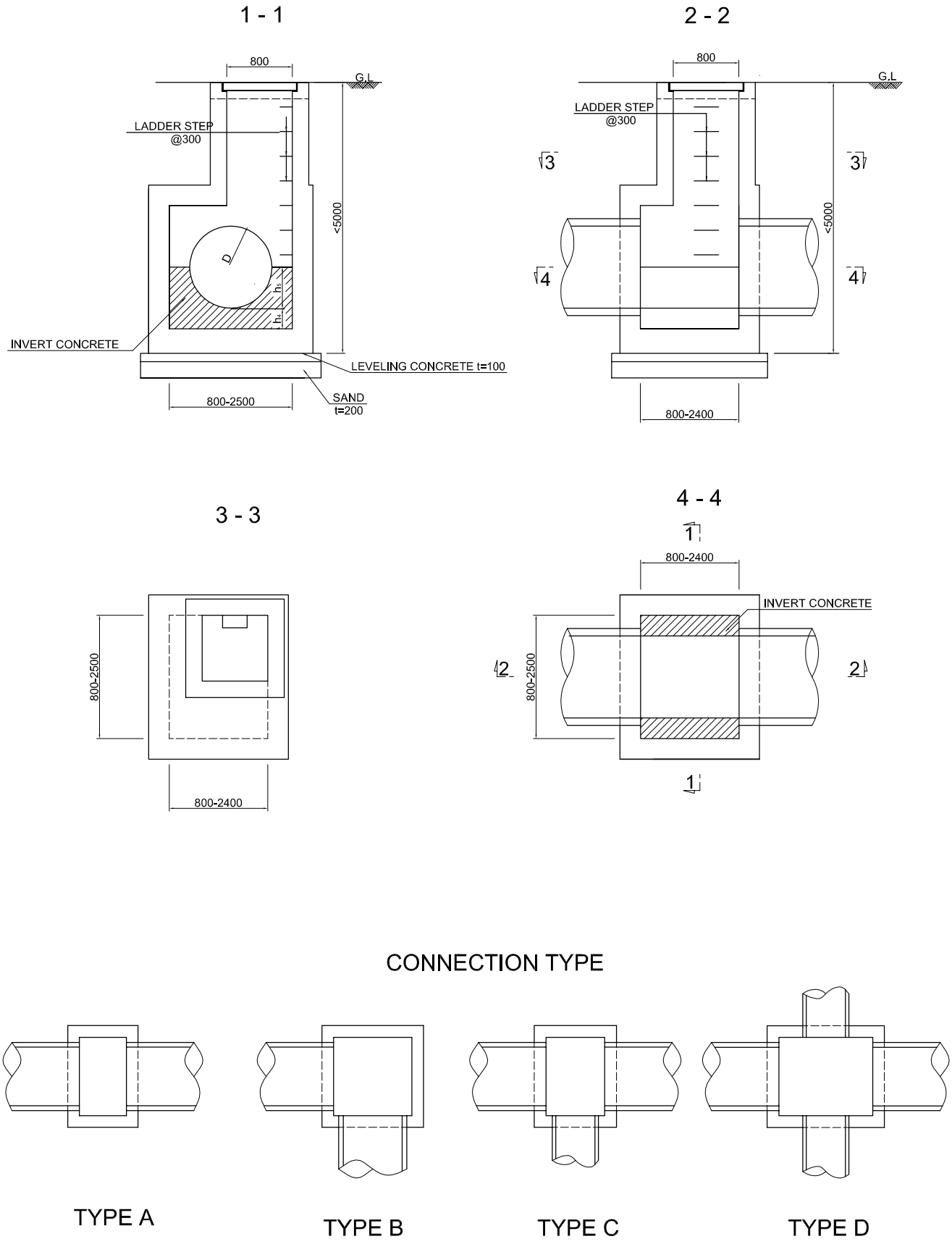


FIG. 4.4 TYPICAL MANHOLE IN SECONDARY INTERCEPTOR

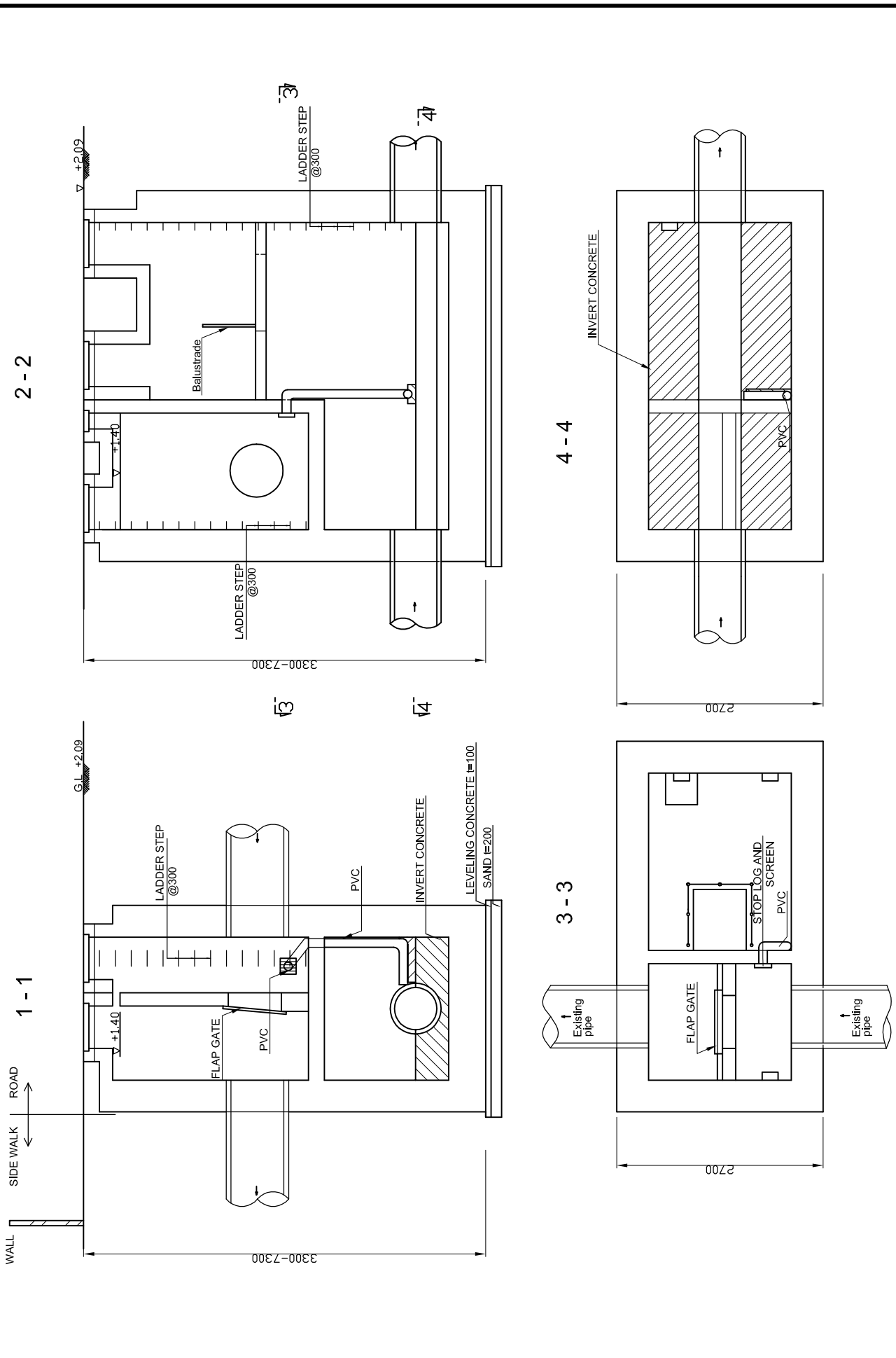


FIG. 4.5 TYPICAL PLAN AND SECTION OF DIVERSION CHAMBER IN MAIN INTERCEPTOR

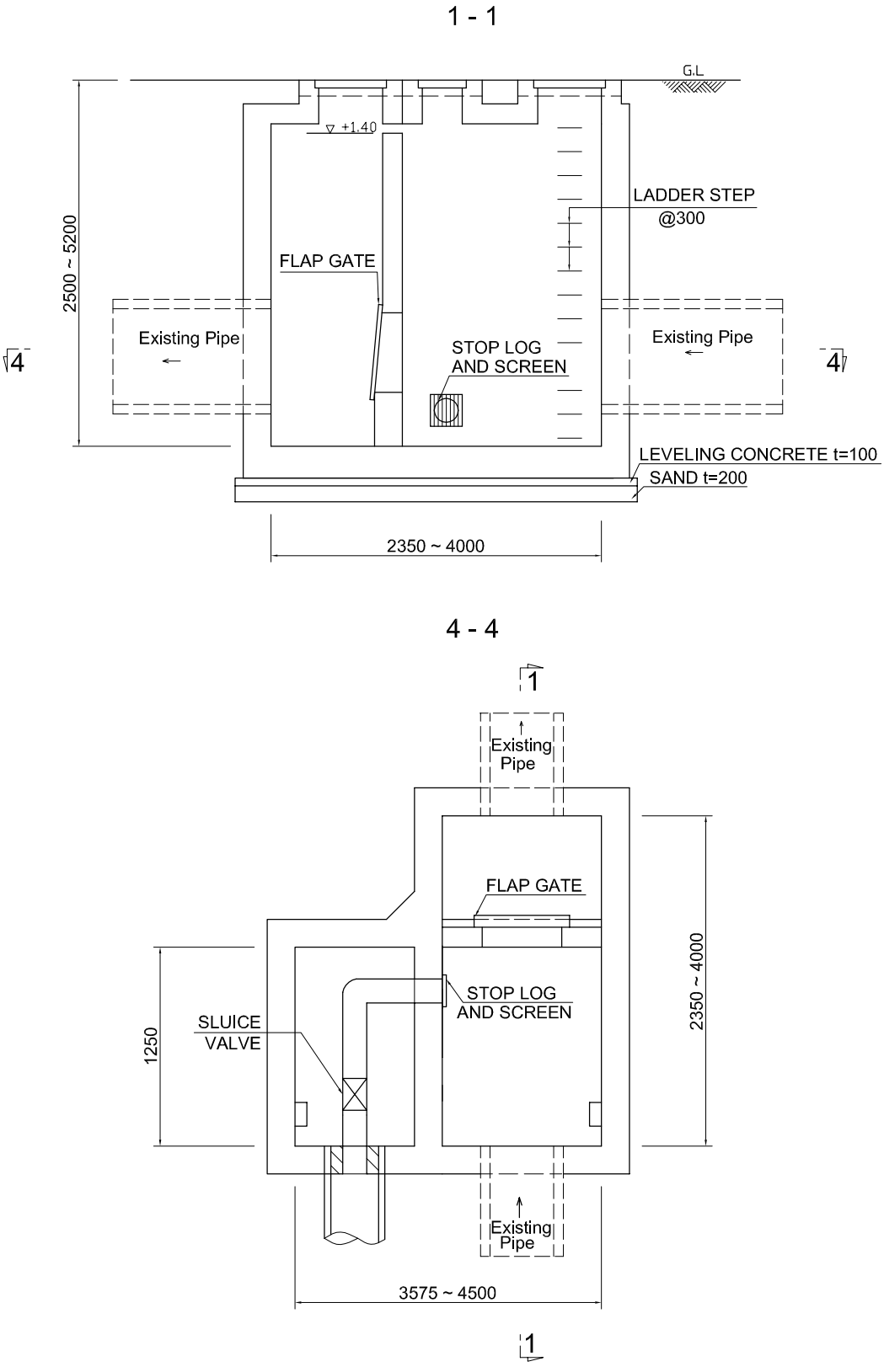
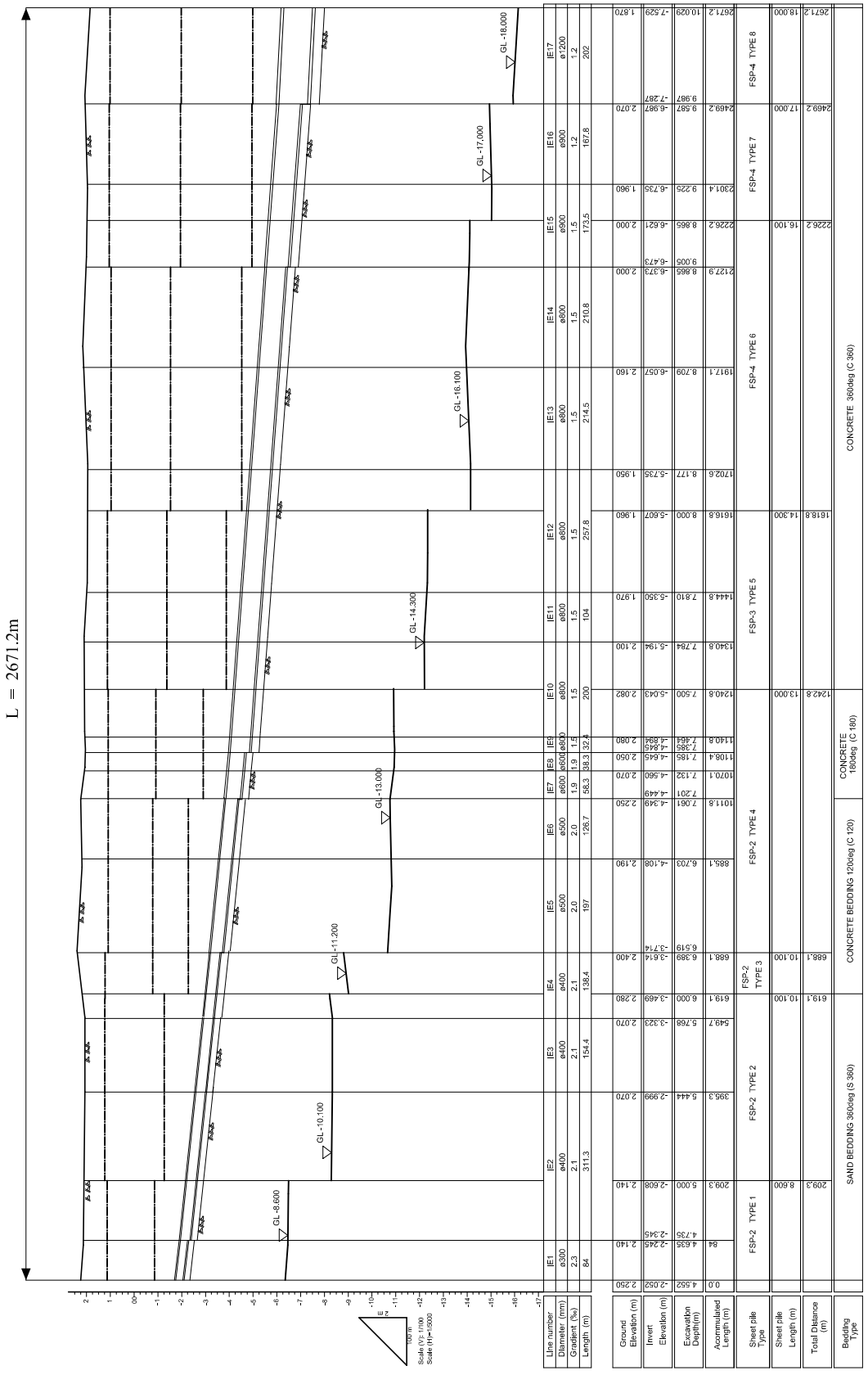


FIG. 4.6 TYPICAL PLAN AND SECTION OF DIVERSION CHAMBER IN SECONDARY INTERCEPTOR



MANHOLE No. IE.1 TO IE.18

FIG. 4.7 TRENCH DEPTH OF MAIN INTERCEPTOR SEWER BY OPEN CUT METHOD

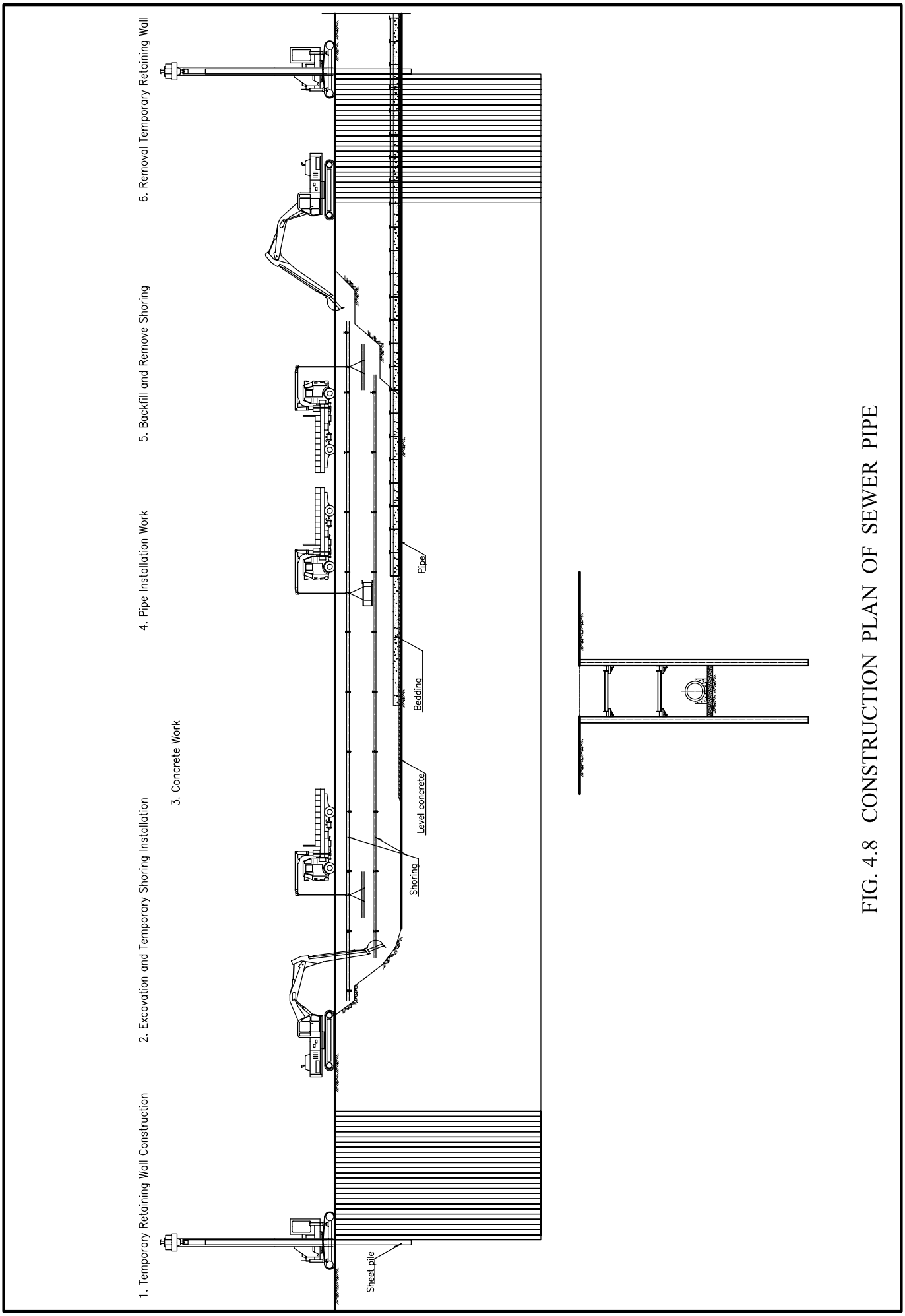


FIG. 4.8 CONSTRUCTION PLAN OF SEWER PIPE

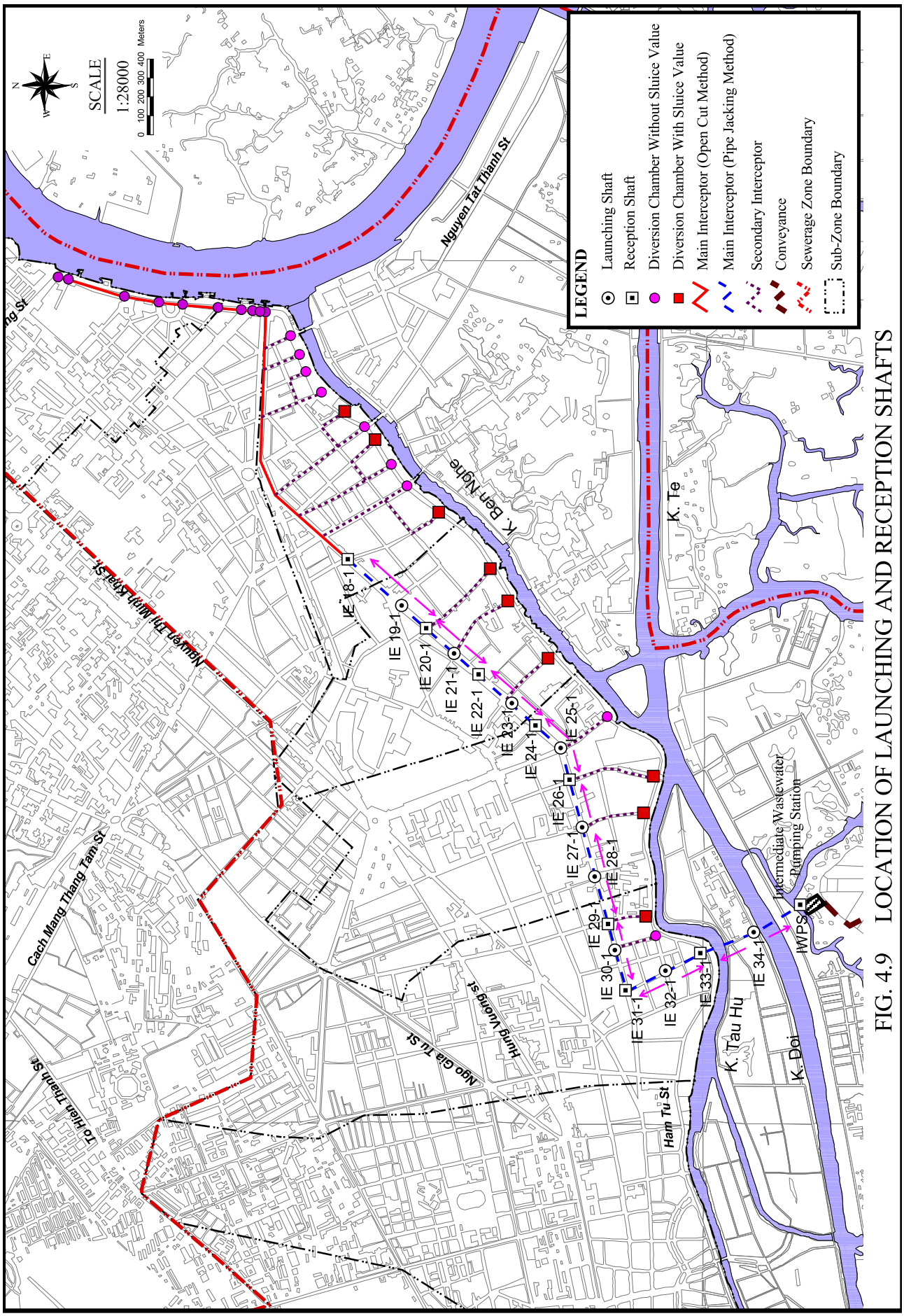


FIG. 4.9 LOCATION OF LAUNCHING AND RECEPTION SHAFTS

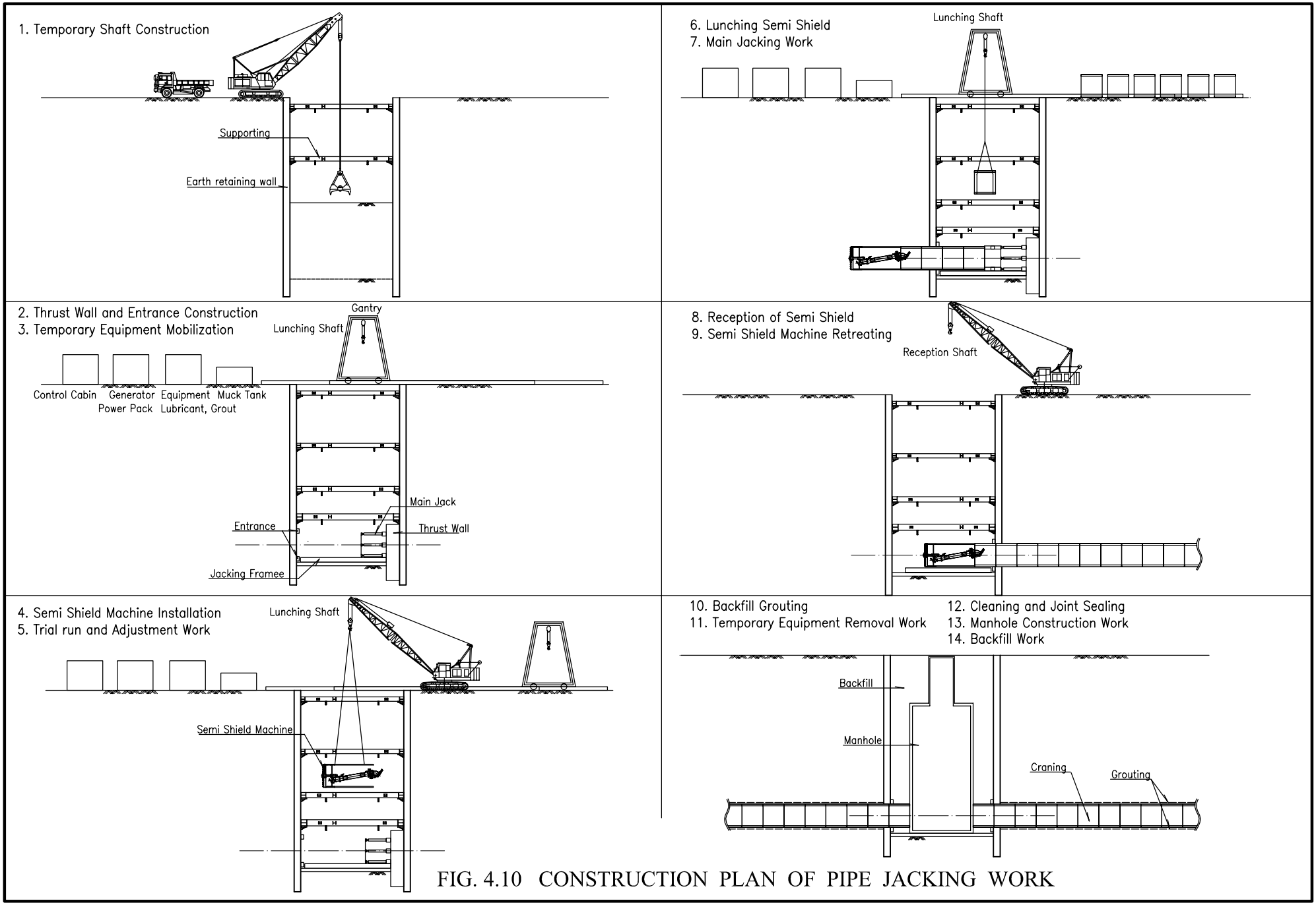


FIG. 4.10 CONSTRUCTION PLAN OF PIPE JACKING WORK